



## **Measures of adaptation at multiple scales**

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Evidence to understand progress under the Global Goal  
on Adaptation and the Global Biodiversity Framework



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Goal on Adaptation and the  
Global Biodiversity Framework

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## ABOUT CDKN

The Climate and Development Knowledge Network (CDKN) is a Global South-led programme founded in 2010. The programme is managed by SouthSouthNorth, and implemented in partnership with Fundación Futuro Latinoamericano and ICLEI South Asia. CDKN works to improve the wellbeing of the most climate-affected people in the Global South, especially marginalised groups, through transformative, climate-resilient action. We work in partnership with the public, civil society and private sectors to mobilise knowledge, leadership and capacity in the Global South from local to global levels.

## ABOUT CASA

The Climate Ambition Support Alliance (CASA) seeks to strengthen the capacity and support the engagement of climate-vulnerable countries in international climate negotiations. The programme provides legal, technical, strategic, diplomatic and media support before, during and after the negotiations. It is 'demand driven', responding to specific requests from climate-vulnerable governments and regional groupings.

## ABOUT SOUTHSOUTHNORTH

SouthSouthNorth (SSN) supports national and regional responses to climate change through policy and knowledge interventions, partnerships and deep collaboration. SSN does this by connecting people and information, enhancing capability and mobilising resources to respond innovatively to the challenges and opportunities that climate change presents.

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# Key messages

This publication presents case studies exploring how developing countries set local and national adaptation ambitions, their desired outcomes, and how and why they monitor, evaluate and learn from adaptation. The case studies reveal that:

- Existing local and project MEL systems already generate large volumes of adaptation evidence.
- Countries are already using this evidence to inform adaptive management; although they could make even more of project and local MEL data, if given more resources to pull it together, analyse it and sustain the effort over time.
- MEL systems and reporting are most useful when they go beyond listing activities to assess the impacts of adaptation for people and ecosystems: whether resilience is being achieved.
- Measuring adaptation goes far beyond biophysical outcomes. People's rights, equity and agency are adaptation outcomes, not merely implementation considerations.
- Global indicators alone cannot capture adaptation effectiveness. They can tell part of the story.
- The starting point for measuring adaptation progress must be indicators that work for communities and countries: where the action happens.
- Some locally-relevant indicators will remain only for local use, because they are so context-specific. Some locally-relevant indicators make sense for national analysis, for global reporting and for global stocktaking and analysis, because they reflect universal rights and concerns. It is logical to think about adaptation and resilience measurement as having these distinctive but complementary tracks.
- Stories matter. Communities and countries are innovating climate-adaptive systems and finding conceptual breakthroughs in how to think about and achieve resilience. These breakthroughs could be highly relevant for global stocktakes of adaptation progress.
- Beyond formal stocktakes, more expansive, imaginative modes of knowledge exchange are needed to communicate adaptation innovation and diffuse new ideas internationally. Although beyond the scope of this publication, this is an important area for future work.
- Ecological boundaries do not follow political boundaries. Non-governmental organisations are addressing this reality by advancing transboundary adaptation in threatened ecosystems. They are using science-based targets as a common denominator to assess progress, and adding further localised initiatives with tailored targets and indicators to unlock more benefits for local communities, including social equity.

Finally, the analysis suggests a specific recommendation for funders of climate, biodiversity, and sustainable development:

- International grant-based finance is critically needed to help countries capitalise on the fragmented but considerable adaptation information they already have. This finance could be directed to improving the flows of information and ideas among local actors and into national, regional and transboundary MEL systems.

## How to use this publication

This publication is not policy-prescriptive. It seeks to provide rich information on how communities and countries are monitoring, evaluation and learning about adaptation and resilience – illustrated with data and stories from their experience.

The authors wrote this publication because they found that people learn best from example. Measuring adaptation progress is a complicated business, but true stories bring the subject to life.

The publication is not meant to be read end-to-end. The reader is encouraged to use the chapters selectively, for their needs.

**Figure 1. How to use this publication**

### IF YOU ARE...

#### A NEGOTIATOR OR TECHNICAL ADVISOR

In the United Nations climate change (UNCCC) or biodiversity (CBD) process

#### A PROGRAMME LEAD OR COUNTRY OFFICER

Responsible for setting adaptation targets and metrics and reporting on them in your own context

#### A RESEARCHER

#### A CIVIL SOCIETY ORGANISATION

Looking for inspiration and practical ideas

#### INTERNATIONAL FUNDERS

Seeking to support climate change adaptation, ecosystem integrity and biodiversity

### WE RECOMMEND...

#### CHAPTER 2

Key findings from local and national experience of measuring adaptation progress, which are directly relevant to UN talks

02

#### OUTCOME AND OUTPUT INDICATORS

Tables at the end of each case study, showing real-life worked examples

01

#### FULL CASE STUDIES

Describing the journey from climate risk assessment, through planning, implementation, and monitoring, evaluation and learning (MEL) – find the ones that match your geographic and sectoral interest

03

#### CHAPTER 2

Key findings on investment gaps that must be filled so that countries can make the most of their adaptation information and learning

02



A woman rides her bicycle, Burkina Faso © Olivier Girard/CFOR

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# 1. About this report

BY MAIRI DUPAR, CDKN

## Why a report on measuring adaptation, and why now

The world is at a critical point in measuring progress on climate change, biodiversity and sustainable development challenges, for setting ambition for the years ahead, and for resourcing action.

Parties to the Paris Agreement have agreed the UAE Framework for Global Climate Resilience (2023) to guide efforts to achieve the global goal on adaptation (see Box 1). Technical work lies ahead to develop methods and standards for the Belém Adaptation Indicators (2025). These indicators, once fully developed, are meant to provide countries with tools for measuring adaptation progress – and should do so in ways that both advance national goals and inform global understanding.

Meanwhile, under the Convention on Biological Diversity, the Kunming-Montreal Global Biodiversity Framework (GBF) was agreed in 2022 and contains 23 targets to be achieved by 2030. Its text contains critical considerations for how human rights must be respected and promoted as countries pursue the biodiversity targets.

Both Conventions will host major stock-taking exercises in the next few years (see Figure 3). This report stems from pressing conversations about setting ambition and measuring progress in ecosystem integrity, biodiversity, and climate resilience, which unite the Paris Agreement and the GBF.

These discussions ask:

- How can communities and countries continue and improve efforts to set ambition and monitor climate resilience in ways that are useful and meaningful to them?
- At the same time, how can we funnel relevant local information on adaptation progress, gaps, and challenges to the national level and even to global arenas to create a ‘virtuous cycle’, so national and international actors can better support adaptation and resilience priorities on the ground?

This publication takes these challenges as its starting point. It presents case studies of how countries are achieving progress on climate change adaptation and ecosystem restoration across a wide range of geographies in the Global South.

The case studies show how it is possible to set ambitious targets and monitor results for nature and people across diverse circumstances. The report explores how this data and analysis can inform decision-making at multiple levels, starting locally and nationally, and – where appropriate – feeding in to the global level.

The report is for climate change negotiators and technical experts who are developing monitoring, evaluation and learning (MEL) and reporting systems for the UAE Framework on Global Climate Resilience and Belém Adaptation Indicators (the GGA framework).

This report is not meant to substitute for UNFCCC guidance on the monitoring, evaluation and learning of National Adaptation Plans (NAPs) by country governments.<sup>1,2</sup>

It focuses on subnational and transboundary adaptation efforts and should be seen as a complement to NAP guidance. This report suggests, for the technical reader, how data flows and novel insights from subnational and transboundary adaptation actions could feed into or sit alongside such vital national efforts.

The central focus of this report is ecosystem-based approaches to adaptation, so it overlaps significantly with key GBF provisions. It should be useful and

relevant to stakeholders who are implementing and reporting on the GBF.

The report highlights local communities' and Indigenous Peoples' involvement in ecosystem stewardship. These insights speak directly to advancing the 'human rights-based approach' set out in Section C of the GBF. Section C has clear synergies with and even goes beyond the human rights and social inclusion language in the GGA Framework.



*Kiribati family demonstrating successful watermelon and bottle gourd production utilising raised garden beds and trellising © Live & Learn*

## Box 1. About the GGA framework

The global goal on adaptation is Article 7 of the Paris Agreement (2015). It calls on countries to:

- reduce vulnerability
- strengthen resilience
- enhance adaptive capacity to the effects of climate change.

Since 2015, countries have sought to provide more guidance to adaptation efforts and to track progress. That is why, in 2023, Parties to the Paris Agreement adopted the UAE Framework on Global Climate Resilience, which is commonly referred to as the 'GGA framework'.<sup>3</sup>

The GGA framework has seven thematic targets, which cover:

- water security
- food security and agricultural production
- human health
- ecosystem health and biodiversity
- poverty and livelihoods
- infrastructure, including green infrastructure
- cultural heritage.

The GGA framework also contains cross-cutting considerations, such as gender, children, local communities and Indigenous and local knowledge,

which countries are encouraged to consider, to advance climate resilience for all.

The GGA framework also includes four dimensional targets, which refer to stages of the iterative adaptation cycle. These are: vulnerability and risk assessment; planning; implementation; monitoring, evaluation, and learning.

In Belém, Brazil, in 2025, countries agreed on 59 Belém Adaptation Indicators to measure progress against the eleven GGA targets. The Belém Adaptation Indicators are intended to measure how well adaptation efforts are working. At the time of writing, methodologies and data standards for these indicators do not yet exist; countries are due to agree on a technical process to advance this work.

In the meantime, much interim attention is on the overarching targets in the run-up to the second global stocktake of the Paris Agreement, 2026–2028. Countries are interested in how progress against the GGA targets can be reported nationally and synthesised globally as part of the stocktake.

This publication contributes to understanding of how existing subnational and transboundary metrics and MEL systems capture progress on the GGA framework and targets, even as we await technical work on new indicators.

## Box 2. About Section C, Considerations for the implementation of the Kunming-Montreal Global Biodiversity Framework

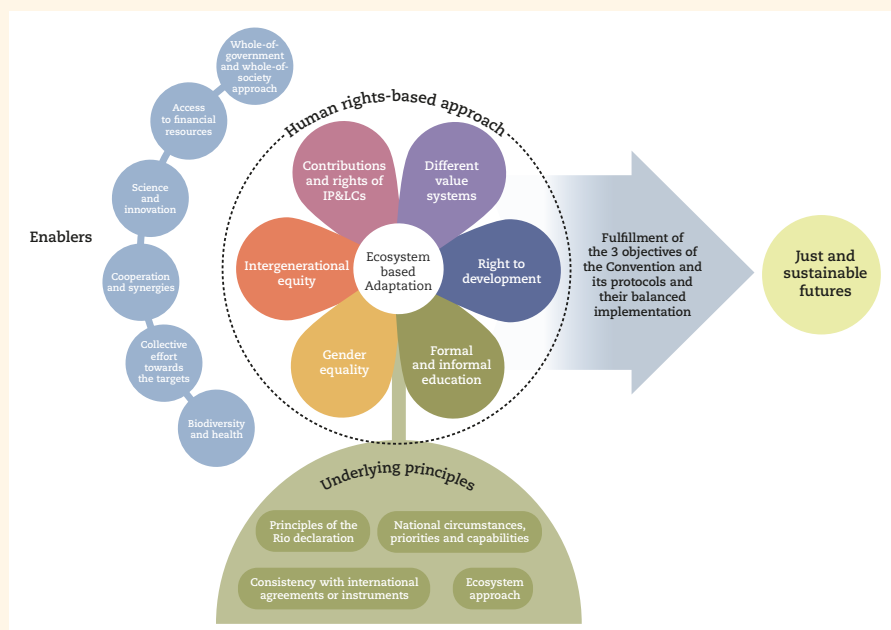
The GBF (2022) includes overarching principles for implementation of its goals and targets. These include Section C, which calls on signatory governments to understand, act on, report and evaluate the GBF's Vision, Mission, Goals and Targets according to cross-cutting considerations that emphasise human rights. Many of these are either identical to or closely aligned with the 'cross-cutting considerations' of the UNFCCC's GGA framework.<sup>4</sup>

The two global instruments contain many of the same commitments to respect and support for the knowledge

and participation of local communities, Indigenous Peoples and other marginalised groups such as women, young people and people living with disabilities.

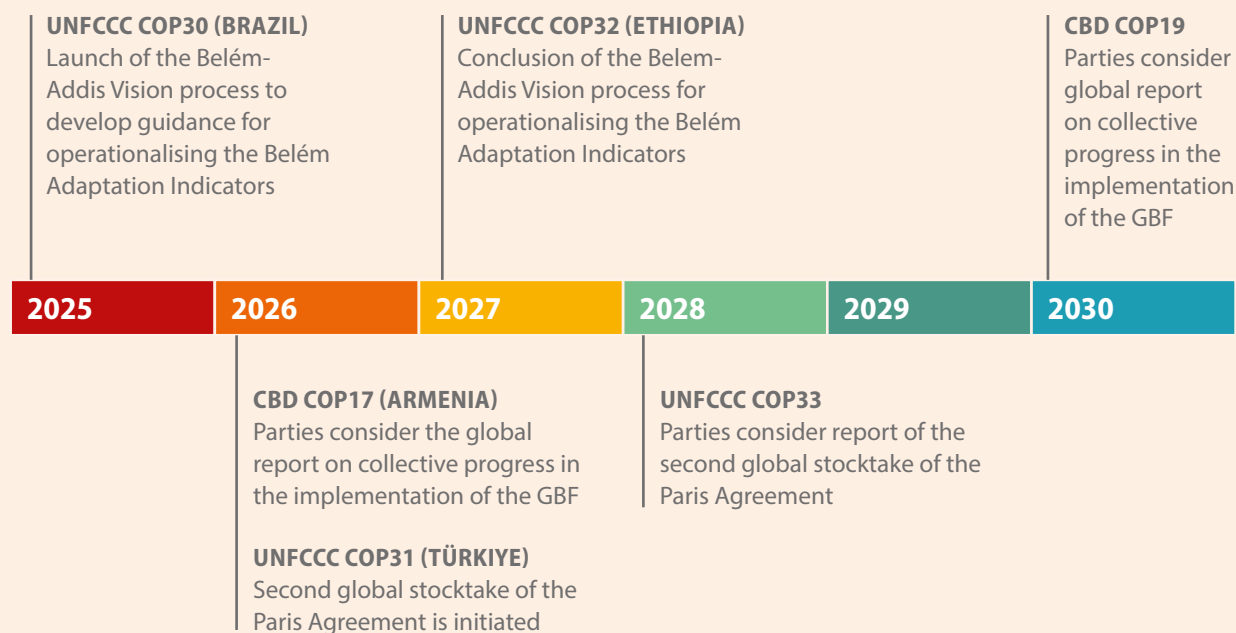
The GBF also includes elements such as recognising the contributions, rights, and different value systems of local communities and Indigenous Peoples. Importantly, the GBF also promotes rights to the development benefits of wise ecosystem stewardship: the right to food, water, health, culture, a healthy environment, and self-determination, all of which come out in the case studies.

**Figure 2. Considerations for the implementation of the GBF**



The human rights-based approach at the heart of Section C has been depicted visually by the Friends of Ecosystem-based Adaptation (2025)<sup>5</sup> in diagram opposite and is included here as a reference.

These elements emerge strongly in the case studies in this publication. The Key Findings, in Chapter 2 below, discuss their relevance to MEL systems and reporting.

**Figure 3. Timeline of climate and biodiversity stocktakes**

Sources: Convention on Biological Diversity (CBD), <https://www.cbd.int/gbf/implementation/globalreview>, United Nations Framework Convention on Climate Change (UNFCCC), <https://unfccc.int/topics/global-stocktake/information-portal>

## The selected case studies

The report explores adaptation ambition, monitoring and reporting through case studies representing an array of physical and human geographies in the Global South. The case studies range from the highly urbanised city-state of Singapore to the vast pampas grasslands that sprawl across borders in Argentina, Brazil, Uruguay and Paraguay. They address the challenges of cultivating poor soils in the atoll nations of Tuvalu and Kiribati. They unpack the restoration

of biodiversity-rich wetlands, mangroves, coral reefs and agroforestry landscapes intertwined with complex poverty dynamics in least developed countries: Burkina Faso, Nepal and Zimbabwe, and the Small Island Developing States (also least developed) of Papua New Guinea and the Solomon Islands.

The cases were selected because their project leaders were already compiling data and analysis on changes in human wellbeing, ecosystem integrity, and biodiversity associated with climate change adaptation.

The case studies were also selected because they address the complementarity and synergy between the Paris Agreement and GBF. They show how socially inclusive, truly participatory ecosystem-based actions that respect human rights can advance multiple global targets simultaneously, while prioritising local needs. They illustrate how action and change on the ground can drive streamlined, effective reporting to national agencies and international conventions, when adequate funding and capacities exist.

## Research questions

Two core research questions are applied to each case study in turn:

1. How are developing countries setting ambition for adaptation and resilience locally and nationally – what are the outcomes they want to see, and why?
2. How are they monitoring, evaluating, learning and using MEL information locally and nationally? For what purpose?

Following this, the case studies are explored collectively as an evidence base to address several further questions of interest to adaptation policy-makers and practitioners internationally. Across the set of case studies as a whole, we ask:

- What general strengths and weaknesses exist across current data sources and reporting structures, as relates to the human and ecological changes produced by adaptation interventions and the recording, understanding and application of the results?
- What does this imply for how governments can benefit from existing knowledge systems? What does it imply for how they should invest further?
- How might countries use such existing MEL information on the outputs and outcomes of adaptation to report progress against the Paris Agreement's GGA framework?
- How might countries use such MEL information to gauge progress on the GBF, especially Section C, which concerns reporting on the participation of Indigenous Peoples and local communities, gender-responsive actions, human rights-based approaches, stakeholder engagement and equitable governance, among others?
- What novel insights do the case studies provide about 'how adaptation works' and can local lessons contribute toward the second global stocktake of the Paris Agreement (2028) and future assessments of the GBF?

Chapter 2 synthesises key findings; Chapter 3 provides an overall guide to the case studies; and subsequent chapters present the case studies.

## 2. Key findings

BY MAIRI DUPAR, CDKN

This chapter presents the key findings and recommendations in response to the research questions set out in Chapter 1. It first discusses the two core research questions, followed by the five further questions used to explore the case studies as a collective body of evidence.

### Understanding adaptation MEL in local and national contexts

**Research question 1: How are developing countries\* setting ambition for adaptation and resilience locally and nationally – what are the outcomes they want to see, and why?**

This study intentionally selected cases that represented good practices for setting targets and establishing monitoring, evaluation and learning (MEL) systems for adaptation and resilience in both ecological and human systems. With this in mind, **several common threads emerge in how communities and countries are defining desirable adaptation and resilience outcomes, and why.** Prevalent goals and targets across case studies include:

- **Economic security for local people** who depend directly on ecosystems for their livelihoods. Priority activities and outputs often feature economic diversification. This combats poverty by reducing the climate exposure and vulnerability of any one livelihood or profession and managing risk (e.g. Burkina Faso, Nepal, Papua New Guinea, Solomon Islands, South American pampas grasslands, Zimbabwe).
- **Perpetuation of a culturally valued way of life** that is intertwined with specific habitats and species, because these relationships support people's sense of place and identity, which they hold to be important (e.g. Papua New Guinea, Solomon Islands, South American pampas grasslands).
- **Improved self-sufficiency in food production, linked to healthy, nutritious diets.** Dependence on less healthy convenience foods – traded or imported – is identified as a source of climate and economic vulnerability and poor human health in several cases. This motivates adaptation leaders to increase local food production using climate-resilient, biodiversity-friendly methods, thereby delivering progress across human nutrition and health, agrobiodiversity, and resilience (e.g. Kiribati and Tuvalu).
- **Reduced disaster risk, as a result of restored ecosystem functions.** Ecosystem protection and restoration is used explicitly across several case studies as a form of green infrastructure: to soak up excess floodwaters, to reduce erosion, or to provide other important geophysical functions in the landscape. But this is never the sole purpose of ecosystem restoration. In all instances, investments are justified by additional anticipated benefits to society, which can include a mix of biodiversity recovery, recreation, public health, aesthetic, spiritual and cultural benefits and more (e.g. Singapore, Solomon Islands).
- **Reduced human-wildlife conflict** in the context of communities' achieving a more balanced, sustainable coexistence with their natural environments. Where human-wildlife conflict exists, it imposes injuries to humans and animals, and loss of property and natural assets (including food) that undermine development and wellbeing. This creates vulnerabilities to climate

and other shocks. Removing these vulnerabilities enhances resilience. Strengthening local institutions for environmental management and formal and informal education are common strategies – with associated output measures – for achieving this and other local and national goals (e.g. Nepal, Zimbabwe).

- **Intergenerational cohesion and collaboration** emerge across case studies as prized outcomes. They are described as consequences of many activities built on shared appreciation of biodiversity, ecosystem integrity and/or local food production linked to context-specific cultural values and the psycho-social benefits of creating or simply being in a healthy environment (e.g. Burkina Faso, Solomon Islands, Kiribati, Tuvalu, Singapore)

- **Intergenerational rights and justice and a sense of duty to younger generations are frequently and spontaneously mentioned** by parents and elders, in respect of their obligations to safeguard young people's right to a healthy environment. (e.g. Papua New Guinea, Solomon Islands, Zimbabwe, Burkina Faso).
- **Enhanced and consolidated local knowledge about environmental conditions and adaptation solutions** is a golden thread tying all the case studies together: mentioned in every one as a vital activity and output to be achieved through formal and informal education and other methods (all).



Papua New Guinea © Ganda Lukman/Unsplash

\* The Rio Convention processes use 'developing countries' so we align with this language, but we normally try to use the terms Global South or majority world.

**Effective adaptation and resilience are defined differently – across countries and contexts.** For example, in Singapore, measures of effective adaptation include species observed and square kilometres of green space created, alongside mental health and recreational benefits, all of which are seen as integral to a good quality of life. In the Solomon Islands, effective adaptation is defined by Indigenous identity, social cohesion and intergenerational collaboration. On the plains of Nepal, adaptation progress is defined as the revitalisation of cultural knowledge and skills, the reappearance of rare bird species, a reduction in invasive species, along with innovation and enterprise creation through a biocircular economy.

**These marked differences do not mean that changes in adaptation and resilience cannot be measured internationally:** there are commonalities that can be shared and aggregated. The important thing to recognise is that global numbers and narratives are just indicative; they will never tell the whole story.

**Research question 2: How are countries and communities monitoring, evaluating, learning from and using MEL information locally and nationally? For what purpose?**

**Their main motivation for collecting monitoring and evaluation data is to drive local and national learning about ‘what works’** with a view to adaptive management of existing initiatives or to modify and expand initiatives further. Alongside this, local and national actors collect and use this data to build investment cases for further adaptation actions or to more informally understand how to invest funds, labour and local resources most wisely.

The community and national stakeholders who have contributed their case studies to this publication universally situate and apply their adaptation MEL findings toward sustainable development. It does not make sense to try and understand adaptation effectiveness outside the context of sustainable development.

“These marked differences do not mean that changes in adaptation and resilience cannot be measured internationally: there are commonalities that can be shared and aggregated. The important thing to recognise is that global numbers and narratives are just indicative; they will never tell the whole story.”



Handicraft works © Bird Conservation Nepal

The countries highlighted in this publication are obtaining **quantitative data** from adaptation initiatives, with the purpose of:

- understanding the contribution of adaptation efforts to national development and biodiversity conservation;
- highlighting gaps in adaptation provision to specific social/socioeconomic groups, species or ecosystems that may merit special attention.

Programme indicators based on quantitative data can be readily aggregated and compared across sites when common data standards and methodologies are used. For example, in Burkina Faso and the South American grasslands, income improvements are measured and compared among localities taking up agroecology techniques. Numbers of breeding bird pairs or census numbers of rare species, as in Nepal, are other examples of quantitative indicators: the results are comparable among sites and can be aggregated. In this case, quantitative data from sites makes its way to global-level reporting via the IUCN Red List of Threatened Species.

There is also a strong theme among case studies of gathering indicator results from adaptation programmes to use for cost-benefit analyses. This is important for evaluating investment and justifying future spending, whether funds come from community, government or donor sources. There is a strong imperative to know whether scarce funds are being invested as effectively as possible. The subsequent insights inform policy, management and budget decisions, including national adaptation strategies, plans, and business cases. For example, in Tuvalu, the comparative costs of food cube technologies were assessed in respect of crop yields in a changing climate. Quantitative data from a pilot project informed future programmes.

**In transboundary context, scientists and communities are pooling information across borders to assess the integrity of threatened ecosystems.** The Grasslands Alliance operates in the pampas grasslands that extend contiguously across parts of Argentina, Brazil, Uruguay and Paraguay. The Alliance's national chapters coordinate to gather data for common scientific indicators of ecosystem integrity and species' conservation status. Pooling and analysing the data at transboundary, ecosystem scale enables the Alliance to understand threats and opportunities better, and invest conservation and livelihood enhancement efforts where they are most needed.

**Qualitative information** is invaluable and is being used to describe important changes in people's wellbeing that numbers do not measure adequately, including the relationships between and within human and ecological systems. For example, in Singapore, qualitative information from storytelling methods tells us how community members benefit from tree planting, invasive species removal and/or citizen science monitoring. Participant narratives tell how this activity correlates with increasing species diversity and abundance, and how the healthier environment provides positive feedback loops to their mental health.

Another example comes from the Poposa cluster in the Solomon Islands, where the community describes its resilience as like a 'broom': many strands make a strong, effective whole. There is no quantitative indicator to describe social cohesion as a resilience outcome, in the way that their 'broom' metaphor does. But, from a programmatic perspective, community members and funders can meaningfully use this narrative metaphor to deliberate whether the 'broom' has become stronger or more depleted by adaptation activities and other drivers of change. Countries and localities capture information of this kind to describe human wellbeing across diverse worldviews and cultures, in qualitative ways that defy uniform categorisation and measurement.

The crux of the matter is 'for what purpose is adaptation MEL information being collected and shared?' Evaluation and learning on local specifics might be needed for domestic investment and management purposes. However, if the insights are not universally applicable, they may not need to go any further. Communications to multilateral processes can be more selective.

Qualitative *analysis* as part of countries' adaptation monitoring (as opposed to 'raw data') is also necessary to explain the numbers: the underlying reasons for statistical results at any point in time, and the drivers of statistical trends over time. Sometimes the quantitative statistics show unusual results, and this drives further investigation and explanation of the drivers of change, for instance, explaining why species declined in a Nepali wetland when increases were expected.

Capybara (*Hydrochoerus hydrochaeris*), Brazil © Felipe Peters



## Understanding adaptation MEL in a global context

What general strengths and weaknesses exist across current data sources and reporting structures?

**This study found rich pockets of data and analysis via case studies, but this information is geographically fragmented in most countries, and the resources for tracking outcomes are often linked to donor projects that are time-bound and finance-limited.** This makes it difficult for most developing countries to report on adaptation and resilience progress in a holistic, national manner and to provide joined-up reporting from one national adaptation report to the next. This is a typical feature and reality of the adaptation data landscape in developing countries. There is inadequate funding and a deep need – especially in Least Developed Countries and Small Island Developing States – for international public financing to support MEL systems. This reality should spur new development partnerships that support capacity for more integrative, long-term national MEL systems.

What does this imply for how governments can benefit from existing knowledge systems? What does it imply for how they should invest further?

**If countries were resourced for long-term capacity strengthening of national MEL systems, countries could capitalise on fragmented project data and pull it into coherent narratives. They could also use project data more effectively as a springboard for foresight analysis and planning.** Such an approach would rise above the shorter-term, primarily donor-accountability-driven project approach. It would instead create a national public good approach that drives efficiency, effectiveness, long-term institutional memory and better responsiveness to countries' adaptation strengths and needs.



## Recommendations for development partners

- Provide grants to develop and support adaptation MEL systems in developing countries for the long-term and the domestic capacity to sustain them.

How might countries use such existing MEL information on the outputs and outcomes of adaptation to report progress against the Paris Agreement's GGA framework?

Paris Agreement reporting places a heavy emphasis on country-led statements of ambition – the Nationally Determined Contributions – and regular country reporting – under the Enhanced Transparency Framework. Countries are expected to submit Biennial Transparency Reports of progress (i.e. every two years), although greater flexibility in reporting is granted to least developed countries and small island developing states, because of their particularly constrained human and financial circumstances.

**The case studies show that the broad thematic pillars provided by the GGA framework provide a highly relevant schema for governments to report to the UNFCCC.** The GGA's thematic targets are aligned with how the diverse developing countries presented in this publication are already tracking the human and ecological outcomes of adaptation.

**Even so, much of the impact of the case studies' data and analysis comes from measuring the intersecting dependencies in human and ecological systems that are described by the GGA themes.**

To give a few examples:

- how restoring ecosystems can provide habitats for endangered species while advancing the food security and socio-cultural wellbeing of local people;
- how increasing the biodiversity of mixed agricultural production systems can offer greater resilience for key species in the face of climate shocks as well as providing more economically sustainable livelihoods;
- how creating leadership positions for women in governance structures can restore and revive elements of cultural heritage that help steward ecosystems more sustainably while improving women's social standing, mental health and economic status; and so on.

It is therefore vital to refrain from 'silo-ising' reporting by GGA theme, but instead, to be bold about identifying interdependencies among themes, highlighting these in reporting, and applying this knowledge to future, adaptive policy and management at all scales.

**Changes in human and ecological resilience as a result of adaptation measures are not necessarily straightforward or linear, and outcomes also change over time in response to multiple pressures and responses. For this reason, too, statistics alone cannot tell the whole story: this is a critically important point for the development and use of the Belem Adaptation Indicators.** Qualitative assessment and reporting on the ground, where change happens, is essential to describe the nuance of human and ecological changes, including the messy reality that some indicator results can fluctuate over time, prompting adaptive management. Qualitative narratives can explain the reasons for trends in statistics over time: why things happen, why intended results are or are not achieved and how to course-correct. Qualitative narratives can explain how different drivers interact to advance or undermine ecosystem integrity, biodiversity and people's quality of life.

Narrative stories such as the case studies in this publication enrich our collective understanding of i) how people frame adaptation progress where they live, ii) what is needed to advance holistic and ambitious adaptation in the short to medium term and iii) what is needed to work toward longer-term adaptive capacity and resilience.

Storytelling will always have a place in international forums like GGA reporting and global stocktakes, keeping findings 'real' and illustrating synthetic narratives with the complexity of human experience. Case studies will remain an important vehicle for this. While they may be presented as a snapshot (as in this publication), there is value in updating them over time, as well as highlighting fresh and emergent country experiences on the global stage.

**Reporting across multiple indicators is needed.** Seldom do the results of single indicators relay well whether climate resilience is advancing. However, multiple indicators in combination, which deploy qualitative and quantitative methods, can illuminate whether people are living good lives and ecosystems are being managed sustainably and equitably. The case studies in this volume were selected for the very reason that they do track progress across human and ecological aspects of climate resilience using multiple indicators – they show how it can be done. A caveat is that almost all of them relied on dedicated donor resources for MEL that may not yet be available at national scale or over longer periods.

**While much adaptation information is projectised (see above), countries could still use projects selectively as 'test beds' for defining indicators that are relevant to communities where adaptation is implemented and where the effects are felt, and relevant to countries where enabling policies are set and where much of the finance is mobilised.** This could be pulled through to UNFCCC reporting only where such project information is illustrative of a point of greater resonance and relevance.

**The current analysis also highlights certain gaps in the UNFCCC process and suggests areas for improvement.**

The case studies presented raise certain flags for the GGA monitoring process. They reveal, for example, that certain values and contributions of nature for people are deeply culturally embedded and are pivotal to the design and effective implementation of adaptation. These nuances can be lost in translation when communicating them beyond the local level. These findings resonate with the

Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) emphasis on the diverse values of nature for people.<sup>6</sup>

The case studies imply a need for much stronger cross-cultural understanding in how ecosystem protection and restoration can enhance cultural meaning that is foundational to the identity and wellbeing of different groups in society, especially Indigenous Peoples.



## Recommendations for the GGA process

- The GGA framework's thematic targets are well aligned with how communities and countries are gathering information on the effectiveness of adaptation efforts and resilience outcomes.
- However, countries must be encouraged to highlight the critical interlinkages and interdependencies among the GGA framework's themes; international stocktakes should also acknowledge these.
- Global and regional syntheses can help describe trends in both quantitative and qualitative data. Nevertheless, case studies and narrative storytelling from local places will remain a powerful tool – elevated where appropriate to the global level – for illustrating people's complex realities.
- Greater awareness, acknowledgement and incorporation of concepts from IPBES into UNFCCC processes would improve acknowledgement and respect of different value systems, including culturally rooted values of nature, and the contributions and rights of local communities and Indigenous Peoples. These are foundational concepts in the GBF. They could be better reinforced in the UNFCCC to advance cross-cultural awareness and understanding of how resilience is defined and achieved.

## How might countries use such MEL information to gauge progress on the GBF, especially Section C, on equity and rights?

**Much of the information being gathered on social equity and the manifestation of human rights focuses on participatory processes, rather than on the outcomes, including the benefits, of participation. Documenting participation is valuable, but more capacity, support and resources are needed to document the impacts of adaptation processes for different groups of people.**

There is ample good practice to draw on in how adaptation interventions are scoped and designed using equitable processes to increase the participation of young people, women and other groups who may face marginalisation. Where interventions are projectised and carry project funding, as in the case studies here, quantitative reporting on participation by gender, age group, and by Indigenous status is relatively widespread or could be, and this speaks to the spirit of Section C of the GBF.

However, what is harder to find documented is holistic outcome-level information on gender, intergenerational and social equity of adaptation and resilience efforts. *Economically* equitable outcomes, such as increased income for women compared with men, are the most consistently tracked and are described in several case studies. Differences in how non-economic values of the environment benefit women, men, older, younger, Indigenous/non-Indigenous and other diverse groups of people are poorly measured and monitored. This includes, for example, cultural, recreational, and spiritual values; physical and mental health contributions that are harder to quantify; and how these benefits sustain people's wellbeing and make them more resilient. All of this suggests that there is little material as yet to distil at the global synthesis level on adaptation outcomes for diverse social groups, which could potentially be reported under the GBF or for future efforts under the UNFCCC's GGA.

The lack of outcome-level reporting against measures of equity, different values and human rights in adaptation outcomes might reflect the fact that laws and regulations in most countries focus on 'who participates' (processes that can be measured at 'output' level such as proportion of women in committees) or, when equitable benefits are legislated at all, they are in economic terms, such as equal pay for equal work.

Programmatic examples of more profound equity objectives and monitoring exist. One particularly far-sighted initiative in the Solomon Islands case study describes efforts to understand what equitable adaptation outcomes mean for people living with disabilities in the community. Outcomes are captured through community storytelling about how lives are improved. Another beacon of insight in this volume comes from Singapore, where non-economic and non-material values of nature such as mental health benefits are captured anecdotally by the National Parks department across an age-diverse cross-section of society. A parallel report to this one unpacks examples of transformative ecosystem-based adaptation that CDKN has directly funded: cases that are characterised by the deep norm shifts in behaviours and power relations concerning the use and benefit from natural resources.<sup>7</sup>

Such efforts as these expand the conceptual envelope of how we comprehend and approach the intersections of diverse cultural and non-economic values and human resilience. Funding is needed to support the application of such research in many more countries and contexts to inform national learning, as well as the GBF, GGA and other related processes.<sup>8</sup>

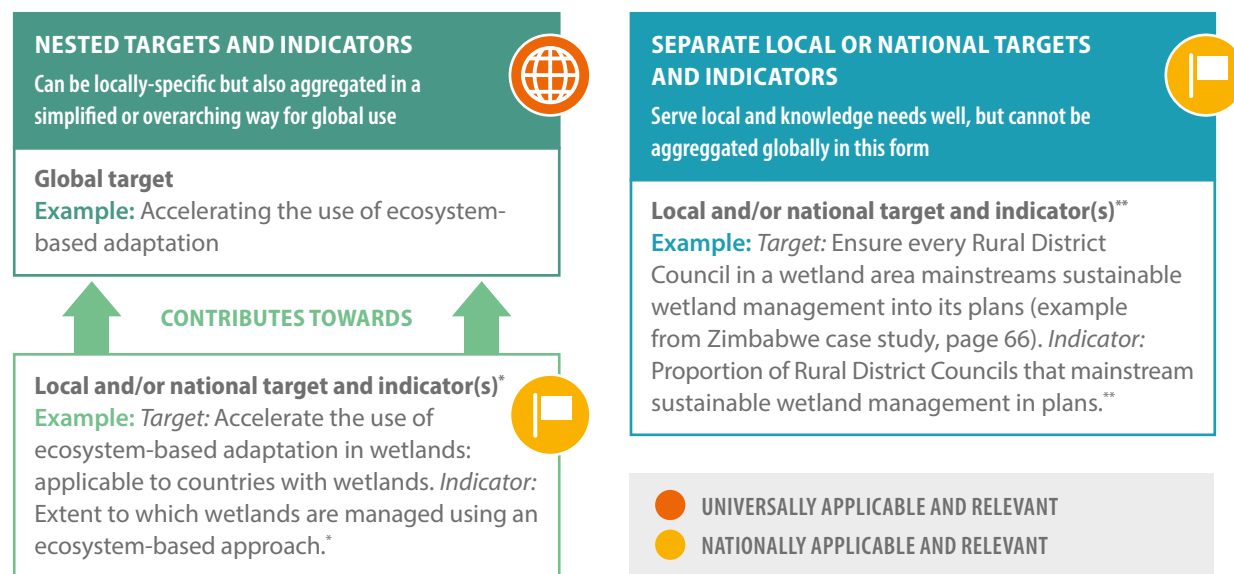
**What novel insights do the case studies provide about 'how adaptation works'? Can local lessons, like these, contribute toward the second global stocktake of the Paris Agreement (2028) and future assessments of the GBF?**

The case studies, as a collection, provide important insights on how adaptation progress can be defined, measured and shared at multiple scales.

First and foremost, it is important to be clear on what information is relevant for which groups of actors and categorise and communicate it accordingly. Global indicators may be deemed relevant for international transparency's sake, but it is vital that local communities, subnational and national actors continue to define and implement measurement systems for the wider suites of

human and ecological wellbeing outcomes they consider most relevant. These can be either 'nested' indicators that fall under the chapeau of global indicators, perhaps providing extra layers of detail for local use, under a common global heading. Or they can be additional measurements of adaptation and resilience progress that are (separately) locally and nationally defined and pursued. Indicators that can be used productively in local and national contexts are not expected to be adopted in exactly the same form by other countries because they are not universally applicable (see Figure 4).

**Figure 4. Nested and separate targets and indicators to measure adaptation progress**



\* Wetlands are site-specific but data could be aggregated nationally under the umbrella of 'ecosystems' (in general) for reporting to global frameworks such as GGA/GBF, where there is a demand for information on ecosystem integrity.

\*\* Governance arrangements are a key enabler of adaptation to be tracked, but this specific metric is necessary and relevant for local and national use. It does not fit readily into GGA/GBF reporting frameworks and that's okay: there's not a global demand for information that is this specific and detailed.

Source: author's own

**National reporting bodies and the secretariats of the multilateral environmental agreements could look harder at how to elevate breakthrough concepts and practices** – beyond indicators of established practices and ways of thinking – to accelerate our conceptual understanding of adaptation. These breakthroughs are happening in localities and have broader relevance.

For example, in Nepal, communities have achieved a conceptual and practical leap by generating economic uses from otherwise ecologically harmful plants: invasive and alien weeds. This is an example of a 'biocircular economy' where local supply and demand are driven by Indigenous knowledge, skill and cultural heritage, to advance multiple human and ecological resilience goals.

**Such principles and approaches are not currently captured in a single GGA or GBF target, but have the potential to transform systems. Major conceptual and practical advances of this kind should be well documented** – even if the specifics differ from one location to another – to encourage innovation elsewhere.

Stakeholders should continue to use qualitative documentation and storytelling to capture these narratives to inform global stocktakes and diffuse knowledge. Expert actors deploying Indigenous and local knowledge may not necessarily be able to access formal and academic publishing routes (e.g. for inclusion in IPCC and IPBES assessments which inform policy). Thus, other documentation and knowledge exchange mechanisms will be required.

Also, such innovations and conceptual breakthroughs are not well suited to indicator reporting, and even raise some questions about indicator use: does the reliance on indicator reporting to the global conventions have the potential to privilege the 'tried and tested' (in terms of processes and outputs recorded) and so steer attention away from innovation?

The pace of climate change and our urgent need to both mitigate and adapt means we must be agile and open-minded to avoid lock-in to yesterday's solutions. It is time for 'lighthouse awards' for climate innovation to step out of the side event spaces and into the core of political discussions and financial commitments.

“Indigenous and local knowledge is an essential input into adaptation and also an evidence system in its own right, i.e. Indigenous and local knowledge are not only sources of data for adaptation. They are legitimate knowledge systems that shape adaptation goals, values, indicators and definitions of success.”

**Nadia Sitas, Ecosystem-based Adaptation Lead,  
CDKN**

## 3. Introduction to case studies

BY MAIRI DUPAR, CDKN

### Case studies at a glance

Table 1 shows, at a glance, which thematic elements and cross-cutting considerations of the GGA framework are highlighted by each case study, noting that the 'ecosystems' target of the GGA framework is aligned with several targets of the GBF, most notably GBF targets:

- 1: Plan and manage all areas to reduce biodiversity loss;
- 2: Restore 30% of all degraded ecosystems;

- 3: Conserve 30% of land, waters and seas;
- 8: Minimise the impacts of climate change on biodiversity and build resilience; and
- 11: Restore, maintain and enhance nature's contribution to people.

Environmental goods and services are flagged in the case studies according to the IPBES definition of 'nature's contributions to people', which are broadly classified as 'regulating' contributions provided by the environment, 'material' and 'non-material' contributions: greater detail is provided in each case study chapter.

Oriental pied hornbill, Singapore © Matthew Schwartz/Unsplash



**Table 1. Case studies at a glance: Global Goal on Adaptation (GGA) and Kunming-Montreal Global Biodiversity Framework (GBF) linkages**

● LINKAGE HIGHLIGHTED IN THE CASE STUDY    ◻ PARTLY

|                                                                 |                                                                               | Burkina Faso | Nepal | Zimbabwe | Atoll Islands<br>(Tuvalu, Kiribati) | Papua New Guinea | Singapore | Solomon Islands | South America |
|-----------------------------------------------------------------|-------------------------------------------------------------------------------|--------------|-------|----------|-------------------------------------|------------------|-----------|-----------------|---------------|
| <b>THEMATIC TARGETS OF THE GLOBAL GOAL ON ADAPTATION (GGA)*</b> | Water                                                                         | ●            | ●     | ●        |                                     | ●                | ●         |                 |               |
|                                                                 | Food and agriculture                                                          | ●            | ●     | ●        | ●                                   | ●                |           | ●               | ●             |
|                                                                 | Health**                                                                      |              |       |          | ●                                   | ●                | ●         |                 |               |
|                                                                 | Ecosystems                                                                    | ●            | ●     | ●        | ◻                                   | ●                | ●         | ●               | ●             |
|                                                                 | Infrastructure                                                                |              | ●     | ●        |                                     | ●                | ●         | ●               |               |
|                                                                 | Poverty and livelihoods                                                       | ●            | ●     | ●        | ●                                   | ●                |           | ●               | ●             |
|                                                                 | Cultural heritage                                                             |              | ●     |          | ●                                   | ●                | ●         | ●               | ●             |
| <b>PROVISIONS OF GGA***</b>                                     | Vulnerable ecosystems, groups and communities                                 | ●            | ●     | ●        | ●                                   | ●                | ●         | ●               | ●             |
|                                                                 | Science-based indicators, metrics and targets                                 |              | ●     | ●        | ●                                   | ●                | ●         | ●               | ●             |
|                                                                 | Ecosystem-based adaptation, nature-based solutions                            | ●            | ●     | ●        |                                     | ●                | ●         | ●               | ●             |
|                                                                 | Private sector engagement                                                     | ●            | ●     | ●        |                                     | ●                | ●         | ●               | ●             |
| <b>JOINT PROVISIONS OF GGA &amp; GBF</b>                        | Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems | ●            | ●     | ●        | ●                                   | ●                |           | ●               | ●             |
|                                                                 | Intergenerational equity                                                      | ●            |       | ●        | ●                                   | ●                | ●         | ●               |               |
|                                                                 | Gender equality                                                               | ●            | ●     | ●        | ●                                   | ●                |           | ●               |               |
| <b>PROVISIONS OF GBF (SECTION C)</b>                            | Contribution and Rights of Indigenous Peoples and LCs****                     | ●            | ●     | ●        | ●                                   | ●                | ●         | ●               | ●             |
|                                                                 | Different value systems                                                       | ●            | ●     |          |                                     | ●                |           | ●               | ●             |
|                                                                 | Formal and informal education                                                 | ●            | ●     | ●        | ●                                   | ●                | ●         | ●               | ●             |
|                                                                 | Right to development                                                          | ●            | ●     | ●        | ●                                   | ●                |           | ●               | ●             |
| <b>NATURE'S CONTRIBUTIONS TO PEOPLE</b>                         | Regulation of environmental processes                                         | ●            | ●     | ●        |                                     | ●                | ●         | ●               | ●             |
|                                                                 | Materials and assistance                                                      | ●            | ●     | ●        | ●                                   | ●                | ●         | ●               | ●             |
|                                                                 | Non-material contribution                                                     | ●            | ●     | ●        | ●                                   | ●                | ●         | ●               | ●             |

\*Note that the GGA ecosystems target also links directly to GBF targets 1: Plan and manage all areas to reduce biodiversity loss; 2: Restore 30% of all degraded ecosystems; 3: Conserve 30% of land, waters and seas; 8: Minimise the impacts of climate change on biodiversity and build resilience; and 11: Restore, maintain and enhance nature's contribution to people.

\*\*Nutrition and dietary diversity are covered in almost all the case studies but are here classified under 'food security' rather than 'health' – and 'health' is checked when the case studies describe other health benefits such as mental health benefits.

\*\*\*Cross-cutting considerations in the GGA framework

\*\*\*\* LCs – local communities

## About the case study key

Each case study includes a key on the opening pages. The key includes relevant GGA themes, cross-cutting considerations (GGA and section C of GBF), and Nature's contributions to people (NCP). It serves as a reference point to guide readers in thinking about how targets and monitoring, evaluation and learning systems at the local and subnational levels could align with global frameworks and reporting mechanisms.

## Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study.



**Water:** (a) Significantly reducing climate-induced water scarcity and enhancing climate resilience to water-related hazards towards a climate-resilient water supply, climate-resilient sanitation and access to safe and affordable potable water for all



**Food and agriculture:** (b) Attaining climate-resilient food and agricultural production and supply and distribution of food, as well as increasing sustainable and regenerative production and equitable access to adequate food and nutrition for all



**Health:** (c) Attaining resilience against climate change related health impacts, promoting climate-resilient health services and significantly reducing climate-related morbidity and mortality, particularly in the most vulnerable communities



**Ecosystems:** (d) Reducing climate impacts on ecosystems and biodiversity, and accelerating the use of ecosystem-based adaptation and nature-based solutions, including through their management, enhancement, restoration and conservation and the protection of terrestrial, inland water, mountain, marine and coastal ecosystems



**Infrastructure:** (e) Increasing the resilience of infrastructure and human settlements to climate change impacts to ensure basic and continuous essential services for all, and minimising climate-related impacts on infrastructure and human settlements\*



**Poverty and livelihoods:** (f) Substantially reducing the adverse effects of climate change on poverty eradication and livelihoods, in particular by promoting the use of adaptive social protection measures for all



**Cultural heritage:** (g) Protecting cultural heritage from the impacts of climate-related risks by developing adaptive strategies for preserving cultural practices and heritage sites and by designing climate-resilient infrastructure, guided by traditional knowledge, Indigenous Peoples' knowledge and local knowledge systems

\* In the context of this report, infrastructure principally refers to green, nature-based infrastructure and/or how it can combine with and add resilience to built infrastructure.

## Cross-cutting considerations

GGA framework and Section C of the GBF:



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Different value systems



Intergenerational equity



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key NCP that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

Specific illustrations in the case studies:

- Habitat creation and maintenance
- Pollination and dispersal of seeds and other propagules
- Regulation of air quality
- Regulation of climate
- Regulation of ocean acidification
- Regulation of freshwater quantity, location and timing
- Regulation of freshwater and coastal water quality
- Formation, protection and decontamination of soils and sediments
- Regulation of hazards and extreme events
- Regulation of detrimental organisms and biological processes

### Materials and assistance

Specific illustrations in the case studies:

- Energy
- Food and feed
- Materials and assistance
- Medicinal, biochemical and genetic resources

### Non-material contribution

Specific illustrations in the case studies:

- Learning and inspiration
- Physical and psychological experiences
- Supporting identities
- Maintenance of options



Village meeting, Driefontein, Zimbabwe © Barend van Gernerden/BirdLife International

## Guide to the case studies

The case studies have been formatted to answer the core research questions by including two distinct components: the expert practitioner's analysis and the independent analysis.

**The expert practitioner's analysis:** Case studies are presented by leading practitioners who have delivered adaptation in diverse ecosystem and country contexts. The case study format shows how actors in the country or locality define the climate adaptation and resilience they want to see and monitor in their contexts. The case studies present locally and nationally relevant indicators for human and ecosystem resilience that are currently

being used or have historically been used. The practitioners further discuss how local and national actors have used the indicator results to evaluate adaptation progress and identify further work to be done in each context.

**The independent analysis:** The independent analysis at the end of each case study zooms out from the local and national specifics to identify areas of possible alignment with the global commitments and reporting frameworks. The analysis also identifies narrative lessons that suggest novel approaches to designing, implementing, and/or monitoring, evaluating and learning from adaptation experience, which could advance international understanding. These innovations and conceptual breakthroughs could even change how actors think about measuring adaptation across scales in the future.

# CASE STUDY

## Burkina Faso's shea parklands: Birds, bees and business – promoting livelihoods, social inclusion and nature

By Adama Nana, *Naturama*, Adrian Atieno, *BirdLife Africa* and Javiera Perez Ribalta, *BirdLife International*



Implementing organisations:  
*Afrique Verte Burkina,*  
*Association Tiipaalga,*  
*FairClimateFund, Cordaid and*  
*Vogelbescherming Nederland*

### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Water



Food and  
agriculture



Ecosystems



Poverty and  
livelihoods



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Different value systems



Intergenerational equity



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

- Habitat creation and maintenance
- Pollination and dispersal of seeds and other propagules

### Materials and assistance

- Energy
- Food and feed

### Non-material contribution

- Maintenance of options



Bee © Oktay Yildiz/Unsplash



**Figure 5. Burkina Faso**



Source: © Cartography, Chandra Jayasuriya

## 1. About the agroforestry ecosystem

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Across large swathes of West and central Africa, shea trees grow in agroforestry systems known as ‘parklands’. Agroforestry, or the practice of ‘trees on farms’, is a mixed-crop landscapes that have the potential to yield different forms of food and fibre to farmers over the seasons. Agroforestry systems can be planted and managed so the nutrient needs and cycles of different plant species complement each other and support as many other forms of biodiversity as possible.

Diverse trees and shrubs – both in individual plots and at the landscape scale – support more abundant honey bee (*Apis mellifera*) populations and are associated with more frequent visits by other pollinators to the trees, compared to farms with less plant diversity.<sup>9</sup>

Shea crop yields are greater when pollinators are more abundant. So, shea yields benefit from more pollinators being present, and pollinators benefit from a range of tree and shrub species in the parklands.<sup>10</sup>

Diverse plantings in agroforestry landscapes also provide important habitat for birds, mammals, reptiles and other wildlife. The swathe of shea parklands known as the shea ‘belt’ across the Sahelian region is a stopover ground for long-distance birds that migrate from their European breeding grounds to over-winter further South on the African continent.

## 2. People’s resilience in the context of a healthy ecosystem

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The butter produced from the shea tree is famously known worldwide as the basis for cosmetics and skincare products, and as an ingredient in foods. It is produced from the shea trees (known locally as ‘Karité’) which grow predominantly in these parklands.<sup>11,12</sup> As well as the economic value of shea butter made from the seeds, other parts of the seeds and fruits are processed into products with significant economic, nutritional and cultural value for local people.<sup>13</sup>

In addition to the direct benefits of parts of the shea trees to people, they support other species valued by local people. For instance, the shea caterpillar that feeds on the trees is not harmful to the trees or wider biodiversity and is an important source of protein in local diets.<sup>14</sup>

In the past 30–40 years, social and economic pressures on the parklands have led to ecosystem fragmentation and degradation. More diverse agroforest systems have been converted to monocultural cropland through the widespread deforestation and destruction of shrubs surrounding the shea trees (leaving monoculture shea in place) and the application of pesticides, decimating pollinators. Also, areas of land which were typically left fallow on a rotating basis to recover their fertility have been overused. Trees are cut to clear the land for agriculture, and to use as energy in household cooking and shea processing.

Climate change is taking its toll, with more unpredictable rain (sometimes more intense when it arrives), longer dry spells and conditions that erode the topsoil. More intensive, monocultural land management makes it more likely that climatic conditions will drive erosion and land degradation: a dangerous combination.



*Plant nursery workers © Naturama*

As a consequence, the abundance and productivity of pollinators (and their benefits for shea trees) declined, the value of the parklands as bird habitat decreased, and the long-term economic sustainability of the parklands has come into question.<sup>15</sup>

Ecosystem fragmentation has been severe over the past three decades. For example, in Dano commune of Burkina Faso – one of the sites where Naturama established a restoration programme – shrubby and grassy savannah decreased from 85% to 44% of land cover; and rainfed agriculture and agroforestry have increased from 12% to 53% (1990–2020).

The long-term consequences of this environmental degradation weigh heavily on the shoulders of women producers – both mothers and daughters – who have traditionally overseen shea nut collection in Burkina Faso's

rural communities. This work is passed down through generations along the female line.<sup>16</sup> It is estimated that well over half a million people in Burkina Faso rely on non-timber forest products such as shea nut harvesting for their livelihoods, and almost 400,000 of these are women.<sup>17</sup>

At the same time, women's economic empowerment in the sector is judged to be poor, with much potential for improvement. Women's roles are typically at the bottom of the value chain: extracting shea nuts for sale to intermediaries who aggregate volumes and sell the nuts en masse for processing. Only a diminutive slice of the revenue accrues to the women farmers. In this unfairly biased system and considering women producers' Indigenous and local knowledge as stewards of the parklands, a consortium of NGOs saw an opportunity to develop value-added products for shea locally that would benefit women, ecosystems, and biodiversity.

### 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

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#### 3.1 Overarching objectives

In Burkina Faso's Nahouri, Sissili, Ziro and Loba provinces, the non-governmental organisation Naturama and its partners Afrique Verte and Tiipaalga, came together with the goals of:

- Augmenting the biodiversity of the agroforestry parklands with a particular focus on supporting pollinator populations and protecting migrant birds and their habitats.
- Strengthening the institutional capacities of local institutions and communities in the sustainable management of natural resources.
- Enhancing and diversifying the communities' sources of income, particularly women's.

The agreed strategies to pursue these goals are:

- Strengthening community leadership and responsibility for sustainable management of shea parkland.
- Developing better market systems for non-timber forest products such as shea butter.
- Enhancing local capacities for shea parkland management and eco-enterprise.

Progress across the three areas of biodiversity, local institutions and economic security aims to reduce vulnerability and strengthen resilience of human and ecological systems, in the face of climate and other shocks. A diverse, integrated package of activities was formulated to reach these objectives; activities included:

- **Direct ecological restoration**
  - Support to communities for ecosystem conservation within locally managed landscapes: land demarcation and delineation of conservation areas; the development and implementation of forest management plans; establishment and capacity-strengthening of management committees, etc.
  - Reforestation, with a particular focus on tree species that complement shea trees in the landscape. This is intended to provide diversity for pollinators, provide habitat for migratory birds, and strengthen ecosystem integrity.
  - Use of organic fertilisers instead of chemical alternatives. Organic fertilisers have a lower greenhouse gas footprint than chemical ones; they provide better conditions for pollinators and enhance the fertility of degraded soils. Their ability to retain vital moisture contributes to climate resilience in times of erratic rainfall.
- **Cross-cutting climate change adaptation and mitigation**
  - Installation of three-stone fireplaces: a straightforward and highly efficient alternative to conventional cookstoves. Three-stone fireplaces require substantially less fuelwood, reducing timber harvesting in the parklands – both for cooking and shea processing uses. Consequently, greenhouse gas emissions and ambient air pollution (including smoke in houses) are reduced, and more trees are retained in the parklands.
  - Improved cookstoves reduce wood consumption by up to 50% and therefore reduce pressure on trees. The CO<sub>2</sub> reduction is certified as carbon credits. The cookstoves offer even more benefits for local women, who spend less time collecting firewood, and living conditions improve because harmful smoke is



reduced. Women are trained to produce and maintain the cookstoves and, in return, receive a microloan to start other income-generating activities.<sup>18</sup>

- **Capacity strengthening for individual producers**

- Producers trained in species interaction and the role of biodiversity in conferring improved sustainability in production systems, including shea production.
- Producers trained and supported in assisted natural regeneration of key plant species that are foundational for the establishment and maintenance of more diverse trees and shrubs.
- Producers – especially women producers – trained in shea butter cultivation as part of a mixed-crop agroforestry system. The role of 'model farmers' in disseminating knowledge to others is especially significant (see sidebar).

- **Support to local institutions to integrate ecological sustainability into their planning and operations**

- Training for elected representatives and local leaders on environmental legislation, with the aim of strengthening their technical and research capabilities, as well as to facilitate communication between officials and the general public on issues of natural resource management.



### **The role of model farmers (*paysans modèles*)**

In Burkina Faso's agroforestry parklands, "model farmers" are pioneering farmers who adopt and master sustainable techniques, such as integrating soil-fertilising trees (e.g. certain *Acacia* species<sup>19</sup>) on their fields. They provide technical demonstrations of techniques such as mounding, inter-cropping, and soil fertility management to increase yields for other farmers in the community. Naturama has intentionally worked with model farmers to illustrate practice and results at the plot level.



'Birds, Bees and Business' training © Naturama

### 3.2 Specific targets and indicators for ecosystem health and biodiversity<sup>20</sup>

| Objectives                                                                         | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                   | Means of verification                                                                                                                                                                                                                 |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Increase in ecosystem integrity, increase in threatened species populations</b> | <ul style="list-style-type: none"> <li>Abundance of pollinators in agroforest parkland is stable or increasing</li> <li>Abundance of migrant bird species in forests is stable or increasing</li> <li>Number of new seedlings planted</li> <li>Number of existing trees protected and maintained</li> </ul> | <ul style="list-style-type: none"> <li>Baseline and regular population monitoring data of specific pollinator species and threatened bird species</li> <li>Baseline and regular monitoring of tree survival and land cover</li> </ul> |



#### Mitigation co-benefit of restoring the ecosystem for livelihoods, biodiversity and climate resilience

Amount of carbon dioxide equivalent (Co2eq) emissions avoided and/or sequestered per annum (in thousands of tons).

| Objectives                                                                                                                                        | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                | Means of verification                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Greater area of land under conservation management</b><br><br><b>Greater area of land under sustained, wildlife-friendly production regime</b> | <ul style="list-style-type: none"> <li>Number of hectares established under conservation management and protection</li> <li>Number of hectares established under wildlife-friendly, productive agroforestry management (evidence of producers' applying ecologically sustainable practices)</li> </ul> | <ul style="list-style-type: none"> <li>Management plans are in place, and there is evidence of their use</li> <li>Baseline and regular survey data from producers on management regimes</li> <li>Baseline and regular data from surveys into the threats to forest-dependent bird species</li> </ul> |

Important assumptions include:

- Measures that are adaptive to climate change, e.g. soil moisture retention, are successful in maintaining the viability of production systems
- Regular monitoring of threats to key threatened wild species takes place



| Objectives                                                             | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Means of verification                                                                                                                                                  |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Capability and capacity enhanced for managing forest ecosystems</b> | <p>Number of people who are trained in sustainable natural resource management, comprising the following sub-indicators:</p> <ul style="list-style-type: none"><li>• Number of people sensitised on the importance of ecosystem restoration, protection of biodiversity and sustainability</li><li>• Number of people trained in appropriate forest ecosystem restoration techniques, specific to the area</li><li>• Number of people applying sustainable agricultural practices thanks to the project; Number of people trained in the production of organic fertiliser and its application;</li><li>• Number of people trained on the demarcation of land for woodlots</li><li>• Number of producers, including number of and proportion of whom are women, expressing their increased confidence in managing parkland for sustainability</li><li>• Number of women's cooperatives with sustainable natural resource management plans</li></ul> | <ul style="list-style-type: none"><li>• Training attendance, surveys, and pre- and post-training assessment report(s)</li><li>• Management plan(s) available</li></ul> |

Important assumptions include:

- Trained personnel remain in institutions and participate in annual monitoring of populations and threats to threatened birds
- Local stakeholders participate actively and contribute to project planning
- Trained personnel remain in institutions and use skills for the management of forest lands
- Local communities will adopt management of mixed agroforestry parklands for a new source of income and follow management plans

#### Sample programme targets, linked to the indicators

- 440,000 new seedlings planted over three years
- 600,000 existing trees protected and maintained thanks to the project over three years

### 3.3 Specific targets and indicators for human wellbeing and resilience

| Objectives                                                                              | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Means of verification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Sustainable livelihood enhancement in place, local economic empowerment achieved</b> | <p>Number of green jobs created, disaggregated as follows:</p> <ul style="list-style-type: none"> <li>• Number of producers practising beekeeping and producing honey and wax as a result of the intervention</li> <li>• Number of shea, honey and wax producers who have gained access to credit, thanks to the intervention</li> <li>• Number of trainers capacitated to train others in the marketing of their honey, wax and other non-timber forest products</li> <li>• Number of trainers trained to be able to capacitate others in the development and use of three-stone fireplaces</li> <li>• Number of households trained to use three-stone fireplaces that require far less fuelwood</li> <li>• Number of savings banks established by the women's cooperatives and operational in providing revolving loans to practitioners of climate-resilient agroforestry</li> <li>• Amount disbursed in loans, number of loan beneficiaries, purpose (including green objectives) for loans</li> <li>• Number of collectively owned and cultivated plots under climate-resilient agroforestry production</li> <li>• Number of individuals benefiting directly from such collective plots (disaggregated by women, men)</li> <li>• Number of people or organisations capacitated on green business plans</li> <li>• Number of business plans created for local producers to develop sustainable enterprises based on diverse parkland products</li> <li>• Number of carbon credits sold and fair trade bonus/premium payment remunerated to local community funds for disbursement</li> </ul> | <ul style="list-style-type: none"> <li>• Evidence of green jobs created and longevity over time</li> <li>• Records of outreach meetings</li> <li>• Evidence of business plans created</li> <li>• Records of Savings and Loans Community Funds' establishment</li> <li>• Enterprise and Cooperative registration records e.g. magnitude of loans disbursed, number of beneficiaries, purpose of loans</li> <li>• Training records evidencing number of trainers trained</li> <li>• Records evidencing number of fireplaces acquired by participating households</li> <li>• Baseline and regular household survey reports</li> </ul> |

Important assumptions include:

- Integrated agroforestry systems are managed as intended for sustainable financial as well as ecological benefit
- Market prices of shea butter and other non-timber forest products are sufficiently stable, and entrepreneurs succeed in accessing markets



### 3.4 Targets and indicators for gender- and socially equitable development

| Objectives                                                                                              | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                        | Means of verification                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Women's sustainable livelihood enhancement in place, local women's economic empowerment achieved</b> | <ul style="list-style-type: none"> <li>• Proportion of producers practising beekeeping and producing honey and wax as a result of the intervention who are women</li> <li>• Proportion of shea, honey and wax producers who have gained access to credit for their sustainable activities thanks to the intervention who are women</li> <li>• Number of plant nurseries established to strengthen the production capacities of women's cooperatives</li> </ul> | <ul style="list-style-type: none"> <li>• Baseline and endline survey reports on women's entrepreneurship</li> </ul>                                                                                                  |
| <b>Sustainable use of natural resources promoted through women's economic empowerment</b>               | <ul style="list-style-type: none"> <li>• Number of women selling more shea butter from sustainably managed parklands</li> <li>• Number of women's economic cooperatives trained in commercial knowledge of non-timber forest product development from sustainably managed parklands</li> <li>• Increase in the annual income of women producers</li> </ul>                                                                                                     | <ul style="list-style-type: none"> <li>• Local committee member lists</li> <li>• Questionnaire report and forest condition assessment report</li> <li>• Baseline and endline socioeconomic survey reports</li> </ul> |

Important assumptions include:

- Women are willing to learn and actively participate in decision-making processes
- Safeguarding measures are in place to ensure women's safe participation
- Women's entrepreneurship activities generate sufficient income to serve as incentives for ecologically friendly practice

#### Sample programme targets, linked to the indicators

- 50% of producers who practice beekeeping and produce honey and wax as a result of the intervention are women
- 50% of recipients of credit for the sustainable business activities are women



### 3.5 Measuring resilience over time

Thanks to the integrated approach, sustainable development is progressing. The following key indicators show progress of ecosystem conservation and restoration efforts for people, ecosystems and biodiversity:

**Ecological recovery was secured** and the climate resilience of agroforestry production systems enhanced:

- More than 440,000 new trees were planted, nurtured and maintained – all native species with multiple biodiversity benefits, over three years. 800,000 existing trees were protected and maintained.
- Fourteen management charters were developed – delineating local conservation areas – and were adopted by village assemblies.

**Local livelihoods were enhanced** as the basis for local people's resilience, reduced vulnerability and improved wellbeing, including in gender dimensions:

- **Capacity strengthening:** More than 22,000 people were trained in income diversification and business skills.
- **Business models:** Women's economic cooperatives developed new business models for non-timber forest product cultivation, harvest, processing and sale, thanks to the training courses and outreach to over 100 community-based organisations. Women's average income in the 'Birds, Bees and Business' programme area increased by 23 percent over four years, even for those not directly enrolled in the cooperatives.<sup>21</sup> New supply chain relationships were established that continue to this day.<sup>22</sup>
- **Green job creation:** Permanent jobs for local people were created, including establishing or retraining people into green jobs in plant nursery management and beekeeping. For example, after establishing the plant nursery sites, 50 nursery workers (across

five nurseries) received technical skills training to produce and maintain ecologically appropriate seedlings.

- **Clean cooking-related emissions savings and forest protection (for adaptation and mitigation):** The Tiipaalga Association, which led in promoting improved three-stone fireplaces, succeeded in training 2,375 women trainers across 95 villages; these trainers then socialised the technology with other women in their communities. These efforts, supported by a self-managed micro-credit fund,<sup>23</sup> helped reduce fuelwood use, lower carbon emissions, and increase income-generating opportunities. More than 35,000 three-stone fireplaces were built in almost 15,800 households, saving more than 50,000 tonnes of carbon dioxide equivalent (CO<sub>2</sub>-eq) emissions each year. The carbon credits generated are sold on the fair trade carbon market: FairClimateFund provides the communities with an annual bonus payment of around 50,000 euros to invest in community-led climate change adaptation activities as a result of this arrangement – via a local women's cooperative.
- **Savings and loan community funds:** The project established hundreds of self-managed Savings and Loan Community Funds, enabling women to save regularly and access loans. By the end of the project, total savings reached the equivalent of around US\$240,000, which was disbursed in loans to over 6,000 women. These funds supported income-generating activities such as small-scale processing, trade, agriculture, and livestock, contributing to household food security, children's education, and family healthcare.



*Training on Birds, bees and business strategy © Naturama*

**Political support was secured** for forest ecosystem restoration and integrated agroforestry that creates resilience for local people in the face of climate and other shocks:

- The project secured political support from the start: it was launched by the provincial governor and also the mayor of the district.
- In total, Naturama worked with more than 200 district managers and village leaders, who were trained in sustainable natural resources management and biodiversity and sustainability issues.

**Local people's knowledge and skills were enhanced** for managing natural resources for resilience:

- The project established an important and enduring system of model farmers. The 60 model farmers have worked fields that others can visit for demonstrations
- The model approach serves to make selected fields useful throughout the year, not only in the rainy season when they are cultivated; it also showcases new technologies and techniques for the sustainable management of Sahelian agroforestry landscapes. Critically, the model field/model farmer promotes the integrated management of species and habitats in a context of significant rural land-use change.



Outstanding challenges remain:

- **Stable, functioning local government institutions are required** – which cannot always be taken for granted. The demarcation of sustainable ecosystem management zones – and their ongoing protection – requires these local institutions to be in place and running effectively at commune and village levels.
- **The establishment of small enterprises and the strengthening of their capacities is an ongoing endeavour.** The process of developing beekeeping enterprises, and of setting up the Dê Kigsina cooperative to manage the fair trade premium, all require longer-term capacity support until these local institutions and processes can run themselves.

#### Key lessons learned

Farmers now understand the importance of knowing when trees flower throughout the year so they can select species to plant according to their specific objectives (species providing non-timber forest products and/or nitrogen-fixing plants, timber production, etc.). This diversity of selected plant species ensures year-round insect presence in the field, acting as bait to attract birds, insects, and bees. This provides insectivorous migratory birds with a guaranteed food source and ensures a reliable source of pollination for crops:

“One of the key lessons is that we must carry out reforestation with biodiversity in mind. This means that the trees planted are beneficial to birds, to insects and to humans.”

**Adama Nana, Conservation Director, Naturama**

Experience suggests that future programmes should:

- Promote a similar approach of advancing key resilience and sustainability goals for local people and key species and habitats simultaneously, across other ecological zones.
- Support communities' legal process for securing productive agricultural and agroforestry land, as well as investment capital.
- Target women producers as a discrete group.
- Intentionally engage with local elected officials and seek to strengthen their capacities for sustainable management of agroforestry parklands and key wildlife habitats.
- Urge conservation organisations to integrate mixed agroforestry systems for local people (including shea parklands) into wildlife conservation initiatives in the Sahelian region.

## 4. Understanding how targets, monitoring and reporting can work well together at different scales

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### INDEPENDENT ANALYSIS – BY MAIRI DUPAR

**Technical results from Burkina Faso's shea parkland agroforestry systems may be useful across localities in the region that have similar human and physical geography, including climate characteristics climate characteristics.** Evaluation data on the climate resilience and productivity of different plant species and agroecological techniques and their contribution to improved crop yields, biodiversity and ecosystem integrity may be relevant at an eco-region scale in the Sahelian region. Naturama's results highlight the potential role for national and regional technical institutions to disseminate adaptation information across borders.

**Zooming to a global level, Burkina Faso's measures of ecosystem integrity and biodiversity in productive landscapes (outside protected areas) are directly relevant to the GGA's ecosystems target and to the Global Biodiversity Framework.** The Burkina Faso data can contribute to a global picture of climate and biodiversity outcomes by demonstrating advances in ecosystem health and biodiversity, and reversals in land degradation.

**By the same token, the capacities of local institutions are highly variable and context-specific in this case study.** Local institutional capacities can enable effective, climate-resilient production systems – or, where such capacities are missing, they might slow adaptation progress. But these enablers are particular to Burkina Faso's overall system of government and to the capacity conditions in each locality. What would be the purpose of reporting such information to a global body? The levers for change lie domestically, in the purview of domestic governance systems and the information is most relevant in national context.

Women's economic empowerment is a cornerstone of adaptation progress in this case, and it is targeted and measured in two important ways: i) by the proportion of producers benefitting from community-wide adaptation activities who are women, and ii) by the number of women-led institutions that strengthen their capacities and improve their economic and ecological outcomes. Monitoring women's empowerment in both tracks is a good practice example of gender-responsive/transformative programming for climate resilience. Interventions ensure that women have an equitable say in and benefit from activities the entire community pursues, while also assigning bespoke leadership roles to women's organisations to represent women's (traditionally marginalised) interests.

**Importantly, an assumption behind the Birds, Bees and Business model is that women will be confident enough to step up and take the leadership opportunities offered to them.** This reminds us how important it is to shift social norms that may be holding people back. Targeted actions with and through women's groups can build confidence and offer mutual support to change norms for the good. Although the data was not available for this case study, it is possible to devise indicators and systems that document people's increase in self-confidence and agency over their lives, over time. These are important aspects of resilience.<sup>24</sup>

# CASE STUDY

## Koshi Tappu wetlands: Restoring ecosystems for biodiversity, livelihoods and resilience in Nepal

By Ishana Thapa, *Bird Conservation Nepal*, and Javiera Perez Ribalta, *BirdLife International*



### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Water



Food and agriculture



Ecosystems



Infrastructure



Poverty and livelihoods



Cultural heritage



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Different value systems



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

- Habitat creation and maintenance
- Regulation of freshwater quantity, location and timing
- Regulation of hazards and extreme events
- Regulation of detrimental organisms and biological processes

### Materials and assistance

- Energy
- Food and feed
- Materials and assistance
- Medicinal, biochemical and genetic resources

### Non-material contribution

- Learning and inspiration
- Supporting identities
- Maintenance of options



## 1. About the wetland and grassland ecosystem

The Sapta Koshi River, a tributary of the Ganges, runs through Nepal's south-eastern lowlands – the 'terai' – near the border with India. Monsoon rains reach the area from late May or early June until September, causing the Koshi River to surge and flood a large area of swamplands and grasslands. Patches of *Khair-sissoo* scrub forest and mixed, deciduous, riverine forest dot the landscape. The mixed ecosystem provides important habitats for diverse wild species.

*Positioned between two flood control embankments in the eastern and western banks parallel to the Koshi River, the reserve experiences significant annual inundation during July and August. Approximately 70% of the reserve's land area is characterised by grasslands, water bodies, and riverine forests.”—Koshi Tappu Management Plan, 2024*

The embankment and river are an important stopover site for birds migrating across the Himalayan region. In 1976, a 176 sq. km area of the Koshi River's flood plain, between its eastern and western embankments, was designated as the Koshi Tappu Wildlife Reserve, a national park, to conserve habitat for the Wild buffalo. The grasslands are home to Nepal's last remaining population of wild buffalo, the Arna (*Bubalus arnee*), which is distinguished from the domestic buffalo by its large horns; together with Hog deer, wild boar, spotted deer, blue bull, and rock python.

A remarkable 535 bird species have been recorded (more than half are migratory), including 26 globally threatened species such as the critically endangered Bengal florican. The river supports 80 fish species, the endangered gharial crocodile, and the gangetic dolphin.

In 1987, Koshi Tappu was further declared a Ramsar site, a wetland of international significance. In 2004, the Government declared a buffer zone almost as large as the

**Figure 6. Map of Nepal and the Koshi Tappu Wildlife reserve**



Source: © Cartography, Chandra Jayasuriya

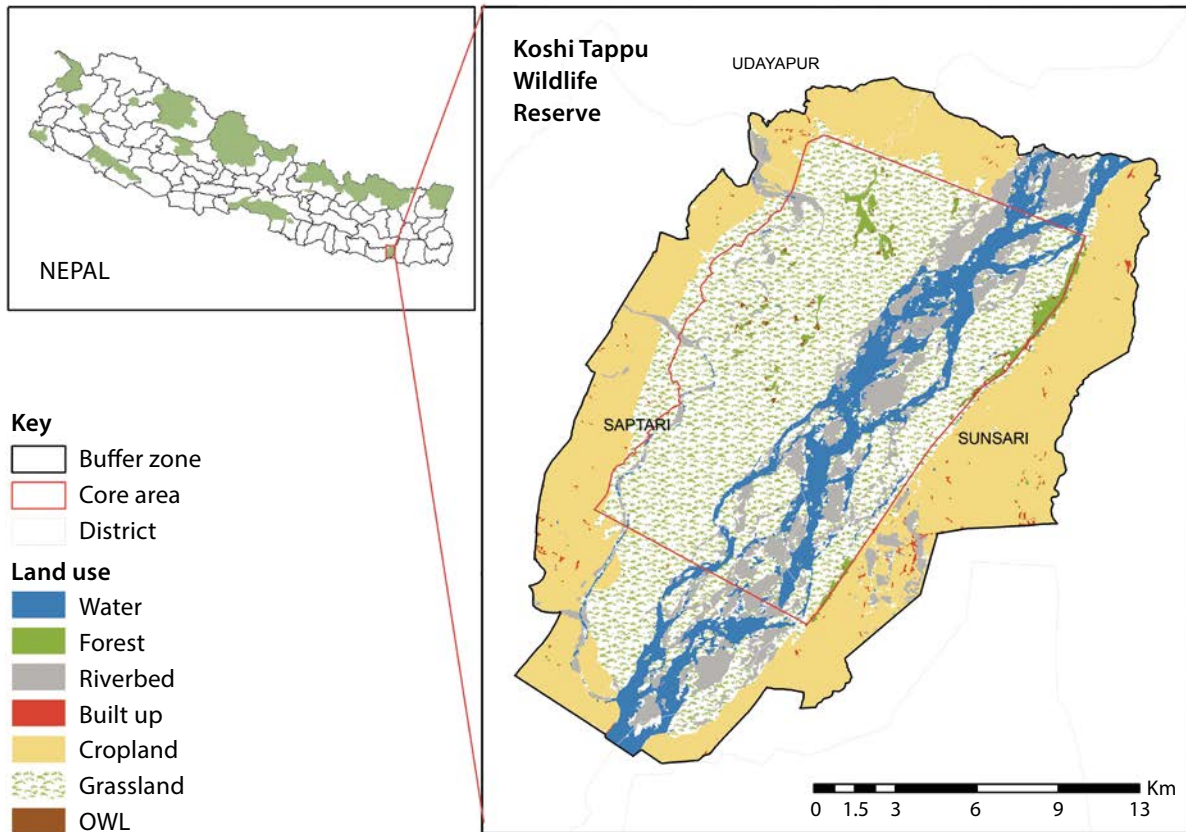
nature reserve itself (173.5 sq. km) to support local people's sustainable management and use of resources.

The ecosystem also provides functions such as water regulation, soil fertility and retention, and carbon sequestration and storage.

## 2. People's resilience in the context of a healthy ecosystem

The area's natural resources have historically underpinned local people's economic, social and cultural wellbeing. The buffer zone has 26,488 households engaged in fishing, farming, animal husbandry, and wage labour,<sup>25</sup> as well as receiving remittances from migrating family members.

**Figure 7. Koshi Tappu Wildlife Reserve and its buffer zone**



Source:

They fish in the river to obtain fish for direct consumption and for sale. They rely on the ecosystem for a variety of plant fibres for house and building construction, fuelwood, basket and homeware production, including from grasses and *Typha* plants ('bulrush' in English). Most families in the area are in economic poverty. Around a third of the local communities could be called 'wetland dependent' and of these, some 60% are classified economically as very poor.<sup>26</sup>

Recently, levels of both legal and illegal natural resource extraction reached unsustainable levels in and around the national park. Of particular concern were unfettered cattle and livestock grazing in the reserve, illegal fishing and harvesting.

Depleting the natural resource base and biodiversity impoverishes communities over the long term and makes



them more vulnerable to climate shocks. It also weakens the resilience of the ecosystem itself to recover from climate shocks.

As a way to strengthen the health of the natural environment for both people and biodiversity, Bird Conservation Nepal and its many partner organisations, with funding from the UK's Darwin Initiative, have been working to reduce pressures and restore the health of the wetland and grassland ecosystem.



### **The governance of the Koshi Tappu Wildlife Reserve and Buffer Zone**

Nepal introduced buffer zones in the mid- to late-1990s in response to conflicts between people and parks, when people were shut out or restricted from using natural resources in core protected areas. Buffer zones restrict some natural resource use but permit sustainable management, and they also allocate 30–50% of park revenues to communities. The main aim is to reduce human-wildlife conflict, sustain livelihoods and engage people in conservation. Restrictions include logging, mining, and over-harvesting, and there is a ban on poaching and illegal wildlife trade. Grazing is controlled in buffer zones, unlike on private lands. There are 13 Buffer Zone Community Forest User Groups around Koshi Tappu, all of which liaise with the national park authorities. They receive 50% of the nature reserve income from entrance tickets. A joint buffer zone and national park management concept and plan includes all agreed provisions between the government and community representatives.<sup>27</sup>

## **3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress**

### **3.1 Overarching objectives**

Bird Conservation Nepal, together with the Koshi Tappu Wildlife Reserve and community institutions such as the Community Forest User Groups and buffer zone communities, have been working together to conserve, restore and sustain a healthy environment.

Their aim? To protect the grassland and wetland ecosystems of the Koshi Tappu Wildlife Reserve, so that:

- populations of grassland and wetland-dependent bird species remain at stable levels (as a key indicator of healthy ecosystems);
- local communities' multidimensional poverty is addressed – across economic-financial, health, education and other aspects of wellbeing.

Progress in both these axes: stable biodiversity levels and improved human wellbeing, would contribute to reduced vulnerability and strengthened resilience of human and ecological systems, in the face of climate change and other shocks.

A diverse and integrated package of activities aims to achieve these objectives. The activities have involved strengthening data, planning and management:

- developing management plans for the threatened grassland and wetland ecosystems
- training of both nature reserve staff and local people (members of the buffer zone committees) on monitoring of threatened bird species and management of grassland and wetland habitats for the benefit of specific species

- studying the threats to the ecosystems, to inform efforts to improve ecosystem integrity
- implementing specific measures, such as managing grasslands to different sward heights, to meet the requirements of threatened bird species through their life cycles
- putting the management of grasslands and wetlands into community hands, as a basis for sustainable development.

Cessation of economic activities that damage ecosystems and biodiversity:

- reducing the harvest of wild fish stocks in the river running through the nature reserve
- reducing illegal cattle grazing on grasslands and wetlands to enable them to be restored and replenished

- removing alien and invasive plants from the wetlands.

And support for nature-positive economic activities that enhance local livelihoods, and benefit 5,500 households in the buffer zone:

- turning the fibres from invasive plant species into economically valuable handicrafts
- supporting women's entrepreneurial skills development and economic cooperatives to enable women to generate added value from their skilful use of natural resources to make handicrafts
- a 'one household one fish pond' programme to support households to rear fish through low-input aquaculture (instead of wild fishing)
- roll-out of improved cookstoves to deliver cooking services to households without need for over-extraction of forest resources.



Handicraft works © Bird Conservation Nepal



### One household, one pond

The 'one household, one pond' scheme engaged communities living in the buffer zone, providing alternative sources of fish protein from maintained fish ponds and helping them manage the area's grasslands sustainably to prevent over-harvesting. People and wildlife have also clashed in the area: while fishing and harvesting, people have been attacked by elephants and wild buffalo in the nature reserve. Shifting fishing from the wild river in the nature reserve into managed ponds – aquaculture – in the buffer zone and reducing the footprint of harvesting was a way to reduce these negative interactions. This is how the 'one household, one pond' initiative was born.

“The project idea was to keep the people in the buffer zone area rather than fishing in the river itself, to maintain the fish stock and minimise the human-wildlife conflict.”

**Ishana Thapa, CEO, Bird Conservation Nepal**



Grassland grass collection © Bird Conservation Nepal

The initiative came about through a partnership among local communities and their Buffer Zone User Communities, the non-governmental Bird Conservation Nepal, and the Park Authorities.

The joint idea was to build on the skills communities already had: they knew how to fish, but they would be assisted to build a fish pond for every household and rear fish in it, instead of depleting wild stocks. External organisations topped up the local people's know-how with some aquaculture training and some marketing advice for how to sell excess fish: families eat for themselves the fish they need, and sell the rest.

With dwindling wild fish stocks in the river, this provides much needed food security, and the extra income is very welcome. The inputs for the fish-rearing are few and are available in their environment (e.g. worms as food and bait), and the community has both learned to breed their own fish fries, and to access – when desired – subsidised fish fries from the government.

The 'one household, one pond' idea did not go completely to plan: some households had too little property for the idea to be viable; they did not have enough land to construct their own pond. However, the concept was adapted so that the poorest households could use a common pond stocked with fish instead, on government-owned land.

### Households blend farming with eco-tourism roles

Livestock rearing is also an important income source. For this, farmers need to get grass from the reserve. The initiative provided grass cutting machines to the buffer zone residents to make it much easier to provide feed for livestock from resources in the buffer zone area. Villagers mix cattle husbandry with vegetable farming and some ecotourism.

A few large resorts are owned by the businesspeople from big cities; villagers have also come up with 'homestay' offers, so visitors can stay with them. Some local people have received nature guide training and are now working as tourist guides.

Young people participate in the scientific surveys like-water buffalo count, water bird count, dolphin count and as nature guides. They organise some awareness events themselves, such as the Wetland Day celebration, the Wildlife Week, and the vulture awareness day. They are paid to be resource persons for these events.

#### **Turning invasive species into economic assets**

The other main initiative was to turn invasive species in the wetland environment, such as water hyacinth and the typha, into a source of fibre for handicrafts that could be a source of significant added value and revenue for local people.

Again, this intervention built on local skills and knowledge: villagers and especially village women were already skilled in weaving and other homewares from fibres in the forest and grassland, to carry rice and other goods.

The project worked with the local people to introduce designs for goods they could weave skilfully to sell to a more diverse and urbanised market base, such as pen holders, table runners and place mats. The project connected women's small enterprises with various shops in the cities – and the shops requested different designs.

This time, the plant fibres came from the water hyacinth and typha that were destroying the wetland and needed to be removed from the environment.

The nature reserve office provided the handicraft group with a space to exhibit their wares. Tourists come to the reserve for birdwatching and ecotourism. When they purchase their entry ticket, they can visit a small shop selling housewares woven from the invasive plant fibres, and hear the story of the goods' provenance.

Indicators have been important, in the context of funded programmes, to track progress towards both ecological and socioeconomic objectives. They are summarised in the next section. The indicators used by Bird Conservation Nepal and its partners were SMART indicators: Specific, Measurable, Achievable, Relevant, Time-bound. In these pages, we have simplified and summarised the indicators used so that readers may see how parameters can be used that are both applicable across diverse countries and regions and aggregable at the global level, while also able to be tailored for local circumstances.

“To build interest, you have to link what people were doing from the past. Interventions are very useful that modify what is already present, rather than bringing a very new concept or methodology that may take them a bit of time to adapt.”

**Ishana Thapa, CEO, Bird Conservation Nepal**



### 3.2 Targets and indicators of ecosystem health and biodiversity

| Objectives                                 | Indicators: measuring resilience outcomes                                                                                 | Means of verification                                                                                               |
|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Recovery of threatened species populations | <ul style="list-style-type: none"><li>Population size of important grassland and wetland dependent bird species</li></ul> | <ul style="list-style-type: none"><li>Baseline and regular population monitoring data of threatened birds</li></ul> |

| Objectives                                 | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                      | Means of verification                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sustainable use of grasslands and wetlands | <ul style="list-style-type: none"><li>Grassland and wetlands management committees that develop and follow management plans for grasslands and wetlands in the nature reserve</li><li>Proportion of people with a fishing licence who practice sustainable fishing (e.g. leave young fish in the water so that stocks are not depleted)</li><li>Number of cattle grazing illegally inside the nature reserve</li><li>Status and extent of threats to grassland- and wetland-dependent bird species</li></ul> | <ul style="list-style-type: none"><li>Management plans are in place and there is evidence of their use</li><li>Fishing licence records; fisherfolks' questionnaire and report on their responses; fish stock assessment report</li><li>Baseline and regular survey data on grazing</li><li>Baseline and regular survey data on threats to grassland- and wetland-dependent bird species</li></ul> |

Important assumptions include:

- Stakeholders in Koshi Tappu Wildlife Reserve prioritise conservation of threatened birds and their habitats
- Local government supports and collaborates to provide livelihood support to local communities
- Regular monitoring of threats takes place
- Although some level of flooding is expected and may be inevitable, the adaptation measures implemented will help the people and the ecosystem to cope and recover better from each flood event

| Objectives                                                                                 | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                           | Means of verification                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Threats are reduced to threatened bird species                                             | <ul style="list-style-type: none"> <li>• Number of nature reserve staff and community representatives who are capable of monitoring populations of threatened bird species and threats to these bird species</li> </ul>                                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• Evidence of post training data and reports prepared by reserve staff and community</li> </ul>                                                                                                                                                                |
| Capability and capacity enhanced for managing grassland and wetland for threatened species | <ul style="list-style-type: none"> <li>• Number of nature reserve staff and community representatives in buffer zone committees trained to manage existing grasslands and wetlands and restore grasslands</li> <li>• Extent of areas secured under community management</li> <li>• Number of MSc students who complete theses on population monitoring and threats to grassland and wetland dependent bird species</li> <li>• Area of disturbance of grasslands and wetlands by people</li> </ul> | <ul style="list-style-type: none"> <li>• Training attendance and pre and post-training assessment reports</li> <li>• Management plans available</li> <li>• MSc student theses produced</li> <li>• Photographs, Land cover maps, drone-captured video footage for mapping of habitat change</li> </ul> |

Important assumptions include:

- Trained personnel remain in institutions and participate in annual monitoring of species populations and threats; and use skills for the management of grasslands and wetlands
- Local stakeholders participate actively and contribute to project planning
- Local communities adopt management of grasslands and wetlands for new source of income and follow management plans



### Sample programme targets, linked to the indicators

- The populations of Bengal Florican, Yellow-breasted Bunting, Bristled Grassbird, Swamp Francolin, Grey-crowned Prinia, Indian Courser, Northern Pintail and Cotton Pygmy Goose stop declining by year 3
- Grassland and wetlands management committees with the support of the Koshi Tappu Wildlife Reserve (KTWR) develop and follow management plans for grasslands and wetlands in the nature reserve by year 3
- 300 out of 380 individuals with fishing licences are fishing sustainably by year 3
- Number of cattle grazing illegally inside the nature reserve is reduced to a target number, in a set time period; e.g. reduction of illegal cattle by 50% from 2,000 to 1,000 animals by year 3
- Threats to grassland and wetland dependent bird species are reduced by 80% within three years, from the baseline
- 20 staff and 50 community members are capable of species and habitat monitoring and analysis by year 2
- 10 staff and 50 community members are trained in habitat management in year 1
- Two grasslands of each >100-hectare area are restored in the buffer zone for threatened bird species and at least 300 hectares of natural wetlands is restored in the buffer zone, and the local community takes management responsibility for all
- Area of grassland and wetland disturbance by people is reduced, e.g. a 50% reduction between the baseline and year 3



Wild water buffalo, Koshi Tappu © Kiran Gosai

### 3.3 Targets and indicators of human wellbeing and resilience

| Objectives                                                | Indicators: measuring resilience outcomes                                     | Means of verification                                                               |
|-----------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Sustainable use contributes to household wellbeing</b> | <ul style="list-style-type: none"> <li>Annual income of households</li> </ul> | <ul style="list-style-type: none"> <li>Socio-economic assessment reports</li> </ul> |

Important assumptions include:

- Local government supports and collaborate to provide livelihood support to local communities

| Programmatic objectives                                                                               | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                | Means of Verification                                                                                                                      |
|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Sustainable livelihood enhancement programme in place to support local communities' well-being</b> | <ul style="list-style-type: none"> <li>Number of households (including proportion of Indigenous households) benefitting from training and 'one household one fish pond' programme</li> <li>Number of households benefitting from use of alternative energy (biogas/Improved cooking stoves)</li> </ul> | <ul style="list-style-type: none"> <li>Monitoring and evaluation reports</li> <li>Baseline and regular household survey reports</li> </ul> |

Important assumptions include:

- Local government will provide partial support to local communities for establishing fish ponds and biogas plant and will promote stall feeding of cattle in the project area
- Management committees will provide equal distribution of benefits from grasslands and wetlands to local communities
- Fish ponds, restored grasslands and wetlands and women entrepreneurship activities (see below) generate sufficient income to serve as conservation incentives



#### Sample programme target, linked to the indicators

- Overall, annual income of households in project area increased by 50% in set time period
- Sustainable use contributes to the wellbeing of 5,500 households
- 1,500 households benefit from 'one household, one fish pond' over three years
- 2,000 households benefit from community-managed grasslands and wetlands over two years
- 500 households benefit from use of alternative energy (biogas/Improved cooking stoves) over three years
- Number of women embarking on their own enterprises increases from baseline of 10 women, up to 100 women within three years
- Three women-led economic cooperatives become operational within three years

### 3.4 Targets and indicators for gender and social equity and rights

| Programmatic objectives                                                                                                                          | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                               | Means of Verification                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sustainable use of natural resources promoted through involvement of women, Indigenous people and local communities in decision-making processes | <ul style="list-style-type: none"><li>• Number of women and Indigenous people represented in local natural resource governance committees</li></ul>                                                   | <ul style="list-style-type: none"><li>• Local committee member lists</li><li>• Baseline and regular socioeconomic survey reports</li></ul>                                  |
| Sustainable livelihood enhancement involves women equitably                                                                                      | <ul style="list-style-type: none"><li>• Number of women embarking on their own enterprises in a set time period</li><li>• Number of women-led economic cooperatives that become operational</li></ul> | <ul style="list-style-type: none"><li>• Baseline and regular survey reports on women's entrepreneurship</li><li>• Enterprise and cooperative registration records</li></ul> |

Important assumptions include:

- Women and Indigenous people are willing to learn and actively participate in decision-making processes
- Buffer Zone Community Forest User Committees are positive to include sustainable harvesting of natural resources and conservation of threatened birds in their operation plan and implement it

#### Sample programme target, linked to the indicators

- Number of women and Indigenous people represented in local natural resource governance committees increased by over baseline in set time period, e.g. 150 women (50% increase from baseline of 100) within three years
- Number of women embarking on their own enterprises increases from baseline of 10 women, up to 100 women within three years
- Three women-led economic cooperatives become operational within three years

### 3.5 Measuring resilience over time: experiences from the Koshi Tappu Wildlife Reserve and Buffer Zone

Thanks to the integrated approach in the Wildlife Reserve and Buffer Zone areas, there is progress in sustainable development. The following key indicators show the progress of ecosystem conservation and restoration efforts for people and biodiversity:

- The capacity of local people to reduce risks to threatened wildlife species has been considerably enhanced; e.g. from 2022–25, a total of 37 reserve staff and 35 local buffer zone users were trained in active species monitoring and community-based nature conservation interventions.
- From 2018–24, 65 research projects were carried out in the reserve and buffer zone area, primarily on wildlife monitoring, such as wild water buffaloes, Gangetic river dolphins, Bengal florican, vultures, winter bird counts, etc., and undertaken by graduate students, nature societies, etc.
- An annual count of migratory waterbirds continues to track the abundance of these birds through the area over time.<sup>28</sup>
- Looking over a longer history, since the establishment of the reserve, numbers of wild water Buffaloes have gradually increased from 63 in 1976 to 498 in 2021.
- The area of grassland under sustainable management practice is being consolidated over time across both the core reserve and the buffer zone: this means the consistent application of grassland management practices such as grass cutting, ploughing, controlled burning, and cut and burn being employed in specific pockets near waterholes or wetlands; and the control of inappropriate cattle grazing by providing householders with stall feeding supplies: from 2023–25, cattle numbers inside the core reserve declined by over 31%.
- The removal of invasive species in the wetland areas has been undertaken, principally water hyacinth and the hectareage under invasive species management has been monitored carefully over time.
- The removal of invasive species in the forest areas has also been undertaken and carefully tracked: this principally concerns invasive weed species such as *Eupatorium adenophorum*, *Lantana indica*, and *Mikania michrantha*. While authorities are monitoring areas where invasive species have been removed, it is important to stress that this is not a one-off endeavour, as the invasives will come back. Thus, the true indicator of achievement is ‘area of high integrity ecosystem that is controlled for alien and invasive species’.
- Incidents between people and wildlife, where people have been injured or even killed by elephants and buffalo and property (crops etc.) have been trampled or damaged, are a major concern in the area. Nepali laws provide for monetary compensation for affected households. Activities to mitigate risk



include the installation of solar-powered fences to restrict wildlife incursions into human settlements, and patrols with the use of torches, noise and other tactics. Success is measured by a reduction in human injuries and fatalities, as seen from 2020–21 to 2021–22 thanks to the implementation of these steps (although still not at ‘zero’ fatalities as desired), and the reduction in compensation claims. Just like the work of addressing invasives, the effort for harmonious human/wildlife co-existence needs to be maintained over time.

- 484 households obtained new access to fish ponds and 340 people were trained in aquaculture over the period 2023–25 as a way of boosting sustainable livelihoods and relieving pressure on wild fish stocks in the Koshi River.
- 900 households received improved cookstoves during 2023–25 as a way of delivering energy services with less need for fuelwood from the forest; the cookstoves have the co-benefit of reducing indoor air pollution and improving, particularly women’s and children’s health.
- Some measures of people’s resilience (including their economic development and resilience) and of biodiversity have fluctuated or have fallen below desired targets. Here, the importance of using meaningful indicators consistently over time is shown, as it reveals challenges and gaps and areas where local, national and international partnerships can focus further efforts:
- The abundance of the Critically Endangered Bengal florican and also of fish stocks decreased in 2025. It is thought this is because of the reduction of floodplain habitat, although research is ongoing on the possible causes and consequences.

- The reserve stands as the premier destination for bird watching in Nepal, attracting educational tours and pleasure trips, particularly in the eastern region. From 2012–13 to 2022–23, a total of 110,188 tourists visited, generating revenue of almost 10 million Nepali Rupees and there is a rising trend in revenues. In the fiscal year 2022–23, more than 11,000 tourists visited the reserve from Nepal, SAARC countries, and other international countries; the greatest number were domestic Nepali tourists who do not pay for entry.
- Revenues from tourism in the Koshi Tappu Wildlife Reserve, of which 30–50% are disbursed to the local community for development projects, are still considered to be too low to meet community needs. Park authorities consider there is much potential to boost the attractiveness of the site and number of visits by eco-tourists, including: infrastructure for water tourism, cycling and avitourism and the establishment of homestays and cultural centres.<sup>29</sup>

“Special programmes entail the reintroduction of rhinos and swamp deer, and extending the ecological continuity of terrestrial and aquatic ecosystems, especially for the long-term conservation of mega species under potential climate change impact.”

**Koshi Tappu Wildlife Reserve Management Plan  
(2024)**





## 4. Understanding how targets, monitoring and reporting can work well together at different scales

### INDEPENDENT ANALYSIS – BY MAIRI DUPAR

**Indigenous knowledge and culture can shape markets for goods and services that are environmentally sustainable and climate resilient: demonstrating the interwoven dependencies of ecosystems, cultures and livelihoods.**

In this case, local communities, with women's leadership, have removed invasive alien plants from the ecosystem to improve ecosystem health, and used the fibres to create homewares, based on their Indigenous skill and knowledge. Communities have achieved a conceptual and practical leap by generating economic uses from otherwise ecologically harmful plants. It is an example of a 'biocircular economy' where supply and demand are driven locally.

Bio-circular economies like this, and the underpinning idea of 'turning waste to wealth', can advance multiple adaptation and resilience goals. Such principles and approaches are not currently captured in a single GGA or GBF target, but have the potential to transform systems. Major conceptual and practical advances of this kind should be well documented – even if the specifics of invasive and pest species differ from one location to another. Such innovations are not well suited to indicator reporting, but other qualitative and storytelling outlets could capture these narratives to inform global stocktakes and encourage innovation elsewhere. National reporting bodies and the secretariats of the multilateral environmental agreements could look harder at how to elevate breakthrough concepts and practices – beyond indicators of established practices and ways of thinking – to accelerate our conceptual understanding of adaptation.



Handicraft Training © Bird Conservation Nepal

**The resilience-building measures described in this case study represent a recovery after a massive hydrological disaster in 2008 when the Koshi River embankment was breached. A disaster-prone country, Nepal will face repeated instances of having to rebuild, as discovered again in 2026.** At the time of this publication's going to press in 2026, a disastrous glacier collapse in the Himalayas of western Nepal sent a deadly torrent of rock and ice down river valleys<sup>30</sup>; it is far – on the other side of the country – from the Koshi Tappu Wildlife Reserve and the embankment containing the Koshi River. However, the disaster awakens memories of the terrible 2008 disaster when the Koshi River breached its embankment, ultimately killing around 500 people and displacing millions of people in eastern Nepal and downriver in the Indian state of Bihar. As well as the human cost, the disaster impacted the biodiversity of the Koshi Tappu Wildlife Reserve and it has taken some time for the area's wildlife to recover.

There was no attribution study to establish a link between the 2008 event and climate change. A scientific assessment of the 2026 western Nepal event has linked it to climate change.<sup>31</sup> The point is that adaptation has to be seen through the prism of recovery efforts in our climate-changing world. Adaptation will need to be monitored and measured in the wake of mounting climate change impacts. This is the case for Nepal, and globally.

**Biodiversity results can fluctuate, including as a result of climate shocks that are difficult to manage on the ground. Only qualitative narratives can capture the story behind the numbers.** The abundance of key species can fluctuate, as in this case where environmental improvements supported populations of some birds, but other species' numbers decreased due to short-term

climate shocks (in this case, flood events from heavy rain). The numbers cannot tell this story in full – qualitative narratives can explain the mixed results. Furthermore, it can take some years to study and understand the underlying drivers for these changes. And for migrating species, transboundary analysis is necessary: it is possible that changes in other parts of the migration route are having effects on bird populations, even if habitat conditions in the single site improve.

**Formal collaboration between local and national government institutions creates locally effective adaptation approaches and also reporting efficiencies.**

A line department of the national government—the National Park Authority—is represented at the local level, where it manages the Koshi Tappu Wildlife Reserve. The National Park office has formal reporting accountabilities to the capital through its line relationship, and also has accountability to the local communities. Buffer zone management committees directly represent and negotiate with the local National Park office concerning communities' livelihood and ecosystem management interests. This collaboration means that management targets are negotiated locally to balance community needs and national priorities that are also aligned with internationally agreed biodiversity commitments. Zimbabwe has a similar institutional set-up (next chapter).

**Local people can be trained as citizen scientists – providing jobs and enabling them to combine local and Indigenous knowledge with scientific understanding.** This information can benefit national and international policy assessments and decision-making. Opportunities like this can also support the academic and professional development of participating local residents, when desired.

# CASE STUDY

## Driefontein Grasslands: Restoring Zimbabwe's blue heart

By Julia Pierini and Shingirai Sakarombe,  
*BirdLife Zimbabwe*, Javiera Perez-Ribalta,  
*BirdLife International* and Tambudzai Bangure,  
*Environmental Management Agency*



### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Water



Food and  
agriculture



Ecosystems



Infrastructure



Poverty and  
livelihoods



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Intergenerational equity



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

- Habitat creation and maintenance
- Regulation of freshwater quantity, location and timing
- Regulation of freshwater and coastal water quality

### Materials and assistance

- Food and feed
- Materials and assistance
- Medicinal, biochemical and genetic resources

### Non-material contribution

- Maintenance of options



**Figure 8. Location of the Driefontein Grasslands in three districts of Zimbabwe**



Source: © Cartography, Chandra Jayasuriya



## 1. About the mixed wetland-grassland ecosystem

The Driefontein Grasslands are an extensive mosaic of partly-modified grassland and wetland ecosystems across three districts in southern Zimbabwe. Although the name is 'Driefontein *grasslands*', the wetlands are an equally distinct and important ecological feature. The wetland biodiversity here is of international importance, earning the area a designation as an Important Bird and Biodiversity Area (IBA) and a wetland of international importance under the Ramsar Convention.

Driefontein is home to about 85% of Zimbabwe's total population of the globally Endangered grey crowned crane (*Balearica regulorum*) and the Vulnerable wattled crane (*Grus carunculata*). The area also provides an ideal breeding and feeding ground for the Endangered secretarybird (*Sagittarius serpentarius*), and globally Near Threatened saddle-billed stork (*Ephippiorhynchus senegalensis*) and kori bustard (*Ardeotis kori*).

Also dependent on this habitat are the black-bellied bustard, black-chested snake eagle, African marsh harrier, African Fish Eagle and several duck species.



## 2. People's resilience in the context of a healthy ecosystem

Farming in designated fields away from wetlands has failed to meet communities' food security and livelihood needs. By contrast, wetland areas are often considered fertile for agriculture. This has prompted local people to convert wetlands into agricultural land. Unfortunately, converting wetland areas into farmland has undermined resilience for both people and biodiversity.

Communities found it very difficult to obtain satisfying harvests due to poor soil quality and the ongoing loss of moisture in the wetlands before the programme started. Moisture loss resulted from both unsustainable management and, to some extent, climate variability and change. In recent years, erratic and unpredictable rainfall patterns have led to crop failure in unirrigated fields. As a result, poor rainfall and crop failure on cultivated lands have driven people to take up gardening activities in core wetland areas.

Where human disturbance has displaced natural wetlands, key species' habitats have been lost. As a result, cranes began feeding on crops when they were germinating, prompting people to scare off the birds and creating a situation that was poor for wildlife and people. Unsustainable management was making the fragile environment more vulnerable to climate impacts: the conversion of grasslands to croplands increased the risk of fire, and afforestation with eucalyptus (to be used for wood) disrupted ecosystem integrity and functioning given eucalyptus' thirst for water. The communities habitually lost track of their livestock in the wetlands and escaped livestock destroyed the wetland by trampling it.

In this context, local people needed diversified livelihoods that were not wetland-dependent and carried a light ecological footprint, while also generating

reliable incomes and economic security. A healthier, restored ecosystem with improved ecological function offered the promise of greater multidimensional resilience for local people and biodiversity.

A pilot project by BirdLife Zimbabwe, with external funding from the UK's Darwin Initiative, sought to ascertain how people's livelihoods could be sustained while also restoring and maintaining a biodiverse wetland ecosystem. The area for a pilot intervention consisted of four communities, or villages, namely, Markdale, Chinyaure 1& 2, Shashe and Daviot. The initiative 'Community livelihood and capacity support for securing Zimbabwe's wetland diversity' was implemented by BirdLife Zimbabwe and its partners over the period 2019–2022. The objectives, indicators and outcomes tracked have informed learning and adaptive management in the years since. The story of this initiative highlights important global lessons about how to balance ecosystem restoration for long-term benefit with short-term development needs, and how to set targets and measure progress.

“Climate change amplified wetland deterioration before the project: lack of water on fields pushed people into ecologically important, ecologically sensitive wetland areas to try and grow food, whereas, vital core wetland areas are needed to provide ecosystem services to people and nature.”

**Javiera Perez Ribalta, nature-based solutions specialist, BirdLife International**

### 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

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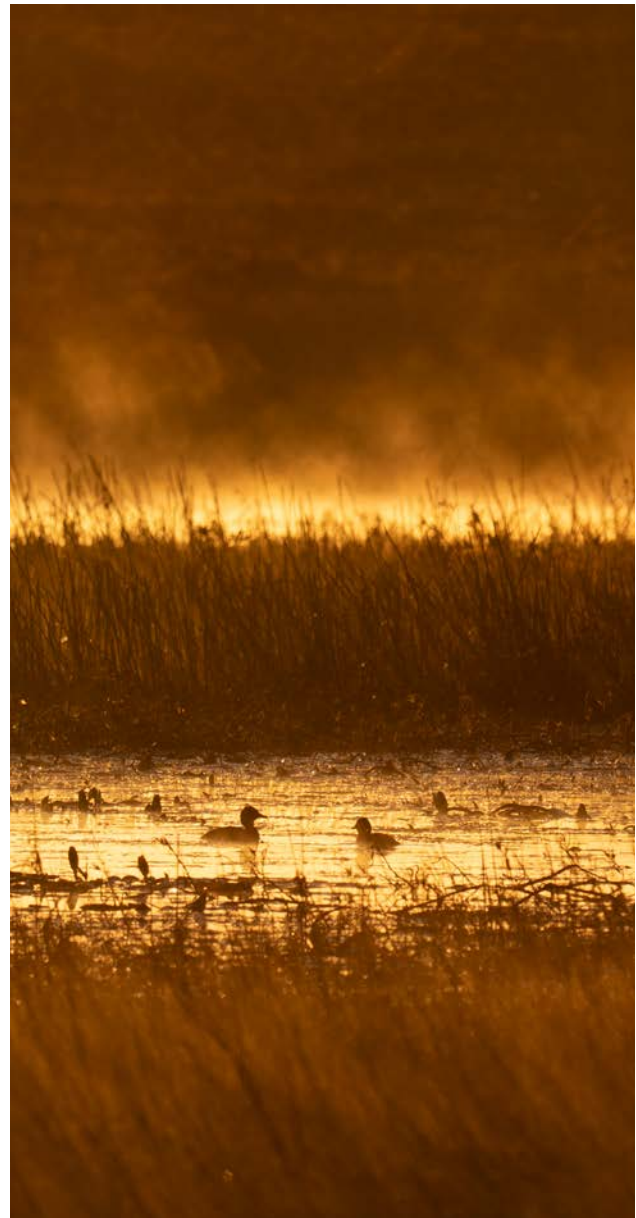
#### 3.1 Overarching objectives

Activities focused on:

- **Climate-resilient livelihoods.** Communities were provided with alternatives to crop cultivation and gardening. These included poultry, bee-keeping and pig-rearing. Livestock escape has been partly addressed by the introduction of a paddock system in Chianyaure, and some of the wetlands have also been restored through fencing to allow regeneration and relief of environmental pressure.
- **Strengthening communities' capacity.** Coaching communities to improve the integrity of the surrounding wetland ecosystems: managing land and water in the landscape, and monitoring biodiversity, including for globally threatened bird species.

Due to the diversity of micro-climates and land conditions across the Driefontein landscape adaptations were required in every small-scale locality. This meant that there was a lot to learn and adapt to.

The selection of livelihood activities was generated and prioritised by the communities themselves, in a co-design process between communities and the facilitating external organisations on the project. The involvement of the Rural District Councils was key: they could act as the representatives of and interlocutors with the local community members. Once this relationship was established, the partnership took off among the communities and the project consortium, comprising non-governmental organisations' Chikukwa Ecological Land Use Community Trust, Zimbabwe AIDS Prevention Project, BirdLife Zimbabwe and BirdLife International.



*Ducks, Driefontein Grasslands © Barend van Gernerden/BirdLife International*



### 3.2 Targets and indicators of ecosystem health and biodiversity

| Objectives                                                                                                               | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                | Means of verification                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Improved wetland status</b><br><br><b>Improved breeding success and abundance of globally endangered bird species</b> | <ul style="list-style-type: none"><li>• Soil moisture content in key wetland areas</li><li>• Presence of breeding cranes in key wetland areas (as an indicator of habitat richness)</li><li>• Number of breeding pairs of wattled crane and grey crowned crane</li></ul> | <ul style="list-style-type: none"><li>• Important Bird Area (IBA) monitoring records, baseline and annually</li><li>• Maps developed and produced showing key wetland sites and sightings of endangered crane species, at baseline and annually</li></ul> |

| Objectives                                                                         | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Means of verification                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Significant improvement of wetland management in the Driefontein Grasslands</b> | <ul style="list-style-type: none"><li>• Number of local community members trained in wetland management techniques including fire management</li><li>• Number of local community members who gain and apply skills in crane counting and bird monitoring for sustainable wetland management</li><li>• Number of agreements between District Environmental Officers and Rural District Councils on avoidance of farming in ecologically sensitive wetlands</li><li>• Changes in local bylaws on where grazing and cultivation is permitted</li><li>• Number of local government and civil society organisations that mainstream the Driefontein Environmental Management Plan into their operational strategies</li></ul> | <ul style="list-style-type: none"><li>• Training records (disaggregated by gender)</li><li>• Meeting records and minutes</li><li>• Local bylaw text changes</li><li>• Evidence in Rural District Council plans of integration and alignment with Driefontein Environmental Management Plan</li></ul> |



Conservationists discuss the wetland's restoration © Javier Ribalta Perez

### Sample programme targets, linked to the indicators

*Key wetland areas in this project context are defined as wetland areas that were scientifically identified as being critical for ecological restoration and that are managed by local communities*

- Improved soil moisture content is evidenced in at least 10 key wetland areas that were pre-identified and targeted because of their ecological vulnerability
- Breeding pairs of crane species occupy at least 6 of the 10 key wetland areas within 4 years
- The number of breeding pairs of wattled crane and grey crowned crane increases by 20% over a four-year period



### 3.3 Targets and indicators of people's wellbeing and resilience

| Objectives                                                                          | Indicators: Measuring resilience outcomes                                                                                                                                                                                                       | Means of verification                                                                                                   |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| <b>Improved household incomes, including for particularly vulnerable households</b> | <ul style="list-style-type: none"><li>• Increase in household income</li><li>• Households' income gains arise from adoption of alternative, more ecologically sustainable and climate-resilient livelihoods supported by the project.</li></ul> | <ul style="list-style-type: none"><li>• Income logs/progress reports</li><li>• Repeat survey results annually</li></ul> |

| Objectives                                                                                     | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Means of verification                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Improvement of livelihood security for communities living in the Driefontein Grasslands</b> | <p>Alternative livelihood options established and adopted by community members, which relieve pressure on key wetland areas:</p> <ul style="list-style-type: none"><li>• number of villagers trained in climate-resilient income-generating activities, including technical animal husbandry skills</li><li>• number of villagers adopting viable beekeeping, poultry rearing, pig keeping livelihoods</li><li>• number of villagers trained in financial record-keeping and marketing for their climate-resilient economic activities</li></ul> | <ul style="list-style-type: none"><li>• Baseline survey of sources of household income and livelihood completed for four villages</li><li>• Business plan for alternative income generation activities completed</li><li>• Survey results</li><li>• Repeat survey results annually, including disaggregated for vulnerable groups</li><li>• Training logs and participant satisfaction surveys</li></ul> |

#### Sample programme targets, linked to the indicators

- Household income in the project area is increased by at least 50% during a two-year period
- Number of villagers adopting viable beekeeping, poultry rearing, and pig-keeping livelihoods within two years

### 3.4 Targets and indicators for gender and social equity and rights

| Objectives                                                                                               | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Means of verification                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Improved household incomes for vulnerable households</b>                                              | <ul style="list-style-type: none"> <li>• Increase in income of female-headed households and of households with people living with disabilities or orphaned or vulnerable children, specifically</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"> <li>• Repeat survey results annually, including disaggregated for vulnerable groups</li> </ul>                                                                                                                                                                           |
| <b>Wetland conservation in Driefontein Grasslands by key stakeholder groups and inclusive governance</b> | <ul style="list-style-type: none"> <li>• Diverse stakeholders, including women and vulnerable households express their increased capacity for sustainable wetland management</li> <li>• Diverse stakeholders, including women and vulnerable households say they are satisfied that they are participating meaningfully in wetland governance, including implementation of the Driefontein Environmental Management Plan</li> <li>• Key stakeholder groups locally and nationally, such as traditional authorities, women's groups, and the Department of Gender and Women's Affairs, express their understanding and articulate their support for wetlands conservation</li> <li>• Local community women, equally as men, gain and apply skills in crane counting and bird monitoring for sustainable wetland management</li> <li>• Development of new livelihood options benefits orphans, people living with disabilities, and vulnerable households such as female-headed households caring for the sick and elderly</li> </ul> | <ul style="list-style-type: none"> <li>• Participation of traditional authorities and women's groups in meetings – meeting notes</li> <li>• Stated commitments of stakeholder groups to support wetland conservation aims and activities</li> <li>• Qualitative reports gathered from households</li> </ul> |



| Objectives                                                        | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Means of verification                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Strengthened capacities for sustainable wetland governance</b> | <ul style="list-style-type: none"><li>• Number of stakeholders who participate in training on governance, conflict resolution and gender equality</li><li>• Documentation of lessons learned from the pilot project and active exchange of learning among government and civil society actors at local and district levels, comprising:<ul style="list-style-type: none"><li>• Number of knowledge products created</li><li>• Number of learning and knowledge exchange events held</li><li>• Number of community-based stakeholders participating</li><li>• Number of national stakeholders participating</li></ul></li></ul> | <ul style="list-style-type: none"><li>• Training logs, progress reports</li><li>• Evidence of knowledge products</li><li>• Participation lists from learning events</li><li>• Qualitative evidence captured regarding stakeholders' intention to adopt lessons</li></ul> |

**Sample programme targets, linked to the indicators**

- Household income is increased by at least 50% during a two-year period for female-headed households and for households with people living with disabilities or orphaned or vulnerable children
- 50% of villagers who adopt viable beekeeping, poultry rearing, and pig-keeping livelihoods within two years are women, and 10% are people living with disabilities



Beekeeping, Driefontein Grasslands © Javieria Ribalta Perez



Community discussion, Driefontein Grasslands © Javiera Ribalta Perez

### 3.5 Measuring resilience over time: experiences from the Driefontein Wetlands

By providing alternative livelihoods for the communities, the intervention promoted improved land-use management and contributed to reduced human pressure on some of the wetlands. The result has been improved management, particularly in the targeted participating communities.

The water now seeps into villagers' lands (see 'soil moisture content' indicator, above) and has enabled them to increase the number of times they plant in their gardens from once during the rainy season to three times per year, and the moist soils also support a broader diversity of crops. Previously, maize, tomatoes, rice, and green vegetables were planted, but potatoes and other nutritious plants have since been introduced. This indicates that the

project is assisting in food and nutrition, social protection, environmental protection, climate resilience, and natural resource management.

Following the intervention, an area of 60 hectares of wetlands is now managed by local communities who have been trained in wetland and grassland conservation and also in practices for bird conservation. 75% of the restored wetlands have been recolonised by key species, such as globally threatened crane species. BirdLife Zimbabwe, the Environmental Management Authority, and the Zimbabwe Parks and Wildlife Management Authority have conducted ground surveys showing that the number of breeding crane pairs in the Driefontein Grasslands has increased.

Knowledge developed and put in practice by the communities and external partners has resulted in



effective firefighting and protection of river banks and wetland seeps. All of these activities have contributed to the reduction of human pressure on the environment and specifically on the ecologically sensitive wetland areas.

Fires were reduced by 40% in the key bird foraging and breeding areas and the quality of habitat was improved over the three-year pilot period.

One of the harder aspects of the pilot project was to secure buy-in for the integrated nature conservation and development activities from one of the local villages involved that is populated with resettled people from another part of Zimbabwe. Perhaps because they lacked a more longstanding connection to the ecosystem, it was more difficult to engage the resettled residents with the vision for ecosystem protection and enhancement.

In particular, beekeeping had mixed results: only half the hives became active, and marketing was weak. A key lesson was that one cannot assume that methods from one ecosystem will transfer directly to another, and reliable market linkages must be secured early to make livelihoods sustainable. Trainers brought in from Chimanimani were themselves unfamiliar with Driefontein's harsher conditions, creating a steep learning curve for both experts and community members. Furthermore, while beekeeping is potentially lucrative, it requires patience and its livelihood and financial returns are delayed. By contrast, chicken farming provided quick benefits to households. Communities need to negotiate and clearly understand timelines and expectations for progress in adaptation and resilience-strengthening.

Overall, there has been a deep shift across the pilot sites in explicit knowledge and practices to conserve wildlife and ecosystem health and manage resources in a more careful way that sustains farming for the longer term. For example, with the area being prone to poaching and grassland fires, the community is now very conscious of the need to protect some of the wetter areas of the wetland – and also of the need to prevent overgrazing.

The timescale for impacts of restoration is longer than the project, so there is a need for resources to monitor impacts beyond project lifetimes and for systematic inclusion of these monitoring systems in broader national systems.

“The community is monitoring many things for themselves now: it's very important because it's a part of their ownership. They feel more connected to the cranes and they report to BirdLife Zimbabwe when they see the nests present on the ground.

**Julia Pierini, CEO, BirdLife  
Zimbabwe**

## 4. Understanding how targets, monitoring and reporting can work well together at different scales

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### INDEPENDENT ANALYSIS – MAIRI DUPAR

**The presence of key species in an ecosystem can be an indicator of ecosystem health. Indicator species can create powerful resonance and provide useful information for actors at multiple scales of governance.**

In the Driefontein Grasslands, a mix of local community and national actors monitor endangered species such as the critically endangered wattled crane for multiple purposes. National agencies use the information to track biodiversity loss and recovery, including via the IUCN Red List of Species, which is published globally. The data is meaningful locally, because the presence of species like cranes in the wetlands is an indicator of ecosystem health and the wider array of nature's contributions to people. And so, these species are clear indicators of a well-functioning natural environment that local communities can readily relate to and monitor themselves.

**User-centred indicators – where people express their satisfaction with their situation – play an important part in tracking progress toward climate resilience.** In this case, the project used participant satisfaction surveys to ask a cross-section of traditionally marginalised people if they were satisfied with their involvement in wetland governance. Instruments like these can be used to establish a baseline and track results over time, just like any other indicator. As in the example above, this data can have powerful resonance for local institutions and support adaptive management by highlighting where things are going well, or where problems remain. The data can also send vital signals to national and global levels about the inclusion and leadership of the most marginalised and climate-vulnerable people.

Private sector engagement, in a context like this, can mean incubating and helping launch locally owned, locally run enterprises with an ecological and social purpose. In places like the Driefontein Grasslands, the gestation and evolution of locally led, small enterprises may be crucial to the long-term financial viability of adaptation action. Entrepreneurial training and development can even indicate progress toward sustainable financing for resilience. In a multilateral environmental agreement context, the idea of 'private sector engagement' is often implied to mean working with existing, large corporations. The Driefontein Grasslands experience implies something quite different. Private sector engagement could mean supporting locally led small enterprises, including start-ups.

**The institutional enablers for scaling up adaptation are country and context-specific. Progress on institutional enablers can be measured with indicators, but these markers make sense nationally; they are not universally applicable.** The institutional arrangements for this Zimbabwean project have been fundamental to achieving adaptation progress and point to the potential for scaling up. Namely, the Rural District Councils became successfully involved, and so, a measure of effective scaling is whether neighbouring Rural District Councils want to join similar ecosystem restoration ventures. This could be an indicator for future success, but it is a highly country-specific one.

# CASE STUDY

## Atoll nations of Kiribati and Tuvalu: Strengthening food security and climate resilience

By Yan Lai, *Live & Learn*



### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Food and  
agriculture



Health



Ecosystems  
(partly)



Poverty and  
livelihoods



Cultural  
heritage



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Intergenerational equity



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Materials and assistance

- Food
- Materials and assistance
- Medicinal, biochemical and genetic resources

### Non-material contribution

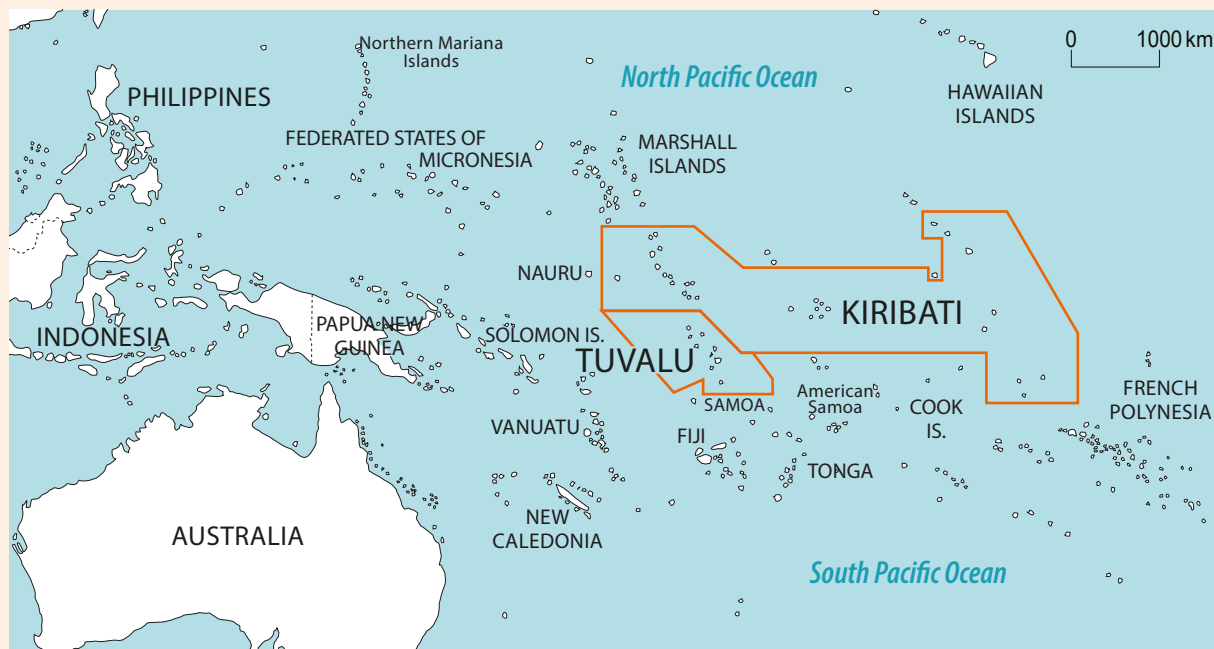
- Supporting identities



Dryland wicking bed where taro is grown © Atoll Food Futures



**Figure 9. Kiribati and Tuvalu**



Source: © Cartography, Chandra Jayasuriya

## 1. About the atoll ecosystems

Kiribati and Tuvalu are low-lying atoll nations whose physical geography presents fundamental constraints on food production. Both countries, like most atoll environments, consist of narrow coral islets with limited land area and naturally porous coral-sand soils. These soils are inherently nutrient-poor and alkaline, which limits nutrient availability to plants. The soils also lack structure, biological activity, and the cohesion to stick together due to their gritty texture. This results in soils with poor water retention, slow breakdown of organic matter, and rapid leaching of nutrients into the water table below.

Climate-related degradation worsens this soil environment. Rising sea levels and saltwater intrusion are increasingly affecting low-lying coastal soils, while more frequent droughts and extreme weather events further reduce the productivity of traditional crops and the availability of arable land. Freshwater is naturally scarce across both nations, given the thin freshwater lens (underground layer of fresh groundwater that floats on top of denser seawater) and the increasing rate of saltwater intrusion, leaving communities with little buffer against these compounding pressures.





The capital islets of each country, Fongafale in Tuvalu and Tarawa in Kiribati, experience these constraints significantly. Both are densely populated relative to their land area, leaving most households with very limited space for subsistence farming. The dense, urbanised nature of these islets means there is little vegetation available to generate organic material for compost, further limiting household-level soil improvement.

By contrast, outer islands such as Nukufetau in Tuvalu and Abaiang in Kiribati present a different physical geography. Population density is lower, so households typically have access to more land per household. This greater land area is generally accompanied by more abundant vegetation, giving outer island households comparatively greater access to organic material that can support soil improvement and food production. Overall, the physical geography of these atoll nations creates a uniquely constrained environment for agriculture and food production, with conditions varying significantly between dense urban capitals and more land-abundant outer islands for household agriculture.

## 2. People's resilience in the context of a healthy ecosystem

Ecosystem degradation within Kiribati and Tuvalu is driven predominantly by climate-related pressures rather than large-scale deforestation or land conversion, which are common drivers elsewhere in the Pacific. Rising sea levels, coastal erosion, king tides, saltwater intrusion, and increasing soil salinity threaten both natural ecosystems and agricultural production systems. These pressures reduce soil fertility, damage crops, contaminate freshwater lenses, and limit the productivity of already fragile atoll environments. In addition, dependence on imported foods has created vulnerabilities to supply-chain shocks. Combined with urbanisation, population pressure, and declining engagement in local food production, these environmental changes continue to challenge the

sustainability of ecosystem services and the resilience of communities that depend upon them.

The people of Kiribati and Tuvalu have a long-standing relationship with their atoll ecosystems, particularly through food production systems that historically supported community livelihoods, cultural identity, and food security. However, rapid urbanisation, population growth on the capital islets, changing dietary preferences, and environmental pressures have significantly altered these interactions in recent decades.

Historically, communities relied heavily on local natural resources for food production. Traditional crops such as giant swamp taro (*Cyrtosperma merkusii*) remain highly valued for their cultural significance and role in customary ceremonies and food security. Other important ecosystem assets include coconut, pandanus, breadfruit and pawpaw, which have traditionally contributed to household nutrition and resilience. These crops and trees provide multiple ecosystem services, including food provision, cultural value, shade, soil stabilisation, and the preservation of traditional knowledge and practices.

The Atoll Food Futures programme<sup>32</sup> has supported communities to reconnect with these local food systems after increasing dependence on imported processed foods. By promoting traditional crops alongside a wider range of annual vegetables, communities have strengthened their engagement with local ecosystems while improving dietary diversity and nutrition. This has helped revive traditional agricultural knowledge while introducing practical approaches that can produce food within shorter growing cycles and under challenging atoll conditions.

Despite the continued cultural importance of local food production, the relationship between people and ecosystems has changed considerably, particularly on the densely populated capital islets of South Tarawa in Kiribati and Funafuti (Fongafale) in Tuvalu. Limited land availability, poor soil quality, scarce organic matter,

and increasing access to imported foods have reduced reliance on local agricultural systems. Many households now depend primarily on imported foods, supplemented by food products sent from outer islands through family and community networks. Even traditionally abundant resources such as coconuts can be difficult to access consistently now. As a result, the direct dependence of many households on local ecosystems for daily food production has declined, weakening traditional stewardship practices and community connections to the land.

Stewardship and management of ecosystem resources are closely linked to customary land tenure systems. In both Kiribati and Tuvalu, most land is owned collectively by families and inherited through customary

arrangements. These systems play an important role in protecting land ownership rights and maintaining cultural connections to place. However, they can also create barriers to agricultural development and ecosystem restoration activities, as agreement from multiple family members is often required before land can be used for cultivation or income-generating activities. In Tuvalu, these challenges are compounded by provisions under the Native Lands Act (2008),<sup>33</sup> which restrict access to resources such as organic matter on land not owned by the individual collecting it. Given that many residents of Funafuti, the capital of Tuvalu, originate from outer islands and do not own land in the capital, access to materials needed for composting and soil improvement is often limited.



Atoll agroforestry demonstration site Funafuti, Tuvalu © Atoll Food Futures



### 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

#### 3.1 Overarching objectives

The Atoll Food Futures Program's (AFF) objective was to strengthen climate and disaster resilience in food security and nutrition in Tuvalu and Kiribati through gender-responsive, inclusive and locally led agriculture programmes and partnerships delivered from 2022–2025.

The goals of the programme were:

- Participants (including women and people with disabilities) have increased local production of fruit and vegetables through access to climate-resilient agro-ecological technologies.
- Participants (including women and people with disabilities) have improved food security and diet quality.
- Participants (including women and people with disabilities) and their local communities have increased access to fruit, vegetables, value-added food and agricultural inputs through short value chains.

The programme outcomes and indicators focused on food security and nutrition, and the interventions delivered under the programme were underpinned by agroecological principles and practices. Key characteristics of the technology and techniques included:

- Introduction of diverse crop varieties
- Targeted composting for soil health, stability and biodiversity
- Moisture retention and water efficiency.<sup>34</sup>

#### Increased local production

The AFF programme promoted climate-resilient agricultural practices to help communities vulnerable to climate change sustainably increase their food production. All training activities under the programme were designed to help communities grow nutritious food while considering climate risks and protecting the natural environment.

The programme provided support in the following key areas of climate-resilient agriculture:

- Climate-resilient technologies
- Climate-resilient crop selection\*
- Soil health management, including:
  - composting
  - organic liquid fertilisers
- Water conservation techniques, such as:
  - mulching
  - drip irrigation
- Pest and disease management
- Heat stress mitigation

*\*Climate-resilient crops were broadly defined as planting material sourced from local farmers or government nurseries that exhibit strong performance in the local atoll conditions.*

These practices were adapted to suit the unique environmental conditions of each country, addressing key climate stressors such as drought, flooding, cyclones, saltwater intrusion and sea level rise.

The programme built on the trialling of various climate resilient technologies that began under the Tuvalu Food Futures project, particularly food cubes. Food cubes are modular containers made from recycled food-grade plastic and filled with soil, which increase the reliability of crop production and food security in atoll environments.



*Kiribati farmer on the outer islands demonstrating successful adapted “dig in” (trench) garden beds © Atoll Food Futures*

They cost around \$NZ350 (USD 200) each; Tuvalu installed 80–100.<sup>35</sup> This highlighted that while food cubes proved an effective climate-resilient solution for cultivating annual vegetables and traditional root crops, they also pose several contextual challenges that affect their long-term sustainability in atoll settings, particularly accessibility and affordability. In addition, the programme explored alternative, locally sourced, low-cost climate-resilient agricultural technologies and garden beds to complement food cubes as household-level vegetable production systems suitable for low-lying atoll conditions.

Over the course of the implementation, the programme also aimed to balance the cultivation of introduced annual vegetable crops, which largely rely on imported

seeds, with the production of traditional crops that are often naturally adapted to atoll environments. This approach sought to strengthen household food security while promoting sustainable, context-appropriate agricultural practices.

### **Increased food security and diet quality**

AFF encouraged island communities to increase their consumption of fresh fruit and vegetables and improve their knowledge of healthy eating practices, with a particular focus on the consumption of produce from climate-resilient gardens supported by the programme. By reducing reliance on processed, store-bought foods and increasing knowledge of nutrition, healthy cooking and food preservation, AFF aimed to increase diet quality and overall food security.



Summary of the activities over the three years:

- **Climate-resilient, agro-ecological food production contributing to increased access to nutritious food:**

- Expanding community understanding, ability, and access to growing a diverse range of crops.
- Educating communities on how to create healthy soils for better human health.
- Providing training on culturally appropriate harvesting and storage practices.

- **Improving knowledge on nutrition:**

- Enhancing existing knowledge, skills and confidence about diet diversity and the health benefits of increasing fruit and vegetable consumption, often in collaboration with local health authorities.
- Empowering communities to make informed dietary choices.

- **Encouraging behaviours for improved consumption of nutritious foods:**

- Providing cooking classes on culturally appropriate recipes that incorporate crops grown from programme gardens, including development of local cookbooks for distribution.
- Providing food preservation training to increase shelf life and mitigate the challenges of seasonal harvests.
- Organising local competitions, hands-on activities, and culturally relevant campaigns to encourage the transformation of knowledge into action.

- **Improved value chains of locally grown food:**

Throughout the AFF programme, a range of activities were implemented to strengthen the capacity of

individuals, community groups, and local entities to engage in value addition and market linkages for agricultural inputs, fruits, vegetables, and food products. Key activities included the following:

- **Skills development:** workshops delivered in collaboration with local government.
- **Provision of tools, equipment, and supplies:** Community nurseries, women's groups, youth groups, and other local entities were supported with tools, equipment, and training (e.g. shredders, grinders, etc.) to increase the production of gardening inputs such as compost and processed food products.
- **Market days and provision of food stall infrastructure:** Where formal local markets were limited or absent, AFF organised market days to provide participants with opportunities to sell produce directly, and provided them with physical equipment to do so.
- **Cooperative and local government engagement:** Where cooperatives existed, AFF worked with them to strengthen operations. In locations without functional cooperatives, AFF collaborated with local government to support the revitalisation of cooperative entities for collective production and marketing.
- **Informal development of short value chains:** AFF facilitated communication, coordination, and transport between producers and customers, effectively acting as an intermediary to establish initial market linkages.

Value chain development is inherently gradual; as such, many of these initiatives remain at an early, nascent stage but demonstrate strong potential for future growth and consolidation.

3.2 Targets and indicators for ecosystem health

| Objectives                                                                                                                                                                                                                                                                                        | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                                             | Means of verification                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Participants (including women and people with disabilities) have increased local production of fruit and vegetables through access to climate-resilient agricultural technologies.                                                                                                                | <ul style="list-style-type: none"><li>• Percentage of participants that report increased production (volume, frequency) of fruit and vegetables over the AFF project period (disaggregated by sex and disability)</li><li>• Average weight of fruit and vegetables grown annually per participant per technology introduced</li></ul> | <ul style="list-style-type: none"><li>• Baseline survey</li><li>• Monthly monitoring template</li><li>• End of project beneficiary survey</li><li>• End of project interviews</li><li>• Case studies</li></ul> |
| Important assumptions include: <ul style="list-style-type: none"><li>• An increase in production volume demonstrates increasing soil health and biodiversity, noting that in the case of AFF, these are typically contained to backyard gardens and targeted composting for garden beds</li></ul> |                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                |

Sample programme targets, linked to the indicators

- Increase of 80% of participants reporting increased food production, from baseline (disaggregated by sex and disability)
- Average of 6.97kg of fruit and vegetables grown per annum, per participant, per technology, for example per raised garden bed or per food cube (This is only an approximate value based on previously known average yields from a single food cube in Tuvalu)



Kiribati garden demonstrating all introduced technologies: food cube, raised garden beds, growing a variety of crops © Atoll Food Futures



### 3.3 Targets and indicators for human wellbeing and resilience

| Objectives                                                                                                | Indicators: measuring resilience outcomes                                                                                                                                                                                                                                                                                                                          | Means of verification                                                                                         |
|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Participants (including women and people with disabilities) have improved food security and diet quality. | <ul style="list-style-type: none"><li>• Proportion of participants report a reduction in moderate and severe food insecurity utilising the Food Insecurity Experience Scale (disaggregated by sex and disability)</li><li>• Proportion of participants with MDD-W score of 5 (disaggregated by disability)*</li></ul> <p>* MDD-W score of 5 is the ideal score</p> | <ul style="list-style-type: none"><li>• Baseline survey</li><li>• End of project beneficiary survey</li></ul> |

#### Sample programme targets, linked to the indicators

- 50% of participants report a reduction in moderate and severe food insecurity utilising the Food Insecurity Experience Scale (disaggregated by sex and disability)
- Average of 6.97kg of fruit and vegetables grown per annum, per participant, per technology, for example per raised garden bed or per food cube (This is only an approximate value based on previously known average yields from a single food cube in Tuvalu)
- 50% increase in participants increasing MDD-W Score to 5 (disaggregated by disability)



*Tuvalu household gardener demonstrating variety of technologies: food cubes, dryland wicking beds © Atoll Food Futures*

### Box 3. Using international food and gender-diet metrics

#### **About the Food Insecurity Experience Scale (FIES)**

The FIES is an experience-based metric of food insecurity severity. The FIES estimates the percentage of a population that has difficulty accessing enough safe and nutritious food for normal growth and development and an active, healthy life. It relies on people's direct responses to eight questions about their experiences facing constrained access to food.

The methodology is versatile and can be used to report on SDG Indicator 2.1.2 and to develop additional indicators that measure recent and annual food insecurity at household and at individual levels.



Source: <https://www.fao.org/measuring-hunger/access-to-food/applying-the-fies/en>

#### **Minimum Dietary Diversity for Women (MDD-W)**

The Minimum Dietary Diversity for Women (MDD-W) indicator was developed by FAO and partners to fill the need for a low-cost food-based indicator for

assessing dietary diversity as a proxy for dietary micronutrient adequacy. MDD-W is a simple yes/no indicator of whether or not women of reproductive age (aged 15 to 49 years) have consumed at least five out of ten defined food groups in the previous 24 hours. The higher the proportion of women in the sample reaching this threshold, the higher the chance that women in the population are consuming micronutrient-adequate diets.



<https://www.fao.org/nutrition/assessment/tools/minimum-dietary-diversity-women/en/>

The AFF programme disaggregated data by sex and disability for primary end-of-programme outcomes as part of its Gender Equality, Disability and Social Inclusion (GEDSI) measures. Below is a short summary of the GEDSI integration across the programme, and further insight can be shared through a specific GEDSI report developed for the end-of-programme obligations.

Guided by the *Atoll Food Futures GEDSI strategy* (2024), AFF recognises that geographic, social, economic and cultural contexts differ across target countries, and that a 'one size fits all' approach will not adequately address marginalisation.

Instead, AFF promotes localisation and contextualisation to ensure that inclusion is both meaningful and sustainable. The programme applied a twin track approach, mainstreaming GEDSI principles across activities, while also implementing targeted actions to support equal access to and benefit from agricultural programming for marginalised groups, including women, people living with disability, LGBTQIA+ people, young people and the elderly.



### 3.4 Measuring resilience over time: experiences from Atoll Food Futures

Between 2022–2025, the programme increased the production and consumption of locally grown vegetables and fruit among 739 households across 12 communities, contributing to strengthened climate and disaster resilience, and increased food security through gender-responsive agricultural programs.

The programme specifically sought to measure impact by seeing whether people were more food-secure as a result of having access to fruit and vegetables, produced in a more climate-resilient way. Evidence suggests this goal was achieved: 50% of participants began gardening after joining the programme (63% men and 37% women). 81% of participants (85% of participating men, 76% of participating women) reported that they had sufficient access to the compost and planting materials needed for their gardening – as compared to just 45% of participants beforehand. Participants report improved confidence, knowledge and skills in climate-resilient agriculture practices (86% are ‘very’ or reasonably confident in climate-resilient agriculture skills). As a result, 94% of all participants (91% of participating men, 95% of women) have increased their fruit and vegetable production.

No baseline data is available on participants’ level of agricultural production before the intervention. Therefore, the data presented below asks participants to compare their current production with what they thought it was before the programme and draws on other available data as a proxy. This is augmented with qualitative evidence from participants on how they feel their production methods, diets and lives have improved.

There is quantitative evidence to show how participants’ food security and dietary quality improved as a result of the programme:

- By the end of the third year, 74% of all participants grew at least one crop from each of the four groups (\* perennial leafy greens, root crops, fruit and annual vegetables), up from 65% in year 1.
- 82% of all participants (84% of men, 81% of women) report to be ‘very’ or ‘reasonably’ confident in cooking, nutrition and food preservation now, compared to just 8% exhibiting such confidence before AFF.
- Outcomes in regard to improved consumption of fresh fruit and vegetables were strong, with 99% of all participants (98% of men, 100% of women) now eating from their gardens, with most (88%) reporting to eat 2–3 times per week or more, compared to 27% before AFF.
- On average, participants reported greater dietary diversity and an overall downward trend of food insecurity since participating in the AFF programme. Over two-thirds (78%) of women participants recorded an MDD-W score of 5 or above, meaning that they were recorded to have eaten from 5 or more food groups, a level required for minimum diet diversity. Overall, food insecurity decreased among **56%** of participants.
- In comparison between 2022–2023 Food Insecurity Experience Scale data and 2024–25 data, there was an average **reduction in moderate food insecurity by 9%**, and an average **reduction in severe food insecurity by 11%** for participants in the two countries, Tuvalu and Kiribati.

#### Insights to guide future interventions

Experiences from the AFF programme have highlighted key learning that the implementers seek to apply to future programmes. These include the reflection that gender equality, disability and social inclusion (GEDSI) should be integrated into all stages of the programme cycle from design through implementation through MEL. A key strategy for doing this is by engaging fully with older people’s organisations, women’s and youth organisations

to leverage their local expertise and lived experience. Change starts from within, too: programmes benefit from having GEDSI focal points who provide targeted support to staff, promote intentional and consistent inclusion, and help embed GEDSI into design, delivery, and monitoring. They can also run targeted staff training sessions focusing on techniques and strategies to assist people who need practical accommodations to benefit optimally from adaptation programmes, such as the elderly or people living with disabilities. Learnings from AFF highlight that promoting gender equality, disability and social inclusion is an ongoing process, requiring flexibility, local engagement and intentional design.

“Most of all, we have validated the importance of prioritising accessible, adaptive, and contextually relevant interventions – carefully considering local contexts and prioritising the inclusion of traditional and Indigenous knowledge”

**Yan Lai, Programme Manager, Live & Learn Environmental Education**

#### **Box 4. An unexpected outcome: water efficiency**

One outcome of the programme was positive and somewhat unexpected. Participants discovered that food cubes significantly improve the water efficiency of production and reduce householders' workload and time needed for fetching water.

Tererenti Tiiman, a householder in Abaiang, Kiribati, tells the story from his personal experience. He and his family received food cubes, gardening tools, and training in compost-making to improve soil quality; his wife attended workshops for cooking and food preservation. Tererenti's family were able to increase production of cabbages, eggplants, pumpkins, cucumbers and melons so that they now have a surplus to sell, which provides meaningful income. The extra income helps cover

school expenses for their son, who is studying in Tarawa (the main atoll), a source of great pride to the family. In using the food cubes, they realised that they needed only one-fifth the amount of water previously needed, and this cut their workload significantly:

*“Before, we would walk to the well – which is a short distance away in the middle of the kainga [small group of extended families living together] – and fill up our buckets again and again just to water the garden. The traditional garden needed about 10 buckets of water every day. But with the food cubes, we only need a few buckets every 2–3 days. Now we have more time. Food cubes – everyone should have one!” – Tererenti Tiiman, Abaiang*



Source: Excerpted with permission from Live & Learn (2026), Atoll Food Futures. More than just saving water in Kiribati. Melbourne: Live & Learn. <https://livelearn.org/resources/case-study-more-than-just-saving-water-in-kiribati/>



Tungaru Youth Association Compost Microenterprise, Kiribati  
© Atoll Food Futures

## Box 5. 'The right ingredients'

For the past three years, members of the Tungaru Youth Agriculture in the Kiribati capital of South Tarawa have been slowly building a dream. A dream made of just the right mix of seaweed, chicken manure, green and brown leaves, coconut husks and rusty iron – all mixed in precise proportions to produce South Tarawa's best, and only supply, of organic compost. Tungaru Youth Agriculture is a subsection of Tungaru Youth Action, a dynamic national youth organisation that aims to equip youth in Kiribati with the tools they need to reach their full potential.

*"We are all young, unmarried men. We work here, sleep here and cook here on the farm together like brothers. We came together because we have an interest in*

*growing food and helping the community to grow food."* – Tungaru Youth Agriculture participant

The Tungaru Youth Agriculture established a farm site alongside the runway of Kiribati's Bonriki International Airport, where they are establishing new gardens and a small commercial compost enterprise. It is here that their dream is finally becoming a reality. The demand for both garden produce and compost alike is extremely high, and the group is on the cusp of establishing themselves as a successful local enterprise.

*"We want to help people – so we're not just selling them compost, but teaching them how to use it, and how to look after their plants."* – Tungaru Youth Agriculture participant



Source: Excerpted with permission from Live & Learn (2025), Atoll Food Futures. The Right Ingredients: Tungaru Youth Agriculture compost social enterprise. <https://livelearn.org/resources/case-study-south-tarawa-youth-group-compost-enterprise/> Melbourne: Live & Learn.

## 4. Understanding how targets, monitoring and reporting can work well together at multiple scales

### INDEPENDENT ANALYSIS – BY MAIRI DUPAR

**Imagining and progressing ‘Ecosystem-based Adaptation’ on land looks quite different in atolls than in other terrestrial contexts.** Atoll islands are unique environments that do not offer the same kinds of land-based ecosystem services to their human residents as other environments, due to their poor soil and tiny size. Even freshwater provision by natural systems looks different: being available through freshwater lenses that sit on top of heavier saline water, rather than through rivers or watersheds or groundwater aquifers. The concepts of ecosystem integrity and nature’s contributions to people are globally recognised concepts that can be applied in atoll nations, but they manifest entirely differently here than in other contexts. The soil is essentially ground coral and stone with little organic substance; and so, enriching agro-ecological systems in this context calls for mixing unique organic components at hand, as the Tugaru youth found.

**The right to a healthy environment – one of the key global human rights – has different practical applications in atoll contexts than it does in other places on Earth.** The human rights basis for climate change adaptation is central to the Paris Agreement’s global goal on adaptation framework and to the Global Biodiversity Framework. In atoll nations, like Tuvalu and Kiribati, this right has unique implications. The vast ocean environment and people’s ancestral knowledge as seafarers and ocean stewards afford them access to the fruits of the sea. But the fruits of the land are altogether scarcer. It takes highly tailored, contextualised approaches like the AFF programme to realise a healthy land environment in atolls that provides plants for food and nutrition and fibres in residents’ own environment, without relying on expensive imports.

Gender can play a dominant force in how people are expected to shape and implement adaptation actions, within their local and national contexts. Gender roles are shaped by society, whether those pertain to expectations around male or female roles, or the third gender or gender-fluid identities indigenous to many Pacific societies. In this example, we see that within a traditional household, the wife was the one to access tailored food preparation workshops, for example.

**Given the reality of gender roles, it is important to co-create local adaptation goals and targets that are gender-responsive and incorporate diverse social groups’ priorities. Equally, it is highly feasible and desirable to measure and monitor adaptation progress that is disaggregated by gender.** Such a gender-responsive approach, which also can speak to LGBTQIA+ people’s priorities and wellbeing, creates visibility for the benefits enjoyed and challenges encountered by different social groups. Only by having this information can interventions be managed adaptively to address shortfalls and gaps.

**Stories have real power: stories from people who are implementing adaptation can reveal unintended as well as intended consequences of adaptation actions and put the ‘L’ for learning into ‘MEL’.** Stories and supporting processes for gathering qualitative information can yield critical insights that initial monitoring and evaluation frameworks could miss. This is exemplified by the story of the household that discovered the water-saving, labour-saving benefits of food cubes. These stories help communities and programmes to learn and do better. When stories are compiled and analysed at an aggregated level, they may teach the country or the international community important lessons about the deployment of adaptation technologies and approaches: lessons that could be useful to know elsewhere.

# CASE STUDY

## Yule Island's reefs: Building resilience through community-led restoration in Papua New Guinea

By Lauren Hodgson  
and Annelise  
McDougall, *Kyeema  
Foundation*



### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Water



Food and  
agriculture



Health



Ecosystems



Infrastructure



Poverty and  
livelihoods



Cultural  
heritage



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Different value systems



Intergenerational equity



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

- Habitat creation and maintenance
- Pollination and dispersal of seeds and other propagules
- Regulation of climate
- Regulation of freshwater and coastal water quality
- Formation, protection and decontamination of soils and sediments
- Regulation of hazards and extreme events

### Materials and assistance

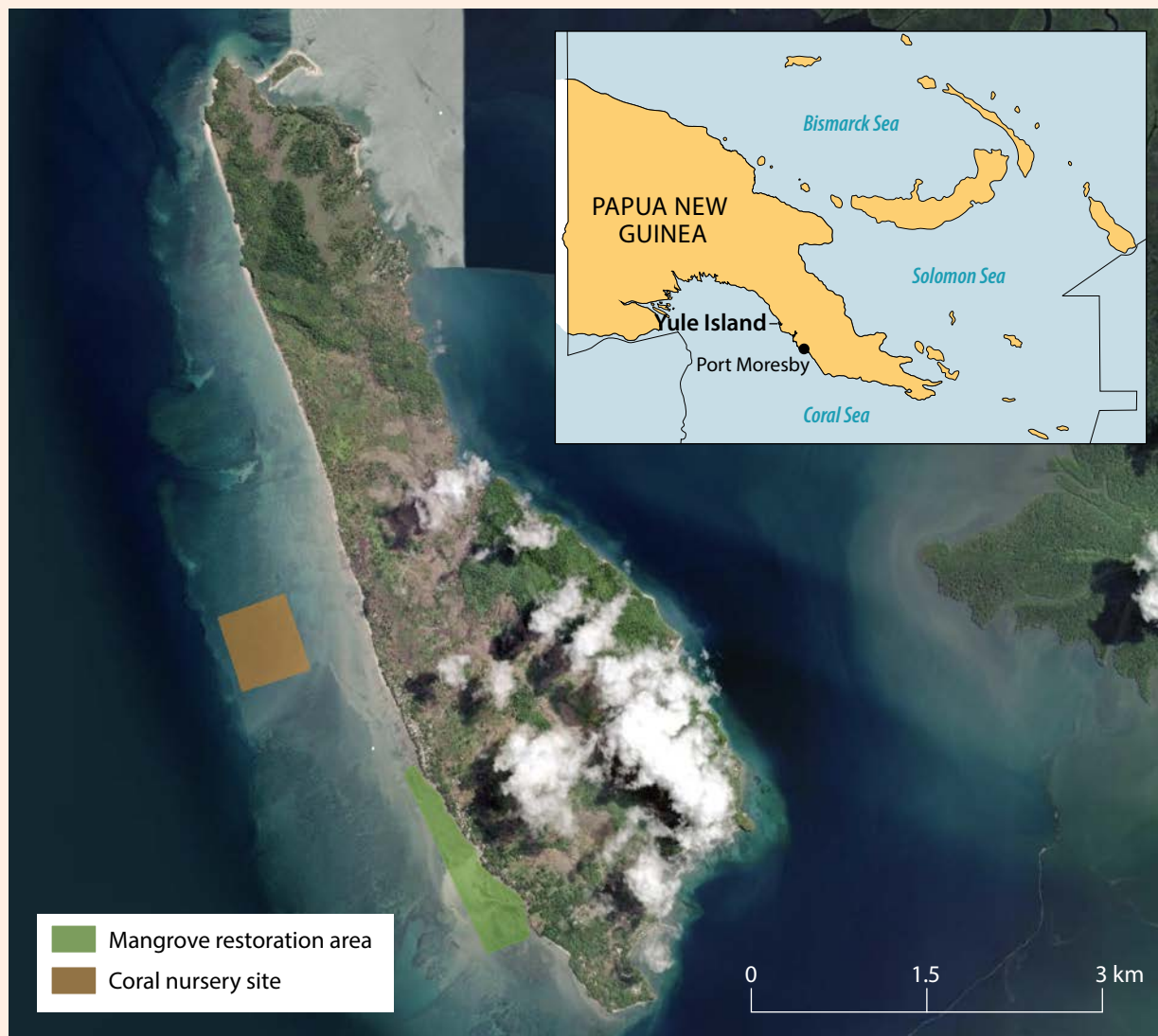
- Food and feed
- Materials and assistance
- Medicinal, biochemical and genetic resources

### Non-material contribution

- Learning and inspiration
- Physical and psychological experiences
- Supporting identities
- Maintenance of options



**Figure 10. Distribution of coral reef and mangrove habitats around Yule Island, Papua New Guinea**



Source: © Satellite imagery sourced from Arc GIS/Cartography, Chandra Jayasuriya

## 1. About the coastal and marine ecosystem

Yule Island is a small, low-lying island located off the southern coast of Papua New Guinea in Central Province, approximately 160 kilometres northwest of Port Moresby. Situated within the Coral Triangle, a global epicentre for marine biodiversity, the island is part of one of the richest and most diverse tropical coastal ecosystems on Earth. Yule Island consists of a raised coral platform covering approximately 7km<sup>2</sup> and is surrounded by extensive fringing coral reefs and mangrove forests that shape its physical geography and ecological profile. A fringing reef is one that

grows along the coastline of an island or landmass and is separated from the shore by narrow, shallow lagoons.

The seaward side of the island is protected by a fringing reef that extends approximately 2.4 kilometres westward from the shoreline, with an additional reef located at the island's northwestern end. Together, these reefs form the foundation of a highly productive marine ecosystem and provide essential habitat for fish populations whose abundance is closely linked to reef condition. The island's fringing and barrier reefs also form natural breakwaters along the southern Papua New Guinean coast, with their complex reef structure dissipating up to 97% of wave energy and protecting the shoreline from coastal erosion.<sup>36</sup>



*The team of reef stewards during coral restoration activities © WWF-Australia/Tom Vierus*



Mangrove forests dominate the shorelines surrounding Yule Island and extend along the adjacent mainland for several kilometres on either side, with the exception of small, isolated beaches where coastal villages are located. These mangroves form part of the broader New Guinea Mangrove Ecoregion, the largest and most diverse mangrove ecosystem in Papua New Guinea, covering approximately 37,407 hectares and containing 72 mangrove species. Species such as *Rhizophora*, *Avicennia*, and *Bruguiera* provide critical habitat for fish, crustaceans, birds, reptiles, and other fauna, while helping to buffer the island's low-lying coastline from erosion, tidal inundation, and storm surges. These mangroves also contribute to climate change mitigation by sequestering and storing carbon, with mangrove ecosystems capable of storing up to four times more carbon per hectare than typical land-based tropical rainforests.<sup>37</sup> Despite their ecological significance, climate change is the single biggest threat facing the coral reef and mangrove habitats surrounding Yule Island. Rising sea temperatures and ocean acidification are contributing to coral bleaching and associated coral mortality, leading to observable declines in local fish populations and reef condition. At the same time, sea levels are projected to rise by approximately 5–15 centimetres across Papua New Guinea by 2030,<sup>38</sup> threatening the long-term survival of coral reef and mangrove habitats that are fundamental to the ecological integrity of Yule Island and closely linked to the livelihoods and traditional way of life of local communities.

## 2. People's resilience in the context of a healthy ecosystem

The fringing coral reefs and mangrove forests surrounding Yule Island are more than biodiverse ecosystems. These interconnected habitats have sustained local communities for generations, providing an essential source of food and income in a landscape where agricultural production is constrained by

limited land and relatively infertile coral-derived soils. Community members describe the ocean as a “divine blessing” that provides food, income, and cultural connection, with the health of the marine environment directly linked to their ability to meet household needs and support future generations.

Across Yule Island, the fringing reefs form highly biodiverse nursery habitats that sustain fish populations and provide important fishing grounds for local communities. Fish and other marine resources harvested from these reefs have been dietary staples for generations and continue to provide a source of protein and income for subsistence households across the island. Fishers travel to the reefs using dugout canoes or motorised boats and primarily target reef-associated species using traditional methods such as hand lines, spears, diving, and nets. Yule Island's waters also serve as a key breeding and spawning ground for the ornate rock lobster (*Panulirus ornatus*), known locally as “Yule Island Gold”, with communities traditionally harvesting these lobsters during migration seasons to support both household livelihoods and small-scale cash economies.

Mangrove forests are similarly important to the resilience of Yule Island communities by providing a natural barrier between land and sea. Covering much of the island's coastline, their dense prop-root systems help dissipate wave energy and reduce shoreline erosion, making them a critical first line of defence for the villages and households located along the coast. Despite their importance, mangrove ecosystems are under increasing pressure from rising sea levels, extreme weather events, and local timber harvesting, contributing to coastal erosion and shoreline retreat across parts of the island. While mangrove forests can adapt to gradually rising sea levels, evidence suggests that rates exceeding 6 mm per year may outpace their capacity to adapt and lead to widespread mangrove die-off, further weakening the natural protection they provide along the coastline.<sup>39</sup>



Susan Aku, in the Yule Island mangrove nursery holding a propagated seedling © Kyeema Foundation/Lauren Hodgson

Among the island's four resident clans, many households have already relocated their homes away from the shoreline due to erosion, with community members reporting that changes to the coastline are becoming increasingly apparent each year. These changes are leading to growing concerns for the future, as continued erosion places homes and burial sites at risk of being lost to the sea.

Over recent decades, community members have also noticed changes in the marine environment. Fish populations that were once abundant in the waters surrounding Yule Island have declined, requiring

*“The sea is our gold... the soil here is not fertile. The sea is what we benefit from, so we need to protect it for future generations”*

**Yule Island community member**

subsistence fishers to travel further offshore and spend more time at sea to achieve the same catch. This can increase their exposure to rough sea conditions and place additional pressure on their ability to provide food and income for their families. Fish are also reported to be smaller than in previous generations, and ornate rock lobsters, once common, are now rarely encountered. These ecological changes are making it increasingly difficult for many households to maintain traditional subsistence livelihoods, particularly for families without boats, fishing gear, or the financial means to purchase fuel and travel further offshore.

*“Finding fish is a bit hard. Before, fish used to come right to the shore, but now people have to go right out to find fish. So, it could be the climate change that we are experiencing”*  
– Yule Island Community Member

In light of these changes, healthy coral reefs and mangrove ecosystems remain central to the resilience of Yule Island communities, with well-functioning ecosystems providing food, income, and coastal protection, enabling households to recover from environmental and economic shocks. As coral reefs and mangrove forests deteriorate, so too does the resilience of communities that depend on them, making restoration and protection efforts essential for strengthening community resilience in the face of a changing climate and ensuring traditional ways of life continue for future generations.



### 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

#### 3.1 Overarching objectives

From May 2022 to March 2026, Kyeema Foundation (Kyeema) and Corals for Conservation (C4C), with support from the World Wide Fund for Nature (WWF), implemented a four-year nature-based solutions project on Yule Island, Papua New Guinea. Building on Kyeema's existing relationships on Yule Island, the project was developed in consultation with the Chief and community representatives to respond to locally identified needs. The project aimed to strengthen community resilience to climate change by restoring degraded coral reef and mangrove ecosystems while supporting sustainable livelihood opportunities.

Through an Indigenous-led, community-centred approach, the project combined coral reef restoration, mangrove rehabilitation, and livelihood diversification activities. Recognising that ecosystem restoration takes time and cannot be achieved in isolation, the project introduced backyard village chicken keeping to provide households with an additional source of food and income while reef ecosystems recovered. By strengthening local capacity and engaging community members across generations in the stewardship of coastal ecosystems, the project aimed to reinforce existing knowledge and skills to protect Yule Island's reefs now and into the future.

#### Community-led restoration of coral reef and mangrove ecosystems

Guided by the [Reefs of Hope](#) methodology developed by Dr Austin Bowden-Kerby, the project focused on identifying, protecting, and restoring naturally heat-tolerant corals that had demonstrated an ability to survive warming ocean temperatures. The methodology uses these resilient corals to establish nurseries or gene banks

and strategically outplant them in dense restoration patches, with the aim of supporting coral reproduction and the natural recovery of degraded reefs that are better able to withstand future ocean warming. To implement this approach on Yule Island, the Chief selected a young woman from the community to coordinate coral restoration activities and lead a team of local reef stewards, primarily young community members in their early twenties. Although the reef steward team was predominantly male, in part due to caring responsibilities that made women's participation in offshore activities more difficult, women's interest and engagement grew over the life of the project, with more women becoming actively involved in reef restoration activities.

Throughout the four-year project, the team of reef stewards received training and support from Kyeema and C4C in coral reef ecology, coral propagation, nursery management, ecological monitoring, and mangrove rehabilitation.

The ecological restoration activities were implemented through a community-led governance model, with the Chief providing local oversight, the local coral restoration leader coordinating day-to-day implementation, and the team of reef stewards establishing and monitoring coral nurseries. This approach ensured that restoration efforts were locally owned while also creating opportunities for community members to develop the skills and confidence to lead future conservation efforts. As a result, capacity strengthening became the heartbeat of the project, with the aim not only to restore degraded coral reefs and mangrove ecosystems, but also to equip community members with the knowledge and skills needed to become long-term stewards of their reefs.

Coral restoration activities began with surveying the reefs surrounding Yule Island to identify naturally heat-tolerant corals located within nearshore reefs and shallow lagoons known as "hot pockets". These areas currently support some of the most bleaching-resistant corals in local waters;

however, as ocean temperatures continue to rise, even these corals are expected to exceed their thermal limits unless they are moved to cooler waters. By targeting these corals for propagation, restoration efforts focused on colonies with the greatest potential to survive future warming and bleaching events.

Fragments from bleaching-resistant corals, particularly habitat-forming species such as *Acropora*, *Porites*, and *Pocillopora*, were rescued and translocated to a reef-based rope nursery established in cooler waters. The purpose of this nursery was to maintain a living repository of bleaching-resistant coral genotypes and provide a sustainable source of coral fragments for future restoration activities. The nursery was located in an area with good water flow and protected from cyclone waves and strong currents to ensure the heat-adapted corals could be maintained over multiple years.

As corals within the nursery grew, the team of reef stewards harvested fragments to establish A-frame and spider structures within degraded reef areas surrounding the nursery. These outplanting sites were designed to increase coral cover, provide fish habitat, and create strong settlement signals for incoming coral larvae. By clustering diverse strains of coral species within the outplanting sites, the project increases the likelihood of crosses between bleaching-resistant and cool-adapted strains when the corals spawn. These crosses may produce more heat-tolerant coral larvae, helping spread resilience to ocean warming more broadly across the reef.

Beyond nursery establishment, monitoring and maintenance formed an important component of the project, with both the nursery and outplanting sites requiring ongoing care to ensure corals remained healthy. The team of local reef stewards monitored the nursery and outplanting sites on a monthly basis, with a focus on recording coral health, growth, and survival, along with fish abundance and diversity. While an important reporting mechanism, monitoring was primarily designed as a

tool for the community to strengthen local ownership of their reefs and observe tangible evidence of the benefits, including the return of fish to previously degraded reef areas. By regularly engaging with the nursery and outplanting sites, community members could monitor changes in reef condition over time and develop a sense of trust in the restoration process. The community-led nature of the restoration also attracted wider attention beyond Yule Island. The project was featured in the ABC documentary [\*Common Cause: The Coral Gardeners\*](#), which documented the work of the Yule Island restoration team and brought greater visibility to the role of the local reef stewards in responding to coral reef degradation and climate change.

Complementing the coral restoration work, mangrove rehabilitation focused on buffering wave energy in areas of coastal erosion. To begin, the team of reef stewards collected propagules from local *Rhizophora* mangroves and raised them in a land-based nursery, where seedlings were grown for approximately six months before undergoing saltwater hardening to prepare them for outplanting. The outplanting process proved challenging because high wave energy around Yule Island frequently washed away newly planted seedlings. To address this, the team planted mangroves in concrete planters designed to protect young seedlings as their root systems became established and trialled different planting arrangements to reduce wave energy. Over time, these mangrove patches are expected to trap sand and sediment, potentially forming small islands that provide additional protection by dissipating wave energy and reducing erosion.

### **Village chicken keeping as a resilience strategy**

Recognising that healthy ecosystems and resilient communities are closely connected, the project complemented coral and mangrove restoration activities with village chicken keeping as an alternative livelihood and source of nutrition. By providing households with an alternative source of protein and reducing reliance on fishing, village chicken keeping led to growing discussions



*Yule Island outgrower with his self-constructed village chicken house © Kyeema Foundation/Lauren Hodgson*

around establishing no-take areas as a next step towards reducing fishing pressure and supporting the long-term recovery of restored reefs. The village chicken model was built around a master farmer approach, with the Chief selecting a retired married couple to become the project's master chicken farmers. With technical support from Kyeema Foundation, the couple established and expanded their own chicken flock before delivering training workshops on the basics of backyard village chicken keeping to other community members, known as "outgrowers". These outgrowers were generally between 40 and 60 years of age, with relatively equal participation among women and men. Beyond the individual outgrowers, village chicken keeping often became a family activity, with other household members, including young children, becoming involved in caring for the chickens. Its household-based nature also provided an accessible way for women to contribute directly to household food

security and income generation. The training workshops focused on housing, breeding, preventing disease, setting goals, and monitoring, along with the preparation of chicken feed using locally available resources such as coconut.

Outgrowers were required to construct their own chicken coops using locally sourced materials before participating in the training and, upon completion, received two hens, one rooster, and fencing materials to establish their own flocks. By requiring participants to contribute labour and materials before receiving chickens, the project helped ensure they were invested in raising chickens and took ownership of their flocks. After receiving their chickens, the outgrowers continued to receive advice and mentoring from the master farmers to help overcome challenges and successfully raise chickens for household consumption, income generation, and local trade.

### 3.2 Targets and indicators for ecosystem health and biodiversity

| Objectives                                                                                                                            | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                                                                  | Means of verification                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Bleaching-resistant corals saved from further decline and used to support the recovery and resilience of coral reef ecosystems</b> | <ul style="list-style-type: none"> <li>• Survival and health of coral fragments maintained in the coral nursery</li> <li>• Fish abundance and diversity associated with coral nursery and restoration sites</li> <li>• Biodiversity surveys indicate restoration of functional reef patches from which healthy coral can spread into the system</li> </ul> | <ul style="list-style-type: none"> <li>• Coral nursery monitoring records</li> </ul>                       |
| <b>Mangrove restoration activities contribute to the recovery and resilience of coastal ecosystems</b>                                | <ul style="list-style-type: none"> <li>• Growth and survival of mangrove seedlings at restoration sites</li> </ul>                                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Mangrove monitoring records</li> <li>• Project reports</li> </ul> |

| Objectives                                                                                                             | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                       | Means of verification                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Community-led restoration activities are implemented to conserve and restore coral reef and mangrove ecosystems</b> | <ul style="list-style-type: none"> <li>• Number of people trained in coral and mangrove ecosystem restoration, disaggregated by age and gender</li> <li>• Number of coral nursery and restoration structures established and maintained</li> <li>• Number of ecological monitoring surveys completed</li> <li>• Number of mangrove seedlings propagated for restoration activities</li> </ul> | <ul style="list-style-type: none"> <li>• Training attendance records</li> <li>• Coral and mangrove monitoring records</li> <li>• Project reports</li> </ul> |

Important assumptions include:

- Community members remain willing and able to participate in restoration, monitoring, and maintenance activities
- Environmental conditions remain suitable for coral and mangrove growth and survival
- Severe marine heatwaves, cyclones, disease outbreaks, or other disturbances do not cause widespread mortality of nursery or restoration sites



### 3.3 Targets and indicators for human wellbeing and resilience

| Objectives                                                                                           | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                       | Means of verification                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Increased household resilience through alternative livelihoods that reduce pressure on reef habitats | <ul style="list-style-type: none"><li>• Number and percentage of participants reporting improved household food security through village chicken keeping, disaggregated by gender</li><li>• Number and percentage of participants reporting increased household income through village chicken keeping, disaggregated by gender</li><li>• Community perceptions of how coral restoration and village chicken keeping contribute to household wellbeing and resilience</li></ul> | <ul style="list-style-type: none"><li>• Endline household surveys</li><li>• Key informant interviews and focus group discussions</li><li>• Project monitoring reports</li></ul> |

| Objectives                                                                              | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                            | Means of verification                                                                                                                       |
|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Alternative income generation and food security activities established with communities | <ul style="list-style-type: none"><li>• Number of people trained in village chicken keeping, disaggregated by age and gender</li><li>• Number and percentage of trained households participating in village chicken keeping at endline, disaggregated by age and gender</li><li>• Number of village chicken training workshops conducted</li></ul> | <ul style="list-style-type: none"><li>• Training attendance records</li><li>• Endline household surveys</li><li>• Project reports</li></ul> |

Important assumptions include:

- Households remain willing and able to participate in village chicken keeping
- Chickens remain healthy and productive
- Households continue to use village chicken keeping as a source of food and income
- Alternative livelihood activities help reduce pressure on reef resources while ecosystems recover

### 3.4 Targets and indicators for gender and social equity and rights

| Objectives                                                                                                                   | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                           | Means of verification                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>Sustained and meaningful engagement of women and youth in ecosystem restoration and alternative livelihood activities</b> | <ul style="list-style-type: none"> <li>• Community perceptions of participation, leadership, and local ownership of restoration and livelihood activities</li> <li>• Community perceptions of increased awareness of coral reef and mangrove ecosystems and knowledge sharing within the wider community</li> </ul> | <ul style="list-style-type: none"> <li>• Key informant interviews and focus group discussions</li> </ul> |

| Objectives                                                                                                                   | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                             | Means of verification                                                                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Sustained and meaningful engagement of women and youth in ecosystem restoration and alternative livelihood activities</b> | <ul style="list-style-type: none"> <li>• Number and percentage of women participating in village chicken keeping activities, disaggregated by age</li> <li>• Number and percentage of youth participating in coral and mangrove restoration activities, disaggregated by gender</li> <li>• Number of women and youth supported in leadership roles within project activities, disaggregated by age</li> <li>• Number of community-led restoration and livelihood activities coordinated by local leaders</li> </ul> | <ul style="list-style-type: none"> <li>• Training attendance records</li> <li>• Project monitoring reports</li> <li>• Key informant interviews and focus group discussions</li> </ul> |

Important assumptions include:

- Women and young people remain willing and able to participate in restoration and livelihood activities
- Community leaders continue to support the participation of women and young people in project activities and decision-making processes
- Local ownership and leadership of restoration and livelihood activities are maintained after external support ends
- Community members continue to perceive restoration and livelihood activities as beneficial and relevant to their needs



### 3.5 Measuring resilience over time: experiences from Yule Island

Increasing coral cover is an important way to strengthen reef resilience in the face of a changing climate and remains a central aim of coral restoration. While many ecological benefits take years to emerge, improvements that support local livelihoods and community resilience can often be observed much sooner. On Yule Island, community-led restoration efforts alongside village chicken keeping demonstrated early improvements in ecosystem and community resilience.

#### Building resilient reef ecosystems

Over the life of the project, the team of reef stewards established a rope nursery containing 128 heat-tolerant coral fragments from three reef-building coral genera, *Acropora*, *Porites*, and *Pocillopora*, which were progressively outplanted onto four coral tables and five A-frame restoration structures. These structures provided habitat for a diverse range of reef-associated fish species and contributed to the restoration of functional reef habitat. Monitoring data showed high coral survival throughout the project, with 113 of the original 128 coral fragments (88.3%) remaining healthy at endline. Coral fragments showing signs of disease or persistent bleaching were removed to maintain the nursery's overall health.



Local reef steward constructing a coral nursery © WWF-Australia/Tom Vierus

Establishing the nursery was not without challenges, with it taking several attempts to find a suitable location that did not lead to structural damage or coral mortality due to high wave energy or unsuitable environmental conditions. Once the nursery was relocated to a suitable site, the heat-tolerant coral genotypes remained healthy through periods of elevated sea temperatures and challenging weather conditions, demonstrating that heat-tolerant corals can be successfully maintained and propagated by local communities over multiple years. Beyond the project period, the nursery sites remain under the care of the local reef steward team and, as the nursery structures are located close to their homes and shoreline, they will be able to continue monitoring and maintaining them for many years to come.

Complementing the coral restoration activities, a land-based mangrove nursery propagated 585 seedlings, with 285 seedlings remaining in the nursery at endline and over 153 outplanted into intertidal zones. High wave energy and periodic storm surges made mangrove restoration challenging, with many seedlings being damaged or washed away. In response, the reef stewards trialled several outplanting techniques, including cement planters arranged in diamond-shaped formations that helped protect young seedlings from strong waves while reducing wave energy along the shoreline. As these approaches were refined, seedling survival increased from approximately 66% to 84%, with an average growth height of 18.7cm.

Although mangrove restoration proved more challenging than coral restoration, the nurseries remain under the care of the local reef stewards, who established them in their backyards and have continued propagating seedlings and trialling new planting techniques beyond the project period. Motivated by the role mangroves play in protecting shorelines, homes, and burial sites from coastal erosion, the team is also supporting other households across Yule Island to establish their own nurseries using locally collected propagules.

### Return of marine life

In addition to coral health and survival, ecological monitoring consistently recorded a diverse range of reef-associated fish around the coral nursery and restoration sites, including rabbitfish, parrotfish, butterflyfish, green chromis, cornetfish, and farmerfish. By providing shelter and swim-through habitat, the nursery structures supported a variety of reef-associated fish, with cornetfish frequently observed sheltering beneath the rope structures. While no baseline fish monitoring data were available for comparison, the biodiversity surveys indicate that the nursery and restoration structures were functioning as habitat for reef-associated species, providing early evidence of restored ecological function within the project area.

Echoing the ecological monitoring results, community members described seeing greater numbers of fish, larger fish, and the return of species that had become uncommon in the waters surrounding Yule Island. The return of ornate rock lobsters, locally known as “Yule Island Gold”, was also reported, with some households now catching up to eight lobsters per day for household consumption or sale. One reef steward also described observing large schools of parrotfish for the first time while monitoring the restoration sites:

*“While we were looking for corals, there were groups of fish coming. It was the first time I went into the water and saw this. These fish were parrotfish, the blue ones and the brown ones, and they were running in a school.” – Yule Island Reef Steward*

*“When the ladies carry the fish, I always check what fish they have. And I see that the quantity of the fish and the sizes of the fish are getting bigger. Before it was very small. Now the fish are getting bigger.” – Yule Island Community Member*



While these findings are encouraging, it is important to recognise that the observed changes cannot be attributed solely to the restoration activities, as broader environmental factors are also likely to influence fish abundance and distribution. Nevertheless, the ecological monitoring and community observations provide a consistent picture of improving reef condition and suggest that the restored reef patches are functioning as habitat for reef-associated fish.

### **Strengthening community resilience through alternative livelihoods**

Complementing ecological restoration activities, village chicken keeping provided households with an immediate and reliable source of food and income while reef ecosystems recovered. Community members described village chickens as an accessible source of protein that complemented fish during periods of rough weather when fishing was unsafe or not possible. For households without boats or the financial means to purchase fuel, chickens also provided a reliable land-based source of eggs and meat when access to marine resources was limited. Furthermore, participants recognised that village chickens are likely to become increasingly important for household food and nutrition security as communities move towards establishing no-take areas to reduce fishing pressure and allow reef ecosystems time to recover.

Beyond improving food security, village chickens created new livelihood opportunities that diversified household income, particularly for women. Participants explained that they regularly sold chickens and eggs within the community to purchase household essentials, with one participant describing how the income from their first chicken sale was used to buy their granddaughter's school uniform. Several households also reported selling more chickens and eggs during periods of rough weather, when fishing was unsafe, or during festive seasons when demand was higher. Many households also established or expanded vegetable gardens to use home-grown produce to feed their chickens and reduce reliance on purchased feed. Chicken manure was also used to fertilise these gardens, with surplus produce used for household consumption or sold locally to generate additional income.

Participants consistently described coral restoration and village chicken keeping as complementary rather than separate activities. While coral and mangrove restoration addressed the long-term recovery of marine ecosystems, village chickens provided households with an immediate source of food and income while ecosystems recovered. Community members viewed this integrated approach as practical and relevant, with several describing it as the first project to simultaneously support livelihoods and environmental restoration.

“ We never have something like that, the chickens and the corals. It's the first of its kind to us. It's changing the lives of the people, the lives of our community as a whole.”

**Yule Island community member**

### Building local capacity for long-term stewardship

One of the project's most significant outcomes was increased community knowledge, stewardship, and ownership of reef ecosystems. Before the project, several participants explained that because coral looked like stone, they believed it was inert and did not realise it was a living organism capable of growth and reproduction. As participants gained a greater understanding of reef ecosystems, they described seeing the reef and ocean differently, no longer viewing coral as "just another rock," but recognising it as an essential, living component of the marine environment.

Building on this increased understanding of the marine environment, participants described moving away from fishing practices that had previously contributed to reef degradation and overfishing. They explained that customary practices, such as pulling chains across the reef, breaking coral to access crayfish, and damaging coral while retrieving fishing nets, had been used without fully understanding the harm they caused to the reef.

As participants gained a greater appreciation of the reef as a living ecosystem, many described changing these long-standing practices to avoid further damage. Participants also suggested that these changes were beginning to spread within the wider community, as other fishers came to recognise the damage these practices caused and adjusted their behaviour accordingly. These changing attitudes are also reflected in ongoing community discussions around establishing no-take areas to reduce fishing pressure and support the long-term recovery of reefs.

Leadership also became increasingly community-led over the life of the project, with the coral coordinator emerging as a respected local leader in reef restoration. Through the project, she coordinated restoration activities and helped create a strong sense of motivation among the stewards, encouraging them to continue despite ongoing challenges. She was often heard reminding others to never give up and explaining that it was the responsibility of the younger generation to care for, protect, and restore their reefs for future generations. She also played a pivotal role in ensuring restoration activities continue beyond the life of the project, describing the coral and mangrove nurseries as "her gardens" that she will continue to care for now and into the future.

“We had no idea that corals were beneficial to us, or that they were a food source for the marine life. In the past, we thought coral was just another rock, but today we know it is something significant to the marine life.”

**Yule Island Reef Steward**

“I face many challenges, but I stand and face them because I love the work. Even if there is no money, I will still do it because it is like my garden. Maybe our next generation will have more fish.”

**Local Coral Restoration Coordinator, Yule Island**



## 4. Understanding how targets, monitoring and reporting can work well together at different scales

### INDEPENDENT ANALYSIS – MAIRI DUPAR

**This case study shows that ecosystem-based adaptation can have important cascading benefits for societies, which may not be immediately visible. Qualitative documentation helps make these benefits more visible, with implications for decision-making,** prevent cascading harms from climate change, and conversely, it created cascading benefits.

Before the intervention, on Yule Island, Papua New Guinea, deteriorating coastal ecosystems meant fishers had to go further out to sea, facing rougher and more dangerous conditions. Adaptation actions to enrich near-shore, coastal ecosystems and livelihoods improved fishers' personal safety as well as their livelihoods.

The connections between ecosystem restoration and personal safety are not captured by indicator reporting. The causal relationship is context-specific.

However, such local evidence yields important learning about the cascading benefits of adaptation action, which could be significant and useful for decision-makers beyond the local area.

Kyeema Foundation's documentation informs our conceptual horizons about what EbA can achieve. These conceptual advances are worth capturing to inform national decision-making and global understanding.

**This case study illustrates how the different thematic targets of the GGA Framework intersect and have various interdependencies in real-life adaptation action.**

Sea level rise and coastal erosion are putting at risk burial sites and community identity (GGA target g, cultural heritage), ecosystem integrity (GGA target d), poverty and livelihoods (GGA target f), food security (GGA target b) and nutrition (GGA target c, health). Yule Island communities' EbA solutions not only address all these risks, but do so by enhancing green infrastructure (of potential crossover with GGA target e, infrastructure). This demonstrates that reporting adaptation progress against sectoral targets or even against sectoral indicators may have some value but only if part of a broader integrated climate-resilient development picture. Certainly, a 'tunnel vision' view of themes and indicators is not helpful.

**Adaptation is a dynamic rather than static process, which raises challenges for monitoring and measurement over time. Likewise, adaptation itself must keep evolving in any location, unless it hits hard limits and cannot evolve further.** This case study is a reminder that adaptation to climate change itself is itself necessarily a highly dynamic process that must be continuously adaptive.

It highlights that mangrove forests can adapt to gradually rising sea levels, but high rates of sea level rise could outpace their capacity to adapt and lead to widespread mangrove die-off, weakening the disaster risk reduction benefits they provide. This raises the question, for this place in Papua New Guinea, as well as more widely: will global society tackle climate change sufficiently to slow and stop sea level rise and keep ecosystem-based solutions effective? Or will solutions like Yule Island's mangrove and reef restoration hit adaptation limits? Even if human systems are flexible, ecological systems may not be. The GGA Framework's targets are initially for a 2030 horizon and will be reviewed; this case study shows how adaptation options and reporting on 'adaptation progress' will need to be regularly reviewed in any specific country and location to keep pace with changing biogeophysical realities.



*Coral diversity within a nursery © Annelise McDougall*

**It can be difficult from a practical project design and monitoring perspective to separate the ‘adaptation’ part of the intervention from the ‘good sustainable development’ part. This calls for conceptual flexibility in how adaptation progress is reported and understood.**

Here, chicken rearing provides protein to households as an alternative to fish protein. This intervention is aimed at addressing two drivers of ecosystem degradation: indirect climate drivers and the direct human drivers (overfishing).

At both the ‘input’ level of project inputs for resilience, and at the output and outcome levels of measuring reef and mangrove improvement, the intervention creates flows of benefits to local communities that support holistic human resilience and not just resilience to climate hazards in a narrow sense. The GGA framework emphasises reporting on the distinct contributions of ‘adaptation’ interventions compared to sustainable development more broadly. The story of Yule Island communities shows that trying to impose such conceptual separations may not be possible, nor meaningful, in understanding how adaptation works.

# CASE STUDY

## Singapore's 'City in Nature': Urban restoration for healthier communities and ecosystems

By Lim Chung Fee, Stephanie Ng, Cheong Kok Hwee, Mayura Patil, Naufal Khan, Tamara Claire Fernandez, Low Ching Kai and Damien Qiu, *National Parks Board (NParks), Singapore*

### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Water



Health



Ecosystems



Infrastructure



Cultural heritage



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Contribution and rights of Indigenous Peoples and local communities



Intergenerational equity



Formal and informal education

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

- Habitat creation and maintenance
- Pollination and dispersal of seeds and other propagules
- Regulation of climate
- Regulation of freshwater quantity, location and timing
- Regulation of hazards and extreme events

### Non-material contribution

- Learning and inspiration
- Physical and psychological experiences
- Supporting identities



Zhenghua Nature Park, Singapore © National Parks Board, Singapore



**Figure 11. Singapore**



Source: © Cartography, Chandra Jayasuriya

## 1. About Singapore's urban ecosystems

Singapore is a small, low-lying island state with a total land area of just 735 km<sup>2</sup>, comprising the main island and smaller islands dotted in the Singapore Strait. It has a population density of 8,000 people per km<sup>2</sup>, one of the highest in the world (Government of Singapore, 2024).<sup>40</sup>

The country has four legally protected nature reserves that provide vital ecosystem services and are home to rich biodiversity. They represent some of the territory's primary natural habitats and include: terrestrial lowland forests, hill dipterocarp forests, coastal hill forests, freshwater streams and pools, freshwater swamp forests, mudflats and mangrove forests.<sup>41</sup>

Further, there are 400 parks across Singapore and an extensive network of green corridors that connects the nature reserves and parks together – a carefully planned approach that is detailed in this case study. Ecological corridors criss-cross the territory, facilitating species movement across the island state and helping to maintain genetic diversity.<sup>42</sup>

Geographically, Singapore lies in the middle of the Sundaland biodiversity hotspot, a hotspot that stretches for 5,000 kilometres across the Malay Peninsula, Borneo, Sumatra, Java, Bali and smaller islands on the Sunda Continental Shelf – encompassing around 17,000 islands overall.<sup>43,44,45</sup> Biodiversity hotspots are defined as regions that contain at least 1,500 species of endemic vascular plants (i.e., found nowhere else on Earth); and which have lost at least 70 percent of their primary native vegetation.

Visitors enjoying a stroll at Jurong Lake Gardens © Clement Chai/unsplash





The Sundaland hotspot is thus characterised by its notable remaining biodiversity and its need for high conservation effort.

Many of Singapore's native habitats were converted to other uses even during the pre-independence era. Forests were cleared to make way for pepper, rubber, coconut and gambier plantations (gambier is a creeping plant that serves many medicinal and textile-related uses). Mangroves were cut for firewood and charcoal, and to accommodate prawn farms.<sup>46</sup> Coastal ecosystems were modified to support shipping and trading infrastructure.

When Singapore achieved full independence in 1965, the state's new imperative was to urbanise and industrialise. Today, our forest reserves cover a total of approximately 5% of Singapore's present land area; of this, only a small portion is primary forest, and the rest is secondary forest.<sup>47</sup> Nonetheless, Singapore still hosts species of global conservation concern as well as stewarding ecosystem services that underpin both society and economy.

Endangered species include those that dwell in legally protected reserves, such as the endemic Singapore freshwater crab, *Johora singaporensis*. Endangered species also range outside of the formal nature reserves: for example, the offshore isles of Tekong Besar and Ubin host the globally vulnerable Asian small-clawed otter (*Aonyx cinereus*), dugong (*Dugong dugon*), and Indo-Pacific finless porpoise (*Neophocaena phocaenoides*).<sup>48</sup>

By the early 2000s, the government established targets and plans for ecosystem restoration and species recovery. Species recovery refers to efforts to augment wild, self-sustaining populations of target species. This can be achieved through habitat management or active breeding and the reintroduction of individuals to new sites, or both strategies in tandem. At the time of writing, 849 species of fauna had been recorded in Singapore, and 5,103 flora species and cultivars.<sup>49</sup>

The National Parks Board (NParks) is the country's lead agency for greenery, biodiversity conservation, and wildlife and animal health. Since 2016, NParks has announced 94 species of flora and fauna to prioritise for species recovery: 75 plant species, 11 terrestrial animals and eight marine organisms. They include species that are globally Critically Endangered, such as Raffles' banded langur (also known as banded leaf monkey, *Presbytis femoralis femoralis*), giant clam *Tridacna gigas* and Neptune's cup sponge *Cliona patera*, as well as species such as the cryptic painted frog (*Nyctixalus pictus*), which are locally rare.<sup>50,51</sup>

NParks deploys scientific research and modelling tools to inform the safeguarding of natural areas to benefit native biodiversity.<sup>52</sup> Over the past six decades, an initial national focus on greening and park development has evolved into the present City in Nature vision. This places greater emphasis on restoring biodiversity and enhancing ecological integrity and connectivity in the city.

## 2. People's resilience in the context of a healthy ecosystem

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Singaporeans have long regarded green spaces and biodiversity as central to their quality of life. Nature's ability to provide aesthetic, recreational and mental health benefits is widely recognised and appreciated, as well as nature's provision of air and water quality and other vital ecosystem services in the urban environment.

A public commitment to greening the city-state runs deep in the national psyche and has shaped public action for more than six decades. In 1963, founding Prime Minister Lee Kuan Yew planted a keempat tree sapling (*Cratoxylum formosum*) to launch a national tree-planting campaign. Since then, Singapore has planted hundreds of thousands of trees to complement the built environment. The early vision was to transform post-independence Singapore into a 'Garden City'.

As climate change has accelerated in recent decades, nature-based solutions have taken on further, practical importance in strengthening climate resilience for people and for other species.

Revitalising ecosystem functions helps address:<sup>53</sup>

**Higher temperatures:** Singapore has been warming over the last 40 years at an average rate of 0.24°C per decade. Further, the built environment creates an urban heat island effect, especially in the dense Central Business District. Vegetation can have a shading and cooling effect.<sup>54</sup>

**Sea level rise:** Coastal assets need protection from rising seas, including storm surges. Mangroves are effective at reducing wave height and dissipating wave energy. In Singapore, mangroves can reduce storm wave height by 75 percent and so potentially continue to make a critical ecological contribution to disaster risk reduction.<sup>55</sup>

**Intense rain and higher flood risks.** Extreme rainfall is set to increase in Singapore this century: it could potentially increase from 6% to 92% depending on the global emissions scenario (low to high), during the rainiest months, April and May. Singapore's flood management infrastructure is already being assessed for its flood risk readiness; however, green infrastructure will also be important in reducing run-off during periods of intense rainfall.<sup>56</sup>

**Negative effects of climate change on biodiversity:** Native species require sufficiently large and healthy habitats to support them and provide refugia from climatic changes, including climate shocks. Strengthening ecological connectivity and restoring complementary habitat areas around core biodiversity sites can help achieve greater species resilience.

As part of a larger action plan, the Singapore Green Plan 2030, the 'City in Nature' initiative was launched in 2020,

building upon the strong foundations of the Garden City. The mission laid out was: "We will create a green, liveable and sustainable home for Singaporeans".<sup>57</sup>

“ NParks' approach to climate adaptation is anchored in strengthening the resilience of our natural ecosystems. By restoring and connecting habitats, and investing in research to deepen our understanding of climate impacts, we safeguard biodiversity and essential ecosystem services — ensuring Singapore remains a liveable City in Nature, even as our climate continues to change.”

**Mr Ryan Lee, Chief Science and Technology Officer and Executive Director, National Parks, Gardens, Nature Reserves and Community Cluster, National Parks Board**



### What are refugia?

“A refugium [plural, refugia] is a geographical area where a population, species, or community has survived environmental instabilities over long periods of time.”

Source: Oxford Reference Dictionary online



Jurong Lake Gardens, Singapore © Gigit Unsplash



## Singapore's reserves and parks: a guide

**Nature reserves:** Core biodiversity areas home to native flora and fauna, including rare and endangered species.

**Nature parks:** Located at the edges of nature reserves, they serve as green buffers to protect and safeguard nature reserves from the human impacts and pressures arising from nearby urban development.

**Parks:** Green spaces intended to improve people's quality of life.

**Park connectors:** Linear green corridors that link major parks and nature areas across Singapore.

**Nature Ways:** Ecological corridors to facilitate species' movement between green spaces.

## 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

### 3.1 Overarching objectives of Singapore City in Nature

The vision of the initiative is that by 2030, "Singapore will be a green and beautiful City in Nature". To achieve this, the government has defined five priority objectives:<sup>58</sup>

- 1. Grow nature park networks:** Singapore aims to expand the Nature Park Networks that surround the country's nature reserves, creating ecological buffers and complementary habitats that strengthen the protection and resilience of core biodiversity areas.
- 2. Naturalise gardens and parks:** This objective is twofold. It seeks to create entirely new parks, as well as enhance existing parks with features such as:
  - More nature-based solutions.
  - More therapeutic gardens and nature play gardens for children.
  - More native plant and animal species conservation.
- 3. Restore nature into the urban landscape:** More greenery will be introduced into densely built urban areas; for instance, by nurturing vegetation on skyscrapers and in industrial areas.
- 4. Strengthen connectivity between Singapore's green spaces:** The network of green corridors around the main island will be extended via the development of 300km of Nature Ways by 2030. These are multi-tiered and multi-species landscapes designed to strengthen ecological connectivity.

## 5. Enhance veterinary care and animal management:

People's wellbeing is affected by their interactions with both domestic animals and wildlife. The Animal & Veterinary Service (AVS) works to strengthen capacities and elevate animal health, management and welfare practices and knowledge.

### Community and private sector involvement is integral to progress

Singaporeans have ample motivation for nurturing gardens, parks and wildlife across the country, as demonstrated by the decades of sustained citizen actions described above. Community engagement includes:

**Community in Nature:** This is the name for NParks' initiative to connect and engage communities for the conservation of Singapore's natural heritage and support the City in Nature vision.<sup>59</sup> It aims to:

- Connect, educate and inspire diverse communities to actively conserve and celebrate our natural heritage.
- Cultivate champions within the community in protecting nature.
- Nurture and form partnerships to achieve better biodiversity and social outcomes.
- Foster and support community groups and organisations working to reconnect people with the natural environment.

NParks aims to grow its volunteer base to 70,000 people by 2030 to contribute to the 'City in Nature' vision through restoration efforts, citizen science projects and other activities.

The OneMillionTrees movement is a call for the community to plant a million more trees across Singapore by 2030.<sup>60</sup> As well as participating in tree planting activities in-person, community members can become involved in facilitating

tree planting events, propagating native tree saplings, and outreach and education. OneMillionTrees has, to date, seen community members planting trees on the verges of roads, as a significant contribution towards strengthening ecological connectivity, as well as getting involved in forest restoration activities.

The Greening Schools for Biodiversity programme supports primary and secondary schools and colleges to plant native plant species that provide suitable habitats supporting birds, butterflies and other fauna on their grounds. This both creates new habitats and enriches existing ones, while enhancing nature education.

Nature Kakis is an organised network across Singapore that seeks to "bring together passionate like-minded individuals to share and exchange ideas with others in the wider community on how to conserve and steward our natural heritage".<sup>61</sup> People can join or establish neighbourhood Nature Kakis chapters and then self-organise nature recovery efforts in partnership with NParks and others, to enrich Singapore as a 'City in Nature'.

Citizen science is a pillar of the effort to collect information about ecological integrity, connectivity and biodiversity – combining a range of one-off opportunities such as annual 'bio blitzes' which mobilise groups of volunteers, with more regular monitoring activities by individual nature enthusiasts.

*"In Punggol Coast, we were already doing multiple green activities. Sooner or later, we decided to form up and become full-fledged, meaningful programmes. The main idea was to reach out to the residents out there and (...) have the young ones be able to experience what is in their own backyard. And together with that, when they bring their friends, they bring their parents, it also becomes a bigger community on its own. To see the impact it has made across different age groups is heartening for us." – Chris, Nature Kakis Chapter, Punggol Coast<sup>62</sup>*



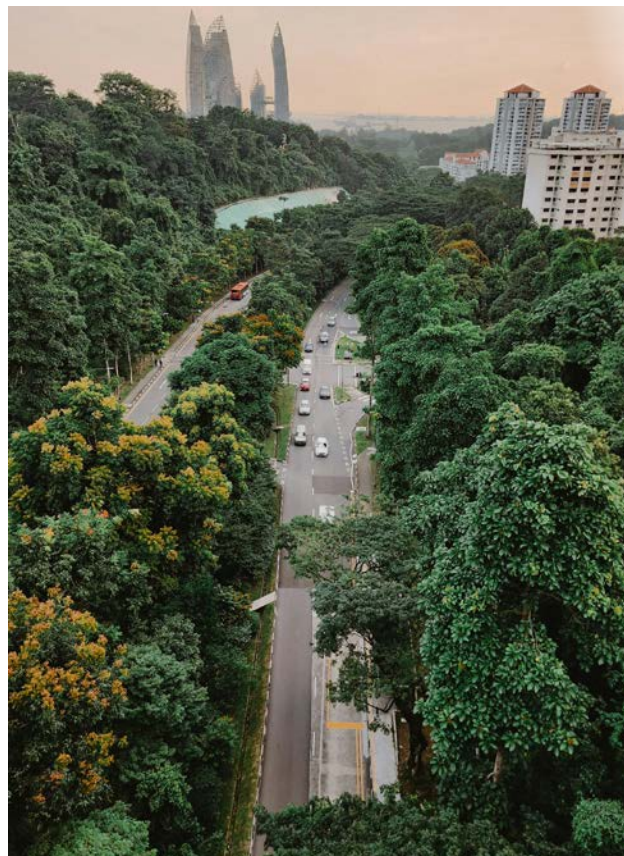
NParks actively engages the private sector to support greening and biodiversity initiatives, including tree planting activities, habitat enhancement and environmental stewardship programmes. Through the Garden City Fund, NParks partners with organisations and individuals to involve them in conservation, research, outreach and education initiatives. For instance, Keppel Corporation pledged \$3 million to support the planting of 10,000 trees in parks and nature reserves, and has since fulfilled this commitment, with the final tree planted in June 2026.

The Skyrise Greenery Incentive Scheme supports building owners of existing commercial, industrial, institutional, community, and non-landed residential developments to create sustainable rooftop and vertical greenery installations. The scheme provides up to 50% co-funding of installation costs, with reimbursement capped at \$200 per square metre for rooftop greenery and \$500 per square metre for vertical greenery.<sup>63</sup>

### **Re-greening and human health are strategically linked**

NParks recognises the therapeutic effects of greenery in Singaporeans' everyday lives. In June 2025, NParks launched the Parks for Health framework, which consolidates and enhances efforts to bring nature and its benefits closer to residents. It introduces contemplative and therapeutic landscapes that are purposefully curated to meet the physical, psychological and social needs of Singaporeans, with the objective of helping people feel restored by nature. Key initiatives under the new framework include:

- the introduction of 15 contemplative landscape sites;
- more rest points along park connectors; and
- the integration of therapeutic landscapes into housing estates and healthcare institutions, coupled with targeted therapeutic horticulture programming.



*Roadside greenery in Singapore © Mudassir Khan/Unsplash*

These initiatives are supported by scientific evidence and extensive research. For example, a specialised tool called the Contemplative Landscape Model has been used to identify which locations within Singapore's green spaces are the most therapeutic. The tool highlights therapeutic benefits on the basis of colour and light, biodiversity, and layers of landscape that enhance the visual quality and experience of visitors.<sup>64</sup> Landscaping, including thick plant growth, is also created to increase shade and people's thermal comfort in hot temperatures.

### 3.2 Targets and indicators for ecosystem health and biodiversity

| Objectives (Defined by Singapore as 'Key Strategies')                                                                                                                                                                                                                                                                    | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                                                                                  | Means of verification                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Expanding the Nature Park network                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>• Number of hectares of new Nature Parks</li></ul>                                                                                                                                                                                 | <ul style="list-style-type: none"><li>• NParks utilises a range of tools to collate data for verification, such as remote sensing and field research</li></ul> |
| Intensifying nature in existing gardens and parks                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>• Extent of areas of biodiversity enhancement in existing parks</li><li>• Number of hectares of new parks in a time period</li><li>• Number of hectares of enhanced forest, marine and coastal habitats in a time period</li></ul> |                                                                                                                                                                |
| Restoring nature into the urban landscape                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"><li>• Number of hectares of skyrise greenery established</li><li>• Number of trees planted in a time period</li></ul>                                                                                                                  |                                                                                                                                                                |
| Strengthening connectivity between green spaces                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"><li>• Number of km of park connectors developed in a time period</li><li>• Number of km of Nature Ways developed in a time period</li></ul>                                                                                            |                                                                                                                                                                |
| Important assumptions include:                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                          |                                                                                                                                                                |
| <ul style="list-style-type: none"><li>• Assumes contributions of private businesses toward activities that take place on private property, such as high-rise buildings</li><li>• Assumes that individuals are willing to volunteer their time to contribute to nationwide planting and land management schemes</li></ul> |                                                                                                                                                                                                                                                                          |                                                                                                                                                                |

#### Programme targets, linked to the indicators

- Add 200 hectares of Nature Parks by 2030
- Enhance around 170 ha of existing parks with more lush vegetation and natural landscapes by 2026
- Develop over 130 ha of new parks by 2026
- Restore and enhance 80 ha of forest, marine and coastal habitats by 2030
- Establish 200 ha of skyrise greenery by 2030
- Plant 1 million more trees by 2030
- Develop 500 km of park connectors by 2030
- Develop 300km of Nature Ways by 2030



### 3.3 Targets and indicators for human wellbeing and resilience

Although there are no specific key performance indicators around human wellbeing, there is nonetheless a clear strategy to improve the mental and physical wellbeing of citizens and visitors through Singapore's ecosystem restoration and re-greening initiatives. Abundant stories

are captured from participants in the NParks programmes and available to view online, such as:



**NParks explains: Our greening journey**

See <https://youtube.com/NParksSG>



**About the Nature Kakis Network**

See <https://naturekakis.nparks.gov.sg>

View from Kent Ridge Park toward the city, Singapore © Andy Wang/Unsplash



### 3.4 Measuring resilience over time: experiences from the City in Nature initiative

Progress against the City in Nature targets is bounding ahead: since its launch in 2021, two of the targets were already exceeded: the development of 130 hectares of new parks; and the establishment of 200 hectares of skyrise greenery. The others are well on track or near completion, including the goal of bringing all Singaporean households within a 10-minute walk from a park.

More than 900 tree species have been planted by NParks across streetscapes, parks and park connectors. Species are selected for different purposes, including providing shade, visual relief, supporting biodiversity, and strengthening ecological connectivity across our green spaces. For instance, the Sparrows' Mango (*Buchanania arborescens*), a native tree that supports bird fauna, has been introduced in parks and streetscapes. Bougainvillea cultivars, which can adapt to hot, dry conditions in Singapore, were introduced from Central and South America as ornamental flowering shrubs at our overhead bridge planters and along roadsides.

Behind the numbers are interesting lessons learned about how change happens. These 'stories behind the trends' can be captured by qualitative narratives as described below.

The therapeutic gardens that are being added within the national parks are founded on scientific research about the benefits of such gardens for physical and mental wellbeing. They are evidenced as augmenting cognitive function, reducing stress, promoting mindfulness and encouraging positive social interactions within the community.<sup>65</sup> Programmes of therapeutic horticulture, involving certified therapeutic horticulturalists, further enhance these mental health benefits for senior citizens and other participants.

NParks is also working closely with Institutes of Higher Learning (IHLs) on research to examine the effect of time spent in Singapore's forest and urban parks on users' physiological and psychological health, as well as how natural environments influence physical and mental wellbeing.<sup>66,67</sup>

As part of the Nature Kakis network, which aims to build Singaporeans' capacity as nature stewards through its neighbourhood chapters, activities are as diverse as tree planting, guided walks and kayak tours, wildlife watching, eco-craft making, workshops and dialogues. Chapter leaders are documenting that participants reap positive, personal benefits from their participation, right away. Nature Kakis activities are credited with fostering intergenerational understanding between children and elders, and the exchange of ecological knowledge and skills. Activities have enabled participants to make new friends and forge social bonds, thus strengthening social capital in neighbourhoods.

Participants have also identified – anecdotally – child development benefits of Nature Kakis activities.<sup>68</sup> Outings are seen as balancing children's screen time with immersive learning in and about nature.<sup>69</sup> Participants testify that these multiple benefits boost their happiness and wellbeing.<sup>70</sup>

Together, these documented benefits, through testimonials and qualitative narratives, represent interwoven threads of human resilience that improve people's everyday lives in their urban environment. This improved personal and community resilience has the potential to help Singaporeans confront climate change, present and future.



## 4. Understanding how targets, monitoring and reporting can work well together at multiple scales

### INDEPENDENT ANALYSIS – BY MAIRI DUPAR

As a severely land-constrained country, low-lying and squeezed by sea level rise, Singapore has limited room for manoeuvre in adapting to climate change. The government's choice to embrace the multidimensional benefits of nature makes sense. It is also the case that, because nature restoration advances many societal

objectives and shows results across many sectors, the approach somewhat defies narrow, thematic reporting. The full story is told through a holistic narrative, not a narrow sectoral one. More green infrastructure and more biodiversity do not just augment physical resilience, such as soaking up floodwaters and regulating water flow. Ecosystem creation and restoration also address mental health and quality-of-life issues and advance residents' formal and informal education; all of these benefits are integral to resilience as well. The Singapore 'City in Nature' initiative and related 'Community in Nature' defy categorisation by any single target of the global goal on adaptation or part of the Global Biodiversity Framework. The initiatives advance climate, biodiversity and human



Aerial View of rooftop gardens at ParkRoyal Collection, Pickering, Singapore © Lester/Unsplash

wellbeing targets simultaneously and speak across the goals of the UNFCCC and Global Biodiversity Framework and beyond. Sometimes it will make sense for Singaporean institutions to report internationally on specific results, such as the status of its globally endangered species. But from a sustainable development standpoint, Singapore's strategies and achievements as an evolving City in Nature are best viewed for what they deliver overall.

**There is much to learn from how Singapore has designed and instigated short-term nature-based activities that offer people immediate measurable benefits, along the trajectory of achieving a longer-term plan for climate and disaster risk reduction, with longer-term objectives and indicators.** Sometimes adaptation and resilience benefits are slow to be realised, especially in the nature-based sector. Singapore's transformation to a City in Nature manages to pursue win-win strategies for residents along short and long-term timescales. The prospect of immediate and short-term benefits, such as sport and recreational opportunities, learning, inspiration, relaxation, nature therapy, teamwork and social bonding through tree planting, is motivating for participants. These lend themselves to a mix of quantitative measurement (such as number of volunteers, number of participants in activities) as well as qualitative documentation (such as how people felt during and after participation). These short-term gains are entirely consistent with, and build towards, longer-term goals for the expansion of nature reserves, parks and ecological corridors.

**The mental and physical health benefits people have enjoyed are principally captured anecdotally and qualitatively, and are building toward a significant evidence base at national level,** as demonstrated on the NParks website. Although principally useful as a national feedback channel, these stories may provide the starting point for later, more systematic research studies and scientific enquiry into the benefits of nature restoration in the urban environment and the challenges and enablers for rolling out such an ambitious scheme.

**Citizen science is a pillar of Singapore's ecological monitoring – building on a history of such public engagement. This makes a material difference to data availability and also benefits those who participate.**

Citizen science makes an important contribution to building the national data picture of environmental health, particularly when it comes to ecosystem integrity, biodiversity and species abundance, which rely on people's eyes and ears (as opposed to, for example, pollution monitoring, which may require specialised equipment). The significance of citizen science and community-based monitoring is already globally recognised and is manifested at national scale in Singapore – for example, Chandler et al. (2017)<sup>71</sup> find that [such] data particularly provide large-scale data on species distribution and population abundance, species traits such as phenology [*changes in nature according to weather and season*] and ecosystem function variables such as primary and secondary productivity." Perhaps there will be a role in Singapore and other countries that can employ citizen science at scale to use this data to inform reporting on the multilateral agreements, as well as to inform national stakeholders – as at present.

The other important lesson from Singapore's community-based monitoring efforts is that they are not just 'instrumentalist' in generating more data. They are also recognised for and designed for the fact that people appreciate nature and the camaraderie involved in the activity. And so, people benefit physically and mentally from participating.

# CASE STUDY

## Ridge to Reef in the Solomon Islands: Protecting connected ecosystems and strengthening community resilience

By Bateteba Aselu, Chloe Malvasio  
and Gerald Hivu, *Live & Learn*  
*Environmental Education*



### Global goal on adaptation (GGA) framework thematic targets

This is not exhaustive, but shows key themes of the GGA framework that are highlighted in the case study

Food and  
agriculture



Ecosystems



Infrastructure



Poverty and  
livelihoods



Cultural  
heritage



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Different value systems



Intergenerational equity



Gender equality



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Regulation of environmental processes

- Habitat creation and maintenance
- Regulation of climate
- Regulation of ocean acidification
- Regulation of freshwater and coastal water quality
- Formation, protection and decontamination of soils and sediments
- Regulation of hazards and extreme events

### Materials and assistance

- Food and feed
- Materials and assistance
- Medicinal, biochemical and genetic resources

### Non-material contribution

- Learning and inspiration
- Physical and psychological experiences
- Supporting identities
- Maintenance of options



**Figure 12. Poposa Cluster, Solomon Islands**



Source: © Cartography, Chandra Jayasuriya

## 1. About Poposa: the watershed and mangrove ecosystem

Poposa is a cluster of six communities: Puatanrau, Haoto, Karesi, Houa, Poposa, and Suruhora. It is located in the Birao Ward District of Guadalcanal Province, Solomon Islands. The geography of the region is defined by a transition from the coast to rugged inland hills, with some communities, such as Puatanrau, situated along the shoreline, while others (Haoto and Karesi) are positioned between 300 metres and over one kilometre inland, and some are further inland. Due to the lack of formal roads, the community is primarily accessed via sea transport.

The local environment is characterised by a tropical climate with distinct dry and wet seasons, though residents note that weather patterns have become increasingly unpredictable since the year 2000. While annual rainfall can exceed 3,000–4,000 mm in higher-elevation regions of Guadalcanal,<sup>72</sup> the coastal areas experience significant environmental shifts, including sea-level rise of approximately 7mm per year – more than double the global average – aggravated by more frequent king tides that cause coastal erosion.<sup>73</sup>

The ecosystem is a complex network of zones the community relies on for survival, centred on the Bauvi forest, a virgin, unlogged area that symbolises local resilience. This forest regulates the climate, provides land

for gardening, traditional herbal medicines, essential building materials, and resources for sustaining their way of life. Beyond the forest, the ecosystem includes mangrove forests (*Ko'a or koko'a*)<sup>74</sup> that act as critical breeding grounds for marine life and provide fruit pods for food, as well as coral reefs and marine areas (*asi*) that are the main sources of income and food security. The land itself features two primary soil types: swampy soil used for growing mangroves and swamp taro, and red soil utilised for general gardening and root crops.



*Basket weaving in Poposa Solomon Islands © Live & Learn*

**Table 2. Poposa cluster resource use and access zones**

| Zones and classification                  | Key assets based on ecosystem goods and services                                       | Access frequency                          | Demographic and gender-based labour                                                 |
|-------------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Zone 1: Domestic and Civic Core</b>    | Residential housing, communal water taps, playing pitches                              | Continuous (daily)                        | Universally accessible (inclusive of disabled persons); primary workspace for women |
| <b>Zone 2: Intensive Agroecosystems</b>   | Subsistence food gardens, localised community piggeries                                | Diurnal (Once daily)                      | Men: Bush clearance, fence building. Women: weeding, planting and harvesting        |
| <b>Zone 3: Extensive Agroforestry</b>     | Coconut plantations, betel nut farms, swamp taro plots, breadfruit trees               | Periodic (1–2 times weekly or monthly)    | Co-managed equally; shared maintenance and harvesting by men and women              |
| <b>Zone 4 &amp; 5: Coastal and Marine</b> | Zone 4: Shoreline mangroves, tidal flats (shellfish). Zone 5: Marau Sound coral reefs. | Variable (Regulated by tides and seasons) | Controlled via community-enforced traditional marine conservation rules.            |



**Figure 13. Madonu/Poposa conservation area, Western Region, Solomon Islands: Proposed Marine Protected Area (MPA)**



MPA area (approx.):  
~ 1,520 hectares

Perimeter:  
~ 20.4 km

Map date:  
15 May 2024

Prepared by:  
Community  
Conservation  
Initiative.

Sources:  
Field Survey, Satellite  
Imagery, GEBCO  
Bathymetry, OSM

Note: Boundaries  
are indicative  
and for planning  
purposes only.  
Not for legal use.  
Not to scale.

**Key**

- Proposed MPA Boundary
- Mangrove
- Land (Upland)
- Village/settlement

- Key community
- ▲ Hill/spot height (m)
- River/stream
- Coral reef

- Reef flat
- Jetty/landing





## 2. People's resilience in the context of a healthy ecosystem

### 2.1 People and community

Poposa is inhabited by Are'Are-speaking people from the southern part of Malaita Island and Birao-speaking people, who are Indigenous to Guadalcanal Island. Over time, the two groups have lived together peacefully, with intermarriage now common between them. Despite their different languages, they communicate well with one another and maintain strong unity and harmony across the cluster communities. This social cohesion is important to the community's overall resilience.<sup>75</sup>

The Poposa cluster has 37 households and a population of 151 people, with women and girls accounting for 56% of the population. About 50% of the community are under 34 years old. A substantial portion of the population lives a subsistence lifestyle. Two-thirds of the population depends on resources from both land and sea. Activities such as farming, fishing, weaving and utilising local produce remain essential to the daily lives of community members.

### 2.2 The Broom

Resilience for the Poposa cluster of communities is seen through the lens of collective unity. Highlighted in the Community Resilience Profile for Poposa, produced under the Climate Resilient Islands (CRI) Programme,<sup>76</sup> the community metaphorically presented the *Korekore* (Are'are dialect)/ *Kasakasa* (Birao dialect) a traditional broom as a symbol of resilience because it signifies strength: individual strands become unbreakable only when intertwined. This social cohesion is closely linked to the health of their environment, particularly the unlogged, pristine Bauvi forest, which also serves as a primary symbol of local resilience. The community recognises a direct parallel between the forest and



*The broom depicting Poposas resilience © Live & Learn*

their tribe, acknowledging that just as every organism and plant within the ecosystem is interconnected, each member of the community relies on one another for survival and prosperity. This thriving forest ecosystem serves as a crucial buffer, providing the community with clean air, land for gardening, traditional herbal medicines, and the building materials essential for sustaining their way of life across generations.<sup>77</sup>

Historically, the resilience of the Poposa people is grounded in a profound knowledge of the natural environment and its seasonal rhythms. Ancestors utilised sustainable harvesting practices and intricate disaster-preparedness techniques, such as preserving yams in dry spaces and constructing houses based on wind directions to withstand cyclones. This absorptive capacity—the ability of the social-ecological system to recover from shocks—was bolstered by a deep understanding of which food crops to utilise during different seasons, such as turning to fruit trees during dry periods and swamp taro during rainy days. Such Indigenous Knowledge allowed the community to survive significant hardships, including years of ethnic tension when garden and store-bought foods were unavailable.

### 2.3 Mangrove and coastal ecosystem services

The mangrove forest, known locally as *koko'a/ko'a*, serves as a vital ecological cornerstone that underpins both the biological diversity and social-ecological resilience of the Poposa community. Flourishing in the region's swampy soils, these forests function as a crucial transition zone between land and sea (*asi*), providing essential resources that households rely on weekly. From a subsistence perspective, the health of the mangrove ecosystem is intricately tied to food security and physical safety, as the community harvests fruit pods for nourishment and utilises the resilient wood of mangrove trees to construct traditional shelters.

In a healthy ecosystem, mangroves serve as crucial breeding grounds for marine life, functioning as nurseries for fish species that eventually migrate to deeper ocean waters. This nursery role is fundamental to the community's absorptive capacity—the ability of the social-ecological system to withstand and recover from climatic shocks. Because the Poposa people rely heavily on the marine (*asi*) and reef (*haho*) zones for their nutritional needs and income streams (production of smoked fish and basked shells), protecting mangrove habitats is vital to ensuring a consistent supply of seafood, even during times of acute environmental stress.

Scientific studies on mangroves in the Solomon Islands highlight their critical role in the ecological integrity of the country, with mangroves covering totalling to 71,348 hectares, making up 2.47% of national territory.<sup>78</sup> In Poposa, these coastal systems stabilise the shoreline against wind, waves and rough seas while anchoring a broader, interconnected marine complex that features:

- Pristine coral reefs: structurally diverse habitats dominated by branching, massive and soft corals.
- Seagrass meadows: Highly efficient marine ecosystems serving as critical carbon sinks.
- Habitat for endangered megafauna: Vital marine corridors providing necessary foraging and nesting sites for endangered green and hawksbill turtles.

### 2.4 Challenges

Poposa's interconnected ecosystems are under severe pressure from both climate impacts and local human activities. The islands' ridge-to-reef systems, which link upland forests to downstream rivers and coastal reefs, are severely disrupted. Upstream commercial logging operations have accelerated environmental degradation, increasing runoff and sedimentation that elevate water turbidity, river silting and contaminate the reef with debris. These disturbances have also displaced wild pigs, which now frequently damage community gardens.

The environmental pressures are compounding existing food security and livelihood challenges. Baseline data indicate that 83% of surveyed households in Poposa currently experience moderate to severe food insecurity. As the population grows, the overharvesting of local resources has led to a decline in fish stocks. Climate change impacts, including saltwater intrusion, are further complicating the situation by spoiling traditional swamp taro patches. This has forced households to move gardens and dwellings further inland into previously undisturbed forest.



The resulting land-use shifts, combined with topsoil erosion from heavy rains continue to challenge the productivity and health of the ecosystems on which the community depend.<sup>79</sup>

### 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

#### 3.1 Overarching objectives

Despite escalating environmental pressures, the people of Poposa are actively safeguarding their community's future by strengthening their relationship with the surrounding environment. Driven by a shared sense of stewardship, community members have prioritised a symbiotic relationship with nature to ensure long-term, collective well-being. To turn this commitment into action, the community established the Poposa Ecosystem Protection and Management initiative in 2023–2026 under the Climate Resilient Islands programme.<sup>80</sup>

This intervention focuses on community-led 'Ridge to Reef' protection:

- Rehabilitating and sustainably managing forest, mangrove, and coral reef ecosystems to enhance community resilience against climate change impacts
- Supporting sustainable resource management practices through increasing community capacity and by providing them with alternative livelihoods.

#### Conservation and management of the terrestrial and marine ecosystems

A key objective of the initiative is to convert some traditional resource management practices (*tabu* in the Solomons) into legally recognised practices through a Protected Area under the Protected Area Act 2010. This formalisation will strengthen governance structures and provide a legal framework for rule enforcement.

To operationalise this framework, the initiative focuses on:

- *Capacity building:* raising awareness and training community members in reforestation, protection and sustainable resource management practices & monitoring. This includes selecting and training local rangers in national standard biological monitoring protocols
- *Resource regulation:* Establishing sustainable harvesting for key ecosystems across reefs, mangroves, and forest areas.

#### The Ridge-to-Reef approach

To successfully achieve these objectives, Poposa adopted a holistic ridge-to-reef approach to manage and protect its environment. This strategy recognises that the health of the marine environment (the reef) is directly tied to the management of the highlands and rivers (the ridge), meaning that degradation in the upper watershed inevitably flows downstream to harm coastal areas.

In Poposa, this ecological interconnectedness is defined by distinct local ecosystem zones. Under this framework, land-use actions in the upper forest (Zone 3) and community areas (Zone 1) cascade down to directly impact the health of the mangroves and the sea (Zones 4 and 5). To secure these interconnected zones, a core goal of the initiative is to transition existing, traditionally managed areas into a legally recognised Protected Area under the *Protected Areas Act 2010*.

This formalisation strengthens community governance and provides a robust legal framework to protect vital terrestrial habitats and marine spill-over zones that replenish local fisheries. Crucially, formalising this protected area does not exclude local people from their ancestral lands; rather, it legally empowers the community to establish and enforce their own rules for sustainable harvesting, safeguarding vital resources for both current livelihoods and future generations.



Community member Betsy in the mangroves © Live & Learn

Integrated management process starts at the highest point of the ecosystem:

- *The ridge: Protecting and managing the Bauvi forest:* The ridge in Poposa is the virgin Bauvi forest, which the community views as a symbol of resilience. Protection and management of the forest is a preventative measure to ensure no further logging activities damage downstream waterways, while active planting helps stabilise degraded patches. Under the current ridge-to-reef approach, terrestrial protection and management are achieved through three key mechanisms:
  - Community-led reforestation: the community receives training from forestry officers and plants native trees like *koilo* (*Calophyllum inophyllum*).
  - Land use mapping: Supported by the CRI initiative, local rangers map customary boundaries to better regulate land use, resolve boundary disputes and advocate for low-impact commercial logging practices that preserve downstream systems.
  - Formal legal protection: A critical step in the “ridge” process is the ongoing work to have the terrestrial forest formally registered as a Protected Area, to establish a permanent legal barrier against further commercial logging encroachment.
- *The coastal buffer:* Sustainable management and protection of mangroves: Mangroves serve as the critical interface between land and sea (the ridge and the reef), acting as a natural sediment filter for land-based debris and a natural buffer against escalating storm surges. Currently, these ecosystems are under severe stress from heavy, mud-laden runoff washed downstream from commercial logging concessions. To address these pressures, including overharvesting driven by population growth, the Protected Area



management plan includes coastal mangroves and applies traditional bylaws to control and sustainably manage mangrove ecosystems and the resources they contain. For example, it strictly regulates the extraction of mangrove timber for housing construction and fuelwood. These controls are complemented by community-led alternative livelihood and resource-use strategies that reduce dependence on mangrove, forest and marine resources, thereby easing pressure across the wider ridge-to-reef system.

- *The reef: Safeguarding Tribal Marine Resources:* Protecting Poposa's marine resources is vital because they are the community's primary source of dietary protein and economic income. Traditional marine governance has long relied on customary protocols to prevent overharvesting and enforce seasonal *tabu*; however, these measures have become increasingly difficult to uphold because of poaching by fishers from other areas, boundary disputes with neighbouring tribes, and the additional downstream impacts of commercial logging described earlier. The Climate Resilient Island programme strengthens these traditional practices by integrating them into the Protected Area management plan to secure their marine areas.
- *Cross-cutting knowledge and monitoring:* The ridge-to-reef process is also underpinned by the Indigenous Knowledge Leadership Programme (IKLP) for ranger knowledge and technical capacity building. Together, these initiatives strengthen local knowledge, community-based monitoring, food and livelihood resilience, and the capacity of communities to participate actively in ecosystem management and conservation.
- *Intergenerational knowledge transfer:* Elders pass down traditional skills and knowledge to young people to foster resilience and independence from the cash economy. Key initiatives include:
  - Traditional weaving: Knowledge holders mentor women in weaving traditional fans and baskets used daily for harvesting local resources, as well as food and floor mats.
  - Customary crafting of tools and fishing: Elders mentor young men and boys in crafting traditional bows, arrows, spears, and customary netting to harvest reef resources sustainably.
  - Disaster-resilient food preparation: Young women are mentored on how to cook *kakake* (giant swamp taro), a traditional food, an essential food security buffer when extreme weather and flooding wash away standard garden plots. This traditional dish is known as *hausu*, and it is prepared using the giant swamp taro with coconut oil and ngali nuts with its shell intact, then stored in traditional baskets woven from coconut leaves. Ngali nuts are an edible nutrient-dense nut harvested from the *Canarium indicum* tree native to the rainforest of the Solomon Islands.
- *Ranger training and community-based monitoring:* Local community members are trained as rangers by the Solomon Islands Ranger Association in leadership, local data collection, meeting facilitation, biodiversity monitoring and threat assessment, and communication within and beyond protected areas.
- *Livelihood and food security resilience:* A primary objective of the program is to safeguard and secure Poposa's exceptionally high level of self-sufficiency, where two-thirds of the community relies on local gardens, farms, and the sea to supply 61–80% of their daily food. Restoration activities are therefore designed to improve the health and productivity of these resources while reducing pressures on ecosystems.

- *Nature-based alternative livelihoods:* Sustainable subsistence income opportunities and alternative food sources were implemented by the Poposa community to reduce reliance on natural resource extraction. These include:
  - Climate-smart gardening: Designing and maintaining 30m-by-30m model gardens utilising composting and crop rotation to preserve soil fertility, secured against wild pigs by planting a protective perimeter of pineapple suckers.
  - Local community piggery: Operating a community piggery built from local trees, sago palm, and bush ropes. To keep operations sustainable, farmers use localised feed formulations made entirely from local root crops and fruit trees.
  - Value-Added Micro-Enterprise: Training on preserving and processing foods such as local cassava and banana yields into chips and selling produce at the weekly local market to build long-term household financial security, ensuring resilience.

By integrating these strategies, Poposa seeks to realise the “Broom” vision—a connected and resilient landscape where each component of the ridge to reef system is restored and managed together through strong and sustained community engagement.



Poposa youth rangers © Live & Learn



### 3.2 Targets and indicators for ecosystem health and biodiversity

| Objectives                                                                                        | Indicators: measuring resilience outcomes                                                                                                                                                                                                                                                                  | Means of verification                                                                                                                        |
|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ecological resilience – Improved ecosystem resilience through nature-based land management</b> | <ul style="list-style-type: none"><li>• Area (% of total) of terrestrial and/or marine ecosystems with improved resilience through actions based on community resilience profiles and plans</li><li>• Community reports of increased alignment of ecosystem management with Indigenous knowledge</li></ul> | <ul style="list-style-type: none"><li>• Surveys</li><li>• Endline MEL (Community Nature-based Solutions Resilience Actions Report)</li></ul> |

Important assumptions include:

- Logging deterrence: It is assumed that formalising legal boundaries under the Protected Area Act 2010 will deter upstream commercial logging. Success relies on provincial government support to ensure commercial logging concessions do not override community Protected Area status

| Objectives                                                                                                                           | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                                                | Means of verification                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indigenous Land Management- Indigenous nature-based solutions for climate resilience are identified, strengthened and enabled</b> | <ul style="list-style-type: none"><li>• % increase of total area of ecosystems with improved resilience by end of programme</li><li>• Communities are supported to establish legally protected areas as measured by:<ul style="list-style-type: none"><li>• Extent of ecosystems with legal protection</li><li>• Development of appropriate ranger training</li><li>• Proportion of community members reporting increased knowledge and skills in indigenous nature-based solutions for resilience</li></ul></li></ul> | <ul style="list-style-type: none"><li>• GIS mapping of boundary, Progress Reporting<ul style="list-style-type: none"><li>• Protected Area Boundary Mapping &amp; Tenure Verification</li></ul></li><li>• Training sheet agenda</li><li>• mWater Participants monitoring</li><li>• Stories and field photos</li><li>• IKLP Survey 3 months after the IKLP Programme (mWater)</li></ul> |

|                                                                                                                 |                                                                                                                                                                                                      |                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <b>Ecological Resilience<br/>– Improved ecosystem resilience through community nature-based land management</b> | <ul style="list-style-type: none"> <li>• Proportion of community engaged in implementing community resilience action plans that target ecosystem resilience</li> </ul>                               | <ul style="list-style-type: none"> <li>• Community Resilience Plans on Ecosystem Restoration</li> </ul> |
|                                                                                                                 | <ul style="list-style-type: none"> <li>• Ecosystem resilience grants delivered based on Community Resilience Plans to support ecosystem management, restoration and protection priorities</li> </ul> | <ul style="list-style-type: none"> <li>• Community Resilience Grants Reporting</li> </ul>               |

Important assumptions include:

- Boundary enforcement: Formalising legal boundaries under national legislation (e.g., the Protected Area Act 2010) is assumed to counter encroachment of commercial logging. However, success requires continuous community-led monitoring and provincial coordination
- Logging concessions do not override Protected Area status
- Improving marine biodiversity depends on sustained local compliance with harvesting bans and alternative means to reduce the burden on overharvested marine ecosystems

#### Sample targets, linked to indicators

- Community has prepared documentation for legal protection of ecosystems
- At least 20% of community members reported increased knowledge and skills in indigenous nature-based solutions for resilience
- 20% of community is engaged in implementing community resilience action plans that target ecosystem resilience across selected locations by the end of the programme (in this case, safer pig management, better hygiene practices, and reduced impacts on the surrounding ecosystem)
- (at least) 80% of grant funds are disbursed for the implementation of nature-based solutions, community ecosystem resilience activities outlined in community resilience plans



### 3.3 Targets and indicators for human wellbeing and resilience

| Objectives                                                                       | Indicators: measuring resilience outcomes                                                                                                                                                                                                                                            | Means of verification                                                                                                                                |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enhanced community resilience through nature-based livelihoods and food security | <ul style="list-style-type: none"><li>• Proportion of participating households reporting a score of 0–3 on the FAO Food Security Experience Scale</li><li>• Proportion of participating households with new and /or additional income source from nature-based livelihoods</li></ul> | <ul style="list-style-type: none"><li>• Food Insecurity Experience Scale Survey tracked in mWater and captured during baseline and endline</li></ul> |

| Objectives                                                                                                                                  | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                                                            | Means of verification                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communities are developing economic resilience through operating new and / or diverse sustainable livelihood enterprises                    | <ul style="list-style-type: none"><li>• Establishment of resilient nature-based food production techniques</li><li>• Measures of pig quality, quantity and household income improvement (as a resilient food-security alternative)</li><li>• Number of trainings conducted in resilience of food system technologies and practices</li><li>• Volume, number of resilience grants and support provided to community livelihood enterprises; including proportion of grant funds disbursed</li></ul> | <ul style="list-style-type: none"><li>• Survey tracked in mWater during baseline and endline</li><li>• Training sheet Agenda</li><li>• mWater Participation monitoring log</li><li>• Images and stories from participants and community</li><li>• Progress Report</li><li>• Community resilience grants reporting</li></ul>                              |
| Communities are using adapted nature-based food production techniques and technologies that contribute to resilient household food security | <ul style="list-style-type: none"><li>• Proportion of participating households with increased food production from family gardens</li><li>• Proportion of participating households applying new agricultural technology systems or practices</li></ul>                                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>• Food systems survey done during profiles and endline</li><li>• Food systems survey.</li><li>• Training sheet Agenda</li><li>• mWater Participation monitoring log</li><li>• Images and stories from participants and community</li><li>• Quarterly and Annual Progress Report</li><li>• Endline Report</li></ul> |

### Sample targets, linked to indicators

- 80% of participating households reporting a score of 0–3 on the FAO Food Security Experience Scale by the end of the programme
- 80% of participating households have new and /or additional income sourced from nature-based livelihoods by the end of the programme
- (at least) 80% of grant funds are disbursed by the end of the programme to support community livelihood enterprises
- 10% of participating households show an increase in food produced from family gardens
- 25% of participating households are applying new agricultural technology systems or practices





### 3.4 Targets and indicators for gender and social equity and rights

| Objectives                                                                                                                   | Indicators: measuring outputs and processes that lead toward resilience                                                                                                                                                                                                                                                                                                                                                                                          | Means of verification                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enhanced community resilience through nature-based livelihoods and food security                                             | <ul style="list-style-type: none"><li>• Equal participation of men and women in Community Resilience Committees</li></ul>                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>• End of programme evaluation report for gender equality, disability and social inclusion</li><li>• Progress report and endline reporting</li></ul>                                                                 |
| Improved ecosystem resilience through community nature-based land management                                                 | <ul style="list-style-type: none"><li>• Intergenerational engagement with Indigenous nature-based solutions for climate resilience</li><li>• Proportion of young people who report increased confidence in Indigenous nature-based solutions</li><li>• Proportion of young women and girls and of young boys and men who participate in the Indigenous Knowledge Learning Programme (IKLP)</li><li>• Number of community rangers trained who are women</li></ul> | <ul style="list-style-type: none"><li>• Completion of the IKLP Survey 3 months after the IKLP workshop</li><li>• Workshop attendance sheet</li><li>• Participation survey (tracked on mWater)</li><li>• Stories from participants (qualitative)</li></ul> |
| Communities are developing economic resilience through operating new and /or more diverse sustainable livelihood enterprises | <ul style="list-style-type: none"><li>• Participation of all genders and all age groups in piggery training (participation numbers, disaggregated by gender and age group)</li></ul>                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>• Attendance training sheet</li><li>• Participant monitoring (tracked on mWater)</li><li>• Endline reports</li></ul>                                                                                                |

Important assumptions include:

- A critical assumption is that the younger generation will remain willing to learn traditional “dying skills” (like canoe carving) to avoid the rising costs of the cash economy and maintain self-reliance
- It is assumed that the Community Resilience Committee will provide the strong leadership required to maintain individual and collective ownership of activities once external project support concludes
- For the piggery, the community assumes responsibility for feeding and maintenance, with a breeding plan in place to distribute future piglets to households
- Success relies on women and young people continuing to be empowered to speak up in decision-making forums and their technical perspectives remaining central to Protected Area management

#### Sample targets, linked to indicators

- 20% of young people report increased confidence in using Indigenous nature-based solutions [within the programme timeframe]
- Equal numbers of young women/girls and men/boys participate in the Indigenous Knowledge Learning Programme.
- One or more female youth leaders are appointed and trained as community rangers to integrate female perspectives into resource management
- Women take up leadership roles in the Community Resilience Committee at parity or near-parity with men (e.g. 60%/40%)

### 3.5 Measuring resilience over time: experiences from the Poposa mangrove and ecosystem restoration initiative<sup>81</sup>

The impact of the Poposa mangrove restoration and ecosystem initiative is best understood through the personal experiences of the community members who are actively weaving traditional wisdom with new technical skills. These stories reflect a shift from being a remote, overlooked community to one that is empowered through governance, technical leadership, and intergenerational knowledge transfer.

#### Empowerment through governance and connectivity

For the people of Poposa, a significant impact of the initiative is the bridge it has built between their remote shores and national government support. Peter Manetanau, the Climate-Resilient Islands chairperson and a local pastor, explains that this connection has transformed their disaster preparedness. Through this initiative, Peter has established direct contact with senior forecasters in the Meteorology division, enabling the community to move from passive recipients of radio alerts to active participants in disaster-response governance.



### **Intergenerational justice and ecological restoration**

Community members view restoring coastal buffers as a fundamental act of survival for future generations. Betsey Toata, a woman aged 40+, identifies tree planting as an urgent necessity to counter the decline of natural resources caused by external pressures like logging:

*“Tree planting is very important for our community because the number of children is increasing, while our natural resources, especially trees, are declining... If we do not plant trees for them today, they will have to go far to find them, and we ourselves will make them suffer in the future. If we are not prepared now, our children will face a hard life later” – Betsey Toata*

During field demonstrations, Betsey actively encouraged local boys to plant useful trees found in the bush,

emphasising that “talking about the future means talking about ourselves, and most importantly, about our children”.

### **Revitalising traditional skills for self-reliance**

The Indigenous Knowledge Leadership Programme (IKLP) has fostered a resurgence of traditional survival skills, such as weaving, thereby reducing the community’s dependence on the cash economy. Freda Ikaua, an IKLP holder and expert in weaving, shares how she uses these skills to mentor her daughter:

*“My younger daughter finishes one of the baskets I started with young coconut fronds, and she made it all wrong at first. After realising it was her, and knowing she wishes to learn, I helped her make a new one. Now she weaves it to help her pack goodies she needs when going out to clean the coral nurseries” – Freda Ikaua*



Basket weaving in Poposa © Live & Learn

This transfer of knowledge ensures that younger generations can provide their own supplies for livelihood and restoration work, such as baskets for marine nursery maintenance.

### **Inclusive leadership and technical capacity**

The initiative has also broken barriers in social equity by ensuring women and youth are represented in technical monitoring roles. Mazella Rere'uma, a 26-year-old youth leader, participated in intensive ranger training while in her third trimester of pregnancy to ensure a female perspective is included in the management of the cluster's proposed Marine Protected Area (MPA):

*"I am privileged to learn about the different things concerning rangers. I reflected that our community really needs to work on a good governing structure and a good leader. These two must always come together. When I go back, I will share this to the rangers and I will of course be part of it."*

Similarly, Francis Liumai, an elder and DRR chairperson, reflects on how the initiative has built his confidence in formal administrative leadership:

**“ I really learn new things in this workshop, especially how to put agendas and how to arrange them in a meeting... These are important skills as we are called to carry leadership roles in our community, but we did not go to school to learn these things. But now I am confident that I will do it better.”**

**Francis Liumai**



*Traditional food preparation © Live & Learn*

### **Choosing sustainable livelihoods**

Finally, the impact is seen in the personal sacrifices community members make to shift toward nature-based economic models. Maesach Mane, a local teacher, opted to miss a week of his formal job to attend piggery and feed formulation training:

*"I see this training is of important to me. I want to obtain the pig feed formulation knowledge and skills so that piggery activity will be my family's alternative source of income when I started my piggery farming again." – Maesach Mane*

By learning to use local root crops and fruits for feed, Maesach aims to build a self-reliant livelihood that supports his family while protecting the surrounding ecosystem from the pressures of commercial, imported feeds.



## 4. Understanding how targets, monitoring and reporting can work well together at different scales

### INDEPENDENT ANALYSIS – BY MAIRI DUPAR

This case study is a great example of how adaptation can and should be approached coherently at multiple scales. Likewise, its results can be measured at multiple scales – by the appropriate actors – to provide an integrated understanding of how human and physical geographies interact.

The Ridge to Reef approach recognises the hydrological, geological and ecological connections among different parts of the watershed and coastal zone: how environmental degradation or improvement at one point has knock-on effects on another. From a governance perspective, the community actors have power and agency over some localised resilience solutions, such as community forest and swampland management. However, they need the policy and management interventions of actors operating at other geographic scales to stop the drivers of environmental degradation: namely the national government, with its authority to designate national parks and regulate logging.



Because the drivers of communities' vulnerability and resilience are at different scales and entry points across the landscape, the accountability for adaptation action also rests with different actors at different scales. This has implications for who commits to which actions, and who monitors, tracks and communicates which adaptation and resilience results.

**The community members' focus on the outcomes of adaptation action and who benefits, as well as the process, is a critical perspective with applicability to the international adaptation community at large.** The people of Poposa are clear that it is one thing to consider the differential vulnerabilities of certain groups, such as people living with disability, at the ideation and design stage of an initiative. But it is also critical to track benefits for these climate-vulnerable groups all the way through to outcomes and impacts of a programme: e.g. were the benefits of adaptation action both sufficient *and* equitable for people living with disability? And if not, how could the equity of outcomes be improved?

**The Poposa community's definition of social unity and cohesion as 'what good resilience looks like' is somewhat specific to their society and culture. It is an indicator of resilience that members of the community can readily identify with.** The Poposa community defines social cohesion as the core of their resilience. It's also true that when community cohesion is achieved, it is not necessarily documented in any formal way for external use – neither does it have to be. It is fine for some measures of resilience to be locally-specific and used tacitly, as in this example, upheld by social norms and collective dialogue and understanding at the local level. Not every indicator will be formal and will be universally applicable.

**It is possible for other understandings of 'adaptation progress' or 'resilience' to be compatible with local world views such as these and to be implemented, measured and monitored in parallel, because they speak to universal human needs e.g. water and food security, fertile and stable land, gender and intergenerational equality and other human rights.** Targets and indicators of adaptation progress that are universally recognised and adopted, such as these, can co-exist alongside communities' own distinct motivations and visions of resilience. Results of indicators that are both locally prioritised and also universally applicable and supported can be reported to national development machineries and subsequently to international entities such as the UNFCCC and CBD (see Figure 4, page 25, on nested indicators and separate indicators).

**The assumptions behind the indicators and targets for ecological and human resilience in this case study are in many ways as important as the indicators themselves because they will provide rich grounds for adaptation-related learning.** A standout example is the assumption that young people will be motivated to revitalise traditional handicraft skills to improve their multidimensional resilience. There need to be opportunities for learning that permit adaptation champions to revisit and adjust their assumptions about what works and to undertake impact assessments over a period of years – such learning and impact assessment opportunities need dedicated funding.

# CASE STUDY

## South America's grasslands: Ecosystem-based Adaptation for climate resilience, biodiversity and livelihoods

By Natalie Dudinszky and Javiera Perez Ribalta

*Grasslands Alliance: Argentina, Brazil, Paraguay and Uruguay, Aves Argentinas, Aves Uruguay, Guyra Paraguay, SAVE Brasil and BirdLife International*



### Global goal on adaptation (GGA) framework thematic targets

Food and  
agriculture



Ecosystems



Poverty and  
livelihoods



Cultural  
heritage



## Cross-cutting considerations: GGA framework and Section C of the GBF



Vulnerable ecosystems, groups and communities



Science-based indicators, metrics and targets



Ecosystem-based adaptation, nature-based solutions



Private sector engagement



Traditional knowledge, Indigenous Peoples' knowledge, local knowledge systems



Contribution and rights of Indigenous Peoples and local communities



Different value systems



Formal and informal education



Right to development

## Nature's contributions to people

This is not exhaustive, but shows key Nature's contributions to people that are highlighted in the case study and measured by stakeholders (from IPBES, 2019).

### Materials and assistance

- Food and feed
- Habitat creation and maintenance

### Non-material contribution

- Learning and inspiration
- Physical and psychological experiences
- Supporting identities
- Maintenance of options



*Culicivora caudacuta, Brasil* © Glayson Bencke



**Figure 14. Grasslands Alliance operational area**



Source: © Cartography, Chandra Jayasuriya

## 1. About the grassland ecosystem

A vast area of 75–100 million hectares of grassland across Argentina, Brazil, Paraguay, and Uruguay, called the 'pampas', has extraordinary biodiversity. As shown by the yellow areas on the map (below), the pampas hold many Key Biodiversity Areas (KBAs), which are sites of global significance for biodiversity. For example, thousands of species of vascular plants have been detected here, and a high diversity of vertebrates. The pampas are home to around 540 species of birds, 138 species of mammals and 225 species of reptiles.

Among the species of the grasslands are the iconic southern long-nosed armadillo (*Dasypus hybridus*) and maned wolf (*Chrysocyon brachyurus*). Several well-known pampas species are under conservation pressure, such as the vulnerable greater rhea (*Rhea americana*), the Argentinean horned frog *Ceratophrys ornata*, the endangered saffron-cowled blackbird (*Xanthopsar flavus*), and the marsh seedeater (*Sporophila palustris*), among many others.





## Box 6. Key Biodiversity Areas (KBAs)

The KBA concept builds on decades of experience in identifying important sites for biodiversity, in particular Important Bird and Biodiversity Areas (IBAs). The KBA Standard, published by the International Union for Conservation of Nature (IUCN) in 2016, provides an overarching framework to harmonise these existing approaches. The KBA Partnership is an ambitious partnership of 13 global conservation organisations tasked with supporting nationally led efforts to identify KBAs, maintaining the World Database of KBAs, and promoting conservation of these sites. BirdLife and IUCN co-host the KBA Secretariat.

For thousands of years, since the times when Indigenous peoples were the sole human presence and before European colonisation, the pampas have been grazed by a variety of wild mammals. These include large- to mid-sized herbivores such as the pampas deer (*Ozotoceros bezoarticus*, Near Threatened) and the marsh deer (*Blastocerus dichotomus*, Vulnerable), which in the present day have scattered and threatened populations (IUCN, 2025).

The guanaco (*Lama guanicoe*, Least Concern) is a native large, wild camelid (related to the llama) that feeds on dense grass and shrubs. It used to range across the drier pampas areas. It is now restricted mostly to the Andean grasslands.

Small-sized herbivores such as Pearson's tuco-tuco (*Ctenomys pearsoni*, Near Threatened), the Rio Negro tuco-tuco (*Ctenomys rionegrensis*, Endangered) and the plains viscacha (*Lagostomus maximus*, Least Concern) used to dominate these areas. The plains viscacha is a large rodent that lives in burrow colonies and also feasts extensively on the grasses.

Natural grazing mammals left the swards of grass at different heights, which created the optimal conditions for breeding by diverse bird species as well as microhabitats that suited a range of diverse plant life. Europeans introduced cattle and other livestock from the 16<sup>th</sup> century onwards.<sup>82</sup> Over time, as cattle-keeping expanded over these lands, the pampas came to be managed as rangelands with extensive livestock keeping.



Extensively grazed Brazilian grasslands © Felipe Ulbrich



## What are rangelands and extensive livestock management?

Rangelands are defined by the International Livestock Research Institute (ILRI) as: “Rangelands can be described as land on which the vegetation is predominantly grasses, grass-like plants, forbs or shrubs, and often with trees that are grazed or have the potential to be grazed by livestock and wildlife. They are diverse in their vegetation, driven by highly fluctuating rainfall, temperature and other climate phenomena, and provide habitat for a wide range of wildlife, many species of which are found nowhere else. Rangelands store vast amounts of carbon and either originate or serve as freshwater catchment areas for most of the world’s largest rivers and wetlands. Rangelands are home to millions of people, from pastoralists to hunter-gatherers to ranchers to conservationists. Rangelands feed millions of people worldwide. Rangelands have significant cultural and aesthetic value too, and for many, are places of inspiration and beauty.”

Source: ILRI, IUCN, FAO, WWF, UNEP and ILC. <sup>83</sup>

Extensive livestock production is defined as an “animal farming system characterised by a low productivity per animal and per surface. It uses small amounts of inputs, capital, and labour compared to the farmed land area. Extensive livestock production systems usually have a low stocking rate and are essentially based on grazing (permanent grasslands, natural pastures).”

By contrast, intensive agriculture uses markedly more inputs, such as fertilisers, human-made feeds, and diversion of water or intentional management of water for the farming system.



Source: Dictionary of Agroecology, <https://dicoagroecologie.fr/en/dictionnaire/extensive-livestock-production/>

Cattle-keeping as practised today is not ‘natural’ in the historic sense. It is a new system. However, it has, nevertheless, the potential to be managed in a way that permits the grass to regrow naturally, creating a synergistic relationship between the livestock and diverse wild species. These extensive cattle ranging systems can, to some extent, replicate aspects of the original system, whereby cattle became the new grazers, in balance with other elements of the grassland ecosystem. From an ecological perspective, this supports far more biodiversity than monocultural crop plantations, which are an alternative land use.

“ Keeping natural grasslands under sustainable management provides a richer home for biodiversity while storing more carbon in the soil than converting them to monoculture farming systems.”

**Natalie Dudinszky, BirdLife Regional Coordinator**



In more recent decades, as described further below, grasslands have been converted to cropland and/or afforested with monocultural species, leading to habitat fragmentation and biodiversity loss. Intact and extensively managed grasslands are good for biodiversity and for other NCPs such as regulation of water flows and so are critical in the race to climate resilience. Grasslands also play an incredible role in carbon storage; when carefully stewarded, they are important to mitigating climate change.

Around 95 percent of the lands across the pampas region are privately owned. Some 60–70% of the historic pampas land area is already converted – mostly to croplands – but also to afforestation with exotic species. The 30–40% of remaining pampas grasslands are mostly dedicated to livestock production, but these and their associated species are at risk of disappearing.



*Pampas grassland ecosystem, Paraguay © Selene Davey*

## 2. People's resilience in the context of a healthy ecosystem

Since the 1960s and 1970s, the grasslands have been under great pressure for conversion to more intensive agriculture and forestry across the biome. Government subsidies and technological investment in soy and wheat varieties drove the expansion of mono-cropping in the grasslands.<sup>84,85</sup> Policy choices also incentivised conversion to corn.<sup>86</sup>

Some 50% and 75% of the original natural grassland cover of the Southern Cone has been lost due to land use change, causing ecosystem fragmentation, wetland desiccation, soil and nutrient loss, and loss of original biodiversity.<sup>87</sup>

Total land-use conversion to monoculture plantations (croplands or afforestation with exotic species) alters the natural geophysical and ecological interactions among soil, water, and land cover in grasslands. As a result, grassland specialist species—those that cannot successfully breed or persist in other habitats—are losing critical habitat features. Ecosystem services provided by healthy natural grassland ecosystems—such as carbon and water storage in roots and soils, regulation of water flows, erosion prevention, and climate change mitigation—have been disrupted. When grasslands are fully converted to monocultures, many species and their habitats are lost; however, where landscapes retain a mosaic of agricultural land and natural grasslands, a greater number of species can persist.<sup>88</sup>

If agriculture is done sustainably, for example, maintaining biological corridors and using good management practices, such as rotating crops, creating terraces on uneven lands, using direct seeding to protect soil coverage and avoid water evapotranspiration and soil erosion, using integrated natural biological control of pests, etc., it is possible to achieve agricultural production alongside conservation outcomes.



A symbol of gaucho culture, Brazil © Acervo Alianzadel Pastizal BR

Approximately 95% of the land in the Southern Cone is in private hands with a strong historical and cultural livestock tradition.

Not only do the pampas grasslands, as a major, transboundary ecosystem, present unique opportunities and challenges for the interaction of people and nature through native grassland, agriculture and forestry practices. They are home to a unique culture, also. The rangelands traditional lifestyle is called 'gaucho' in the region, a term describing the independent, rugged spirit of the horseman and cowhand ranging over the pampas. The 'gaucho' spirit indeed has been integral to the national identity in Argentina, Brazil, Uruguay and Paraguay for centuries.

While this has tended to be male-dominated, it is not exclusively so. There are many women *gauchos* also. These cultural aspects of the grasslands have given rise to local festivals and all-of-community traditions, and have provided the basis for an emergent tourism industry, attracting both domestic and international visitors.<sup>89</sup>

For these reasons, a unique alliance of producers, NGO conservationists, companies, academics, researchers, technicians, government representatives and private sector actors was formed in 2006 to promote nature conservation and the sustainable rural production of the natural grasslands of the Southern Cone of South America. The objective? To maintain viable livelihoods and protect and enhance ecosystem services and biodiversity. The Grasslands Alliance is also sensitive to the cultural ties of gauchos to the pampas ecosystem. Spearheaded by Aves Argentinas, Aves Uruguay, Guyrá Paraguay and SAVE Brasil, together with BirdLife International, they adopted as their motto 'Production and Conservation'.

“ I refuse to convert these lands into agriculture, and within the Grasslands Alliance I've been learning sustainable practices that keep the environment healthy for birds and other wildlife.”

Participating landowner



### 3. Enhancing ecosystem integrity for the benefit of people and biodiversity and measuring progress

#### 3.1 Overarching objectives

The vision of the Grassland Alliance is to achieve a region of the Pampas grasslands of the Southern Cone of South America where:

- Extensive livestock production on natural grasslands becomes a more competitive and profitable activity, carried out sustainably by promoting grassland conservation through grazing systems that are appropriate for ecosystem conservation.
- Agriculture and forestry are conducted responsibly, with careful management of soils and water, prudent use of agrochemicals, and ensuring sufficient areas for native grassland wildlife.
- Urban growth takes into account the Pampas landscape, guaranteeing the conservation of natural grasslands.
- Officially recognised protected areas conserve at least 10% of the original natural grasslands in each country and are properly implemented to effectively fulfil their role.
- Where the 'traditional culture' of the Pampas holds a meaningful and valued place in our societies.<sup>90</sup>

The mission is transboundary and cooperative in nature. It seeks to strengthen its current form as a broad and trusted platform for conservation organisations, academic institutions, rural associations and unions, governments, and society at large, to support project development, policy creation, the promotion of scientific research, assistance to rural producers in adopting good practices for sustainable production management, and the active promotion of the



*Strange-tailed tyrant (Alectrurus risora), Paraguay © Selene Davey*

conservation of natural grasslands and their biodiversity within the grasslands of the Southern Cone of South America (Argentina, Brazil, Paraguay, and Uruguay).

The basis for the Grassland Alliance's formation and for its activities is that:

- Well-managed grasslands can reverse degradation, increase production, and enhance their carrying capacity, thus entering a virtuous cycle of productivity and profitability.
- Natural grasslands provide ecosystem services such as soil and watershed protection; aquifer recharge (e.g. through excellent filtration of rainwater through soils); carbon sequestration, particularly in the roots of the grassland plant species and top layer of soil; habitat

for insects and birds that have a role in pollination and pest control; habitat for mammals, reptiles and amphibians; and scenic landscapes, among other benefits, which society is beginning to value.<sup>91</sup>

The Grassland Alliance partnered with landowners whose landholdings make up an important proportion of the Southern Cone grassland area. The criterion to become a member of the Grassland Alliance is to maintain 50% of one's landholding with natural grassland cover, which it can still be grazed in a sustainable manner with conservation outcomes. In reality, members average 75–80% of their land in natural grassland cover.

The members of the Alliance recognise the biodiversity values of the extensive system and are increasingly aware of the carbon sequestration value in a warming climate. The motivation for members to join up, other than a passion for the natural environment and the wide open grasslands they love? By becoming members, they receive significant assistance with developing and marketing eco-labelled produce and carbon credits from the area – as detailed further below.

The Grassland Alliance's approach goes beyond promoting the “extensive” cattle grazing that existed (as described above). Instead, it focuses on improving grazing management practices to balance both conservation and production objectives, with a particular emphasis on using natural native grasslands as the main forage resource.

The Alliance encourages more proactive, adaptive grazing approaches, such as rotational, holistic grazing or other techniques that help maintain grassland health, support vegetation recovery, and provide habitat for key grassland bird species and other wildlife. The focus is on smart, ecologically informed management of native grasslands that sustains productive livestock systems while preserving biodiversity.<sup>92</sup>



## Grassland Alliance facts and figures

Southern Cone grasslands (over four ecoregions):

**70–100 million hectares**

Area covered by the Grasslands Alliance initiative for biodiversity-friendly landowners:

**1.34 million hectares**

Number of landowners involved:

**847 landowners registered, and their families**



*Extensive rangeland management, Argentina © Candelaria Neyra*



## Box 7. Ownership and management of the grasslands

Medium to large-scale landowners often directly manage operations, either personally or through family-run businesses. In these cases, decision-making on grazing practices, conservation agreements, and sustainability is usually kept within the family or ownership group.

Management may be delegated to hired administrators or managers, especially when owners do not live on the land. These managers often oversee staff and make day-to-day decisions, but conservation commitments still require owners' approval.

In smaller holdings, it's common for landowners to manage the land themselves and also carry out the work with limited hired labour. In these cases, engaging directly with landowners for conservation practices is both practical and impactful.

Because of this variability, it's important to consider both landowners and land managers in programme design, monitoring, and implementation. Many of the conservation agreements under the Grassland Alliance are signed by landowners, but successful outcomes often depend on day-to-day actions by managers and field workers, who must also understand and commit to grassland-friendly practices.

The Southern Cone grasslands cover a very large area with thousands of landowners holding plots of varying sizes. While an exact total number of landowners in the programme area is not precisely known, available land tenure data and rural census information suggest that the Alliance's 847 producers represent a significant portion of the people managing the core productive grasslands.

Activities for ecosystem conservation and local development include:

- **Avoiding the conversion of natural grasslands** (at least 50%) to other land uses such as monocultural cropping or afforestation with exotic species, to maintain an adequate habitat for grassland-dependent birds and other key biodiversity, and maintain vital ecosystem services such as water and carbon regulation. These grasslands can still be sustainably grazed to achieve dual conservation and production outcomes.
- **Identifying properties that support threatened species-or Alliance Focal species-** or that overlap with Alliance Focal sites or Key Biodiversity areas (KBAs) to incorporate them into the Alliance network.
- **Implementing targeted management practices** to maintain a heterogeneous grassland structure—critical for grassland birds- controlling grass height via adjustments in the stocking rates and the grazing regime. These practices aim to create a mosaic of tall and short grass patches that favours a wide range of grassland birds, including resident and migratory birds.
- **Promoting sustainable grazing practices** that enhance soil carbon sequestration, strengthen climate resilience, and provide producers with access to financial incentives through Climate, Community and Biodiversity (CCB) credit programmes (see sidebar), while simultaneously delivering social and biodiversity benefits.

- **Creating biological corridors and refuges** to increase biodiversity connectivity of the natural grasslands across the landscape (i.e., habitat connectivity for birds, native herbivores, pollinators and other key species).
- **Sustainable management of other land use types** and production systems carried out on the Alliance members' land.
- **Preventing serious fires through monitoring and active management**, because fires are a risk to grassland ecosystems and to their climate and economic benefits.
- **Promoting high standards of animal welfare** through responsible livestock management practices.
- **Where key wildlife is present (for example, native herbivores and carnivores), taking these into account** in land planning and management with wildlife-friendly practices.
- **Promoting and strengthening private nature reserves** where Alliance members are dedicated conservationists and have dedicated part of their lands for this purpose (for example, in Argentina: Reserva Paititi, La Siempre Viva, Piedra del Agua, Fortín Cué, El Carrizal, El Erandio, Estancia el Corralito, Estancia La Titina, Estancia San Antonio, Garrapatas, La Aurora del Palmar, Las Dos Hermanas, Los Ñanduces, Nahuel Ruca, La Herminia, El Retoño). In Uruguay, a new law will allow the development of these types of reserves.<sup>93</sup>





## What's a Carbon, Community and Biodiversity credit programme?

Carbon, Community and Biodiversity (CCB) are a set of standards for land management projects that are 'high integrity' for nature, climate and people, verified by Verra. The CCB standards are used in association with the Voluntary Carbon Standard, which is the world's most widely used programme for the certification of carbon credits. CCB standards:

- Identify projects that simultaneously address climate change, support local communities and smallholders, and conserve biodiversity.
- Promote excellence and innovation in project design and implementation.
- Through the certification process, generate verified credits that the project implementers can sell, thus providing them with an income stream from their design and ongoing implementation of land management projects that deliver net positive benefits for climate change mitigation, for local communities and for biodiversity.



Source: Verra <https://verra.org/about/overview/> and <https://verra.org/programs/ccbs/>

### Livelihood diversification holds key to better outcomes for nature, climate and people

The Grassland Alliance has been active in supporting its members to diversify their sources of household income into a range of livelihoods which offer viable alternatives to intensive cropping. Foremost of these has been the development of a seal of origin for beef.

The Grassland Alliance has undertaken a sustained programme to promote 'premium' beef production from extensively managed rangeland. The prerequisites to qualify for the seal of origin 'Carnes de Pastizales Naturales de la Alianza del Pastizal, amigables con la conservación de la biodiversidad de los pastizales naturales del Cono Sur sudamericano' (in short, ©Carnes del Pastizal) are the same prerequisites as those to become a member of the Grassland Alliance. However, specific criteria are added around completing the production cycle in natural grasslands. In Brazil, further criteria are included, to do with the cattle breeds and quality of the meat.

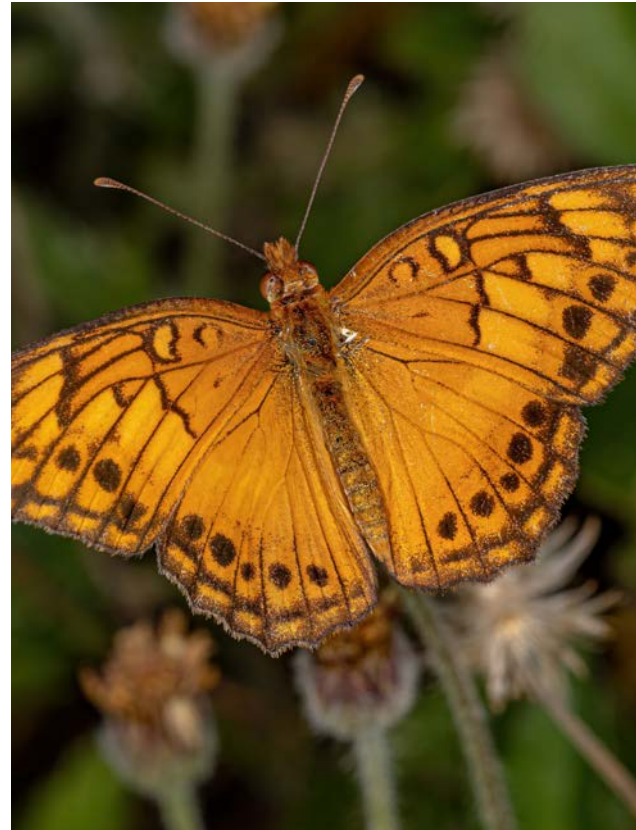


Argentine gaucha Maggie Marin © Grasslands Alliance

The Alianza seal can be used as a certificate of origin in other grassland products such as wine, olive oil or honey—not to certify these supply chains themselves, but to indicate that these products come from ranches where biodiversity-friendly cattle management is being implemented.<sup>94</sup>

The most limiting factor is securing retail partners that can commit to long-term procurement agreements. At present, Grasslands Alliance organisation SAVE Brasil is most engaged in promoting the Alianza seal. It is working with local slaughterhouses and supermarkets to promote premium Grasslands Alliance sustainable beef. Aves Argentinas used to work with supermarket chain Carrefour for domestic trade and with brokers exporting to Europe, and Aves Uruguay used to export Grasslands Alliance beef to the Netherlands.

Generating reliable revenues from the sale of carbon credits is another major venture. The grasslands are important stores of terrestrial carbon – and keeping that carbon locked in the soils is an important measure in mitigating climate change. Aves Argentinas and Guyrá Paraguay have documented these carbon stores in natural grasslands, and identified the potential for landowners to quantify carbon storage and sell carbon credits. They have partnered with Boomitra, a carbon project developer that uses satellite technology and artificial intelligence to measure soil carbon. Through this innovative approach, producers can help fight climate change while earning economic benefits from carbon or CCB credits (verified by Verra). These funds can then be reinvested to scale up sustainable practices that conserve grasslands and safeguard birds and wildlife, while improving community livelihoods.



*Mexican fritillary butterfly, Brazil © ViniSouza128/iStock*

Some producers also engage in alternative production such as olives, wine, or honey, but these are not their main activities. In addition, the Alliance is beginning to explore other branding opportunities, such as avitourism, which is already being piloted in Uruguay by Aves Uruguay.<sup>95</sup>



### 3.2 Specific targets and indicators for ecosystem health and biodiversity

Based on an initial species assessment, the Grassland Alliance identified a broad set of bird species that are dependent on the pampas grasslands. Building on this, experts prioritised 14 species to be the focus of conservation efforts. According to these experts, management actions targeting the conservation of the 14 species are expected to benefit the wider community of grassland birds and associated biodiversity.<sup>96,97</sup>

These focal species were selected due to their conservation relevance, including threatened, endemic, and migratory species. They include, among others, the strange-tailed tyrant (*Alectrurus risora*), black-and-white monjita (*Heteroxolmis dominicanus*), buff-breasted sandpiper (*Calidris subruficollis*), saffron-cowled blackbird (*Xanthopsar flavus*), and several endangered *Sporophila* seedeaters.



Black-and-white monjita, Argentina © Pablo Grilli

| Objectives                                                                                                   | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Means of verification                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Restore the species richness of the grassland ecosystems and reverse declines in globally endangered species | <ul style="list-style-type: none"> <li>Proportion of focal bird species and (grassland) ecosystem sites showing positive conservation indices, by a target year</li> <li>Proportion of land where conversion from natural grassland is prevented, by a target year</li> </ul> <p>More detailed sub-indicators include:</p> <ul style="list-style-type: none"> <li>Percentage change in the abundance of grassland specialist bird species (farm averages) in relation to control farms, by a target year</li> <li>Number of grassland specialist bird species recorded on each farm property</li> <li>Percentage change in the number of targeted properties with the presence of at least one globally threatened species, by a target year</li> <li>Percentage change in the abundance of threatened species, by a target year, compared to the baseline</li> </ul> | <ul style="list-style-type: none"> <li>Baseline and regular population monitoring data</li> <li>Number and type of focal sites/species protected, index of bird diversity, Number of producers in the biodiversity focal sites</li> </ul> |

### Sample programmatic targets, linked to the indicators

The headline indicators are:

- By 2033, at least 95% of the focal birds and sites show positive conservation indices
- By 2033, at least 40% of land conversion is prevented

More detailed sub-indicators include:

- By 2033, the abundance of grassland specialist bird species (farm averages) remains constant or increase (in relation to control farms)
- Of the total number of species recorded on each property, at least 10 species on average will be grassland specialist species
- By 2033, the number of targeted properties with the presence of at least one globally threatened species increases by 20%
- By 2033, the abundance of threatened species increases compared to the baseline



## CASE STUDY: South America's grasslands: Ecosystem-based Adaptation for climate resilience, biodiversity and livelihoods

| Objectives                                                                                                                   | Indicators: Measuring resilience outcomes                                                                                                                                                                     | Means of verification                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The quality and availability of habitat (grass height heterogeneity and extent) for key grassland bird species is maintained | <ul style="list-style-type: none"><li>Proportion of the land on which natural grasslands are maintained with a mosaic of tall and short grass patches, through use of sustainable grazing practices</li></ul> | <ul style="list-style-type: none"><li>Annual Alliance Land Audits, ICP Index (Index for the Contribution to conservation of the grasslands, developed by the Grassland Alliance<sup>98</sup>)</li><li>Vegetation monitoring (following the Bird Monitoring Protocol and now incorporating drone monitoring, particularly for the case of the Carbon Projects). Grassland Alliance Database Platform (under development)</li></ul> |
| Water balance is regulated in focal sites                                                                                    | <ul style="list-style-type: none"><li>Number of ranches/hectares with improved water infiltration and water retention index results, by a target year</li></ul>                                               | <ul style="list-style-type: none"><li>Remote sensing, TESSA (Toolkit for Ecosystem Service Site-based Assessment)<sup>99</sup></li></ul>                                                                                                                                                                                                                                                                                          |
| Fires of high magnitude and severity are prevented                                                                           | <ul style="list-style-type: none"><li>Number of hectares burned, by a target year</li><li>Fire severity index results, by a target year</li></ul>                                                             | <ul style="list-style-type: none"><li>Remote sensing, satellite image, NASA Fire Information for Resource Management System (FIRMS)<sup>100</sup></li></ul>                                                                                                                                                                                                                                                                       |

Important assumptions include:

- Availability of funded time or voluntary time of adequately skilled personnel and their availability over time to collect and analyse longitudinal data
- Availability of technology and technological maintenance facilities to operate drones, and availability of financing to obtain remotely sensed imagery where needed

### Sample programmatic targets, linked to the indicators

- In at least 50% of the land, natural grasslands are maintained, and a mosaic of tall and short grass patches is favoured by producers, using sustainable grazing practices
- Water balance is regulated in at least 95% of Grassland Alliance ranches and associated focal sites by 2028
- Fires of high magnitude and severity are prevented in at least 99% of Grassland Alliance ranches and associated focal sites by 2028

### 3.3 Specific targets and indicators for human wellbeing and resilience through ecosystem restoration<sup>101</sup>

| Objectives                                                                                                                            | Indicators: Measuring resilience outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Means of verification                                                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Local incomes are sustained in part through the sale of carbon credits from grassland holdings that are well managed for biodiversity | <ul style="list-style-type: none"> <li>• Number of tons of Carbon equivalent (per hectare) sequestered in the soil of grasslands</li> <li>• Increase in net income of participating households under the scheme</li> <li>• Number of households reporting increased social benefits and increased resilience to climate change (these are intertwined)</li> <li>• Sub-indicators: <ul style="list-style-type: none"> <li>• Happiness index values</li> <li>• Net/gross income</li> <li>• Access to water, food, shelter, education, recreation</li> <li>• Number of hectares on which grassland-friendly approaches are implemented</li> <li>• Number of producers implementing grassland-friendly approaches</li> <li>• % of land where conversion to intensive monocultural systems is avoided</li> <li>• Stocking capacity of land</li> <li>• Kg meat/ha/yr., etc.</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Remote sensing, satellite image processing and artificial intelligence (AI)</li> <li>• Records of transactions in voluntary carbon markets</li> <li>• Social and socioeconomic surveys</li> </ul> |

| Objectives                                                                                                                         | Indicators: Measuring resilience outcomes                                                                                                                                                                                    | Means of verification                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Human resource capacity to understand and monitor biodiversity is enhanced and the knowledge informs ecosystem restoration efforts | <ul style="list-style-type: none"> <li>• Grassland managers in the priority biodiversity areas have acquired the skill to monitor and record emblematic grassland species that are indicators of ecosystem health</li> </ul> | <ul style="list-style-type: none"> <li>• Records from the target grassland areas are uploaded to eBird, wikiAves, iNaturalist and environmental registries and other credible and useful online platforms</li> </ul> |



| Objectives                                                                                  | Indicators: Measuring outputs and processes that lead toward resilience                                                                                                                                     | Means of verification                                              |
|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Activities are held to enhance local capacity for biodiversity understanding and monitoring | <ul style="list-style-type: none"><li>• Number of agricultural producers and community members trained to monitor and record emblematic grassland species that are indicators of ecosystem health</li></ul> | <ul style="list-style-type: none"><li>• Workshop reports</li></ul> |

#### Sample programme targets, linked to the indicators

- By 2030, at least 1,5–2 tonnes of Carbon equivalent per hectare (Tn C eq/ha) are sequestered in the soil, generating an increase in total net income of at least 15% for participating households, in a grasslands area of at least 500,000 ha., where the income is obtained through Carbon and Climate Community and Biodiversity (CCB) credits
- Biodiversity-friendly ranching increases social benefits and resilience to climate change for at least 2,000 families, in at least 2 million hectares of target grasslands

### 3.4 Measuring resilience over time

The main challenges encountered during the design and implementation of the project have been:

- **Aligning multiple stakeholders with diverse priorities:** The Grassland Alliance brings together NGOs, producers, government bodies, and international partners across four countries. Ensuring alignment across different legal frameworks, conservation agendas, and institutional capacities required significant negotiation and coordination.
- **Balancing conservation and production needs:** Sustainable grassland management had to respect both biodiversity goals and the socio-economic realities of local ranchers. Designing conservation actions that genuinely support both bird conservation and livelihoods—especially under pressure from agroindustry and land use change—was a continuous challenge.
- **Ensuring financial sustainability:** While the programme attracted significant interest from donors and technical partners, securing long-term funding (especially for monitoring, producer engagement, and governance structures) was a persistent hurdle. Innovative funding mechanisms such as carbon credits and blended finance are still in early stages and require time to mature.

Among the innovations to grow out of the long-term commitment and cooperation are the development of the Grassland Conservation Index (ICP) as a tool to provide incentives to producers who conserve natural grasslands.<sup>102</sup> The index consolidates measurement of critical grassland ecosystem services and, at the time of its production in 2014, had the buy-in of the four governments of the region: Argentina, Brazil, Paraguay and Uruguay.<sup>103,104</sup>

The main lessons have been:

- **Invest in trust and local ownership:** Long-term relationships with producers and local organisations are crucial. Trust built over years allows for the adoption of practices that benefit both grasslands and livelihoods. Flexibility and respect for local contexts go a long way.
- **Leverage partnerships to amplify impact:** Working under the BirdLife partnership umbrella regionally and through collaboration with other regional and international partners has allowed us to scale knowledge, access technical expertise, and advocate at global policy platforms
- **Integrate biodiversity and climate co-benefits:** Framing conservation in terms of both biodiversity and climate resilience (e.g., through carbon projects and ecosystem services) has opened new doors for financing and visibility. It has also made the case stronger when engaging with the private sector and governments.
- **Promote active participation and knowledge exchange among producers:** Producers' active involvement is central to the Alliance's approach, recognising their knowledge, experience, and capacity for innovation. Continuous exchange of information across the network strengthens learning and adaptive management. This is reflected in the annual regional Grassland Ranchers meetings, which bring together producers, researchers, technicians, conservationists, NGOs, government representatives, and the general public as open spaces for dialogue, peer-to-peer exchange, and collective problem-solving.

The Grassland Alliance approach has already been successfully replicated and adapted in other parts of the continent. These projects ensure long-term sustainability by building on the proven model of the Grassland Alliance originally developed in the Southern Cone. These models also promote the conservation of native grasslands

through partnerships with producers and stakeholders that integrate sustainable production with biodiversity conservation. For example:

- In Bolivia, the partner organisation Armonía is implementing the *Alianza Ecoganadera Beni*, adapting the Grassland Alliance framework to the Llanos de Moxos region through collaboration with ranchers to conserve habitat for threatened birds and maintain traditional, low-impact grazing systems.
- In Colombia, Calidris coordinates the *Sabana Alliance*, applying the Grassland Alliance principles to the Colombian Llanos, strengthening conservation through science-based planning, community engagement, and advocacy.

These replications demonstrate the adaptability and effectiveness of the model across diverse ecological and socio-economic contexts. These projects contribute to a broader effort to scale up this approach through a hemispheric grassland conservation strategy led by BirdLife and its Partners from Canada to Argentina. This includes:

- Supporting policy advocacy at national and international levels
- Enhancing local capacity and technical tools
- Encouraging sustainable financing mechanisms, such as biodiversity-friendly certifications, payment for ecosystem services, and carbon credits where viable

Through this interconnected strategy, the Grasslands Alliance fosters long-term resilience to climate change through the maintenance and enhancement of a broad array of ecosystem services from grasslands – also known as Nature's Contributions to People – and ranging from water and climate regulation to biodiversity, local culture and livelihood. The wider suite of advocacy, capacity development and financing activities creates pathways for scaling across other grassland landscapes in the Americas.



## 4. Understanding how targets, monitoring and reporting can work well together at different scales

### INDEPENDENT ANALYSIS – BY MAIRI DUPAR

This case study provides a striking example of how designing, implementing and measuring climate resilience can take complementary, aligned approaches across multiple scales. Decisions on land management – with knock-on effects for climate resilience, climate change mitigation and biodiversity – are the responsibility of individual landowners and ranchers, and engagement on management choices and measurement of results starts at the ranch scale.

By contrast, the pampas grasslands comprise an entire transboundary eco-region spanning multiple South American countries. Anchored in science, the Grasslands Alliance has established land management criteria that maintain and enhance the pampas' fundamental ecological characteristics and NCPs: shared criteria that make sense for managers in all the relevant grassland countries.

Adherence to these management criteria enhances the resilience of ecosystems, as well as for the people who live there – thus advancing the global goal on adaptation targets for ecosystem-based resilience as well as multiple Global Biodiversity Framework targets (3, 8, 11 and more).

There are national dimensions, too: with these shared criteria for sustainable grassland management as a starting point, individual land managers can then choose to take further decisions, such as which cattle breeds to keep, if they want to qualify for distinct nationally defined marketing schemes.

The Grasslands Alliance itself is an alliance of national NGOs, each with a licence to operate at national level within the policies, laws and regulations of their respective



*Community members working with native plant materials, Paraguay*  
© Cindy Galeano/Guyra Paraguay

countries. These national NGOs provide the personnel who coordinate with, engage and support the individual land managers and ranchers. Governments in the region, in collaboration with NGOs and independent scientists and researchers, can compile information on grassland ecosystem integrity (e.g., National Ecosystem Assessments and other reports) to inform their own decisions and contribute to global assessments. In summary, we see through this case study how both the goals and targets for resilient ecosystem management, and the monitored results, link effectively across multiple scales.

**The Alliance demonstrates how global standards that verify the ‘high integrity’ of land management for climate, nature and people can be applied effectively across a biome or eco-region.** In this case, the CCB standard provides guidance for the high standard to be reached, and the validation of results is both an indicator of high integrity outcomes as well as a marketable asset (in the form of CCB credits) that can augment land managers’ income.

Diversifying and strengthening income from climate-resilient, biodiversity-friendly production can also have national constraints and opportunities, which sit alongside regional and international dynamics. The Grasslands Alliance, which operates over the transboundary pampas eco-region, is comprised of national NGOs – each NGO has a licence to operate under national laws and regulations. Equally, the opportunities for land managers and agricultural producers are shaped to some extent by national commercial opportunities: as described above, the agreements for sale of Alianza certified beef and grassland products differ by country.

**Advocacy and environmental education are critical enablers for achieving positive climate, biodiversity and social resilience outcomes: and highlighting iconic species is a useful part of this, because so much of the grassland ecosystem’s value is less visible.**

The carbon values of grasslands, their water retention, filtration and soil permeability values and their relation to aquifers are largely underground and hidden from view. But without widespread appreciation and, in some cases, economic valuation of these ecosystem dynamics, the grasslands are more susceptible to loss. Advocacy and education highlight the dynamics and benefits of grassland ecosystems to people, while scientific measurements provide validation. Focusing on more visible and emblematic species such as threatened birds that are themselves indicators of healthy ecosystems is a great hook for engaging land managers and other decision-makers.

**Socio-cultural identity is strong, with the chance to unpack social dynamics further as an entry point for measuring resilience and designing future programmes.**

There is further opportunity to use gender disaggregated data, such as the proportion of participating producers who are women, the number of women trained, the number of women in leadership positions/benefiting from certification schemes, etc and also variables for youth participation and the role of Indigenous/ local knowledge. Measuring these variables would illuminate any existing gaps and programmatic opportunities.

**There is also future potential to expand the climate resilience metrics used in the grasslands – to foreground their further benefits for society.** This could include, for instance, tracking the number of producers implementing climate-adaptive grazing systems, the proportion of production maintained during drought years, people’s climate risk perception and preparedness, and recovery time after drought or fire events. The Grasslands Alliance already represents an impressive merger of science and local know-how; and such knowledge partnerships could contribute even more to the understanding and practice of adaptation solutions.

## Appendix 1: Glossary of key terms

**Ecosystem-based Adaptation:** “The use of biodiversity and ecosystem services [Nature’s contributions to people] as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change.” – Convention on Biological Diversity

 Source: <https://www.cbd.int/article/biodiversityagainstclimatechange-1>.  
See also Friends of Ecosystem-based Adaptation (<https://friendsofeba.com/eba-criteria/>)

**Global stocktake:** “The global stocktake is a process for countries and stakeholders to see where they’re collectively making progress towards meeting the goals of the Paris Climate Change Agreement – and where they’re not. The global stocktake is like taking inventory. It means looking at everything related to where the world stands on climate action and support, identifying the gaps, and working together to chart a better course forward to accelerate climate action. The stocktake takes place every five years.” UNFCCC

 Source: <https://unfccc.int/topics/global-stocktake/about-the-global-stocktake/frequently-asked-questions-about-the-global-stocktake>

**Indicator:** “An indicator is a quantitative or qualitative variable that can be measured over time to provide information about something being assessed and evaluated.” – UNESCO

 Source: <https://whc.unesco.org/en/glossary/272>

**Nature-based solutions:** “Nature-based Solutions address societal challenges through actions to protect, sustainably manage, and restore natural and modified ecosystems, benefiting people and nature at the same time.

They target major challenges like climate change, disaster risk reduction, food and water security, biodiversity loss and human health, and are critical to sustainable development.” – International Union for the Conservation of Nature, IUCN

 Source: <https://iucn.org/our-work/nature-based-solutions>

**Nature’s contributions to people:** “All the contributions, both positive and negative, of living nature (i.e., diversity of organisms, ecosystems and their associated ecological and evolutionary processes) to the quality of life of people. Beneficial contributions from nature include such things as food provision, water purification, flood control, and artistic inspiration, whereas detrimental contributions include disease transmission and predation that damages people or their assets. Many NCP [Nature’s contributions to people] may be perceived as benefits or detriments depending on the cultural, temporal or spatial context.”

 Source: <https://www.ipbes.net/glossary-tag/natures-contributions-people>

## Appendix 2: Abbreviations used in the report

|                 |                                                                                                                          |
|-----------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>BCN</b>      | Bird Conservation Nepal                                                                                                  |
| <b>CBD</b>      | Convention on Biological Diversity                                                                                       |
| <b>CCB</b>      | Carbon, Community and Biodiversity credit                                                                                |
| <b>FAO</b>      | Food and Agriculture Organization of the United Nations                                                                  |
| <b>GBF</b>      | (Kunming-Montreal) Global Biodiversity Framework                                                                         |
| <b>GEDSI</b>    | Gender equality, disability and social inclusion                                                                         |
| <b>GGA</b>      | Global goal on adaptation (of the Paris Agreement)                                                                       |
| <b>ILRI</b>     | International Livestock Research Institute                                                                               |
| <b>IPBES</b>    | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services                                         |
| <b>ILC</b>      | International Land Coalition                                                                                             |
| <b>IPCC</b>     | Intergovernmental Panel on Climate Change                                                                                |
| <b>IUCN</b>     | International Union for the Conservation of Nature                                                                       |
| <b>KBA</b>      | Key Biodiversity Areas                                                                                                   |
| <b>LGBTQIA+</b> | Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual and/or Aromantic, with the + representing other identities |
| <b>MEL</b>      | Monitoring, evaluation and learning                                                                                      |
| <b>NASA</b>     | National Air and Space Agency (of the United States of America)                                                          |
| <b>NCP</b>      | Nature's Contributions to People                                                                                         |
| <b>NGO</b>      | Non-governmental organisation                                                                                            |
| <b>NPark</b>    | National Parks Board (of Singapore)                                                                                      |
| <b>SAARC</b>    | South Asian Association for Regional Cooperations                                                                        |
| <b>SAVE</b>     | Sociedade para a Conservação das Aves do Brasil, which translates to Society for the Conservation of Birds of Brazil     |
| <b>UNEP</b>     | United Nations Environment (Programme)                                                                                   |
| <b>UNFCCC</b>   | United Nations Framework Convention on Climate Change                                                                    |
| <b>WWF</b>      | World Wide Fund for Nature                                                                                               |

## Endnotes

- 1 Beauchamp, E., Leiter, T., Pringle, P., Brooks, N., Masud, S., & Guerdat, P. (2024). Toolkit for monitoring, evaluation, and learning for National Adaptation Plan processes. NAP Global Network & Adaptation Committee. Winnipeg: International Institute for Sustainable Development.
- 2 LDC Expert Group (2025). The NAP Technical Guidelines: Updated technical guidelines for the process to formulate and implement national adaptation plans. Bonn: UNFCCC.
- 3 Decision 2/CMA5.
- 4 CBD (2022). Global Biodiversity Framework. <https://www.cbd.int/gbf>
- 5 Friends of Ecosystem-based Adaptation (2025). Centering Equity in Adaptation: Linking Section C and Targets 8 & 11 of the KMGBF with EbA. StoryMap. Washington, DC: IUCN. <https://friendsofeba.com/centering-equity-in-adaptation/>
- 6 IPBES (2019). *Global Assessment Report on Biodiversity and Ecosystem Services*. Bonn: IPBES Secretariat. <https://www.ipbes.net/global-assessment>
- 7 CDKN (2026). *Transformative Ecosystem-based Adaptation*. Cape Town: CDKN.
- 8 For more examples, please see Friends of Ecosystem-based Adaptation (2026). *Centering Equity in Ecosystem-based Adaptation: Operationalising Section C and Targets 8 and 11 of the KMGBF*. Policy brief. Washington, DC: IUCN.
- 9 Delaney, A., Dembele, A., Nombre, I., Lirasse, F. G., Marshall, E., Nana, A., Vickery, J., Tayleur, C., Stout, J.C. (2020). 'Local-scale tree and shrub diversity improves pollination services to shea trees in tropical West African parklands' in *Applied Ecology*. <https://doi.org/10.1111/1365-2664.13640>
- 10 Delaney, A., Dembele, A., Nombre, I., Lirasse, F. G., Marshall, E., Nana, A., Vickery, J., Tayleur, C., Stout, J.C. (2020). 'Local-scale tree and shrub diversity improves pollination services to shea trees in tropical West African parklands' in *Applied Ecology*. <https://doi.org/10.1111/1365-2664.13640>
- 11 Science Direct (2016) 'Shea butter' in A.J. Dijkstra (ed) Encyclopedia of Food and Health. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/shea-butter>
- 12 The Latin name for the shea tree was previously *Butyrospermum parkii*, but now its scientific name is *Vitellaria*, and the sub-species common in west Africa is *Vitellaria paradoxa* (ScienceDirect, 2016).
- 13 Delaney, A., Dembele, A., Nombre, I., Lirasse, F. G., Marshall, E., Nana, A., Vickery, J., Tayleur, C., Stout, J.C. (2020). 'Local-scale tree and shrub diversity improves pollination services to shea trees in tropical West African parklands' in *Applied Ecology*. 57 (8): pp1504–1513. <https://doi.org/10.1111/1365-2664.13640>
- 14 Payne, Charlotte Liberty Ruth. "Moths & Legends: The Contribution of Chitoumou, the Edible Caterpillar *Cirina Butyrospermi*, to Food Security, Agriculture and Biodiversity in a Low-Intensity Agroforestry System." Thesis. Department of Zoology, 2020.
- 15 Naturama, 2023. Endline report of the project Birds, Bees and Business (2023).
- 16 Naturama, 2023. Endline report of the project Birds, Bees and Business (2023).
- 17 Naturama, 2023. Endline report of the project Birds, Bees and Business (2023).

- 18 Fair Climate Fund (n.d.) 'Birds, Bees and Business.' Web page. <https://fairclimatefund.nl/en/projects/burkina-faso-birds-bees-business/>
- 19 For more on how certain Acacia species are valued for their nitrogen fixing properties in West African agroforestry systems, see ICRAF (2015) 'Success with fertilizer trees in West Africa.' Web page. <https://www.worldagroforestry.org/news/success-fertilizer-trees-west-africa>
- 20 Mid-line and endline reports of the project Birds, Bees and Business (2020, 2021, 2023).
- 21 The average income of women in the BBB zone (including women who are not members of these four producer organisations) rose from 119,740 CFA francs to 147,486 CFA.
- 22 For example, CBI's Moringa and Natural Ingredients project in collaboration with Agrodev Services established lasting relationships with Moringa farmers to supply processing companies.
- 23 A credit fund totalling 52,250,000 CFA francs (circa USD 94,000).
- 24 Described, for example, in CDKN's gender and social inclusion training materials, see <https://www.cdkn.org/gendertaining> Regarding the power of social norms in advancing gender equality, please see the ALIGN platform, <https://www.align.org>
- 25 Koshi Tappu Wildlife Reserve (2024). Management Plan.
- 26 Koshi Tappu Wildlife Reserve (2024). Management Plan.
- 27 Paudel et al (2007). 'Buffer Zones: New frontiers for participatory conservation?' *Journal of Forest and Livelihood* 6(2). [https://forestaction.org/wp-content/uploads/2021/12/5\\_Buffer-Zone-final.pdf](https://forestaction.org/wp-content/uploads/2021/12/5_Buffer-Zone-final.pdf)
- 28 Koshi Tappu Wildlife Reserve (2024). Management Plan.
- 29 Koshi Tappu Wildlife Reserve (2024). Management Plan.
- 30 Reuters (2026). 'Over 90,000 affected by Himalayan land slide...' Web article. <https://www.reuters.com/business/environment/over-90000-affected-by-himalayan-landslide-red-cross-says-2026-08-28/>
- 31 World Weather Attribution Initiative (2026). 'Rapid warming in the Himalaya...' Web article. <https://www.worldweatherattribution.org/rapid-warming-in-the-himalaya-exacerbates-geohazard-cascades-beyond-adaptation-limits/>
- 32 Live & Learn Environmental Education (n.d.) Atoll Food Futures. Web page. <https://livelearn.org/atoll-food-futures/>
- 33 UNEP Law and Environmental Assistance Programme (n.d.). Native Lands Act (Cap.46.20), Tuvalu (dated 1956). <https://leap.unep.org/en/countries/tv/national-legislation/native-lands-act-cap-4620>
- 34 Live & Learn Environmental Education (2025). Climate Resilient Atoll Gardening Guide. Melbourne: LLEE. [https://livelearn.org/assets/media/docs/resources/AFF\\_AtollCRHG\\_English\\_Draft\\_final\\_LR.pdf](https://livelearn.org/assets/media/docs/resources/AFF_AtollCRHG_English_Draft_final_LR.pdf)
- 35 Live & Learn Environmental Education (2023). Food cube comparative analysis. Melbourne: LLEE. <https://livelearn.org/resources/foodcube-comparative-analysis-study/>
- 36 Najeeb, S., Khan, R.A.A., Deng, X. and Wu, C. (2025). 'Drivers and consequences of degradation in tropical reef island ecosystems: strategies for restoration and conservation.' *Front. Mar. Sci.* 12:1518701. <https://doi.org/10.3389/fmars.2025.1518701>
- 37 World Wildlife Fund. Mangroves as a solution to climate change. Web page. <https://www.worldwildlife.org/resources/explainers/wildlife-climate-heroes/mangroves-as-a-solution-to-climate-change/>

- 38 Mycoo, M., Wairiu, M., Campbell, D., Duvat, V., Golbuu, Y., Maharaj, S., et al. (2022). Small islands. In: Pörtner HO, Roberts DC, Tignor M, Poloczanska ES, Minterbeck K, Alegria A, et al., editors. *Climate change 2022: impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. pp2043–2121. Cambridge: Cambridge University Press.
- 39 Kiele, R., Mageto, A., Numbasa, G., Miria, G. (2014) Port Moresby, Papua New Guinea: climate change vulnerability assessment. Nairobi: United Nations Human Settlements Programme (UN-Habitat).
- 40 Government of Singapore (2024). Singapore's First Biennial Transparency Report to the UNFCCC. <https://unfccc.int/documents/643039>
- 41 Government of Singapore (2020). Singapore's Sixth National Biodiversity Report to the Convention on Biological Diversity. <https://asean.chm-cbd.net/documents/sixth-national-report-singapore>
- 42 Government of Singapore, NParks (n.d.). About our parks, nature reserves, and park connectors. Web page. <https://www.nparks.gov.sg/visit/when-visiting-parks/about-parks-nature-reserves-pcns/park-pcn>
- 43 UNEP-WCMC. Biodiversity hotspots. Web page. <https://resources.unep-wcmc.org/products/124b9a66d1c642b5bc41d1ff703a0d21>
- 44 Verma, M. et al. (2019). 'Severe human pressures in the Sundaland biodiversity Hotspot' in *Conservation Science and Practice*. 2020;2:e169. [wileyonlinelibrary.com/journal/csp2](https://doi.org/10.1111/csp2.169) 1 of 12 <https://doi.org/10.1111/csp2.169>
- 45 Myers, N., Mittermeier, R., Mittermeier, C. et al. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403, pp853–858. <https://doi.org/10.1038/35002501>
- 46 Heng, L.L. (2024). 'Restoring Singapore's Biodiversity' in Davison, G., Gan, J., Danwei, H., Song, H.W., Lam, S., Yeo, D.C.J. (Eds.). Singapore Red Data Book. Singapore: National Parks Board. <https://www.nparks.gov.sg/resources/singapore-species-red-data-book>
- 47 Heng, L.L. (2024). 'Restoring Singapore's Biodiversity' in Davison, G., Gan, J., Danwei, H., Song, H.W., Lam, S., Yeo, D.C.J. (Eds.). Singapore Red Data Book. Singapore: National Parks Board. <https://www.nparks.gov.sg/resources/singapore-species-red-data-book>
- 48 Nature Society Singapore (n.d.). Vertebrate Study Group. Web page. <https://www.nss.org.sg/vertebrate-study-group/> See also IUCN Red List of Species database, <https://www.iucnredlist.org/species/>
- 49 Government of Singapore, NParks (n.d.). Flora & Fauna Web. Database. <https://www.nparks.gov.sg/florafaunaweb>
- 50 Government of Singapore (2020). Singapore's Sixth National Biodiversity Report to the Convention on Biological Diversity. p38, Table 5. <https://asean.chm-cbd.net/documents/sixth-national-report-singapore>
- 51 Government of Singapore, NParks (2026). New e-publication on biodiversity in Pulau Ubin details two discoveries new to science and 27 new records for Singapore. Web page. <https://www.nparks.gov.sg/news/news-detail/new-e-publication-on-biodiversity-in-pulau-ubin-details-two-discoveries-new-to-science-and-27-new-records-for-singapore>
- 52 Government of Singapore (2020). Singapore's Sixth National Biodiversity Report to the Convention on Biological Diversity. p11. <https://asean.chm-cbd.net/documents/sixth-national-report-singapore>
- 53 Fu, G. (March 2026). 'Together, a Climate-Ready Singapore.' Transcript of speech delivered by Grace Fu, Minister for Sustainability and the Environment and Minister-in-Charge of Trade Relations, at the Committee of Supply debate 2026 on 3 March 2026. <https://www.mse.gov.sg/latest-news/speech-by-minister-grace-fu-committee-of-supply-2026/>

- 54 Meteorological Service Singapore (2025). 'High Resolution Climate Futures for a Climate-Resilient Singapore and Southeast Asia' in The Third National Climate Change Study (V3). <https://www.mss-int.sg/v3-climate-projections>
- 55 Ng, K. G. (2021). 'Tapping mangroves a focus of study on protecting Singapore's north-western coast against sea-level rise'. The Straits Times. <https://www.straitstimes.com/singapore/environment/tapping-mangroves-a-focus-of-study-on-protecting-singapores-north-western>
- 56 Meteorological Service Singapore (2025). 'High Resolution Climate Futures for a Climate-Resilient Singapore and Southeast Asia' in The Third National Climate Change Study (V3). <https://www.mss-int.sg/v3-climate-projections>
- 57 Government of Singapore (2026). City in Nature. Web page. <https://www.greenplan.gov.sg/key-focus-areas/city-in-nature/>
- 58 Government of Singapore (2026). City in Nature. Web page. <https://www.greenplan.gov.sg/key-focus-areas/city-in-nature/>
- 59 Government of Singapore, NParks. Community in Nature. Web page. <https://biodiversitysg.nparks.gov.sg/community-in-nature/about-the-cin-initiative>
- 60 Government of Singapore, NParks. OneMillionTrees movement. Web page. <https://treessg.nparks.gov.sg/pages/about-the-movement>
- 61 Government of Singapore, NParks. Nature Kakis. Web page. <https://naturekakis.nparks.gov.sg>
- 62 Government of Singapore, NParks. About the Nature Kakis Network. Video. <https://www.youtube.com/watch?v=Pm1aSm5X9DQ>
- 63 Centre for Urban Greenery and Ecology (n.d.). Skyrise Greenery Incentive Scheme. Web page. <https://cuge.nparks.gov.sg/grants/skyrise-greenery-incentive-scheme--sgis-/>
- 64 Government of Singapore, NParks. NParks introduces new parks for health. <https://www.nparks.gov.sg/news/news-detail/nparks-introduces-new-parks-for-health-framework-aimed-at-leveraging-existing-parks-and-therapeutic-landscapes-to-boost-community-well-being>
- 65 Government of Singapore, NParks. Join or start a therapeutic horticulture programme. <https://www.nparks.gov.sg/visit/activities/therapeutic-gardens-therapeutic-horticulture-programmes/therapeutic-gardens-parks> Also on youtube, <https://www.youtube.com/watch?v=xYu4la7WZLI>
- 66 Teo, J. (2016). The healing power of communal gardening. Web article. Singapore: Straits Times. <https://www.straitstimes.com/singapore/health/healing-power-of-communal-gardening-gardening>
- 67 Chan, H.Y., Ho, R.C., Mahendran, R., Ng, K.S., Tam, W.W., Rawtaer, I., Tan, C.H., Larbi, A., Feng, L., Sia, A., Ng, M.K., Gan, G.L., Kua, E.H. (2017). 'Effects of horticultural therapy on elderly health: protocol of a randomized controlled trial'. *BMC Geriatr.* 17 (1): p192. <https://www.doi.org/10.1186/s12877-017-0588-z>
- 68 Government of Singapore, NParks. About the Nature Kakis Network. Video. <https://www.youtube.com/watch?v=Pm1aSm5X9DQ>
- 69 Government of Singapore, NParks. About the Nature Kakis Network. Video. <https://www.youtube.com/watch?v=Pm1aSm5X9DQ>
- 70 Government of Singapore, NParks. About the Nature Kakis Network. Video. <https://www.youtube.com/watch?v=Pm1aSm5X9DQ>

- 71 Chandler, M., See, L., Andrianandrasana, H., Becker, D., Berardi, A., Bodmer, R., Constantino, P.D.A.L., Cousins, J., Crimmins, T.M., Danielsen, F., Giorgi, A.P., Huxham, M., Leslie, A., Mistry, J., Mora, B., Nelson, M., Poulsen, M.K., Pratihast, A.K., Theilade, I., Vakil, T., et al. (2017). *The value and opportunities of community-and citizen-based approaches to tropical forest biodiversity monitoring*. In: *A Sourcebook of Methods and Procedures for Monitoring Essential Biodiversity Variables in Tropical Forests with Remote Sensing*. Eds. Gill, M., Jongman, R., Luque, S., Mora, B., Paganini, M., & Szantoi, Z., pp. 223–281 Wageningen University, The Netherlands: GOFC – GOLD Land Cover Project Office. ISSN: 2542-6729.
- 72 Massetti, E. & Tagklis, F. (2026). Climate Change, Macroeconomic Risks, and Adaptation in the Solomon Islands. 2026(069), 23. Retrieved from <https://www.elibrary.imf.org/view/journals/018/2026/069/article-A001-en.xml>
- 73 McGree, S., Smith, G., Chandler, E., Herold, N., Begg, Z., Kuleshov, Y., et al. (2022). Climate Change in the Pacific 2022: Historical and Recent Variability, Extremes and Change. Pacific Community (SPC).
- 73 Albert, S., Grinham, A., Gibbes, B., Leon, J. X. & Church, J. (2016). Sea-level rise has claimed five whole islands in the Pacific: first scientific evidence. *The Conversation*. <https://doi.org/10.64628/AA.v54jd3cxt>
- 74 Bhattarai, B. (2011). Assessment of mangrove forests in the Pacific region using Landsat imagery. *Journal of Applied Remote Sensing*, 5(1). <https://doi.org/10.1117/1.3563584>
- 75 O'Connell, D., Maru, Y., Grigg, N., Walker, B., Abel, N., Wise, R., ... & Mehard, S. (2019). *Resilience Adaptation Pathways and Transformation Approach. A guide for designing, implementing and assessing interventions for sustainable futures (version 2)*. CSIRO.
- 76 Live & Learn Environmental Education (2022). Climate Resilient Islands Programme– Solomon Islands Summary. Melbourne: LLEE. [https://livelearn.org/assets/media/docs/resources/CRP\\_Solomons\\_Summary\\_Final\\_LR.pdf](https://livelearn.org/assets/media/docs/resources/CRP_Solomons_Summary_Final_LR.pdf)
- 77 Live & Learn Environmental Education (2022). Climate Resilient Islands Programme – Solomon Islands Summary. Melbourne: LLEE. [https://livelearn.org/assets/media/docs/resources/CRP\\_Solomons\\_Summary\\_Final\\_LR.pdf](https://livelearn.org/assets/media/docs/resources/CRP_Solomons_Summary_Final_LR.pdf)
- 78 Ahn, H. K., Kwon, S., Song, C. & Lim, C.-H. (2025). Enhanced rapid mangrove habitat mapping approach to setting protected areas using satellite indices and deep learning: A case study of the Solomon Islands' in Remote Sensing, 17(14). <https://doi.org/10.3390/rs17142512>
- 79 Massetti, E., & Tagklis, F. (2026). Climate Change, Macroeconomics Risks, and Adaptation in the Solomon Islands. 2026(069), 23. Retrieved from <https://www.elibrary.imf.org/view/journals/018/2026/069/article-A001-en.xml>
- 80 Live & Learn Environmental Education (2025). *Climate Resilient Islands – Solomons Summary*. [https://livelearn.org/assets/media/docs/resources/CRP\\_Solomons\\_Summary\\_Final\\_LR.pdf](https://livelearn.org/assets/media/docs/resources/CRP_Solomons_Summary_Final_LR.pdf)
- 81 Live & Learn Environmental Education (2025). *CRI Plus annual report 24\_25*. Melbourne: LLEE.  
 Live & Learn Environmental Education (2025). *GEDSI report October 2025*. Melbourne: LLEE.  
 Live & Learn Solomon Islands (2024). *Community resilience profile: Poposa cluster*. Honiara: LLEE.  
 Live & Learn Solomon Islands (2024). *CRP confirmation guide: Poposa*. Honiara: LLEE.  
 Live & Learn Solomon Islands (2025). *DRR pathway progress report: Poposa*. Honiara: LLEE.  
 Live & Learn Solomon Islands (2025). *Ecosystem restoration pathway progress report: Tree planting Poposa*. Honiara: LLEE.  
 Live & Learn Solomon Islands (2025). *Food security pathway progress report: Poposa*. Honiara: LLEE.  
 Live & Learn Solomon Islands (2026). *ER pathway progress report: Ranger training*. Honiara: LLEE.  
 Solomon Islands Government (2011). *National Development Strategy 2011–2020*. Ministry of Development Planning and Aid Coordination, Honiara.

- 82 Herrera, L., Nabinger, C., Weyland, F. and Parera, A. (2014) Caracterización de los Pastizales del Cono Sur, servicios ecosistémicos y problemática actual de conservación in Parera, Paullier y Weyland (Eds.), 2014. Índice de Contribución a la Conservación de Pastizales Naturales del Cono Sur. Una herramienta para incentivar a los productores rurales. Montevideo: Aves Uruguay.
- 83 ILRI, IUCN, FAO, WWF, UNEP and ILC. 2021. *Rangelands Atlas*. Nairobi, Kenya: ILRI
- 84 Aldabe, J., Moran-Lopez, T., Soca, P., Blumetto, O., Morales, J.M. (2023). 'Bird species responses to rangeland management in relation to their traits: Rio de la Plata Grasslands as a case study' *Ecological Applications* 34 (2). <https://doi.org/10.1002/eap.2933>
- 85 Burns, N. (2024). 'The Past, Present and Future of Soy in South America' in *Americas Quarterly*. Available at: <https://americasquarterly.org/article/the-past-present-and-future-of-south-american-soy>
- 86 Many grassland specialist birds that are restricted to the Grasslands of the Río de la Plata (depend heavily on tall grasslands and wetlands and are seriously affected by intensification practices. For these species, patches of tall vegetation are vital for food, shelter and reproduction (Aldabe et al, 2023; 5). Meanwhile, long distant migrant birds (many of them threatened in some degree) highly depend on grassland patches of short grasses of less than 6 cm height (Aldabe et al. 2019).
- 87 Aldabe, J., Lanctot, R. B., Blanco, D., Rocca, P., & Inchausti, P. (2019). 'Managing Grasslands to Maximize Migratory Shorebird Use and Livestock Production.' *Rangeland Ecology and Management*, 72(1). Amsterdam: Elsevier.
- 88 Aldabe et al. (2023). Regional Conservation Strategy and Bird Monitoring of the Grassland Alliance. BirdLife International. [Estrategia-conservacion-y-monitoreo-de-Aves-Alianza-2023-1.pdf](#)
- 89 Herrera, L., Nabinger, C., Weyland, F. and Parera, A. (2014) Caracterización de los Pastizales del Cono Sur, servicios ecosistémicos y problemática actual de conservación in Parera, Paullier y Weyland (Eds.), 2014. Índice de Contribución a la Conservación de Pastizales Naturales del Cono Sur. Una herramienta para incentivar a los productores rurales. Montevideo: Aves Uruguay.
- 90 Official wording of the mission approved by the Grasslands Alliance.
- 91 Carriquiry, E. and Perera, A. (2012). 'Incentivando la conservación de nuestras pampas' in Parera, A., Paullier, I. and Bosso, A. (Eds). *Incentivos para conservar los pastizales naturales del Cono Sur. Una oportunidad para gobiernos y productores rurales*. Montevideo: Aves Uruguay.
- 92 Five mandatory criteria: I. Rural property with legal and administrative status meeting the requirements of its district, province, or country—complying with applicable national procedures, registrations, resolutions, and regulations—featuring a proper farm health plan endorsed by a professional and an employment scheme for staff that is in full compliance with the law. II. Formal commitment by the business owner to the Vision and Mission of the \*Alianza del Pastizal\* (Grassland Alliance) ([www.pastizalesdelconosur.org](http://www.pastizalesdelconosur.org)). III. Unrestricted access for animals to sufficient sources of drinking water and shade. IV. Grass-based diet with a tolerance limit of up to 30% concentrates—or the equivalent of 1% of live weight in the animal's diet—and a total absence of feedlot (confinement) feeding. V. At least 50% of the total land area covered by natural grasslands.
- 93 Government of Uruguay (2024) '¿Qué son las Reservas Privadas?' Web page. <https://www.gub.uy/ministerio-ambiente/politicas-y-gestion/son-reservas-privadas> and Government of Uruguay (2024) 'Resolución N° 1.155/024 Aprobación del "Instructivo para la tramitación de declaración de Reservas Privadas"'. Web page. <https://www.gub.uy/ministerio-ambiente/institucional/normativa/resolucion-n-1155024-aprobacion-del-instructivo-para-tramitacion>

- 94 Aves Uruguay (2020). Los pastizales naturales de Uruguay. El rol de la ganadería en las poblaciones de fauna. Video. [https://www.youtube.com/watch?v=N1\\_BOBdFZVg](https://www.youtube.com/watch?v=N1_BOBdFZVg)
- 95 Aves Uruguay (2013). Biología por un día. Video. <https://www.youtube.com/watch?v=bvvYKZDTQpA>
- 96 BirdLife International (2023). Conservation Investment Plan: Southern Cone Grasslands. Unpublished document.
- 97 Aldabe et al. (2023). Regional Conservation Strategy and Bird Monitoring of the Grassland Alliance. BirdLife International. [Estrategia-conservacion-y-monitoreo-de-Aves-Alianza-2023-1.pdf](#)
- 98 Carriquiry, E. and Perera, A. (2012). 'Incentivando la conservación de nuestras pampas' in Parera, A., Paullier, I. and Bosso, A. (Eds). *Incentivos para conservar los pastizales naturales del Cono Sur. Una oportunidad para gobiernos y productores rurales*. Montevideo: Aves Uruguay.
- 99 TESSA, the Toolkit for Ecosystem Service Site-based Assessment <https://ecosystemsknowledge.net/resources/tool-assessor/tessa-toolkit-for-ecosystem-service-site-based-assessment/>
- 100 NASA (n.d.). Fire Information for Resource Management System (FIRMS). Website. <https://firms.modaps.eosdis.nasa.gov>
- 101 BirdLife International (2023). Conservation Investment Plan for the Southern Cone Grasslands of South America, Executive Summary.
- 102 Parera, A., Paullier I., and Weyland, F. (Eds.) (2014). Índice de Contribución a la Conservación de Pastizales Naturales del Cono Sur. Una herramienta para incentivar a los productores rurales, 181 pp.
- 103 Parera, A., Paullier, I. and Weyland, F. (Eds.) (2014). Índice de Contribución a la Conservación de Pastizales Naturales del Cono Sur. Una herramienta para incentivar a los productores rurales. Montevideo: Aves Uruguay. ISBN: 978-9974-8362-0-4. [Indice-de-Contribucion-a-la-Conservacion-de-Pastizales-Naturales-del-Cono-Sur.pdf](#)
- 104 Parera, A., I. Paullier y A. Bosso (Eds). 2012. Incentivos para conservar los pastizales naturales del Cono Sur. Una oportunidad para gobiernos y productores rurales. Montevideo: Aves Uruguay, 116 pp. ISBN: 978-9974-8362-0-4. [Incentivos-para-conservar-los-pastizales-naturales-del-Cono-Sur.pdf](#)





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