**SUPPLEMENTARY INFORMATION**

**Supplementary Methods**

*Nationally Determined Contributions (NDCs)*

The Paris Agreement has 197 Parties: 195 signatories, plus Syria and Nicaragua which joined the agreement after the deadline for formal signing had passed. Of these Parties, 195 submitted Nationally Determined Contributions (NDCs); Libya and Nicaragua did not. One NDC was submitted for the European Union on behalf of all 28 member states. Therefore, there are 167 NDCs available for analysis from Parties, plus one from Taiwan. Although Taiwan is not a party to the UNFCCC and the United States of America has signalled its withdrawal from the Paris Agreement, both nations’ NDCs were reviewed and are included in all final figures throughout this paper. NDC submissions were accessed using the official UNFCCC portal[[1]](#footnote-1), with the exception of Taiwan’s NDC[[2]](#footnote-2).

Our dataset is based on an in-depth review of the text of the NDCs, and does not include other national adaptation plans (i.e. National Adaptation Plans (NAPs) or National Adaptation Plans of Action (NAPAs)) unless these were attached to the NDC or direct links to websites or other documents relating to current adaption projects were provided. Strategies or policies (including NAPs and NAPAs) that were listed in NDCs but without links or specific explanation for what relevant information could be located within such documents were not reviewed in our analysis. We focused our review and analysis on NDC documents as a high-level indicator of interest in Nature-based Solutions (NbS) in general and Ecosystem-based Adaptation (EbA) in particular and to follow a standardised approach across all countries. While other planning documents such as NAPs and national climate change and biodiversity strategies may provide greater detail on adaptation plans and how commitments are implemented, not all countries have yet written NAPs or detailed national level strategies in the context of adaptation. As such, reviewing these in place of or in addition to NDCs could bias analyses. However, we acknowledge that countries may be doing far more than described in their NDCs, and that consequently for some nations we may underestimate the true extent of adaptation planning.

*NDC analysis: adaptation component*

*Overview and dataset:* We conducted a systematic quantitative content analysis (Neuendorf, 2016) of the text of the adaptation components of the NDCs (n=142 NDCs) with a more light-touch assessment for the mitigation component (n=168 NDCs). We noted whether nations identified threats to ecosystems and/or biodiversity among their main vulnerabilities from climate change, and we noted what rationale was given for adaptation planning, i.e. the actual or potential social, economic or environmental impacts from climate change that a nation wishes to limit or mitigate. We went on to classify statements in the adaptation component of the NDCs with respect to whether they described adaptation “visions”, “actions” and “targets” (these terms are defined below). We then coded vision and action statements with respect to whether they described Nature-based Solutions (NbS). For the purposes of our analysis, we classified NbS as either ecosystem-based adaptation (EbA, i.e. nature-based actions s*pecifically targeted at helping people* adapt to the impacts of climate change; CBD, 2009), or conservation (i.e. actions that appear to be *centred on conservation outcomes* such as protection of species or habitats). We noted whether NbS activities are described within one of five non-mutually exclusive broad ecosystem types or referred to nature-based agricultural practices (defined below). We coded targets with respect to whether they were quantitative and measurable (details below). The review process was undertaken by four observers (co-authors NS, ED, RD and RH) who agreed on the coding and classification process at the outset. Throughout the reviews, queries and uncertain coding were highlighted and collated for discussion between the observers and final decisions made after team discussions. The lead observer conducted an audit process of the other three observers’ reviews to achieve a degree of repeatability; discrepancies were discussed and resolved. The final dataset comprising coded adaptation plans as described in the current versions of the NDCs is publicly available on the Nature-based Solutions Policy Platform ([www.nbspolicyplatform.org](http://www.nbspolicyplatform.org/)).

*Stated climate vulnerabilities.* We noted whether nations identified threats to biodiversity and /or ecosystems as being negatively impacted by climate change. Only references to ecosystems and/or biodiversity (including wildlife) in their own right were noted; references to vulnerability of natural resources for the explicit purpose of human needs were not included.

*Rationale for adaptation planning and action.* We noted what rationale for adaptation planning is provided in the NDC, i.e. the actual or potential social, economic or environmental impacts from climate change that a nation wishes to limit or mitigate. These may be high level and justify a nation’s overall approach to adaptation or may be more specific and focused on justifying action in particular sectors. Across the NDCs, reasons for adaptation planning fell into 11 non-mutually exclusive groups: *Protect biodiversity or ecosystems, protect natural capital or ecosystem goods and services, food security, water security, energy security, sustainable development, protect the economy, livelihood security, enhance human wellbeing and/or health, increase resilience/reduce risk, protect against extreme events (disaster risk reduction)*

Notes on rationale for adaptation planning and action:

* *Biodiversity / ecosystems*: includes reference to the protection, preservation or conservation of biodiversity, ecosystems, wildlife or the natural environment.
* *Natural capital / ecosystem goods and services:* includes references to the protection, conservation or preservation of “environmental services”, “ecological functions”, but does not include “protecting” or “preserving natural resources”, sustainable or responsible natural resource management.
* *Food security, water security, energy security*: includes reference to future access, availability or affordability of food, water or energy.
* *Sustainable development*: includes specific reference to achieving green growth, green economy goals or the Sustainable Development Goals (SDGs)
* *Economy*: includes reference to economic growth and poverty alleviation and any focus on alleviating, minimising financial losses.
* *Livelihood security*: includes reference to maintaining or supporting livelihoods for populations.
* *Human well-being and/or health*: includes reference to the protection or survival of human populations.
* *Increase resilience/reduce risk*: includes reference to increasing adaptive capacity (or “adaptation capacity”) and reducing vulnerability
* *Protect against extreme events*: includes any mention of protecting against extreme climate change related events (i.e. storms, flooding, drought, heat waves), i.e. disaster risk reduction.

*Vision or commitment:* Defined as a high-level pledge or statement of recognition of the importance of NbS for adaptation (i.e. EbA or conservation, as defined above). We searched for high-level pledges or statements of recognition of the importance of EbA in particular, either implicitly or explicitly. An *explicit "EbA vision"* uses the terms “ecosystem-based adaptation”, “ecosystem-based approaches to adaptation”, “forest-based adaptation”, “ecosystem-based climate change adaptation”, “socio-ecosystem based adaptation” or “ecosystems approach”, but does not include “adaptation of ecosystems” as this was assumed to be a commitment to the conservation of ecosystems for their intrinsic value (i.e. a broad NbS or conservation vision). An *implicit "EbA vision"* acknowledges the importance of protecting or restoring natural ecosystems for the benefit of human adaptation or resilience without explicitly referring to the foregoing terms. Commitments to the conservation or protection of ecosystems for their intrinsic value were considered as illustrating a conservation vision; to be classified as having an EbA vision, there needed to be an evident link or connection between the protection of ecosystems and the adaptation or resilience benefits for people.

*Action:* A tangible, locally relevant action or intervention in a particular habitat or the development/implementation of a specific and relevant policy or process that is being implemented or planned for. We considered an action to be broadly “nature-based” if it referred to the protection, restoration or sustainable management of natural ecosystems, including assisted natural regeneration and afforestation. We subdivided such NbS actions into two categories, EbA and conservation, based on the presence or absence of evidence of EbA characteristics arising from the Convention for Biological Diversity definition(CBD, 2009):

1. involve active use of biodiversity and ecosystem services (i.e. natural habitat protection and/or restoration, or nature-based agricultural practices (e.g. agroforestry);
2. help people adapt to climate change (i.e. the explicit provision of socio-economic benefits); and

(c) within the in the context of an overall adaptation strategy.

Characteristic (c) was assumed where an action was stated within the adaptation component of an NDC. Where there was evidence of characteristics (a) or (b) related to an action (in addition to characteristic (c) through implication), it was classified as EbA. Actions that evidenced only characteristic (b) could be community-based conservation actions (i.e. proposed to meet biodiversity conservation goals as opposed to community resilience goals) but for our purposes were still considered as EbA. Nature-based agricultural practices were classified as EbA on the assumption that they seek to provide benefits to people (through improved food security and/or income). Actions that did not evidence either of characteristics (a) or (c) were classified as conservation. We define conservation actions as actions that prioritize positive outcomes for nature without explicit regard for climate change impacts; they have no obvious involvement of local communities nor are aimed at the provision of socio-economic benefits. It should be recognised that there is a high degree of variation between what different nations term as ‘actions’ – some being broader and vision-like and others closely defined with tangible outputs.

*Types of ecosystems included in the NDCs*

NDCs do not use common, standardised terminology for the types of ecosystems in which current or future nature-based actions take place. However, across the NDCs we found that nature-based actions (whether EbA or conservation) could be described as taking place in one or more of five broad, non-mutually exclusive ecosystem types and/or involved a nature-based agricultural practice. These were defined as follows:

1. **River catchments**: Included wetlands and rivers; lake management or protection; fluvial measures; watershed and wetland management; measures to protect large water bodies (including internal seas). Where natural resource management is discussed in relation to watersheds or wetlands, this was assumed to be nature-based. Excluded riverbank protection projects (as these may be involve engineered or soft approaches), and water conservation or management outside watersheds
2. **Grasslands and rangelands**: Included lowland grasslands, shrubland, savanna, tundra;
3. **Terrestrial forests or woodlands**: Included lowland forests and woodlands, references to assisted forest regeneration or restoration, reforestation and afforestation (tree-planting on naturally treeless habitat); excluded mangroves.
4. **Coastal and marine habitats**: Included mangroves, dunes, coastal wetlands and saltmarshes but did not include references to Integrated Coastal Zone Management (ICZM) or equivalent (unless specific reference was made to ecosystem-based activities).
5. **Montane habitats**: Included a range of habitats at elevation, such as hill or montane forest, shrubland, grasslands and tundra;
6. **Nature-based agricultural practices**: Included landscapes in which practices are used to maintain or enhance agricultural yield by working with nature such as agroforestry, conservation agriculture, permaculture activities, “agricultural and forestry systems”, silvo-pasture. Also included the planting of trees in agricultural areas to reduce soil erosion.

Note that some actions were classified across multiple types of ecosystem, for example the protection of coastal wetlands was classified as both coastal and marine action and river catchments. Common overlaps were noted between terrestrial forest actions and other categories, predominantly catchments, montane and nature-based agricultural practices. Forest conservation and protection was noted as an action in catchment and montane landscapes as well as alongside nature-based agricultural practices. Where a specific ecosystem type was not specified for a particular action, that action was considered as a ‘general’ nature-based action and was not assigned one of the six broad categories listed above.

Climate smart agriculture (CSA) activities were not classified as nature-based solutions as they can include both hard and soft approaches such as the introduction of irrigation systems, drought resistant crop varieties, integrated agriculture and aquaculture systems or the use of seasonal rainfall forecasts in agricultural planning (Palombi & Sessa, 2013). As such we consider CSA activities to be a hybrid adaptation measure unless further detail is stated (e.g. to classify as a nature-based agricultural practice and as such as an NbS).

*Targets:* For actions that were categorised as NbS, we assessed stated targets. We define a target as *either a time-bound or quantitative target linked to an adaptation action that could, in theory, be tracked over time*. Broad goals or commitments (often linked to visions) are not classified as targets. For stated targets linked to NbS actions we assessed whether such targets are measurable and long-term/strategic. We considered a target ‘measurable’ if the activity appeared sufficiently precise or focused to be monitored. Targets outlined for 2020 and beyond, and those not related to specific funded projects, were considered as strategic/long-term targets. Note that the assessment of targets was based on the limited information available in NDCs and an element of subjectivity exists in denoting targets as measurable or more difficult to measure.

*NDC analysis: mitigation component*

Within each NDC mitigation component, we identified whether NbS approaches were proposed. We did not differentiate between high-level visions/commitments and actions, instead accepting either as evidence of inclusion of NbS as part of mitigation plans. We considered nature-based actions for mitigation to be habitat protection or restoration/regeneration, reforestation, wetland (including peatland) management, and afforestation. REDD and REDD+ (Reducing Emissions from Deforestation and Forest Degradation) readiness activities (Johns et al., 2009) and other policy and institutional strengthening measures were not considered in our review. Agroforestry and other nature-based agricultural practices were coded as EbA in the mitigation component on the assumption that these activities seek to provide benefits to people (through improved food security and/or income) and are community-based in nature.

*Other datasets*

We organised NDC data with respect to official World Bank income groups[[3]](#footnote-3) and whether they came from nations classified by the UNFCCC as Annex 1[[4]](#footnote-4) or belonged to Least Developed Countries[[5]](#footnote-5).

**Supplementary Results**

**Prominence of EbA in the NDCs**

Twenty-two countries explicitly recognise the importance of, or state a high-level commitment to, EbA in their NDCs (Figure S1). For example, Costa Rica has “committed to develop its adaptation practice from an ecosystem based adaptation focus”, while Armenia “embraces the ecosystem approach for adapting to climate change”.

A further 29 countries acknowledge, albeit with a varying degree of detail, the importance of the interdependencies between natural ecosystems and human adaptation without explicitly using the term EbA. One example of “implicit” visions for EbA comes from Ethiopia, which aims to “enhance the adaptive capacity of ecosystems, communities and infrastructure through an ecosystem rehabilitation approach”; another example comes from Cambodia, which commits to “promoting and improving the adaptive capacity of communities, especially through community based adaptation actions, and restoring the natural ecology system to respond to climate change” (see [www.nbspolicyplatform.org](http://www.nbspolicyplatform.org) for all NbS vision statements).

We found mismatches between adaptation visions and actions in many of the NDCs. For example, of 51 NDCs with an adaptation vision that includes EbA, explicitly or otherwise, only 35 then go on to describe tangible EbA actions ([www.nbspolicyplatform.org](http://www.nbspolicyplatform.org)). The remainder either describe conservation activities with no obvious characteristics of EbA (7 NDCs) or entirely lacked reference to ecosystems in their adaptation plans (9 NDCs). A further 35 countries, though lacking an EbA vision, nonetheless describe EbA actions. For example, Sudan commits to introducing “agroforestry in areas vulnerable to climate change to enhance agricultural production as well as empower vulnerable communities through their involvement in community forests activities / products” (see [www.nbspolicyplatform.org](http://www.nbspolicyplatform.org) for all NbS actions described in the NDCs.

**NbS in a mitigation context**

**Fig. S1. Intentions to implement nature-based solutions to climate change adaptation (i.e. EbA) across the globe** as indicated by the inclusion of such actions described in the adaptation components of the NDCs (n=70). Red numbers denote the 22 nations that explicitly include EbA in their vision for climate change adaptation: 1, Niue; 2, Mexico; 3, Costa Rica; 4, Dominican Republic; 5, Colombia; 6, Grenada; 7, Argentina; 8, Uruguay; 9, Morocco; 10, South Sudan; 11, Zimbabwe; 12, Armenia; 13, Saudi Arabia; 14; Yemen; 15, United Arab Emirates; 16, Seychelles; 17, Madagascar; 18, Nepal; 19, Bangladesh; 20, Myanmar; 21, Vietnam; 22, Vanuatu. Several nations have a level commitment to EbA, but lack current or planned EbA actions (e.g. 7, 9,12).

Twenty-seven countries, though lacking reference to EbA or conservation in the adaptation component of their NDCs, refer to such actions or broad commitments in the mitigation components. These 27 are in addition to the 77 NDCs that include NbS actions in both their adaptation and mitigation components. Of these, seven refer to actions or commitments that although are not technically EbA, on the basis that they are not designed to address adaptation needs, are “EbA-like” in that they meet other criteria for EbA. For example, Vietnam lacks specific EbA actions in the adaptation component of its NDC but in its mitigation component seeks to “manage and develop sustainable forest, enhance carbon sequestration and environmental services; conservation of biodiversity associated with livelihood development and income generation for communities and forest-dependent people”. These intentions for NbS, although not specifically targeting adaptation needs, could still benefit communities by increasing their resilience to a changing climate, thus achieving the same outcomes as EbA. By examining these planned actions and adjusting them for greatest effectiveness in addressing climate vulnerability, countries can achieve adaptation as well as mitigation.

**Regional variation in commitment to EbA actions**

Commitment to EbA actions in the NDCs is more apparent in low and lower middle-income countries. While EbA actions are included in the adaptation plans of 77% of low-income countries and 55% of lower middle-income countries, this is true of only 29% of upper middle-income countries and only 12% of high-income countries (Figure S1). We note that no Annex 1 countries (i.e. industrialised OECD members and economies in transition) commit to EbA actions in their NDC. In contrast, all countries committing to EbA actions are classified by UNFCCC as developing. This includes 34 of the 47 least developed countries (LDCs), which are given special consideration by UNFCCC “on account of their limited capacity to respond to climate change and adapt to its adverse effects”.

Our analysis suggests a greater commitment to EbA in African countries than elsewhere, with 35 out of 53 NDCs submitted by African countries (66%) implementing or planning for EbA. This contrasts with Latin America and the Asia and Pacific regions where only 47% (15/32) and 34% (16/47) of countries respectively commit to EbA actions. Also of note is the finding that only 10 of the 18 countries classified as having high or medium-high vulnerability to climate change (as determined by the Global Climate Risk Index; Eckstein *et al.,* 2019) commit to EbA actions. Of the remaining eight, four are Central American or Caribbean nations (Bahamas, Dominica, Dominican Republic and Guatemala) and four are in South or South-east Asia (Cambodia, Pakistan, Philippines and Vietnam). EbA actions, as part of a suite of adaptation interventions including hybrid and engineered solutions, could play an important role in increasing the resilience and adaptive capacity of vulnerable communities in these regions.

**Types of EbA activities**

To highlight any potential biases in implementation and identify contexts in which EbA action may need to be enhanced, we reviewed the types of current or planned EbA activities across the globe. The most commonly implemented or planned EbA actions involve nature-based agricultural practices (highlighted in 39 of 70, i.e. 56% of NDCs with EbA actions); followed by the protection and/or restoration of terrestrial forests or woodlands (46%), coastal and marine habitats (24%), and river catchments (including wetland) (20%). Far rarer, overall, are plans to restore and protect montane habitats (4%) or grasslands and rangelands (10%); we note that almost all examples of grassland or rangeland EbA actions come from Africa, despite the extensive presence of these habitats on other continents.

In Africa, there is a focus is on nature-based agricultural practices and, to a lesser extent, the protection and/or restoration of terrestrial forests or woodlands. Out of the 35 African countries implementing or planning for EbA action, 27 include nature-based agricultural practices and 16 include forest protection and/or restoration. In the Asia and Pacific region, the most common EbA action is the restoration and/or protection of terrestrial forests or woodlands, often through community management (11 out of 16 countries stating EbA actions). However, we note that this contributes to and has crossover with other EbA actions, particularly in particular the protection of ecosystems within river catchments. For example, Thailand has committed to increase “national forest cover to 40% through local community participation, including in particular headwater and mangrove forests to enhance adaptive capacities of related ecosystem[s]”.

Of particular note was that despite widespread anecdotal association of EbA with coastal areas (for example the use of mangroves as coastal defences), we found that ecosystem-based activities followed the more traditional model of conservation: out of 46 NDCs describing ecosystem-based activities in the coastal zone, only 17 included actions with EbA characteristics. Instead, of all habitats referred to in the NDCs, terrestrial forest was the context in which EbA actions were most numerous and well-defined.

**Table S1** Numbers of NDCs featuring NbS (EbA and/or conservation) visions for adaptation (explicitly or implicitly) and/or tangible actions.

|  |  |  |
| --- | --- | --- |
| Vision | Actions | Number of NDCs |
| Explicit EbA | No Actions | 4 |
| Conservation Actions | 3 |
| EbA Actions | 15 |
| Total | 22 |
|  |  |  |
| Implicit EbA | No Actions | 5 |
| Conservation Actions | 4 |
| EbA Actions | 20 |
| Total | 29 |
|  |  |  |
| Conservation | No Actions | 9 |
| Conservation Actions | 17 |
| EbA Actions | 20 |
| Total | 46 |
|  |  |  |
| No NbS vision | No Actions | 46 |
| Conservation Actions | 10 |
| EbA Actions | 15 |
| Total | 71 |
|  |  |  |
| Total (submitted NDCs) | | 168 |
| EbA Actions (total) | | 70 |

**Supplementary References**

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1. http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx [↑](#footnote-ref-1)
2. http://enews.epa.gov.tw/enews/enews\_ftp/104/1117/174044/Submission%20by%20Republic%20of%20China%20(Taiwan)Intended%20Nationally%20Determined%20Contribution.pdf [↑](#footnote-ref-2)
3. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups [↑](#footnote-ref-3)
4. http://unfccc.int/parties\_and\_observers/parties/annex\_i/items/2774.php [↑](#footnote-ref-4)
5. http://unfccc.int/cooperation\_and\_support/ldc/items/3097.ph [↑](#footnote-ref-5)