Climate Change Impacts on Biodiversity and Protected Areas in West Africa

Summary of the main outputs of the PARCC project, Protected Areas Resilient to Climate Change in West Africa

A GEF-funded project officially known as 'Evolution of PA systems with regard to climate change in the West Africa region'

UNEP

PARCC WEST AFRICA

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The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

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Roan antelope, Hippotragus equinus, in the National Park of Bouba Ndjidda, Cameroon. ©Bertrand Geismar

Foreword

Protected areas have long been used as a key strategy to conserve species and ecosystems. However, they are under increasing threat from climate change, which is now exacerbating other anthropogenic pressures. The Protected Areas Resilient to Climate Change (PARCC) project, funded by the GEF and implemented by UNEP, sought to address this issue by developing science-based tools to assess the vulnerability of protected areas, and by formulating strategies and recommendations to improve the management of protected areas in the face of climate change. The geographic area of the project was West Africa, with more detailed work implemented in The Gambia, Sierra Leone, Mali, Togo and Chad.

This publication summarizes the main outputs of the PARCC project, from regional climate projections to pilot activities at transboundary protected areas, and includes among many other outputs, species vulnerability assessments, species distribution models, protected area connectivity analyses, regional and national conservation planning systems, as well as capacity development activities and policy recommendations.

All the innovative science-based methodologies that were developed for the West Africa region can be applied in other regions. These tools include the integration of species distribution models with species vulnerability assessments based on biological traits to identify the protected areas most vulnerable to climate change, in addition to connectivity analysis of the existing protected area network that allowed the identification of the most important protected areas to maintain connectivity in the region. Furthermore, the systematic conservation planning systems that were developed lead to the identification of priority areas for conservation and the locations where new protected areas should be located, based not only on current biological data, but also taking into account the expected future distribution of species under climate change.

Finally, the capacity development activities, carried out at multiple institutional levels through national and regional workshops, ensured that protected areas staff and practitioners can understand the science related to climate change and use the tools to better manage biodiversity in the region, accounting for predicted future environmental change.

Through this project, UNEP has significantly contributed to enhancing the body of knowledge available on the impacts of climate change on protected areas in West Africa, and has provided tools and recommendations that can be used worldwide.

Mette Wilkie
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Western Area Peninsula Forest Reserve, Sierra Leone. ©Elise Belle

Executive Summary

PARCC West Africa, officially known as 'Evolution of protected area systems with regard to climate change in the West Africa region' is a full-size GEF project focusing on the impacts of climate change on protected areas (PAs), which was implemented from 2010 to 2015. The United Nations Environment Programme (UNEP) was the implementing agency and UNEP World Conservation Monitoring Centre (UNEP-WCMC) was the executing agency, working in collaboration with IUCN West and Central Africa Programme (IUCN PACO).

The project focused on **five core countries in West Africa: Chad, Gambia, Mali, Sierra Leone, and Togo** (Figure 1). An additional three countries (Burkina Faso, Côte d'Ivoire and Ghana) were involved in regional training workshops and some of the activities at the transboundary pilot sites. However, all technical elements of the project (such as the climate projections, vulnerability assessments and conservation planning systems) were completed at the regional scale, covering the entire West African region.

The main objective of the project was to **develop strategies and tools to increase the resilience of PAs to climate change, and build capacity in the region to implement these new approaches**. In the project, we define resilience of protected areas as their ability to cope with climate change impacts in ways that maintain their essential functions and capacity for adaptation. A key aspect of protected area resilience is the capacity to retain biodiversity, which in this project was assessed in terms of the expected turnover of species in the future, taking into account both species biological traits and spatial distributions. To conduct these analyses and achieve its objectives, the project required continuous support and engagement from all national, regional, and international partners.

This brochure highlights the main project achievements. After developing new regional climate projections for West Africa, the vulnerability of species and PAs to climate change was assessed through two complementary methodologies which were subsequently integrated: Species Distribution Models (SDM) and Traits-based Vulnerability Assessments (TVA). An analysis of the connectivity of the West African PA network also highlighted the importance of specific PAs and links between PAs. Based on these findings, systematic conservation planning systems were developed at the national and regional level to help inform conservation priorities in the design of new PAs, both for the countries and for regional bodies such as the Economic Community of West African States (ECOWAS).

Studies on the links between PAs, communities and climate change, and of available options for managing and financing PAs to adapt to climate change were also carried out. Based on the scientific outputs mentioned above, five transboundary pilot sites were selected and activities on the ground implemented. These activities included recommendations for species monitoring and for designing or revising transboundary management plans that consider climate change, as well as the development of a new Management Effectiveness Tracking Tool (METT) integrating climate change aspects.

Importantly, capacity building took place at multiple levels throughout the project lifespan, primarily through national and regional training workshops. Finally, adaptation strategies and policy recommendations were developed for climate adaptation and management at the national and regional level, as well as guidelines for managers of individual PAs in the face of climate change. Furthermore, the results of the PARCC project have been integrated into the Protected Planet website, the web interface of the World Database on Protected Areas (WDPA), allowing access to all project outputs and to the results of the vulnerability assessments for each individual West African protected area (http://parcc.protectedplanet.net). The project thus generated improved information on the effects of climate change on biodiversity and PAs, thereby allowing a better understanding of how to better manage protected areas, especially transboundary PAs, in the face of climate change.

Key messages:

- **The climate of West Africa has been observed to be changing in recent decades, with some of these changes clearly attributable to climate change.** Regional climate projections show that there is a high level of confidence that temperatures will increase in the region, but there is little consensus on the direction and magnitude of potential changes in rainfall, with a high variability between projections. These changes are expected to have significant impacts on ecosystem services such as carbon storage.

- **Biodiversity and protected areas are being affected by climate change and some protected areas are more vulnerable than others to its impacts.** A significant number of West African species (including amphibians, birds, freshwater fish, mammals and reptiles) have been identified as being vulnerable to climate change based on their specific biological traits. Of these species, those that have been assessed as globally threatened should be considered priorities for conservation. A large proportion of amphibian, bird and mammal species are expected to be found in areas of lower climate suitability by the end of the century, and a high species turnover is expected in most protected areas of the region, especially in the Guinean Forest region.

- **Protected area management should be improved in order to enhance the resilience of protected areas to climate change.** Protected areas in West Africa are indeed facing a number of anthropogenic threats. It is therefore crucial to first improve the management effectiveness of existing PAs to give them a better chance to be able to cope with climate change impacts. For species identified as vulnerable to climate change, specific management options are to facilitate their dispersal and to identify sites of suitable climate persisting within their current ranges. In addition, in order to fully protect all essential conservation features of the region, it is recommended that existing PA networks are extended.

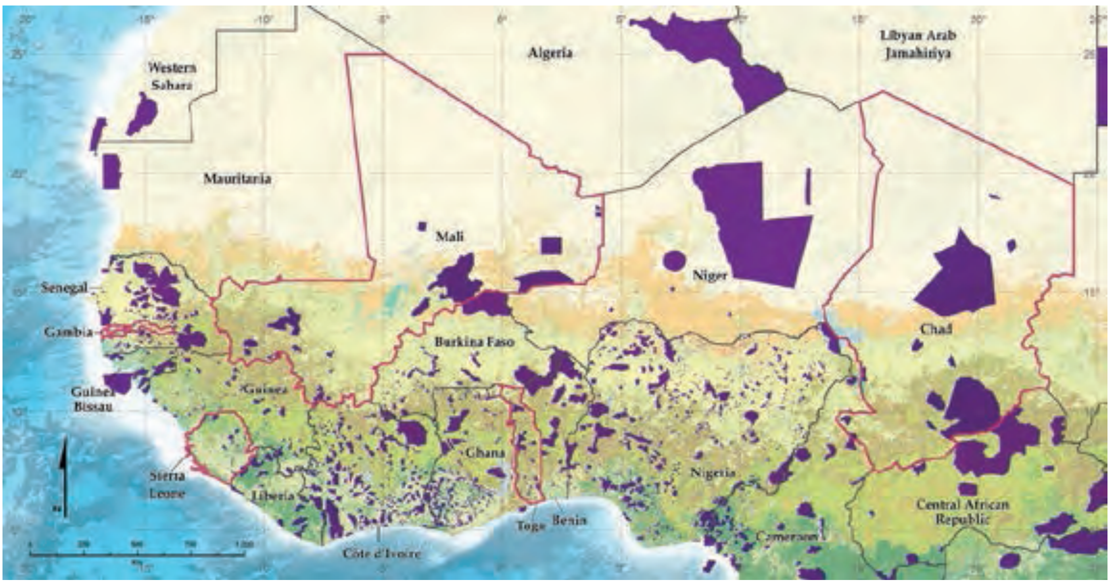


Figure 1. Protected areas in West Africa. Project countries are indicated with red borders.

Introduction

Protected areas (PAs) play a fundamental role in the conservation of biodiversity, as well as ecosystem services, including provisioning services such as water, timber and food, in addition to cultural and spiritual services. However, PAs are under heavy and increasing threats from anthropogenic pressures, which are now being exacerbated by climate change.

Climate change impacts have indeed already been observed on biodiversity. These impacts are causing shifts in the distribution of species, as well as reductions in population sizes, and even extinctions of local populations. This means that PAs that have been created to protect certain species or ecosystem types may not do so in the future. However, such sites may become important for other species or ecosystems of conservation concern, and thereby play a key role in helping them to adapt to climate change. PAs are also a very useful tool in mitigating climate change, notably by optimising carbon sequestration and storage, in particular by preventing deforestation and forest degradation (which constitute a major source of greenhouse gas emissions), and by supporting ecosystem-based adaptation for the benefit of people.

It is therefore crucial to gain a better understanding of the vulnerability of PAs in the face of climate change and the suitability of the existing PA network, in order to design appropriate management and adaptation actions.

Abuko Nature Reserve, The Gambia. ©Elise Belle

PROJECT OBJECTIVES AND STRUCTURE

Objectives

The main objective of the project was to **help countries make their PA networks more resilient to the impacts of climate change**, by:

1. Developing innovative science-based tools for assessing the vulnerability of PAs to climate change;
2. Designing adaptation strategies to strengthen the resilience of PAs;
3. Building capacity in the region for applying the tools and implementing the strategies; and
4. Creating a platform for further field implementation following transboundary pilot site activities.

Organisational structure

The project is managed by the Project Management Unit (PMU), UNEP-WCMC, under the oversight of UNEP DEPI/GEF, and IUCN PACO is the Regional Management Unit (RMU), liaising with representatives from each project country, the National Liaison Officers NLOs), who are in charge of the project implementation at the national level (Figure 2). The project also has a Technical Advisory Group (TAG) made of all the project technical partners, and a Project Steering Committee (PSC).

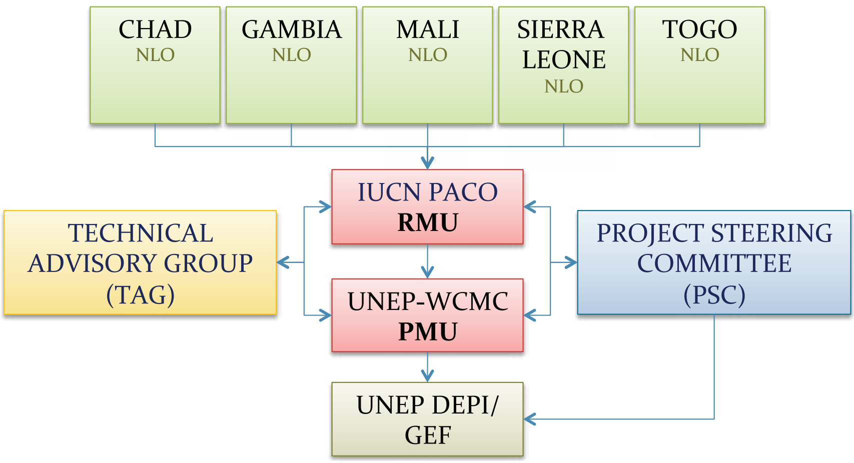


Figure 2. Project organisational structure.

A project in partnership

A strong partnership of stakeholders was built to ensure the best use was made of the wide range of available experience and technical skills. This partnership was critical to the successful implementation of the project.

The key partners for the project included:

- **National governments** of the five core countries (Mali, Chad, Gambia, Togo and Sierra Leone) and the three additional countries (Ghana, Cote d'Ivoire and Burkina Faso) involved in some regional activities;
- **UNEP agencies**: UNEP World Conservation Monitoring Centre (UNEP-WCMC) and UNEP Division of Environmental Policy Implementation (DEPI);
- **IUCN**: Programme for West and Central Africa (PACO, based in Ouagadougou, Burkina Faso) and Global Species Programme (Cambridge, UK);
- **NGOs**: BirdLife (International and Africa Secretariats);
- **Academic institutions**: Durham University and the Durrell Institute of Conservation and Ecology (DICE) at the University of Kent;
- **Met Office Hadley Centre**, UK; and
- **National experts and consultants** who worked alongside international experts on specific topics such as assessing the vulnerability of species to climate change, and the links between communities, PAs and climate change.

Climate projections for the West Africa region

The Met Office Hadley Centre (MOHC) provided **high resolution climate projections for the project**. They also studied the potential future impact of land use change and climate change on ecosystem services in the region, and provided a summary of their projections for each core project country.

HIGH RESOLUTION CLIMATE DATA

The MOHC used an ensemble of Regional Climate Model (RCM) simulations to provide high resolution baseline and future climate projections for the project. **The model simulations were run from December 1949 to December 2099 using the MOHC regional climate modelling system**, PRECIS, to generate a range of future climate scenarios under the IPCC Special Report on Emissions Scenarios (SRES) medium high A1B emissions scenario, over the **50km resolution** Africa CORDEX (CO-ordinated Regional Downscaling Experiment, http://www.cordex.org/) domain. These simulations generated a comprehensive dataset of surface and atmospheric climate variables including minimum and maximum temperatures and precipitation at the daily and monthly timescale. The experimental design used is detailed in the technical report.

Jones R., Hartley A., McSweeney C., Mathison C. and Buontempo C. 2012. Deriving high resolution climate data for West Africa for the period 1950-2100. UNEP-WCMC technical report.

REGIONAL CLIMATE PROJECTIONS

Key findings:
There is a high level of confidence that temperatures will increase in the West Africa region; by contrast, there is little consensus on the direction and magnitude of potential changes in rainfall.

Climate projections were derived from global and regional climate model experiments to assist in informing country-level decision making and adaptation activities in the five project countries. The climate of West Africa has been observed to be changing in recent decades, with some of these changes clearly attributable to global climate change. Projections of future regional climate change are increasingly being used as a tool to inform adaptation, policy and decision making activities, and it is necessary that these be combined with local decision making and adaptation strategies.

Here, **five high resolution regional climate simulations were performed to assess the potential changes in temperature and rainfall across West Africa at a spatial scale relevant to assessing impacts of these changes** (Figure 3). These regional experiments all suggest a general warming trend, in agreement with wider global climate experiments used to inform the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5). In conjunction with this warming, an increase in year-to-year variability is also apparent within the regional climate results, and could result in a greater frequency of unusually hot events. **The high level of agreement across global and regional climate models for West Africa allows us to say with high confidence that a projected increase in temperature is very likely to occur**. This could have large impacts on ecosystems and livelihoods across the West African region, and implies that adaptation of these systems is required in order to make them resilient in the face of any negative consequences.

With regards to rainfall in the five focal countries, the projections of both regional and global climate modelling experiments are highly variable, and often do not provide consensus on the direction, and certainly not the magnitude, of potential changes in rainfall. Within the set of global model results presented in the IPCC AR5, over much of the region, both significant increases and decreases are projected. This is also the case for the regional climate model projections in parts of the five project countries, though in other parts there is a general consensus on either increases or decreases in rainfall. However, given the widespread of results within the IPCC context, these results may not fully encapsulate the range of possible outcomes. Thus, the best advice currently is to build robust resilience to current precipitation variability, as either the drier or wetter events, or both, could be enhanced in the future.

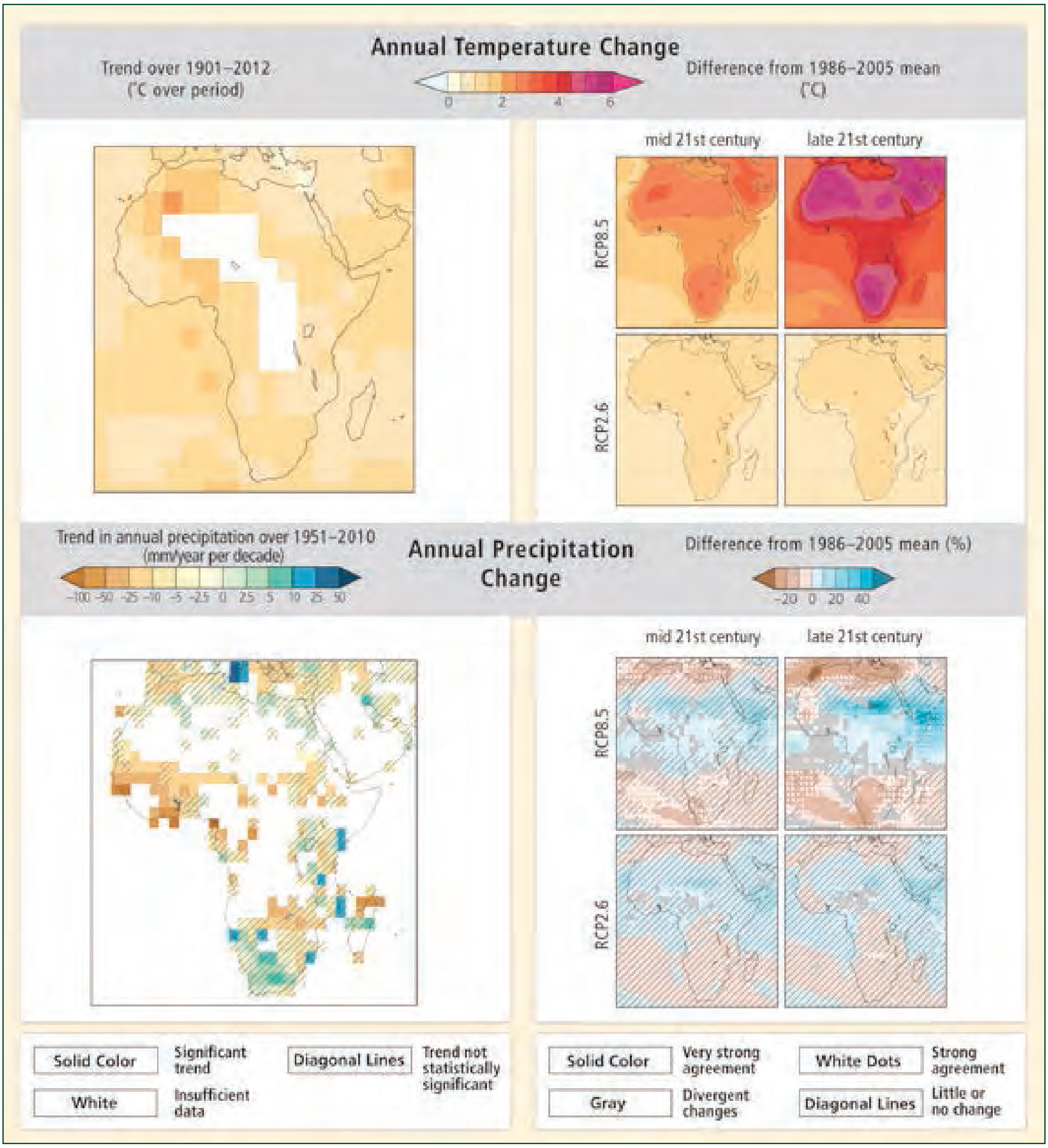


Figure 3. Observed and projected changes in annual average temperature and precipitation. Left panels: Observed annual average temperature change from 1901-2012 (top) and observed annual precipitation change from 1951-2010 (bottom) derived from a linear trend. For observed temperature and precipitation, white areas depict regions which lack sufficient observational data for analysis. Solid colours indicate areas where trends are significant at the 10% level. Diagonal lines indicate areas where trends are not significant. Right panels: CMIP5 multi-model mean projections of annual average temperature changes (top) and average percent changes in annual mean precipitation (bottom) for two time periods (2046-2065 and 2081-2100) under two RCP emissions scenarios. Solid colours indicate very strong agreement amongst models, white dots represent strong agreement, grey areas depict divergent changes, and diagonal lines represent areas with little or no change with respect to current climate variability.

Janes, T., Jones, R. and Hartley, A. 2015. Regional Climate Projections for West Africa. UNEP-WCMC technical report.

PROJECTIONS OF CHANGE IN ECOSYSTEM SERVICES

Key findings:

Climate change is likely to lead to an increase in carbon storage in forests and an increase in vegetation productivity in most of West Africa, but this increase could be limited by land use change. Ecosystems are also projected to shift northwards in central and eastern West Africa.

Busua beach, Ghana, ©Elise Belle

The MOHC subsequently analysed the combined and separate future impact of land use change and climate change on ecosystem services and other benefits provided by ecosystems in West Africa, including carbon storage, water provision and vegetation productivity. The ensemble of regional climate projections developed for the project were used to run a model that simulates exchanges of carbon, energy and moisture between the land surface and the atmosphere, using three different scenarios of future land use change. These scenarios account for different levels of human disturbance of the land surface, and different levels of protection of primary forests.

Confidence in the results from this study is directly related to confidence in the climate projections for both temperature and precipitation. Therefore, we have identified results as either (a) results we have *confidence* in because we have high agreement between the models and a physical understanding of why the change has been projected, or (b) results which are *plausible* because we cannot exclude them as being wrong, but that we have low confidence in because results from other models are different but also plausible.

The main findings for the region are:

- **Carbon storage of forests is projected to increase under the effects of climate change**, however, forest degradation would restrict this increase (confident).
- Generally, **vegetation productivity is projected to increase in most parts of West Africa**. The exceptions to this are in southern Nigeria, where land use scenarios estimate a high level of human activity, and in the western Sahel, where a drying signal is found in the climate projections (plausible).
- **In central and eastern West Africa, ecosystems are projected to shift northwards**. This includes an increase in tree fraction of ecosystems in Cameroon and Central African Republic (confident), increases in shrub fraction in the savannah grasslands of southern Chad and northern Nigeria (confident), and increases in grass fraction on the edge of the Sahara desert in Chad and Niger (plausible).

Key findings for the ecosystem services of each the five project countries are summarized in the report.

Hartley, A.J., Jones, R. and Janes, T. 2015. Projections of change in ecosystem services under climate change. UNEP-WCMC technical report.

COUNTRY FACTSHEETS

For each country (in alphabetical order below), the MOHC provided a summary of the climate projections, their likely impacts on ecosystem services, and advice for national planning. Here we only highlight the findings with regards to ecosystem services and planning recommendations.

Chad

Chad is projected to experience a northward shift of ecosystems. This includes increases in shrub and tree cover in southern woody savannah ecosystems, and increases in grassland vegetation cover in arid and semi-arid ecosystems of central Chad on the edge of the Sahara. Projected increases in surface run off suggest more water available for ecosystems and agriculture, although this is strongly related to precipitation projections that are plausible but not confident. Increases in vegetation productivity in central and southern Chad are also projected, indicating potentially larger crop yields, however, again these projections are related to precipitation change and are seen as plausible but not confident. In the sub-tropical south of Chad, increases in vegetation productivity are more closely related to increases in mean annual temperature, indicating a higher confidence. Projections for precipitation are much less certain, especially in the Sahel region of Chad, an area where vegetation productivity is strongly dependent on precipitation. Therefore, projected increases in precipitation in this region are plausible but not confident, and as the region is subject to significant rainfall variability, drought seasons should still be planned for (Figure 4).

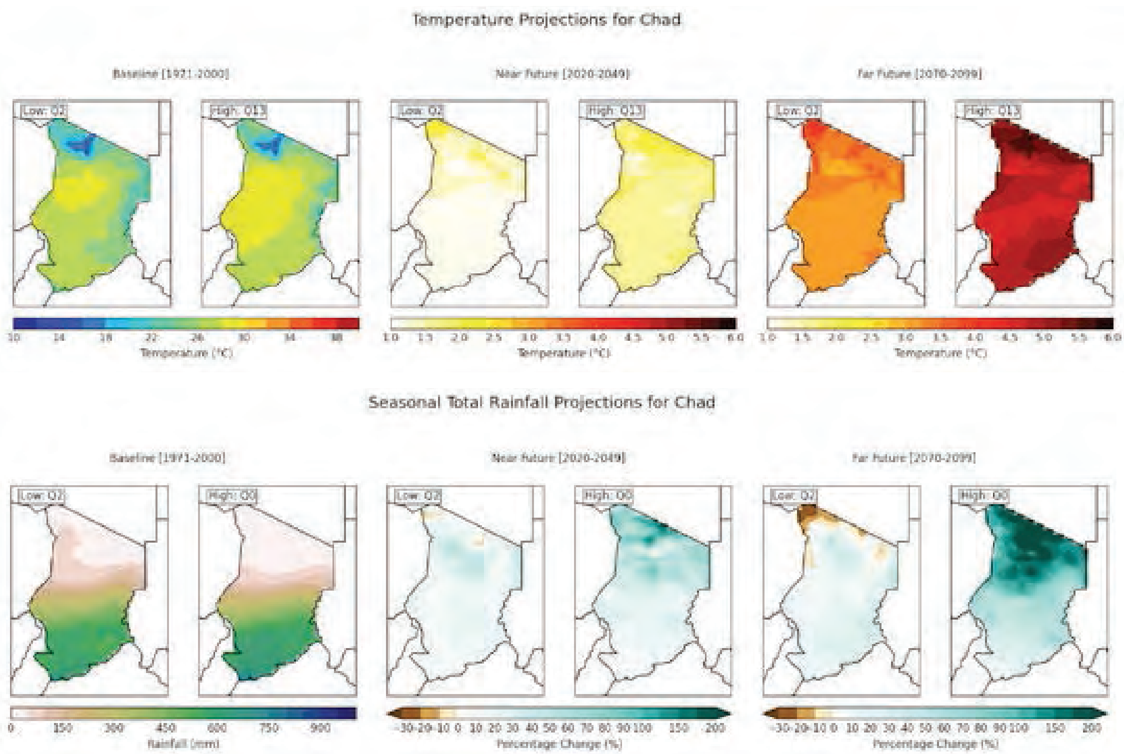


Figure 4. Temperature (annually averaged surface temperature (°C)) (top) and precipitation (seasonal total rainfall (mm) in the JAS season) (bottom) projections for Chad, for the baseline period (1971-2000), and projected changes for the near future (2020-2049) and far future (2070-2099), for the RCM models with the lowest and highest projected sensitivities in the far future time period.

Hartley, A., Jones, R. et Janes, T. 2015. Fiche d'information : Changement climatique et services écosystémiques : Tchad. UNEP-WCMC technical report.

Gambia

Projections for ecosystem services suggest that an increase in the bare soil fraction, replacing grass cover, as well as a small reduction in vegetation productivity might occur. However, these are related to a projected decrease in western Sahelian precipitation and are thus plausible but not confident projections. Projections for change in grass and bare soil fractions in Gambia are also highly sensitive to precipitation variability, indicated by both year-to-year variability and decade-to-decade variability in vegetation cover. Planning should therefore account for the possibility that total monsoon precipitation might decrease in the far future. However, given the lack of robust evidence to support this projection, it would be prudent to plan for climate variability and extremes, as these have been observed in the last three decades. National planners should be aware that temperature increases above the national average (up to 5.5°C in the far future) are projected with high confidence for the east of Gambia (Figure 5).

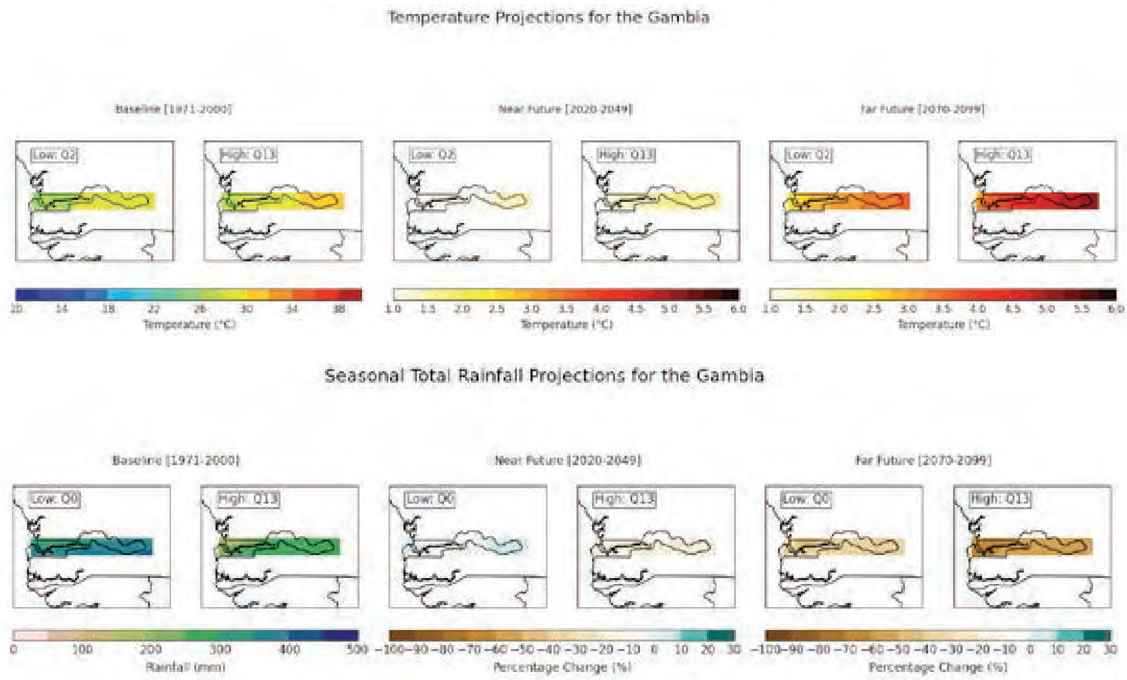


Figure 5. Temperature (annually averaged surface temperature (˚C)) (top) and precipitation (seasonal total rainfall (mm) in the JAS season) (bottom) projections for the Gambia, for the baseline period (1971-2000), and projected changes for the near future (2020-2049) and far future (2070-2099), for the RCM models with the lowest and highest projected sensitivities in the far future time period.

Hartley, A., Jones, R. and Janes, T. 2015. Climate Change and Ecosystem Services Fact Sheet: The Gambia. UNEP-WCMC technical report.

Mali

In the south of Mali, projections are for an increase in the bare soil fraction, replacing grass cover, and a reduction in vegetation productivity in arid and semi-arid parts of the country, however, these are related to a projection of decreased western Sahelian precipitation and so are plausible, but not confident projections. Grass and bare soil fractions in southern Mali are highly sensitive to precipitation variability, indicated by both year-to-year variability and decade-to-decade variability in vegetation cover. While the strong drying signal in the south of Mali is highly uncertain, this is a plausible projection and should be considered as a possibility when planning for the future. When developing climate change adaptation plans, it is essential to build in resilience to wet years, as well as dry years, in order to account for extremes of year-to-year and decade-to-decade variability, as observed in the past. The projections indicate that there is high confidence that this kind of variability will continue into the far future (Figure 6).

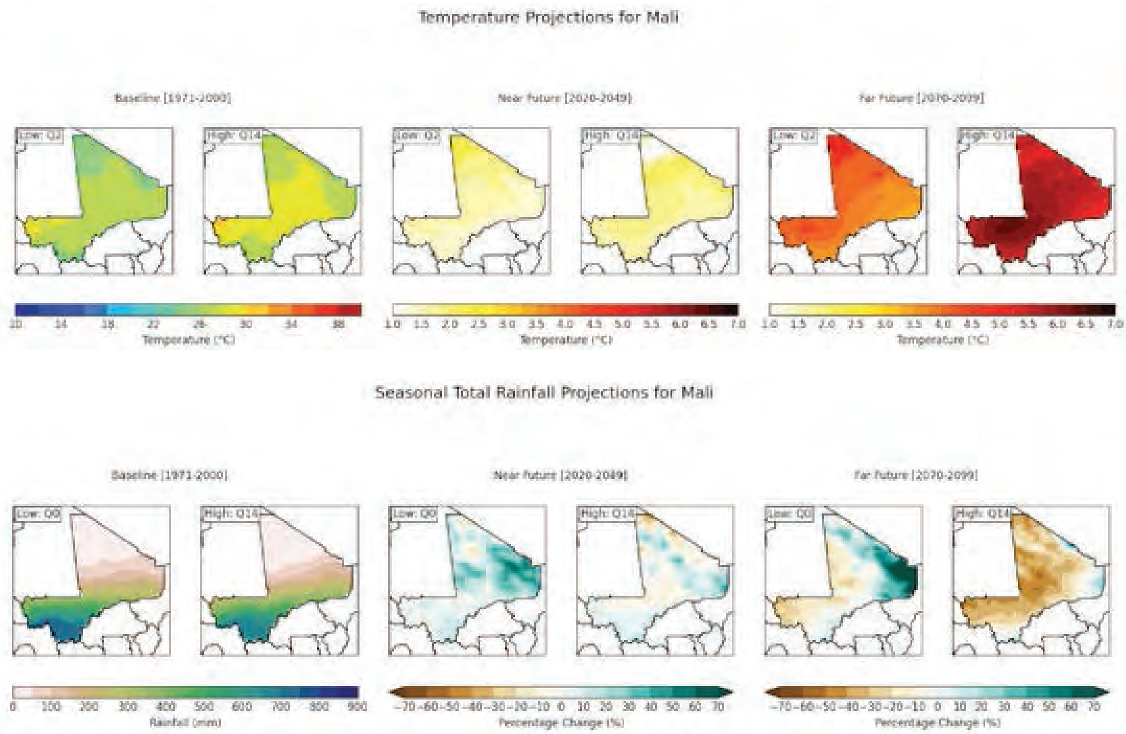


Figure 6. Temperature (annually averaged surface temperature (°C)) (top) and precipitation (seasonal total rainfall (mm) in the JAS season) (bottom) projections for Mali, for the baseline period (1971-2000), and projected changes for the near future (2020-2049) and far future (2070-2099), for the RCM models with the lowest and highest projected sensitivities in the far future time period.

Hartley, A., Jones, R. et Janes, T. 2015. Fiche d'information : Changement climatique et services écosystémiques : Mali. UNEP-WCMC technical report.

Sierra Leone

Increases in the fraction of broadleaf tree cover are projected to occur with high confidence throughout Sierra Leone, although human disturbance would restrict this increase. Vegetation productivity is also projected to increase as broadleaf tree cover increases. This is related to increases in minimum temperature, since photosynthesis is not limited by water availability in this region, and this is therefore a confident projection. There is a large variability in the projections of change in surface runoff with increases towards the end of the century related to precipitation change and thus these projections are plausible but not confident. The results indicate that tropical forests in Sierra Leone will become an even more valuable resource for storing carbon in the future, therefore contributing to mitigation of global climate change. However, including scenarios of future land use shows that human disturbance would significantly reduce this potential and so minimising this would maximise the mitigation potential of the projected increase in forest carbon storage (Figure 7).

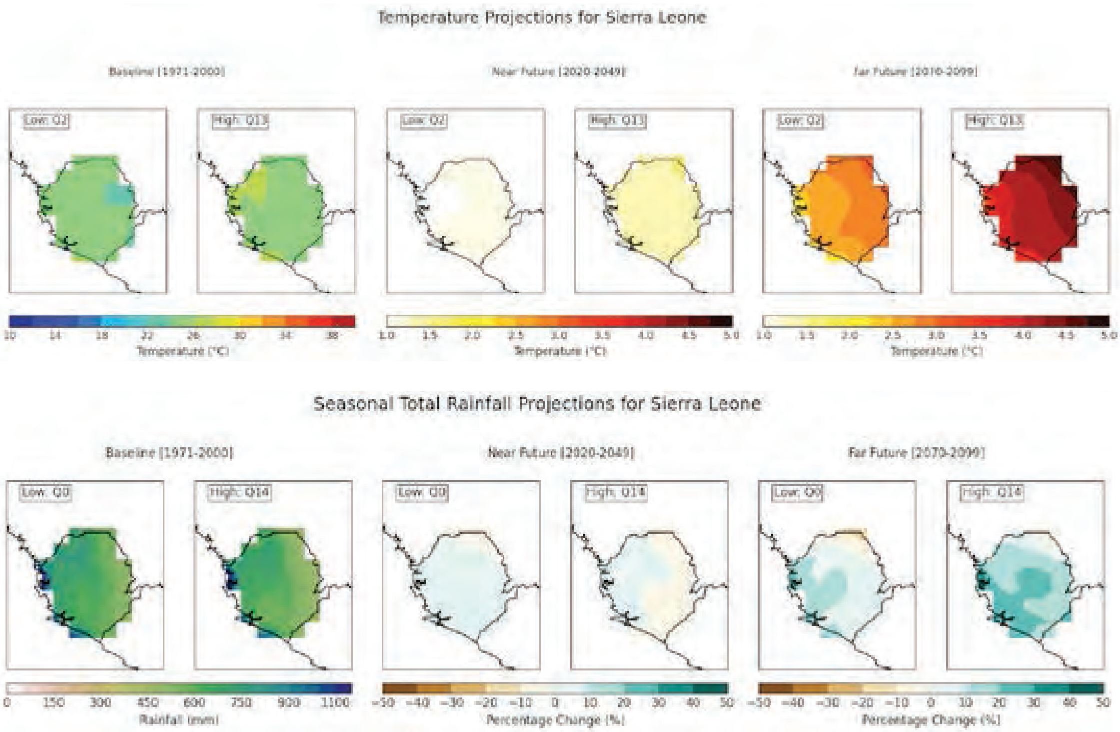


Figure 7. Temperature (annually averaged surface temperature (˚C)) (top) and precipitation (seasonal total rainfall (mm) in the JAS season) (bottom) projections for Sierra Leone, for the baseline period (1971-2000), and projected changes for the near future (2020-2049) and far future (2070-2099), for the RCM models with the lowest and highest projected sensitivities in the far future time period.

Hartley, A., Jones, R. and Janes, T. 2015. Climate Change and Ecosystem Services Fact Sheet: Sierra Leone. UNEP-WCMC technical report.

Togo

Under a scenario of no human disturbance to natural vegetation, small increases in vegetation productivity are projected in Togo, resulting in an increase in vegetation carbon in woody savannah ecosystems, and are related to temperature change and thus confident projections. Including human disturbance, however, leads to a reduction in vegetation carbon in central Togo with high confidence. A small increase in the fraction of broadleaf tree cover over most of Togo is projected in some, but not all, regional climate model projections so should be considered plausible but not confident. In the south of Togo, these results show with high confidence that by limiting future land use change, increases in the carbon storage of forest and savannah ecosystems can be achieved. Future increases in woody savannah in the WAP ('W', Arly, Pendjari) complex, which is a plausible, but not confident projection, may present challenges for the management of biodiversity and the annual fire regime (Figure 8).

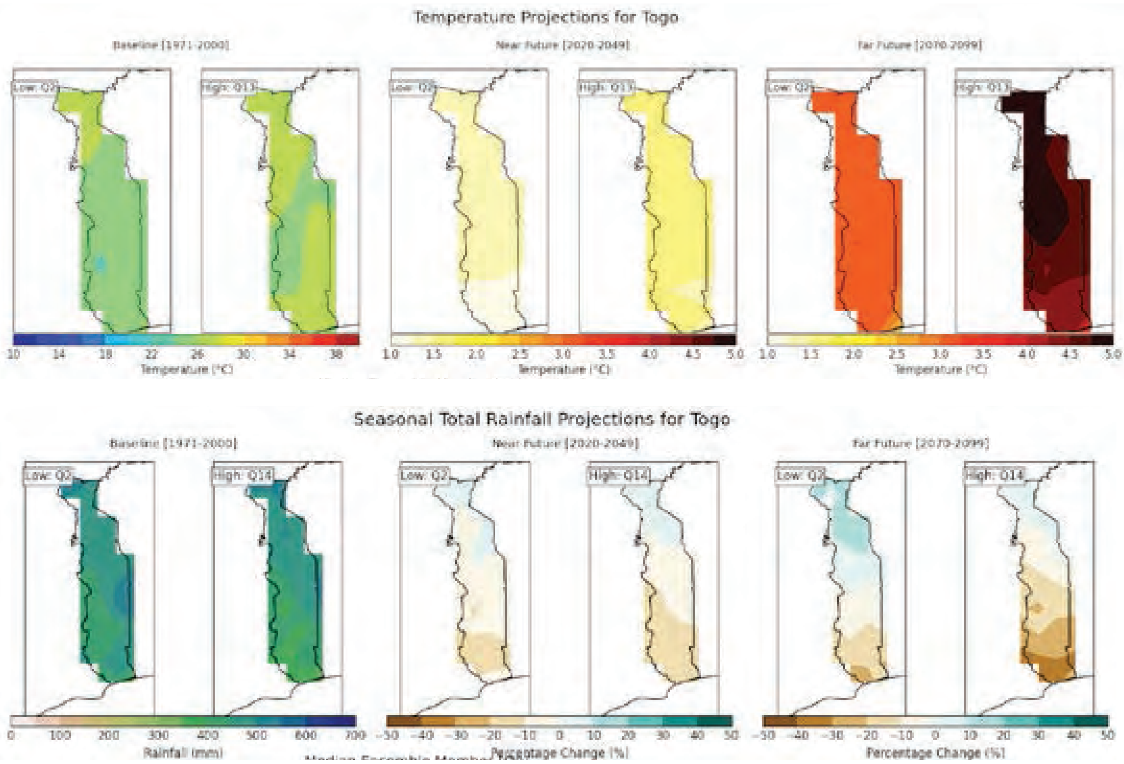


Figure 8. Temperature (annually averaged surface temperature (°C)) (top) and precipitation (seasonal total rainfall (mm) in the JAS season) (bottom) projections for Togo, for the baseline period (1971-2000), and projected changes for the near future (2020-2049) and far future (2070-2099), for the RCM models with the lowest and highest projected sensitivities in the far future time period.

Hartley, A., Jones, R. et Janes, T. 2015. Fiche d'information : Changement climatique et services écosystémiques : Togo. UNEP-WCMC technical report.

Future species distribution in the face of climate change

Key findings:

Biodiversity in West African PAs is expected to be increasingly impacted by climate change during the 21st century, with a large proportion of amphibian, bird and mammal species expected to be found in areas of lower climate suitability by the end of the century. A high species turnover is also expected in most protected areas, especially in the Guinean Forest region.

With climate change driving changes in species' distributions and abundance patterns, it is crucial to evaluate the effectiveness of the current PA network. PAs are a core component of species conservation, yet their static nature makes their long term effectiveness particularly vulnerable as species' ranges shift in response to changing climatic conditions.

Within the framework of the project, Durham University developed Species Distribution Models (SDMs) that link species' distributions to biologically important climatic variables. The projections of future climatic conditions from the MOHC were used, as well as estimates of species dispersal potential, to assess impacts of changing climatic conditions on faunal (birds, mammals and amphibians) distributions and representation across the region's PA network.

Climate change impacts on West African biodiversity across the region's PA network are projected to increase during the 21st Century (Figure 9). **By the 2070-2099 time period, 91% of amphibian, 40% of bird, and 50% of mammal species are projected as 'extremely likely' to have reduced climate suitability across the region's PA network**. No amphibian species, and only three bird and one mammal species, are projected as 'extremely likely' to experience improved climate suitability in the region by 2070-2099.

Each PA is likely to both lose and gain species as species' distributions shift, resulting in changes to faunal communities. Species turnover is a measure of loss and gain of species at a site relative to species richness and provides a measure of community change between time periods. Higher species turnover indicates a greater shift in projected community composition and suggests high climate change impacts. **Median species turnover for amphibians in PAs is projected to increase from 26.5% in the 2010-2039 time period to 45.7% by 2070-2099**. The expected impacts for birds and mammals are lower, yet still represent considerable impacts to communities, with **species turnover by 2070-2099 projected at 32.4% and 34.9% for birds and mammals, respectively**.

A resampling approach was used to identify PAs that were in the upper quartile of projected species turnover for each taxonomic group for each time period, using three uncertainty tolerance thresholds to indicate those impacts for which there is the most confidence. At the 95% confidence level, **80 out of 1,987 PAs are identified as being highly impacted for two or more taxa by the 2010-2039 time period**. However, this falls to only five PAs by 2070-2099. Accepting greater uncertainty, the number of multi-taxa (two or more) 'high impact' sites identified by 2010-2039 increases to 134 at 85% confidence level, and 194 at 75% confidence level. **The majority of the multi-taxa 'high impact' PAs identified are located in the Guinean Forest region**, with most of the PAs occurring within Ivory Coast.

A regional scale assessment of the impacts of incorporating dynamic climate suitability into projections of climate-driven species range changes for species using a dynamic dispersal model was also undertaken. It was shown that the incorporation of dynamic dispersal across landscapes with changing climates can affect projected range shifts, notably resulting in a marked reduction in the number of species able to colonize an area. However, of the five project countries, only Liberia and Sierra Leone appear to be affected by this additional layer of modelling, with the major impacts expected to occur across Ivory Coast, and to affect, in particular, the species rich Guinea Forest and coastal regions. However, overall the impacts of incorporating dynamically changing climate data are relatively limited across much of West Africa.

To conclude, **the projected impacts of climate change represent a significant threat to the region's biodiversity**, which is already under considerable pressure from habitat loss and hunting. This study has highlighted areas of greatest potential impact of climate change on PAs. Where species are likely to decline, steps must be taken to locate and properly protect potential refugia and to maximise connectivity between sites to facilitate range shifts.

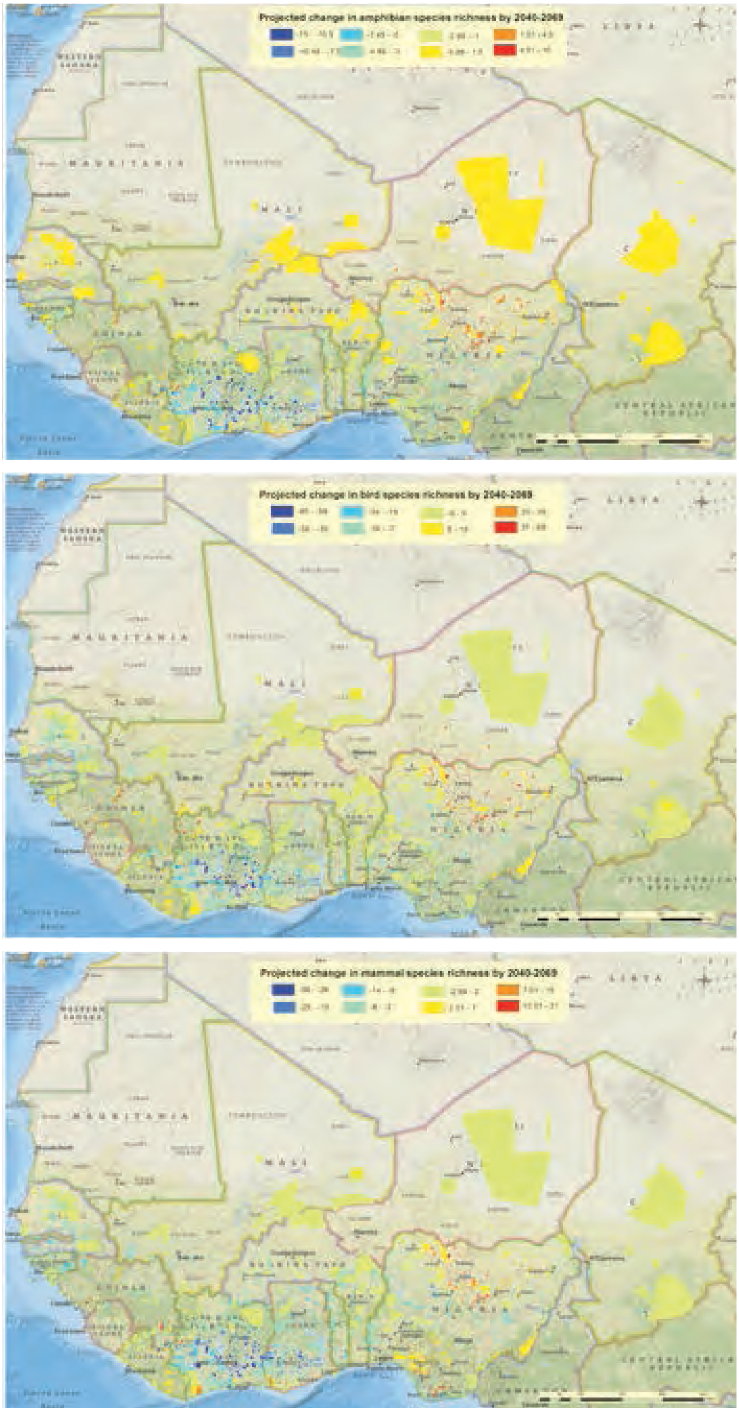


Figure 9. Projected change in amphibian (top), bird (middle) and mammal (bottom) species in individual PAs for the period 2040-2069. Median projections are derived from multiple SDMs and climate projection scenarios. Negative values denote declining species richness compared to current levels, and positive values denote increasing species richness.

Baker D.J. and Willis S.G. 2015. Projected Impacts of Climate Change on Biodiversity in West African Protected Areas. UNEP-WCMC technical report.

Species vulnerability according to their biological traits

Key findings:

A number of West African species (including amphibians, birds, freshwater fish, mammals and reptiles) have been identified as vulnerable to climate change, based on their specific biological and ecological traits. Of these species, those that have been assessed as globally threatened should be considered priorities for conservation.

IUCN Global Species Programme applied a different methodology, called Traits-based Vulnerability Assessments (TVAs), which allowed them to assess the vulnerability of species to climate change based on their specific biological traits, without taking into account spatial aspects of species distributions.

Through two expert workshops, held in Lomé, Togo, with national and international experts, as well as remote consultations, and using data available from previous projects, species biological and ecological trait data were collated **for 183 amphibians, 1,172 birds, 517 freshwater fish, 405 mammals and 307 reptiles. These data were used to infer, for each individual species, their 'sensitivity' and 'adaptive capacity' to climate change**.

Species distribution polygons, collated through the process of assessing species for the IUCN Red List, were overlaid with future climate projections provided by the UK Met Office Hadley Centre to determine the changes in the means and variability of temperature and precipitation that each species may be exposed to. Species that are both considered sensitive and poorly able to adapt to climate change, and are among the most severely exposed to climatic changes, were described as 'climate change vulnerable'.

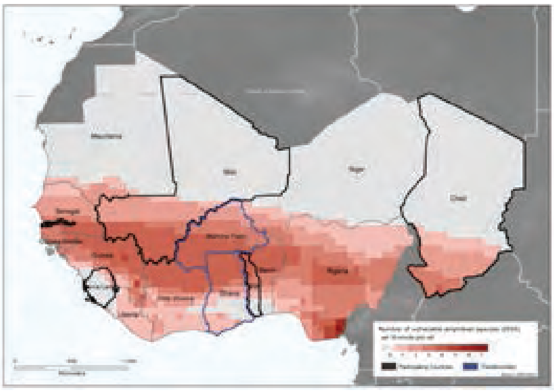
Figure 10. Greatest climate change vulnerability occurs where species face highest Exposure to climatic change, and also possess biological traits that confer both Sensitivity and Low adaptability to such change.

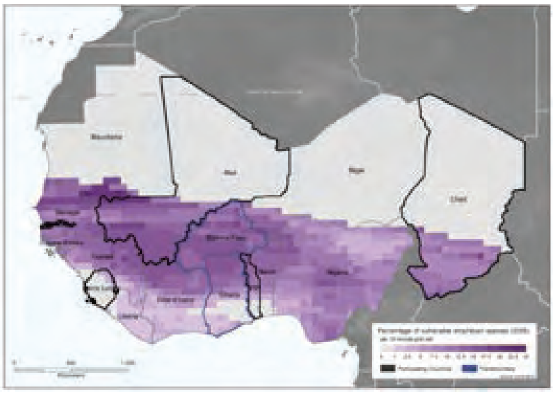
The number of species qualifying under each component of our assessment framework was calculated for all individual biological traits used and for each individual framework 'dimension' (sensitivity, adaptability and exposure) (Figure 10), **as well as the total number of species considered climate change vulnerable**. Based on these results, maps were created highlighting the broad geographical areas that contain high numbers and/or proportions of climate change vulnerable species within a given taxon (Figure 11). This information can help conservationists identify the most prevalent mechanisms through which climate change may impact upon each taxonomic group in the region, and can inform the development of suitable adaptation actions for species or groups of species.

Amphibians

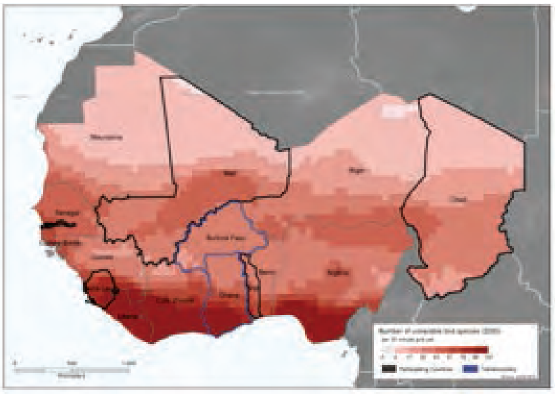
Overall, a total of **12 (7%), 18 (10%) and 46 (25%) amphibian species are considered climate change-vulnerable by the time periods 2010-2039, 2040-2069 and 2070-2099**, respectively, based on regional climate projections and an optimistic assumption of missing data values. In terms of proportions, our assessments suggest that by the time period 2040-2069 the greatest impacts will occur in the more northern arid and semi-arid regions. By 2070-2099, increasing proportions of vulnerable species are visible in the more southern and typically humid zones. Of the species identified as climate change vulnerable by 2040-2069, only one species, *Amietophrynus perreti*, is globally threatened.

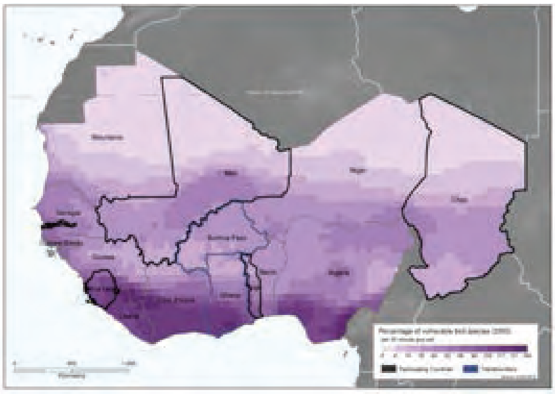
Amphibians



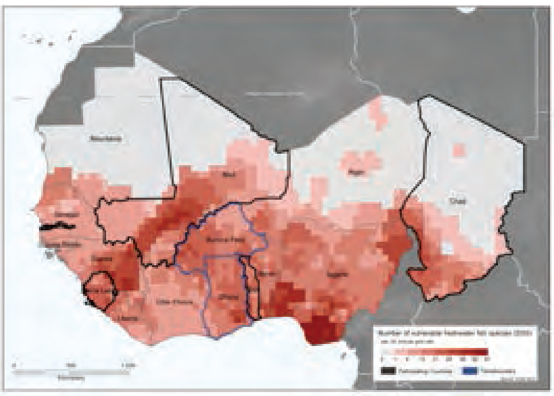


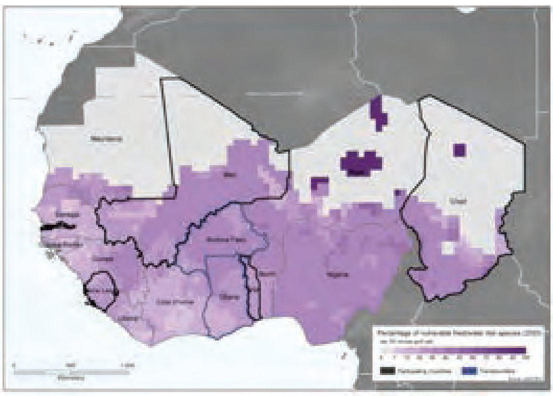
Birds





Freshwater fish





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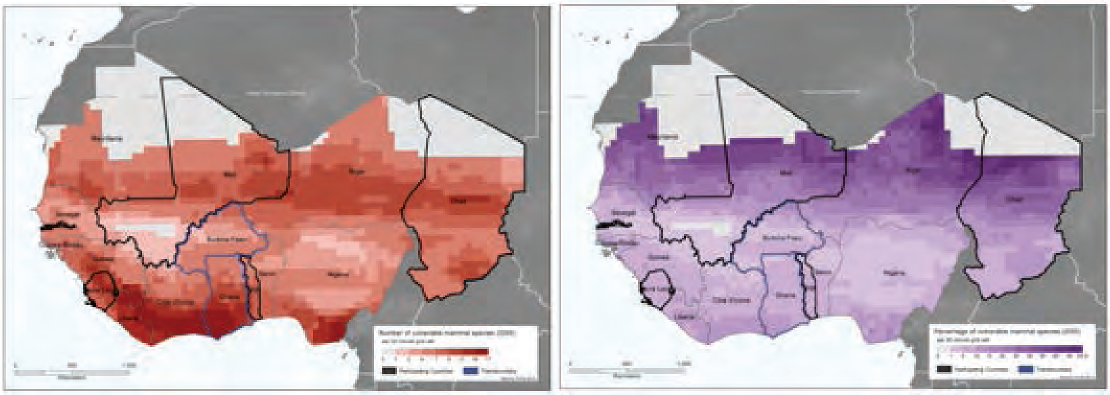
Mammals



Reptiles

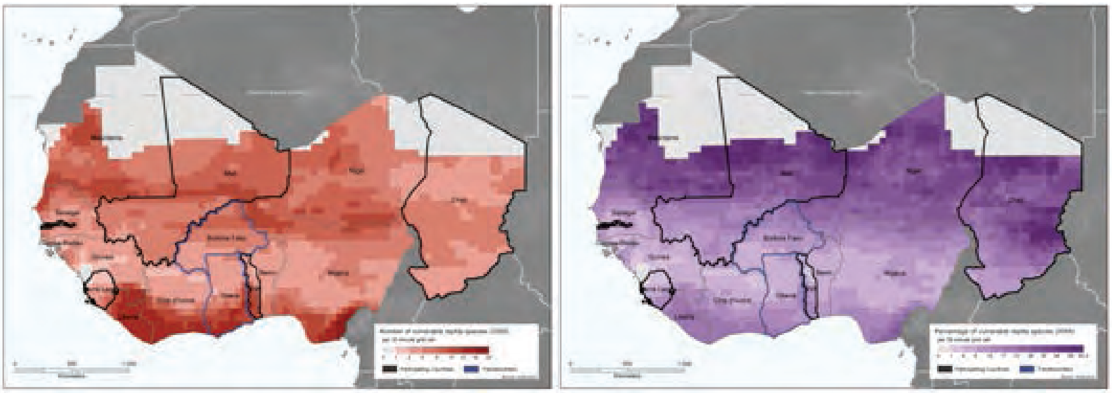


Figure 11. Distribution of climate change vulnerable West African species by the time period 2040-2069. Total number of species per grid cell assessed as climate change vulnerable (Left) and percentage of species in each grid cell assessed as climate change vulnerable (right).

Birds

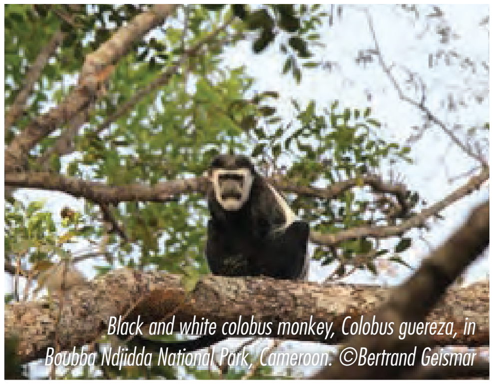
Overall, a total of **17 (1.5%), 247 (21%) and 309 (26%) bird species are considered climate change-vulnerable by the time periods 2010-2039, 2040-2069 and 2070-2099**, respectively, based on regional climate projections and an optimistic assumption of missing data values. In terms of proportions, our assessments suggest that by 2040-2069 the greatest impacts will occur in the southern humid zone, as well as in the northern arid zone (from Mauritania in the West, to Chad in the East), where up to 31% of the species present were assessed as climate change vulnerable. Of the species identified as climate change vulnerable by 2040-2069, 13 species are globally threatened.

Freshwater fish

Overall, a total of **99 (19%), 202 (39%) and 311 (60%) freshwater fish species are considered climate change-vulnerable by the time periods 2010-2039, 2040-2069 and 2070-2099**, respectively, based on regional climate projections and an optimistic assumption of missing data values. In terms of proportions, our assessments suggest that by 2040-2069 the greatest impacts will occur in the desert regions of northern Niger and Chad, where all freshwater species are assessed as climate change vulnerable. By 2070-2099, areas in the east of Mauritania and in the east of Mali also stand out, with over 80% of their freshwater fish fauna vulnerable. Of the 202 species identified as climate change vulnerable by 2040-2069, 62 are globally threatened.

Mammals

Overall, a total of **22 (5%), 63 (16%) and 115 (28%) mammal species are considered climate change-vulnerable by the time periods 2010-2039, 2040-2069 and 2070-2099**, respectively, based on regional climate projections and an optimistic assumption of missing data values. In terms of proportions, our assessments suggest that by 2040-2069 the greatest impacts will occur in the northern, desert regions of Mauritania, Mali, Niger and Chad, where up to 54% of species were assessed as climate change vulnerable. Of the 63 species identified as climate change vulnerable by 2040-2069, eight are globally threatened.



Black and white colobus monkey, Colobus guereza, in Boubba Ndjidda National Park, Cameroon. ©Bertrand Geismar

Reptiles

Overall, a total of **22 (7%), 66 (21%) and 104 (34%) reptile species are considered climate change-vulnerable by the time periods 2010-2039, 2040-2069 and 2070-2099**, respectively, based on regional climate projections and an optimistic assumption of missing data values. In terms of proportions, our assessments suggest that by 2040-2069 the greatest impacts will occur in the Sahel and desert regions of Mauritania, Mali, Niger and Chad, where more than 40% of species were assessed as climate change vulnerable. Of the 66 species identified as climate change vulnerable by 2040-2069, three are globally threatened (although 41 have not been evaluated for the IUCN Red List).

The maps displaying the **geographic areas that contain high numbers and/or proportions of climate change vulnerable species** within a given taxon can be used to determine where conservation measures to reduce the impacts of climate change may be most urgently required, as well as where such measures may be most effective in reducing impacts for the greatest number and/or highest proportion of species.

For each taxonomic group, this study also showed the extinction risk, according to the IUCN Red List of Threatened Species, including maps showing densities of threatened species across the region. **Species that are both globally threatened and vulnerable to climate change should be seen as top priorities for conservation action**. Similarly, species that are only one of threatened or climate change vulnerable should also receive attention, though the specifics of these will vary depending on the outcomes of the assessments. Species that are considered Data Deficient on the Red List and/or were unable to be assessed in terms of climate change vulnerability due to insufficient information should be seen as priorities for research in order to determine the levels of risk that they may face.

Finally, broad examples of ways in which vulnerability assessments can be used to develop conservation strategies are presented. It is hoped that practitioners will consider these findings on a species-by-species basis, and use them to modify existing, or develop new, conservation approaches which explicitly address climate change impacts upon species.

Carr, J.A., Hughes, A.F. and Foden, W.B. 2014. A Climate Change Vulnerability Assessment of West African Species. UNEP-WCMC technical report.

Integration of species distribution and vulnerability assessments

Key findings:

The TVA approach incorporating SDMs showed that fewer species might be vulnerable to climate change compared to using a simple TVA, and resulted in more species with no consensus. The SDM approach incorporating TVAs showed that the projected changes in range under climate change were highly variable. For most species, the recommended management options are to facilitate species dispersal, and to identify sites of suitable climate persisting within the species current ranges.

Once the two approaches to assess the vulnerability of species and PAs to climate change had been implemented, Durham University explored the potential for **combining the SDM and TVA approaches to produce integrated assessments of the potential threat of climate change** to species of conservation concern in West African PAs.

TVAs use species trait data to inform the exposure, sensitivity and likely adaptability of species to changes in climate. SDMs, by relating the occurrence of a species to climate, can be used to assess the sensitivity of a species to projected changes in climate, with climate exposure being informed by projections of changes in climate. However, SDMs do not consider the ability of a species to respond to changes in areas of suitable climate as a result of their biological traits.

Chimpanzee in Gambia River National Park. Copyright: © Elise Belle

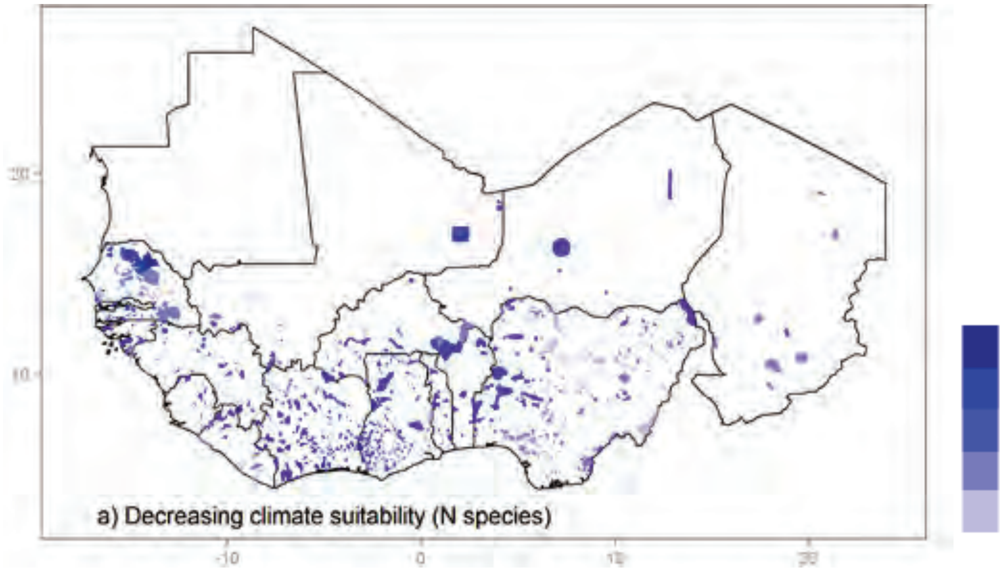
SDM and TVA methodologies were combined in two ways:

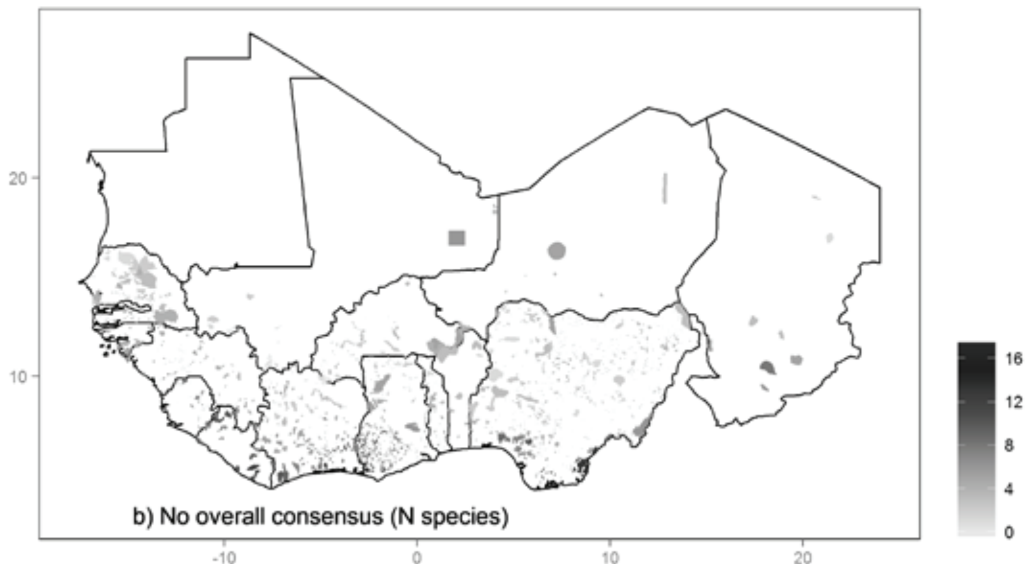
1. Climate suitability projections were used for individual species under scenarios of future climate to replace the simpler climate exposure measures more usually included in TVAs. The likely vulnerability of species to climate change was then estimated by combining these exposure projections with sensitivity and adaptability information from TVA analyses, resulting in an integration of SDM and TVA approaches termed '**modified TVA**'.
2. Relevant trait data were incorporated into SDMs, both as a dynamic element within models of species responses to climate change and, for traits that could not be incorporated within dynamic distribution model, using dichotomous trait-based queries. This resulted in a mixed approach to the combination of traits and spatial modelling, termed '**modified SDM**'.

It was found that the degree to which these two methods differ is greatly affected by how species that have no consensus in their future climate impact (i.e., no consistent trend in their response to predicted changes) are treated.

Compared to the climate change vulnerability assessment of Carr et al. (2014), the 'modified TVA' approach, which incorporates spatially-explicit modelled climate suitability, indicates fewer amphibian species vulnerable to climate change per site and, instead, many more species with little consensus in the degree to which they may be vulnerable to future climate change. The overall climate vulnerability of birds using the 'modified TVA' approach suggests fewer climate vulnerable species than does the original analysis in the southern parts of the region, with around 70 species projected to experience declining climate suitability in PAs in the South, compared to projection of over 100 species in the original TVA analyses. The 'modified TVA' approach also indicated a large number of bird species for which no climate change vulnerability consensus could be reached. The number of mammal species considered vulnerable by Carr et al. (2014) is broadly similar in its patterning to the number arising from the 'modified TVA' but, again, the total number of species identified as vulnerable in the individual PAs are smaller than in the original estimation (Figure 12). The 'modified TVA' approach also highlights less certainty (a lack of consensus) in parts of SE Nigeria and coastal areas of Ghana, Cote D'Ivoire and Liberia.

The '**modified SDM' approach showed that the projected changes in range under future climate change are very variable**, after considering traits such as dispersal ability, generation length, and age to first breeding in addition to climatic suitability. This approach allowed site-level climate vulnerability to be evaluated and the formulation of management recommendations for individual species based on their potential to respond to projected climate change. For most species of West Africa, the principal management options will be (i) to **facilitate the natural dispersal of species** from their current range to areas of suitable climate in future, and (ii) to **identify sites of suitable climate persisting within the species current ranges** that can be prioritised for conservation management.





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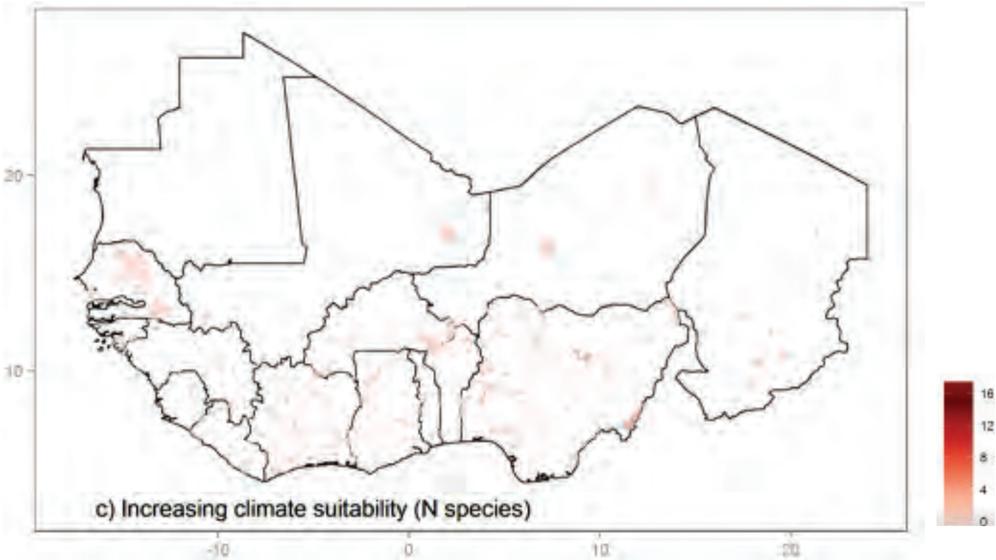


Figure 12. Number of mammal species previously classified as climate change vulnerable by Carr et al. (2014) that are assessed as climate change vulnerable by 2040-2069 using the modified-TVA analyses: (a) number of species experiencing decreasing climate suitability in each PA, (b) number of species with no consensus of future climate impact and (c) number of species for which climate suitability is increasing in PAs.

Durham University. 2015. Integrating species distribution models and trait data to inform conservation planning. UNEP-WCMC technical report.

Mount Agou, Togo. ©Elise Belle

Assessment of the connectivity of the West African PA network

Key findings:

By using generic species to represent the existing diversity among terrestrial species (using a combination of their habitat preferences and maximum dispersal distances), protected areas and potential links between protected areas of importance for maintaining the connectivity of the network were identified, with a special focus on transboundary protected areas.

In the face of climate change, connectivity conservation is key to prevent the negative effects of habitat fragmentation and isolation, by (i) maintaining existing links and patches of habitats and (ii) restoring or creating links between habitats.

In this study, conducted by UNEP-WCMC, a set of **generic focal species were used as surrogates to represent variation amongst terrestrial species**. These surrogates were not based on actual species, but were a **combination of habitat preferences (forest, grassland and generalist) and maximum dispersal distances (short, 1km; medium, 10km; long, 100km)** (Figure 13).

This approach was used to model PAs containing habitat as patches and the Euclidean (straight line) distance between PAs as links. Functional links were those within these maximum dispersal distances. PA values in terms of the connectivity they provide were calculated from the overall change in connectivity of the PA network when a PA was removed. The importance of potential links were calculated by measuring the connectivity change of the network, thereby assessing their contribution to connectivity if an intervention (e.g., PA expansion or corridor management) could help bridge such gaps allowing a functional link between PAs. **For each combination of generic focal species characteristics, results on the contribution of individual PAs and links were generated,** focusing on those near, adjacent to, or crossing country borders.

The results of this study highlighted the importance of using a variety of approaches to improve connectivity for species with different dispersal distances. For short dispersal species, in most instances, habitat management and improvement should be preferentially targeted within PAs, especially since habitat connectivity within PAs is not fully addressed within the framework of this study, most notably for forest or grassland specialists. Medium dispersal species, however, could be appropriate targets for improving links between PAs, especially for forest specialists. For long dispersal species, targeting link improvement may be less cost effective considering that a potentially high number of barriers may be present; therefore, PA habitat management or expansion may be the best use of resources.

The approach used highlighted **specific (potential or existing) key transboundary PAs** (e.g., Gola Rainforest National Park in Sierra Leone, Niokolo-Koba National Park in Senegal, Grebo National Park in Liberia, Comoé National Park in Cote d'Ivoire, Sahel Partial Faunal Reserve in Burkina Faso, and the WAP complex in Benin, Niger and Burkina Faso) and links between PAs which would greatly improve the overall connectivity of the West African PA network. These results should be taken into consideration when prioritising field studies.

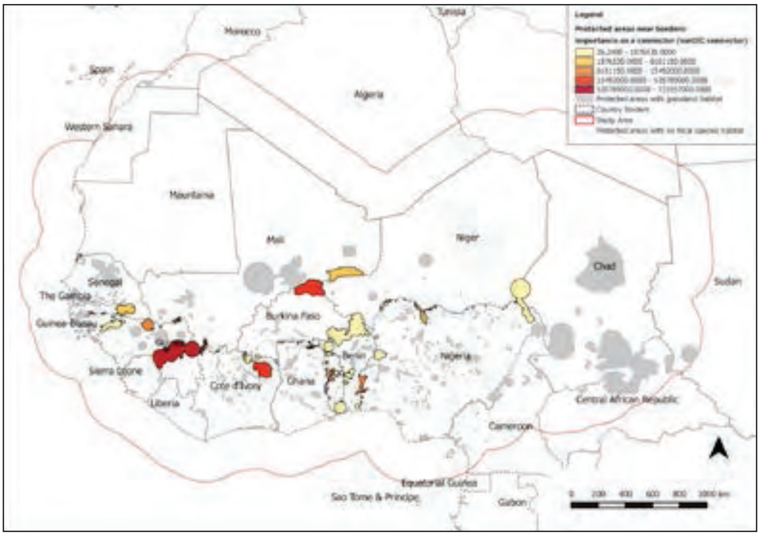


Figure 13. Example: Importance of transboundary PAs for connecting grassland specialist focal species with long range maximum dispersal (100km) abilities.

Arnell, A.P., Belle, E. and Burgess, N.D. 2014. Assessment of Protected Area Connectivity in West Africa. UNEP-WCMC technical report.

Kakum National Park, Ghana. ©Elise Belle

Giraffes in Bouba Ndjidda National Park, Cameroon. ©Bertrand Geismar

Identification of priority areas for biodiversity conservation

Systematic conservation planning (SCP) is the most widely used approach for designing and improving PA networks. It involves producing a list of important species, habitats and ecological processes (collectively known as 'conservation features'), mapping their distributions and setting targets for how much of each conservation feature should be protected. These data are then used to carry out a gap analysis, which measures the extent to which the existing PA system meets these targets, and a spatial conservation prioritisation, which identifies priority areas for filling any target shortfalls. PA networks also need to be robust to the impacts of climate change, as the distributions of the conservation features are likely to shift in response to changes in temperature, rainfall and sea levels. SCP can be used to address this issue by identifying priority areas for conservation that protect both the current and the future expected distribution of important species.

In this study, the Durrell Institute of Conservation and Ecology (DICE) from the University of Kent carried out a **gap analysis and spatial conservation prioritisation for the West African region and the five project countries**: Chad, Gambia, Mali, Sierra Leone and Togo. This involved producing one regional and five national systematic conservation planning systems. These systems were then used to help identify ways in which PA networks could be improved to conserve biodiversity both now and in the future, taking into consideration future climate projections.

REGIONAL PLANNING SYSTEM

Key findings:

A gap analysis showed that the regional network of PAs and IBAs meets conservation targets for over half of the ecoregions represented, but does not conserve any of the East Saharan montane xeric woodland or Mandara Plateau mosaic ecoregions. Conservation targets are met for the majority of species, but some conservation features remain completely unprotected, especially for threatened species. To meet all the conservation targets, over 20% of the West Africa region would need to be protected.

The systematic conservation planning system for West Africa contains data on all 17 natural land cover types, 28 ecoregions, 171 amphibian species, 884 bird species and 230 mammal species found in the region. It also contains data on the predicted distributions of 316 amphibian, bird and mammals species that are listed as Threatened on the IUCN Red List and/or have been assessed as being vulnerable to the predicted impacts of climate change, based on Species Distribution Models (SDMs) for the time period 2010-2039.

The West Africa planning region has an area of 7,311,000 km^2 and 12.6% of this falls within existing PAs, while another 1.1% falls within unprotected Important Bird and Biodiversity Areas (IBAs) that have been identified by BirdLife International and their local partners. The percentage of each country that falls within PAs or unprotected IBAs ranges from 1.1% for Mauritania to 34.8% for Guinea-Bissau. Only seven of these countries would meet their Aichi target 11 if their IBAs were also included in their PA network. **The regional network of PAs and IBAs meets conservation targets for 15 of the 28 ecoregions, but fails to conserve any of the East Saharan montane xeric woodland or Mandara Plateau mosaic ecoregion**.

The combined network of PAs and IBAs meets targets for 89.5% of all conservation features. **Conservation targets are met for 81.3% of amphibian species, 90.8% of bird species and 86.1% of mammal species** (Figure 14) **and for 94.0% of the SDMs in 2010-2039**. However, over 7% of these features are completely missing from this network and this percentage is even higher when considering threatened species, where 12.5% are currently unprotected.

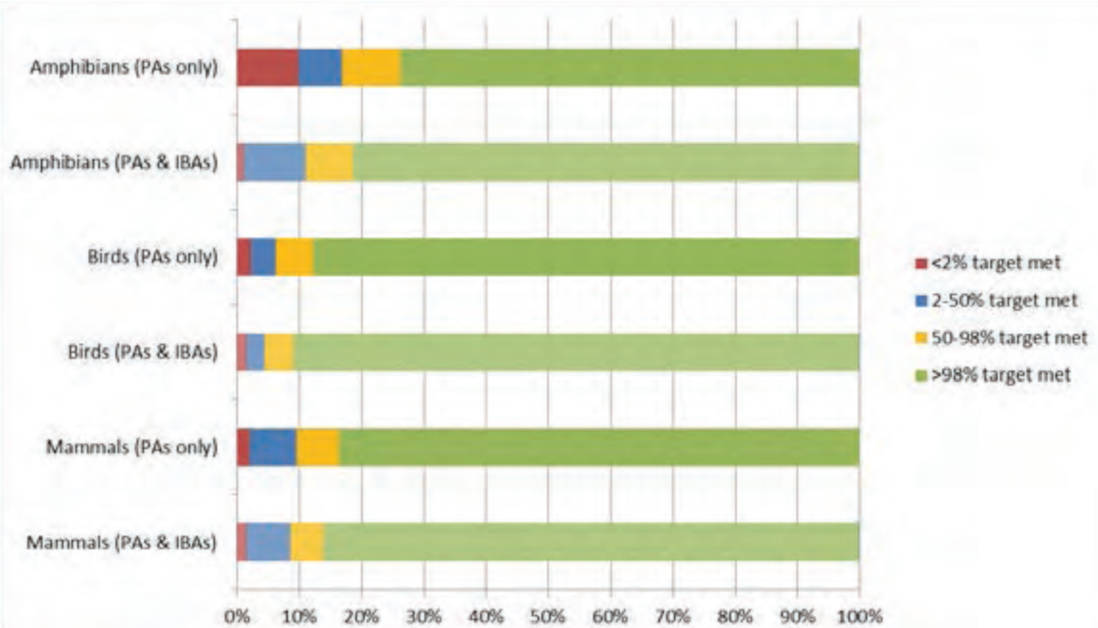


Figure 14. Percentage of amphibian, bird and mammal species for which the set target (i.e., proportion of their current distribution range to be protected) is met by the existing Protected Area (PA) network and Important Bird and Biodiversity Areas (IBAs).

The PA and IBA network is more effective at meeting targets for the future predicted distribution of species in 2010-2039, although 0.8% species of birds and 0.25% of mammals are completely unprotected. In contrast to the findings for the current distribution of species, the future distributions of threatened species are better protected than non-threatened species.

We used the Marxan conservation planning software to identify priority areas for meeting the conservation targets (Figure 15). The analysis was designed to avoid areas of high human population density, where possible, and to identify priority areas that extend existing PAs or are large enough to be ecologically viable. The results of the analysis shows that **meeting all the conservation targets requires an additional 384,765 km^2 to be added to the existing PA network, which corresponds to protecting 21.6% of the region.**

The priority areas that were most consistently identified by Marxan were scattered throughout the region, but the most extensive areas were in Côte d'Ivoire, Ghana and Mauritania. For Côte d'Ivoire and Ghana, this was because they contained important biodiversity, but also because they contained many small PAs that Marxan sought to link. For Mauritania, the large extent identified results from the relatively low PA coverage in the country, meaning that some ecoregions require higher levels of protection to meet the specified targets.

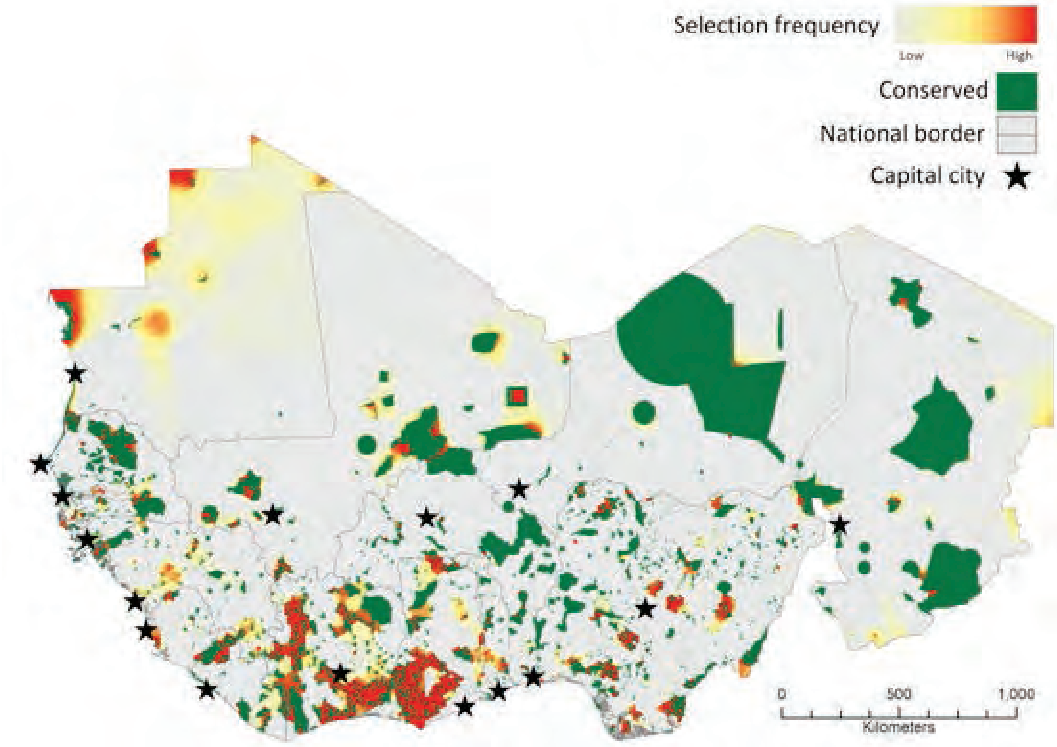


Figure 15. Priority conservation areas for West Africa. Areas shown in red were the ones selected most frequently by Marxan.

The results from the gap analysis and the spatial conservation prioritisation can be used to inform conservation policy and practice in West Africa. However, caution is needed when implementing the results because most of the distribution data were based on range maps that include some unsuitable habitats. Thus, the first step in the practical use of these results is to carry out literature reviews and field surveys to check that each priority area is genuinely important for the conservation features for which it was selected. It is also important to recognise that the West Africa conservation planning system only contained data on three groups of vertebrates and did not include data on a range of factors that might influence implementation, such as ecosystem services, opportunity costs from agriculture, or land-use plans from other sectors. Thus, it is important that national and international researchers and conservation practitioners continue to improve the planning system by updating and adding new data.

Smith R.J. 2015. West Africa Gap Analysis and Spatial Conservation Prioritisation. UNEP-WCMC technical report.

NATIONAL PLANNING SYSTEMS

> **Key findings:**
> The gap analysis carried out for each of the five project countries showed that there is high variability among countries, with the existing network of PAs and IBAs meeting most of the conservation targets in some countries, but failing to conserve a number of conservation features, such as particular ecoregions and important species for conservation (including threatened species) in other countries.

The national planning systems were developed as a collaboration between DICE University of Kent and national experts through a series of national workshops, in which biodiversity experts were taught how to carry out gap analyses and developed conservation planning systems for their countries. At these workshops, initial results from the national planning systems were presented and the outputs were refined by the participants so that they could be used to inform conservation policy and practice. The participants helped set all conservation targets (how much of each conservation feature should be protected), and agreed on areas to be excluded from the set of priority areas (for example because of urban development or mining operations). They were also involved in checking fragmentation levels (to ensure a minimum size for the creation of new PAs) and in identifying a set of priority areas for meeting the protection targets.

The results coming from the planning systems are summarized in a series of reports, which describe for each project country, how each of these planning systems was developed. The reports include **details on how the planning systems were used to measure the degree to which each country's current PA network meets conservation targets, and to identify priority areas for expanding national PA networks**.

Chad

The Chad conservation planning system classified 149,636 km^2 (11.8%) as being already included in PAs and 30,373 km^2 (2.4%) as being in currently unprotected IBAs. The current Chad PA and IBA network is meeting most of the conservation targets set. However, it is failing to conserve any of the East Saharan montane xeric woodland and very little of the Sahara desert ecoregion. Regarding the current distribution of amphibians, birds and mammals, on average, about 80% of these species have met their protection targets in the current PA and IBA system. However, threatened species are less well protected, although the proportion of species where the targets have been met is still relatively high. Most of the identified priority areas are found around existing conservation areas (PAs and IBAs), with smaller priority areas found in patches in the south of the country (Figure 16). The analysis also showed that large areas in the north of the country should also be included in the PA network to meet targets.

Smith R.J. 2015. Analyse des carences et établissement de priorités géographiques pour la conservation au Tchad. UNEP-WCMC technical report.

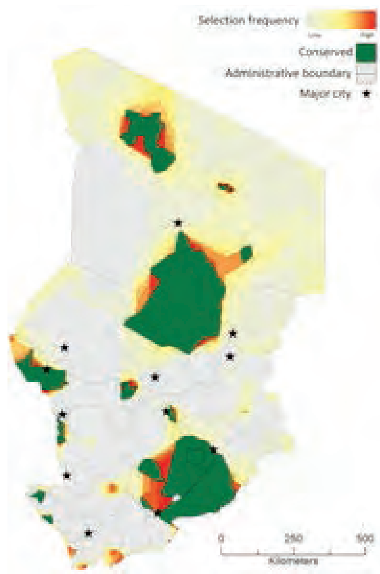


Figure 16. Priority areas in Chad for meeting conservation targets, whilst avoiding areas with high human population density where possible.

Gambia

The Gambia conservation planning system classified 422 km² (4%) as being already included in PAs and 215km² (2%) as being in currently unprotected IBAs. The current Gambia PA and IBA network does not meet most conservation targets. It is indeed failing to meet targets for almost all species, although the unprotected IBAs are playing an important role in increasing protection for all three taxonomic groups. A number of important priority areas were identified in different parts of the country (Figure 17). These are found from East to West and reflect biogeographic patterns.

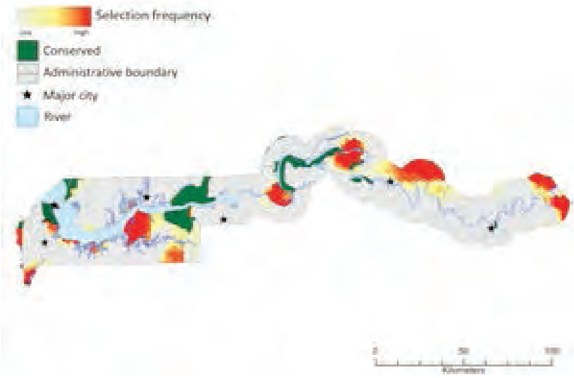


Figure 17. Priority areas in the Gambia for meeting conservation targets, whilst avoiding areas with high human population density where possible.

Smith R.J. 2015. Gap Analysis and Spatial Conservation Prioritisation in The Gambia. UNEP-WCMC technical report.

Mali

The Mali conservation planning system classified 69,839 km² (5.6%) as being already included in PAs and 14,501 km² (1.2%) as being in currently unprotected IBAs. The Mali PA and IBA system is failing to conserve any of the Sahara desert ecoregion and very little of the Inner Niger Delta flooded savanna. Birds are relatively well protected, especially when IBAs are included, but mammals and particularly amphibians are poorly represented. The situation is considerably worse for threatened species, especially for mammals. Most of the priority areas identified are found in the central and southern sections of Mali, in particular around existing PAs (Figure 18). Mali needs to expand its PA network throughout the country to meet conservation targets.

Smith R.J. 2015. Analyse des carences et établissement de priorités géographiques pour la conservation au Mali. UNEP-WCMC technical report.

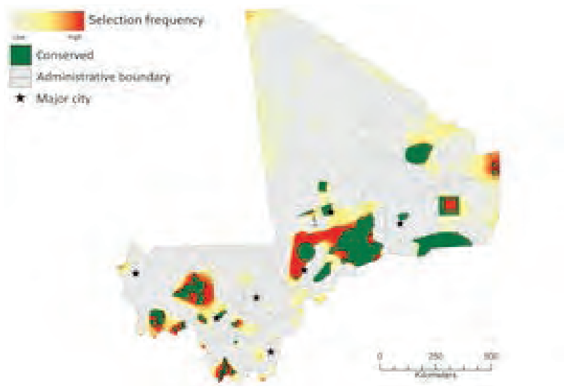


Figure 18. Priority areas in Mali for meeting conservation targets, whilst avoiding areas with high human population density where possible.

Sierra Leone

The Sierra Leone conservation planning system classified 4,211 km² (5.8%) as being already included in PAs and 512 km² (0.7%) as being in currently unprotected IBAs. The current Sierra Leone PA and IBA network does not meet most conservation targets. Notably, it is failing to meet targets for almost all species, especially amphibians. Most of the priority areas are found in the central and western sections of Sierra Leone, particularly around existing PAs (Figure 19). Sierra Leone also needs to expand its PA network throughout the country to meet conservation targets.

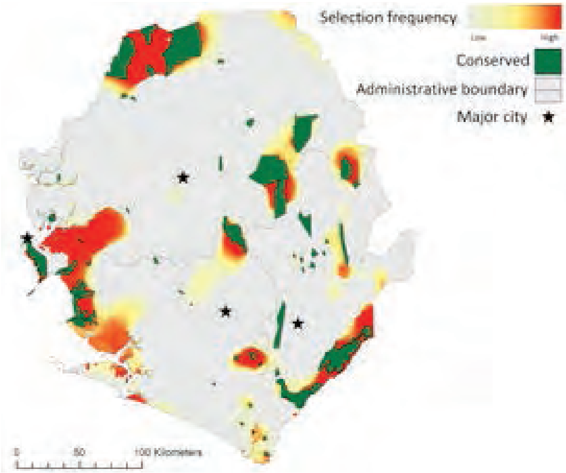


Figure 19. Priority areas in Sierra Leone for meeting conservation targets, whilst avoiding areas with high human population density where possible.

Smith R.J. 2015. Gap Analysis and Spatial Conservation Prioritisation in Sierra Leone. UNEP-WCMC technical report.

Togo

The Togo conservation planning system classified 7.273 km² (12.8%) as being already included in PAs and 151km² (0.3%) as being in currently unprotected IBAs. The Togo PA and IBA system is representing most of the ecoregions and landcover types. The current network is already meeting targets for most species and only a very small proportion are completely missing from the existing PA network. However, it is worth noting that Togo's PA network is currently being revised. A small number of priority areas have been identified outside the existing conservation area network (Figure 20). However, there is still a need to expand the existing PA network in order to meet all the conservation targets, notably with some additional areas in the south.

Smith R.J. 2015. Analyse des carences et établissement de priorités géographiques pour la conservation au Togo. UNEP-WCMC technical report.

Figure 20. Priority areas in Togo for meeting conservation targets, whilst avoiding areas with high human population density where possible.

Links between PAs, communities, and climate change

Key findings:

Local communities living in and around PAs are heavily dependent on the surrounding ecosystems, and are becoming increasingly affected by climate change. However, the inter-relationships between PAs, climate change and communities are not yet well understood. A series of recommendations are therefore provided to enable better integration of climate change information into PA management.

In order to better understand the relationships that exist between climate change, PAs and communities in West Africa, five national studies were commissioned and were subsequently consolidated in a regional report by IUCN PACO.

PAs in West Africa, and in the five core project countries in particular, are subject to considerable pressure, principally caused by human activities (including poaching, the over-exploitation of resources, and bush fires, among others). Habitats are deteriorating and changing, and wildlife populations are gradually diminishing. PAs are becoming increasingly vulnerable, particularly to the effects of climate change, as are the surrounding ecosystems.

The ecosystems surrounding PAs are heavily used by the local communities living in the vicinity of PAs. Indeed, in all five national reports, the most important activities identified around PAs were agriculture, livestock farming, fishing and logging (timber and non-timber forest products). These activities are also highly dependent on climatic conditions for their optimal development. The main climate threats identified by the local communities and in the literature review (namely drought, flooding, strong winds, and irregular rainfall) have an impact both on their livelihoods and well-being. A loss of the animal and plant biodiversity used by the communities, a reduction in grazing land, a drop in crop yields and animal production, a drop in household income, food insecurity, a deterioration of community health and in general an increase in poverty have all been mentioned as consequences of climate change. As a result, resources located within PAs are becoming more attractive as those outside PAs no longer suffice to meet communities' needs, and the communities can thus, in turn, have a negative impact on the PAs. Incursions into PAs for poaching, to find grazing land, new fields and non-timber forest products have indeed been observed.

However, the **relationship between climate change, PAs and the communities living around them is not yet very well understood** by PA managers and political decision makers. Much effort in terms of research, awareness-raising and information is therefore still needed. Some adaptation action plans and programmes have already been implemented in the countries and at a regional level to help communities to adapt to the impacts of climate change policies have also been developed. However, these plans do not take into account how these three elements interact, and more efforts are needed to better understand and reduce the negative interactions between climate change, PAs and the local communities.

To improve the understanding of these relationships and implement appropriate actions, five recommendations concerning the different stakeholders in PA management have been made:

1. Researchers should **develop appropriate tools** for collecting and analysing data to better understand the interactions between PAs, local communities and climate change;
2. PA managers should set up integrated systems which **take climate change into account to monitor PA biodiversity**;
3. PA managers should enhance their actions to **raise awareness** regarding the direct and indirect effects of climate change among local communities;
4. Funders should **improve the capacity of PA managers and representatives of affected communities** to implement climate change adaptation plans and use monitoring and evaluation tools; and
5. Public authorities should **develop integrated climate change adaptation and PA management policies**.

Masumbuko B. and Somda J. 2014. Analysis of the links between climate change, protected areas and communities in West Africa. UNEP-WCMC technical report.


Woman selling cashew nuts, Freetown Peninsula, Sierra Leone. ©Elise Belle

PA management, financing and monitoring within the framework of climate change

OPTIONS FOR MANAGING AND FINANCING PAS TO ADAPT TO CLIMATE CHANGE

Key findings:
The approaches of 'change management' can assist PA managers in successfully implementing adaptation strategies. Many of these strategies are already being applied but need to integrate climate change information and adopt a more dynamic approach. There is a broad range of PA financing mechanisms available, but only a few of them are currently used in West Africa.

This review involved a) researching a broad range of possible adaptation options for managing PAs to minimise climate change impacts, and b) reviewing possible financing mechanisms. The review was compiled via a desktop literature review, consultation with key experts, and validation by the project's technical advisory group. It is targeted primarily at government and non-government agencies responsible for funding and managing PAs, although some findings may also be relevant to donor governments and agencies.

A range of possible adaptation strategies were identified, including some which are already in use in West Africa. Furthermore, it was shown that **'change management' approaches can assist PA managers to successfully implement their chosen adaptation strategies**. Many climate change adaptation strategies are available and already in use. These adaptation strategies use similar tools and approaches to business-as-usual PA management, but integrate information about climate change impacts and a much more dynamic understanding of biodiversity and climate. In West Africa, the PARCC project is at the forefront of efforts to assist PA managers with climate change adaptation. However, there are significant challenges associated with introducing PA agencies to a new more dynamic approach, and change management techniques can assist with necessary transitions.

A broad range of PA financing mechanisms are available, some of them commonly in use in West Africa, however, adaptation financing for PAs is different from other financing mechanisms, and some specific criteria should be taken into account when developing PA adaptation and funding strategies in the region. **Of the many available mechanisms to finance PAs, only a small number are commonly used in West Africa and include tourism charges (especially gate entry fees), central government budgets, and donor funds**. Furthermore, PA financing is not simply about having more funding, but also the mechanisms to manage and use the funding effectively, which are ultimately questions of management effectiveness. It is difficult to distinguish financing for PA adaptation to climate change from general PA management costs, and it may not be useful to do so. West African PAs face particular challenges, which point to seeking out more straightforward solutions to climate change adaptation and financing challenges. A simple nine-step model is proposed to provide general guidance to PA managers in West Africa to successfully meet the challenges, and indeed opportunities, presented by climate change: 1. Start up, 2. Build a coalition, 3. Get better information, 4. Set your evidence-based strategy, 5. Plan for change and manage adaptively, 6. Mobilise resources, 7. Implement, monitor, evaluate and improve, 8. Build capacity, and 9. Share and exchange. Some of the available tools to help PA managers are also presented in the review.

Smith J. 2013. Managing and financing protected areas to adapt to climate change: A rapid review of options. UNEP-WCMC technical report.

REVISED MANAGEMENT EFFECTIVENESS TRACKING TOOL

Key findings:
A new climate change component has been added to the original Protected Area Management Effectiveness (PAME) framework, developed by IUCN's World Commission on Protected Areas (WCPA), and two new indicators on the integration of climate change issues into management effectiveness assessments have been added to the Management Effectiveness Tracking Tool (METT).

The successful management of PAs is complex and requires the full consideration of all threats, including the potential effects of climate change. However, existing site-focused tools for measuring PA management effectiveness do not include the likely impacts of climate change in their assessments.

Additions to the original Protected Area Management Effectiveness (PAME) framework developed by IUCN's World Commission on Protected Areas (WCPA) were formulated, and a new climate change component was integrated. Based on this updated framework, two new indicators related to the integration of climate change issues into site-based management effectiveness assessments were developed. **These new indicators constitute important additions to the existing Management Effectiveness Tracking Tool (METT)** that is mandatory for use in all GEF protected area projects globally, and is also used by many nations and NGOs working with protected areas effectiveness. By adding new questions to the METT that address the planning and management response to climate change at the PA scale, we have proposed changes to a generic tool that can be used in all protected areas to monitor management issues related to climate change.

The two new questions on climate change with each four possible answers are as follows:

1. **Has the protected area been designed to take into account the likely effects of climate change?**
   - 1.0: Climate change was not taken into account during PA design, and no subsequent consideration has been given to address its impact
   - 1.1: Climate change was not taken into account during PA design, some planning, but no action has been taken to address its impact
   - 1.2: Climate change was not taken into account during PA design, but planning and some action to address its impact has taken place
   - 1.3: Climate change was taken into account during PA design or in subsequent planning for impacts and has resulted in changes to the PA design
2. **Is the protected area being consciously managed to adapt to climate change?**
   - 2.0: There have been no efforts to consider adaptation to climate change in management.
   - 2.1: Some initial thought has taken place about likely impacts of climate change, but this has yet to be translated into management plans.
   - 2.2: Detailed plans have been drawn up about how to adapt management to predicted climate change, but these have yet to be translated into active management.
   - 2.3: Detailed plans have been drawn up about how to adapt management to predicted climate change, and these are already being implemented.

Beside this new module on climate change, a question on governance and resource rights was also included. The updated METT tool was successfully tested in the eight PAs of The Gambia as a pilot country. The new tool was then applied to the five transboundary protected areas of the project. By bringing it to the national level, the new tool was applied in different PAs and countries, and helped nations gather important information on the status of management in their PA networks that will enable them to measure changes over time, including in relation to climate change.

Belle E., Stolton S., Dudley N., Hockings M. and Burgess N.D. 2012. Protected Area Management effectiveness: A regional framework and additional METT module for monitoring the effects of climate change. UNEP-WCMC technical report.

Transboundary pilot site activities in order to enhance PA resilience

PILOT SITE ACTIVITIES

Based on the results of the scientific studies described in the previous sections, five pilot sites were selected, to **implement activities on the ground in relation to the scientific results of the project**. These pilot sites were suggested by representatives of the five project countries and selected at a Project Steering Committee meeting.

The following criteria were used for the selection of the pilot sites:

- Site joins across a national border to another site in an adjacent country
- Analysis of climate change impacts using project results indicates that the site has a high vulnerability to climate change
- Habitat connectivity analyses show some important gaps in this geographical area
- The use of tools developed by the project in a pilot situation is possible (e.g., revised METT)
- Synergies could be developed with other projects in the region, such as the MAVA project
- There is a lack of funding which is critically affecting the integrity of the pilot project area, but which could be solved with limited funding
- Countries are willing to engage in the pilot project, notably with the signature of management agreements and/or the development of joint management plans
- The proposed pilot area involves at least one of the additional project countries (i.e., Ghana, Burkina Faso, Ivory Coast), if possible

The five selected pilot sites were:

1. Sena Oura National Park in Chad, with Boubba Ndjidda National Park in Cameroon
2. Gourma Elephant Reserve in Mali, with Sahel Partial Faunal Reserve in Burkina Faso
3. Niumi National Park in The Gambia, with Delta du Saloum National Park in Senegal
4. Gola Rainforest National Park in Sierra Leone, with Gola National Park in Liberia
5. Oti-Kéran-Mandouri (OKM) in Togo, with the WAP ('W', Arly, Pendjari) complex between Benin, Burkina Faso, and Niger

The activities implemented at these pilot sites all aimed at gaining a better understanding of climate change and/or reducing its impacts on biodiversity. Notably, they included the following activities (or actions contributing to the achievement of these activities):

- The signature of a **transboundary agreement** between countries,
- A **joint PA management plan integrating climate change** considerations,
- The implementation of the revised METT,
- Recommendations for species monitoring, and
- Other relevant activities (awareness raising/development of alternative livelihoods for local communities, social vulnerability assessments, and reforestation schemes, among others)

These activities were led by the NLO of each project country, with the support of IUCN PACO. Details of the activities implemented and outputs for each pilot site are given in the sections below.

Sena Oura National Park (Chad) and Boubba Ndjidda (Cameroon)


Bouba Ndjidda National Park, Cameroon. ©Bertrand Geismar

1. Information and awareness raising meetings were held with the local communities living in and around the transboundary site regarding the existence of the transboundary complex, anthropogenic activities incompatible with biodiversity conservation, and the negative effects of climate change.
2. A tree nursery for the complex at the life base of the Sena Oura National Park was created in order to restore the most degraded village areas.
3. Reforestation of degraded areas took place in rural sites in Chad and Cameroon in order to reduce pressures exerted by the communities on the protected areas.
4. A joint management plan was discussed and initiated for the transboundary area, through consultations between the two countries and with the assistance of a consultant, and the new METT was applied to both PAs.

These activities were designed with and coordinated by the NLO of Chad, Mr Brahim Hissein Dagga.

Niumi National Park (The Gambia) and Delta du Saloum National Park (Senegal)

1. An updated transboundary management plan integrating climate change aspects was developed, in collaboration with Wetlands International (which was involved in drafting the original plan prior to the integration of climate change).
2. Networking meetings between local communities and staff from both PAs took place in order to exchange experiences on monitoring programmes, climate change adaptation initiatives, and good practices on local community involvement initiatives in PA management.
3. A social vulnerability assessment of a community in the Delta du Saloum was carried out in collaboration with ENDA Energie, and adaptations action plans were developed.
4. The Niumi Biosphere Reserve management plan was reviewed and updated through the establishment of a taskforce to review the plan, with the aim of submitting it to UNESCO.

These activities were designed with and coordinated by the NLOs of The Gambia, Mr Famara Drammeh and Mr Momodou Suwareh, with the assistance of Mr Omar Ceesay.


Niumi National Park. ©Elise Belle

Gourma Elephant Reserve (Mali) and Sahel Partial Faunal Reserve (Burkina Faso)

1. The 'Agreement relative to the concerted management of shared natural resources between Mali and Burkina Faso', including protected areas, was finalized and signed.
2. A roadmap for a transboundary management plan that takes into account climate change impacts was elaborated, in order to implement the agreement, and the new METT was applied to both protected areas.
3. Support for social mobilisation in Mali was provided within the framework of the implementation of the transboundary agreement, through the engagement of the Management Organisations for Conservation Areas, notably in order to secure both elephant migration routes and communities resources.

Gourma Elephant reserve during the rainy season. ©Bourama Niagate

These activities were designed with and coordinated by the NLOs of Mali, Mrs Haidara Souhayata and Mr Zan Moussa Samaké.

Gola Rainforest National Park (Sierra Leone) and Gola National Park (Liberia)

1. Activities to operationalize the existing transboundary Memorandum of Understanding were undertaken through technical consultations with the Forestry Development Authorities of Liberia, the Forestry Division of Sierra Leone, Gola Rainforest National Park, the Conservation Society of Sierra Leone and other stakeholders. During these consultations, the different parties discussed future actions, including community consultations, land use planning and co-management options and the practical implementation of the agreement. The Transboundary Collaboration Agreement could not be signed, as the precondition of Gola National Park in Liberia being already gazetted was not met.
2. Transboundary chiefdom meetings were held with local communities to raise their awareness about the 2011 Mano River Union Agreement and the process leading to the Greater Gola Transboundary Peace Park creation.

These activities were designed with and coordinated by the NLO of Sierra Leone, Mrs Kate Garnett.

Gola Rainforest National Park, Sierra Leone. ©Elise Belle

Oti-Kéran-Mandouri (OKM) (Togo) and the WAP ('W', Arly, Pendjari) complex (Benin, Burkina Faso, and Niger)

Kéran River, Oti-Kéran National Park. ©Bora Masumbuko

1. Water points were set up to provide a place to water livestock, especially for the dry season, thereby avoiding cattle using similar wildlife transboundary migration corridors. This is especially important in the context of climate change which is likely to reduce water resources. Local populations were also mentored to reduce pressures on PAs by promoting the adaptation of existing agricultural systems to climate change.
2. A spatial study of migration corridors between the OKM and WAP complexes was undertaken, with a special focus on large mammal species, including elephants, and on the links between OKM and the Pendjari National Park.
3. An ecological monitoring system was set up for large mammal species within the OKM-WAP corridor, including elephants, and the new METT was applied to both PAs.
4. A legal study, including a draft agreement, was undertaken for the future development of a transboundary management agreement between OKM and WAP complexes.

These activities were designed with and coordinated by the NLO of Togo, Mr Kotchikpa Okoumassou.

Waterfall in Mount Klouto, Togo. ©Elise Belle

RECOMMENDATIONS FOR SPECIES MONITORING

Key findings:

Monitoring the impacts of climate change on species should be built upon existing monitoring systems, but should also consider additional factors specific to climate issues. Recommendations are provided for the monitoring of species at the five transboundary pilot sites, in particular for those considered vulnerable to climate change and/or globally threatened.

Recommendations for strategies to monitor the impacts of climate change on species at the five transboundary pilot sites were developed on the basis of consultations with national and international species experts.

Information is provided on a) the methods used to identify the species most vulnerable to climate change at both the regional and site scales, b) the importance of monitoring species in the context of climate change, and c) specific recommendations for species monitoring at the five transboundary pilot sites.

The impacts of climate change on biodiversity and the societies that depend on it are likely to be predominantly negative. Species may experience the following as a result of climate change: changes to their habitats or microhabitats, changes in environmental factors beyond tolerable thresholds, disruptions to important interspecific interactions, the emergence or increase of negative interspecific interactions, the disruption of important environmental cues or triggers, and increases in the frequency of local extinctions. Species that are sensitive and exposed to such changes might be expected to respond in one of two ways: (i) to disperse to areas where the environment is more suitable, or (ii) to adapt to change in situ. Species that are unable to respond in such a way (e.g., due to low genetic variability, low reproductive output, the presence of barriers that prevent dispersal and/or a low intrinsic capacity for dispersal) are those species that are considered vulnerable to climate change.

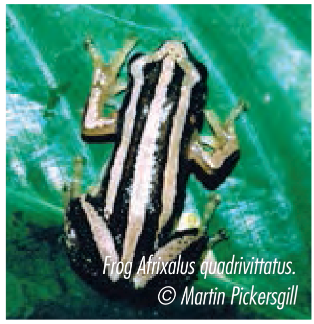
Biodiversity monitoring is widely conducted as a means to detect changes in natural systems and to assess the requirements and effectiveness of management actions. There is now an urgent need to monitor the impacts of climate change on species, so that managers may respond to this emerging threat in the most timely and effective manner. In many cases, **the monitoring of climate change impacts on species can and should be built upon existing monitoring schemes**, but certain additional considerations must be taken into account when developing a monitoring strategy to specifically look at climate change impacts:

1. It is essential to monitor over a long time period;
2. In addition to monitoring biodiversity, it is important to monitor the actual climate;
3. Any monitoring effort needs to set its objectives prior to developing the sampling protocol, as the former will greatly influence the latter;
4. When selecting the species (or species groups) for monitoring, the following questions should be asked: Is there already a monitoring scheme in place? Should I monitor one, several or many species? Are there any other factors at work that may disguise the impacts of climate change? Is my focal species sufficiently observable to detect a population trend?

Specific recommendations for species monitoring at the five transboundary pilot sites are summarized below.

Sena Oura National Park (Chad) and Boubba Ndjidda (Cameroon)

It is recommended to prioritize the monitoring of amphibian species, such as the frog *Afrixalus quadrivittatus*, reptiles such as the blue-tailed skink *Trachylepis quinquetaeniata*, bats (*Eidolon helvum, Hipposideros ruber* and *Lavia frons*) and freshwater fish (ray-finned fish *Brycinus nurse* and freshwater sole *Dagetichthys lakdoensis*), in combination with monitoring of climatic factors (temperature and precipitation), along with habitat availability and quality for these species.


Frog Afrixalus quadrivittatus. © Martin Pickersgill

Carr, J. 2015. Recommandations pour le suivi des espèces pour l'aire transfrontalière du Parc National de Sena Oura (Tchad) et du Parc National de Boubba Ndjidda (Cameroun). UNEP-WCMC technical report.


Manatee Trichechus manatus, image courtesy of the U.S. Geological Survey

Niumi National Park (The Gambia) and Delta du Saloum National Park (Senegal)

Several bird species should be monitored (such as the Eurasian oystercatcher *Haematopus ostralegus*, slender-billed gull *Larus genei*, and other common seabirds and waterbirds), as well as estuarine and freshwater fish communities (e.g., the African rivuline *Pronothobranchius kiyawensis*), amphibians, and mammal species, including the Vulnerable manatee *Trichechus senegalensis* and bat species (e.g., *Eidolon helvum, Hipposideros ruber, Lavia frons*). Climatic factors (temperature and precipitation) should also be monitored, in addition to the availability and quality of the species' habitats.

Carr, J. 2015. Species monitoring recommendations for the transboundary area of Niumi Saloum National Park (the Gambia) and Delta du Saloum National Park (Senegal). UNEP-WCMC technical report.

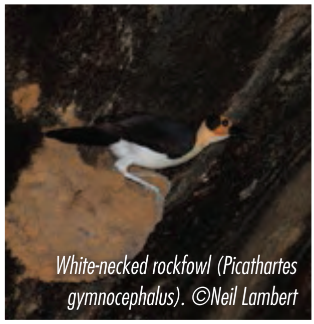
Gourma Elephant Reserve (Mali) and Sahel Partial Faunal Reserve (Burkina Faso)

A number of species should be monitored, including the Vulnerable black-crowned crane B*alearica Pavonina*, the ray-finned fish *Brycinus nurse* and catfish *Synodontis gobroni*, as well as large mammals such as the elephant *Loxodonta africana*; and the Vulnerable Dorcas gazelle *Gazella dorcas*, and small mammals such as the Nigerian gerbil *Gerbillus nigeriae* and bat species (*Eidolon helvum* and *Hipposideros ruber*). Monitoring should also incorporate data on climatic factors (temperature and precipitation) and on habitat availability and quality.


Black crowned crane Balearica Pavonina. ©Michael Gerber

Carr, J. 2015. Recommandations pour le suivi des espèces pour l'aire transfrontalière de la Réserve des éléphants (Mali) et de la Réserve partielle de faune du Sahel (Burkina Faso). UNEP-WCMC technical report.

Gola Rainforest National Park (Sierra Leone) and with Gola National Park (Liberia)



White-necked rockfowl (*Picathartes gymnocephalus*). ©Neil Lambert

Amphibian species (e.g., the Critically Endangered endemic toad *Amietophrynus taiensis* and the Endangered frog *Hylarana occidentalis*) would benefit from being monitored, as well as birds species (such as the Endangered Gola Malimbe *Malimbus ballmanni*, the brown-cheeked hornbill *Bycanistes cylindricus*, white-necked picathartes *Picathartes gymnocephalus*, Timneh parrot *Psittacus timneh* and Rufous fishing owl *Scotopelia ussheri,* all considered Vulnerable). Other species that require monitoring include large mammal species (such as the Vulnerable Diana monkey *Cercopithecus diana*, Endangered Jentink's duiker *Cephalophus jentinki* and Ogilby's duiker *Cephalophus agilbyi* among others), smaller mammals (e.g., the African dormouse *Graphiurus nagtglasii* and the African palm civet *Nandinia binotata*) and bat species (e.g., *Eidolon helvum*, *Hipposideros ruber, Miniopterus schreibersii*). This should be carried out in combination with monitoring of climatic factors (temperature and precipitation), the availability and quality of essential habitats and microhabitats, species harvest by humans and other climate change-driven trends.

Carr, J. 2015. Species monitoring recommendations for the transboundary area of Greater Gola Peace Park (Liberia and Sierra Leone). UNEP-WCMC technical report.

Dorcas gazelle *Gazella dorcas*. ©Frithjof Spangenberg

Oti-Kéran-Mandouri (OKM) (Togo) and the WAP (‘W’, Arly, Pendjari) complex (Benin, Burkina Faso, and Niger)

It is recommended to favor the monitoring of bird species such as the Vulnerable black-crowned crane *Balearica Pavonina*, the ray-finned fish *Brycinus nurse* and catfish *Synodontis gobroni*, large mammals including the elephant *Loxodonta africana*; and the Vulnerable Dorcas gazelle *Gazella dorcas*, small mammals such as the Nigerian gerbil *Gerbillus nigeriae* and bat species (*Eidolon helvum* and *Hipposideros ruber*). Climatic factors (temperature and precipitation) should also be monitored, as well as the availability and quality of the habitats for these species.

Carr, J. 2015. Recommandations pour le suivi des espèces pour l’aire transfrontalière du complexe Oti-Kéran-Mandouri (Togo) et du complexe WAP (‘W’, Arly, Pendjari) (Bénin, Burkina Faso, Niger). UNEP-WCMC technical report.

Regional and national capacity building

Many training workshops were held throughout the project lifetime in order to increase understanding of how climate change is likely to impact biodiversity and protected areas in the West Africa region.

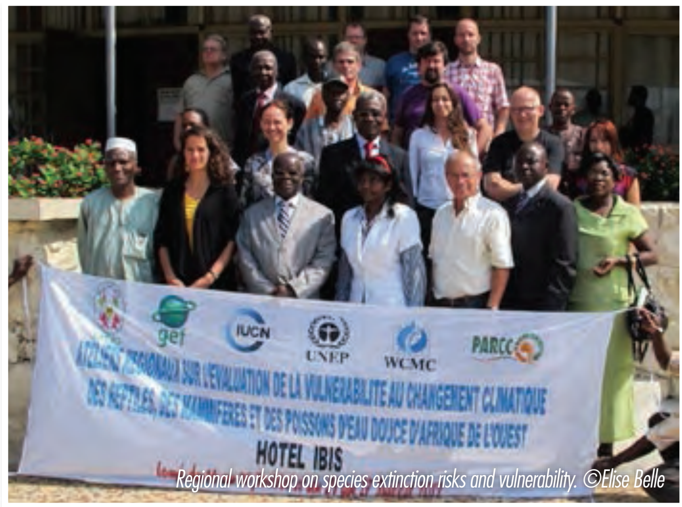
- **Regional inception meeting** (Banjul, The Gambia, March 2011): In addition to launching the project, initial training was provided at the meeting on a number of scientific topics, notably on protected areas and World Database on Protected Areas (WDPA), regional climate modelling and regional climate information, climate change adaptation and modelling climate change impacts on biodiversity, the role of conservation planning in assessing and mitigating climate change impacts on protected areas, and transboundary protected areas.

Project regional inception meeting. ©Charles Besancon

- **National inception meetings and data collection** (Ndjamena, Chad; Lomé, Togo, Bamako, Mali; Freetown, Sierra Leone; Banjul, The Gambia, December 2011): The national inception meetings held in each of the project countries also provided an opportunity for training a higher number of participants (from government, NGOs and universities) on topics associated with climate change and protected areas.
- **Regional training workshop on climate information to enhance the resilience of West African protected areas** (Freetown, Sierra Leone, April 2012): The aim of the workshop was to provide training to representatives of the Met Services from project countries, as well as other West African countries, in basic methods of analyzing climate data, and to promote the importance of weather and climate for biodiversity. A secondary aim was to explore mechanisms and identify best practice for the Met service of each country to enhance communication with protected area managers and ministries relating to wildlife, forestry and/or the environment.
- **Regional workshops on species extinction risks and climate change vulnerability** (Lomé, Togo, July 2012): The objective of the workshop was to gather national and international species experts on different taxa (reptiles, freshwater fish and mammals) to assess their climate change vulnerability based on their biological traits (as explained in the section above on Traits-based Vulnerability Assessments), as well as the extinction risk of reptiles (other taxa having already been assessed). Participants were taught the methodology and subsequently assessed the vulnerability of 317 reptile, 417 mammal and 550 freshwater fish species.

Regional workshop on climate information. ©Elise Belle

- **National training workshops on climate information and species vulnerability to climate change** (Freetown, Sierra Leone, and Banjul, The Gambia, April 2013; Lomé, Togo, November 2013): The main objective of these workshops was to build capacity on how to better link climate and climatic variability to the health of particular species populations. The specific objectives were to provide the participants with a better understanding of the results of climate models and species vulnerability assessments in their country, and the capacity to disseminate them; to build capacity to identify appropriate, species-specific, adaptive actions, and weigh up the pros, cons and possible barriers to their implementation; and to teach participants to develop risk assessments containing details of selected vulnerable species and their associated traits, climatic variables of importance, and possible adaptive responses.



Regional workshop on species extinction risks and vulnerability. ©Elise Belle

- **Regional training workshop on assessing the vulnerability of biodiversity and protected areas to the impacts of climate change** (Ouagadougou, Burkina Faso, July 2013): The main objective of the workshop was to build capacity on (i) Understanding the impacts of climate change on biodiversity and PAs, (ii) Carrying out vulnerability assessments and interpreting the results of species distribution models; and (iii) Planning and implementing adaptation actions.


Regional workshop on assessing the vulnerability of biodiversity and PAs. ©Elise Belle

- **Regional training workshop on systematic conservation planning** (Accra, Ghana, July 2014): The main objective of the workshop was to build capacity on systematic conservation planning, gap analysis and the identification of conservation priority areas. The workshop addressed the following question: Where should countries consider designating new PAs in the light of climate change and given global commitments to reach 17% terrestrial coverage? This involved looking at (i) What are the current PA systems protecting and which species are missing now and/or potentially in the future under climate change?, and (ii) What is the best way to fill those protection gaps? To ensure the relevance of the national conservation planning systems produced by the project, the training also included the following themes: principles of systematic conservation planning approach for identifying where to locate new PAs; the theory of gap analysis and how to set appropriate conservation targets; using the CLUZ and Marxan software to identify priority areas; and developing a data collection plan to ensure relevant information is collected for inclusion in the national systems.

- **National training workshops on systematic conservation planning** (Banjul, The Gambia, February 2015; Lomé, Togo, March 2015): The main objective of the meetings was to design national systematic conservation planning systems for each of the five project countries. Specific goals were for participants to (i) Understand the principles of systematic conservation planning; (ii) Gain a basic knowledge of how to undertake a gap analysis, set protection targets, and use Q-GIS, CLUZ and Marxan software; and (iii) Create draft national systematic conservation planning systems to be later refined based on the participants' feedback (see the final outputs presented in the section above).


Regional workshop on systematic conservation planning. ©Elise Belle

All the references relative to the training provided throughout the project can be found in the project training manual. The manual is available in both English and French and divided into six modules: 1. Protected Areas and the WDPA; 2. Climate data and scenarios; 3. The IUCN Red List of Threatened Species; 4. Species Vulnerability Traits; 5. Species Distribution Modelling; and 6. Conservation Planning.

UNEP-WCMC. 2015. PARCC project training manual. UNEP-WCMC technical report.


Pelicans in Djouj National Park, Senegal. ©Elise Belle

Elephants in Nazinga Game Reserve, Burkina Faso. ©Elise Belle

Adaptation strategies and policy recommendations

Strategies and policy recommendations were formulated on the best approach to managing protected areas in the region and for each project country. Existing protected areas and their management plans have been reviewed for each country, and in particular any reference related to climate change, as well as current plans to design and establish new protected areas. On this basis, regional and national strategies were developed for climate change mitigation and adaptation with regards to protected areas, and policy recommendations were formulated on ways and means to implement the strategy. This included ways to integrate recommendations in National Biodiversity Strategies and Action Plans (NBSAPs) of the Convention on Biological Diversity (CBD) and National Adaptation Programmes of Action (NAPAs) of the United Nations Framework on Climate Change (UNFCCC).

Below is a summary of the adaptation strategy and policy recommendations for the West Africa region and for the five project countries.

REGIONAL STRATEGY FOR WEST AFRICA

Key findings:

The regional strategy and policy recommendations have been developed to allow countries in the region to implement actions which contribute to the strategic goals of the national strategies of the five project countries. Notably, key conservation features that require protection at the regional level have been highlighted. Regional cooperation for the planning and management of PAs in the face of climate change is also recommended.

The regional strategy and policy recommendations were developed to serve as an authoritative point of reference and communication tool to ensure coherence in the implementation of the national strategies, as well as coordination and networking. These regional tools will facilitate (i) the harmonization in legislations and institutions (e.g., interoperability of clearing house mechanisms and data management), particularly for transboundary PAs; (ii) the mobilization of financial resources; (iii) the implementation of human and technological capacity building programmes; and (iv) reporting processes. Regional policy instruments will also have to be developed in response to needs identified in regional policy documents, such as the AMCEN draft Comprehensive African Strategy on Climate Change, or in the Programme of Work on Protected Areas (PoWPA) under the CBD, and in related decisions of the CBD Conference of the Parties.

Freetown Peninsula, Sierra Leone. ©Elise Belle

Elements of the regional strategy, which was validated in consultations held in seven countries (Burkina Faso, Chad, The Gambia, Ghana, Mali, Senegal and Togo) will:

a. Provide for countries in the region to implement **actions relative to the national strategies** under Strategic Goal 1 'Ensure that features identified for conservation when existing PAs were established are really protected to give them enough chances to adapt to the actual and future impact of climate perturbations' and Strategic Goal 2 'Design PAs in anticipation of the impact of climate change taking into account, in particular, the changes in species ranges in response to climate change and using the findings from the PARCC project';

b. Lead to the **identification of features that would require priority protection at the regional level**, and the determination of levels of protection that would enable each conservation feature to resist or remain resilient to climate change, as well as agreement on the contribution of each country taking into account its priorities and resources; and

c. Promote **regional cooperation for the planning and management of climate change resilient PAs**. Cooperative programmes should be developed around strengthening human capacities with support from regional banks and/or regional economic organizations. The strategy also encourages the harmonization of policies, legislations and institutions dealing with PAs (with some focus on transboundary PAs) and climate change matters, including clearing-house mechanisms, databases and stations collecting and analysing climate data.

The implementation of the regional strategy that describes the best approaches to the planning and management of PAs in the face of climate change will support mobilization of additional financial resources. These resources will support the implementation of the Programme of Work on Protected Areas, and related national plans of action, in which all the aspects of climate change impacts will be taken into account. It will also require wide consultation in the region including with organizations that could anchor the strategy and policy recommendations in their processes. Marine and coastal PAs, which could not be fully considered in the project, should be integrated in any future plans, as they are important for the sustainable development of some of countries in the region and can also be very vulnerable to climate change.


Shai Hills Resource Reserve, Ghana. ©Bora Masumbuko

Mulongoy, J. 2015. Regional strategy and policy recommendations for the planning and management of protected areas in the face of climate change. UNEP-WCMC technical report.

NATIONAL STRATEGIES AND POLICY RECOMMENDATIONS

Key findings:

The national strategies and policy recommendations have been developed to ensure the effective uptake and use of the project outputs by the countries. The proposed elements of the adaptation strategies for each country include three strategic goals and eleven objectives, and have been developed taking into account existing adaptation activities.

The five project countries (Chad, The Gambia, Mali, Sierra Leone and Togo) have a rich biodiversity which provides important services for the well-being of their populations. In order to protect this natural capital for present and future generations, these countries have established protected areas that cover 10.2%, 6.4%, 6.2%, 4.1% and 14% of their respective terrestrial national territories. However, these PAs are under significant pressure, largely from deforestation and over-harvesting, changing land-use patterns resulting in habitat degradation and fragmentation. Furthermore, it is increasingly recognized that climate change is exacerbating these pressure on PAs. Climatic disturbances can indeed make PAs unsuitable for the features that they are supposed to protect, particularly where protected species affected by climate change are moving outside PAs in search of more favourable climatic conditions.

Consideration of climate change is therefore essential to maintain PAs effectiveness in time and space. Before joining the PARCC project, these five countries had not yet taken into consideration the full range of current and future climate change impacts in their PA plans and programmes. The PARCC project achieved a number of goals for PA programmes in West Africa including (i) collating climate data and future climate change projections, (ii) modelling the expected future distributions of bird, mammal, and amphibian species, (iii) evaluating the vulnerability of species to climate change impacts, (iv) identifying areas resilient to climate change that would be beneficial to protect as climate refuges for flora and fauna, and (v) designing systematic conservation planning systems incorporating the information mentioned above. These systems allowed to carry out gap analyses of the representation of conservation features in existing PAs and the identification of priority areas for protection, i.e., where new PAs could be established, where existing PAs could be extended and where connectivity corridors could be established or restored.

The development of strategies and policy recommendations for each country is intended to ensure an effective uptake and use of the PARCC project outputs. Elements of the strategies and policy recommendations have been proposed for each of the pilot countries and discussed with national experts. These elements are based on the results and conclusions of the PARCC project and were articulated around the common points of the five countries, so as to facilitate their aggregation in a West African regional strategy.

The proposed elements of the adaptation strategies for each country include three strategic goals, eleven objectives, and depending on the country, 39 to 42 specific actions. The objectives and specific actions have been identified taking into account the ongoing or planned activities in the respective countries. The visions proposed for the national strategies are the same or part of the visions that countries have set in the context of their sustainable development plans or national biodiversity strategies. The objective is to ensure the integration of all aspects of the impact of climate change in PA planning and management.

Strategic goal 1 relates to strengthening ongoing conservation plans and programmes and their implementation so as to improve the performance of existing protected areas (PAs) and, except for Togo, relates to finalising the designation or regulation of areas identified as requiring protection including, as appropriate, currently unprotected important areas for birds and biodiversity, unclassified forests and Ramsar sites. Without protection today, the biodiversity elements that are threatened or vulnerable will have little or no chance to survive the impact of climate change. Rather than expanding its PA system, Togo decided to restore and secure 13 of its PAs (10.21% of the national territory), not only to ensure their effectiveness, but also to improve the living conditions of the populations dependent on these PAs. Implementation of this strategic goal will essentially require that existing and new PAs are made more effective, that the lists of features to be protected are revised, taking into account the sustainable development goals and the national strategies for poverty reduction, and that gap analyses using the new lists of conservation features are conducted.

Strategic goal 2 regards the anticipation of climate change impacts and the proactive response to ongoing and future environmental changes. This implies that knowledge about the observed and projected impact of climate change is increased, particularly at the local level; that areas naturally resilient to climate change and areas that will include the future geographical distribution of displaced species are managed effectively, restored if needed, and connected.

Strategic goal 3 addresses the creation or strengthening of the enabling environment for a successful implementation of national strategies. This includes the integration of elements of these strategies into wider strategies, plans and programmes. This relates particularly to the CBD NBSAPs, some of which are still being updated, and the NAPAs, expected for revision after the 21st meeting of the Conference of the Parties to the UNFCCC, and the national Sustainable Development Goals that the countries will soon develop. In addition, building on ongoing activities including the training activities initiated within the PARCC project, Strategic goal 3 contains provisions for integrating elements of Strategic goals 1 and 2 in countries' human, financial, institutional, legislative and technological capacity building programmes and communication, education, research and public awareness programmes. Mobilization of financial resources is a priority. Considering the cross-cutting nature of climate change, Strategic goal 3 emphasizes coordination and cooperation within the countries and the region, especially across borders through the transboundary PAs programmes.

Abuko Nature Reserve. ©Elise Belle

The main actors for actions under each strategic objective, as well as related policy recommendations, where appropriate, were identified mainly during the expert consultations. Ways and means for the implementation of the strategic elements, including the principles of national strategies, recommendations for a participatory planning and implementation, and the establishment of institutional frameworks for monitoring, evaluation and reporting, have been proposed.

For each project country: *Mulongoy, J. 2015. National strategy and policy recommendations for the planning and management of protected areas in the face of climate change. UNEP-WCMC technical report.*

Guidelines for PA managers in the face of climate change

Key findings:

In the face of climate change, PA managers will increasingly have to manage for change, rather than focus on maintaining existing systems. Key elements of management planning are to (i) review existing goals and objectives from a climate change perspective, in order to adopt forward-looking goals; (ii) assess vulnerability to climate change to identify and select adaptation actions; and (iii) build capacity for adaptation to climate change and monitor the effectiveness of actions.

Practical guidelines have been developed to present good practices and approaches to plan and manage protected areas in the face of climate change, with a focus on West Africa. They are primarily aimed at protected area managers and planners, but can also be useful to other stakeholders involved with the management of protected areas. This report adapted key elements of the IUCN WCPA Best Practice Protected Area Guidelines Series: 'Responding to Climate Change, Guidance for protected area managers and planners' (Gross et al., *in press*), which we complemented with examples and considerations specific to the West Africa region, drawing on the findings of the PARCC project.

PLANNING FOR CHANGE

In the face of climate change, **protected area managers will increasingly be challenged to manage for change rather than focus on conserving existing systems**. A key aspect of climate adaptation for PA management will be reviewing existing goals and objectives from a climate change perspective to adopt forward-looking, climate-informed goals. This involves taking into account the broader physical and institutional landscapes, broadening the temporal aspect of planning, emphasizing ecological and evolutionary processes, and dealing with uncertainty. Adaptation strategies will need to consider specific threats and needs of protected areas, and be capable of addressing the most relevant climate impacts. However, constraints such as competing demands or limited resources may prevent the development and implementation of stand-alone plans. Integrating climate considerations and adaptation into existing processes can help overcome these challenges and connect longer term-adaptation needs with short-term conservation challenges.

ASSESSING CLIMATE CHANGE VULNERABILITY

Climate vulnerability assessments provide the information needed to help identify adaptation options, including lists of important conservation targets, projections of key climate variables, and ecological consequences of changing climatic conditions. A number of approaches exist for assessing the vulnerability of species, habitats, ecosystems, biomes and human communities. Key decisions to be made include selecting the area, period, and the number and specific types of conservation targets to be assessed. A number of climate projections can be used that differ in geographical scale, climate variables, time resolution and methodology. Results from vulnerability assessments can help determine priorities by identifying those vulnerabilities that provide a critical link between conservation goals and adaptation actions. Criteria used to identify vulnerabilities vary with the goals of a protected area or planning process and may include: ecological significance, implications for other relevant societal values, magnitude, likelihood, reversibility or timing of impacts, as well as potential for successful adaptation. In this context, the results of the PARCC project are particularly useful, especially those from species distribution models that helped define expected species distribution under future climate change scenarios and traits-based vulnerability assessments that identified species vulnerable to climate change.

MANAGEMENT STRATEGIES

River Gambia National Park. ©Elise Belle

Identifying and selecting adaptation options can be done through a variety of techniques including brainstorming workshops and scenario planning. It usually involves a mix of topical experts, park managers and decision-makers, citizens or others with local knowledge. "No-regret actions" are actions that PA managers can undertake to be ready for climate change regardless of any chosen strategy and regardless of the extent of climate change the PA is likely to experience. These include: ensuring that management capacity is in place for effective management in a changing climate; making sure that there is institutional support for adaptive management; increasing knowledge and information of impacts and responses to a changing climate; increasing awareness and motivating action by others through improved communication; and engaging participants and partners in common solutions.

Best practices for adaptation at the PA system-level include expanding the PA network in ways that enhance species and ecosystem adaptation to climate change; planning for a mix of PA sizes in the system, but prioritizing for very large representative units; planning PAs that have high physiographic diversity; ensuring that the legal and regulatory framework allows park managers the flexibility to adapt to climate change; ensuring landscape and seascape permeability by retaining and/or enhancing linkages, corridors and connectivity and prioritizing the protection of large, intact systems; integrating PAs into surrounding landscapes so that there is joint planning and considerations for connectivity and transboundary wildlife, among others, as well as regularly reviewing PA boundaries to see if adjustment is necessary. The results of the connectivity assessment of the regional PA network as part of the PARCC project will also be particularly helpful in selecting which PAs and/or missing links between PAs are the most important to maintain, or strengthen, in order to enhance PA connectivity. Furthermore, the development of the West African systematic conservation planning system and the identification of priority areas for conservation will inform the design of new PAs in the region, taking into account climate change impacts on species distributions.

Finally, **strategies to consider at the protected area level** include (i) managing for existing conditions by enhancing ecological integrity and resilience where there is very low species turnover expected, and almost no species considered climate change vulnerable; (ii) actively managing to maintain specific ecological values where some turnover is expected but not very high, with only a few species vulnerable to climate change identified; (iii) managing for significant modifications to former ecological conditions where there is a high turnover, and a significant number of species expected to be affected by climate change; and (iv) moving to new ecological goals and managing a new ecosystem type where there is a very high species turnover, and very high number of species considered vulnerable to climate change. Data on expected species turnover within PAs have been compiled as part of the PARCC project, as well as the list of species considered as vulnerable to climate change, and will therefore support identification of the best management strategy. Another key element of management planning in the face of climate change is building capacity for adaptation to climate change. The PARCC project also contributed to building capacity at multiple institutional levels through a number of regional and national training workshops on the themes of protected areas and climate change.

MONITORING AND EVALUATION

Monitoring and evaluation (M&E) are the basis for identifying successful adaptation processes and management actions, and thus adaptive management. A well designed monitoring and evaluation programme shows how management actions address climate vulnerability, and measures how these actions contribute to adaptation. Good practice includes using established principles and supporting adaptive management, identifying how M&E will contribute to adaptation, anticipating and designing monitoring for change, and including adaptation-specific indicators in existing monitoring practices. The use of the revised Management Effectiveness Tracking Tool (METT), developed as part of the PARCC project, can help monitor how effectively climate change aspects are incorporated into PA design and management.

Misrachi M., and Belle E. 2016. Guidelines for protected area managers in the face of climate change in West Africa, Insights from the PARCC project. UNEP-WCMC technical report.

Waterfall in the Akwapim-Togo hills, Ghana. © Elise Belle

Integration of the project results into Protected Planet

Information on the project, including background information, the project structure, the partners involved and **the main outputs can be found at the following website: http://parcc.protectedplanet.net**. The seven issues of the PARCC newsletter can also be consulted on the website.

Furthermore, the results of the vulnerability assessments are available through the Protected Planet website at http://protectedplanet.net (Figure 21). Protected Planet is the online interface for the World Database on Protected Areas (WDPA), a joint project of UNEP and IUCN, and the most comprehensive global database on terrestrial and marine protected areas.

For each protected area in West Africa (over 2,000 in total), the results displayed include the following data:

- Number and percentage of species considered vulnerable to climate change,
- Expected species turnover for the PA by the time periods 2010-2039 and 2040-2069,
- List of species considered vulnerable to climate change, by taxonomic group (mammals, birds and amphibians), and
- List of species expected to gain or lose in climate suitability, also by taxonomic group.

The link to these results can be found either by accessing the project website mentioned above, or by searching for a specific West African protected area on the Protected Planet website or by consulting all the results for the West Africa region on http://parcc.protectedplanet.net/sites.

Figure 21. Example: Partial screenshot of the results of the vulnerability assessments for Gola Rainforest National Park (Sierra Leone).

LIST OF TECHNICAL REPORTS

References of reports which are available for multiple countries or sites contain a '/' sign to indicate the different reports in the series.

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The PARCC Vision

To provide the tools and build the capacity to create protected areas resilient to climate change, not only in West Africa, but in other African regions and beyond.

To learn more about the project, please visit the project website at **http://parcc.protectedplanet.net**

PARCC

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