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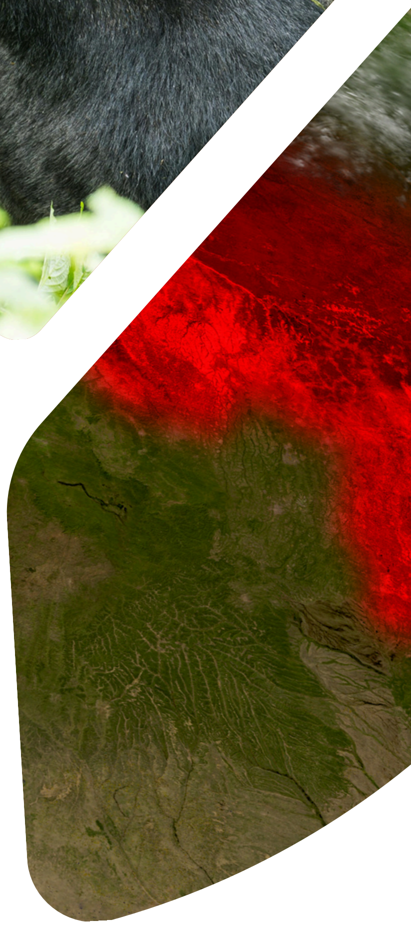

Climate analysis and policy reccomendations

On incorporating Climate Change Considerations into Integrated Land Use Management Plans in the Congo Basin

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Transformational Change in Sustainable Forest Management in Transboundary Landscapes of the Congo Basin Project

Climate Analysis and Policy Recommendations on Incorporating Climate Change Considerations into Integrated Land Use Management Plans in the Congo Basin

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EXECUTIVE SUMMARY

This climate and policy analysis is in support of the Transformational Change in Sustainable Forest Management in Transboundary Landscapes of the Congo Basin Project as part of the GEF 7 Congo Basin Sustainable Landscapes Programme. The analysis addresses Output 4.2.1: "Downscaled climate models including scenario planning developed for and applied to the priority landscapes [...] and recommendations for policy makers on how Integrated Land Use Management Plans (ILUMPs) can incorporate climate change considerations."

This analysis examines climate impacts in four critical transboundary landscapes in the Congo Basin— Campo Ma'an-Rio Campo, Monte Alén-Monts de Cristal, Sangha Tri-National, and Lac Télé-Lac Tumba—focusing on five key climate indicators: the annual number of dry days, extreme precipitation rate and frequency, heat (specifically as related to carbon stocks in tropical forests), and precipitation seasonality. Results show increasing dry periods, extended high heat conditions, and an intensification of precipitation seasonality and extreme precipitation.

Together, these changes threaten already endangered wildlife as well as the capacity of tropical forests to efficiently store carbon.

While the need to consider biodiversity, climate impacts, and land management are acknowledged in Congo Basin forest governance plans, they remain siloed by sector and secondary to a dominant land-conversion economic paradigm.

This report identifies strategic pathways for the integration of these priorities through binding cross-sectoral land use planning, fiscal reforms for stewardship, and the recognition of biodiversity as productive capital, and stronger links between rural livelihoods, ecosystems, and national growth strategies.

Despite widespread data gaps, ILUMPs play a critical enabling role in unlocking forest and landscape finance needed pursue these pathways and secure the long-term ecological integrity of the world's second-largest rainforest.

1. Introduction

This analysis focused on four transboundary landscapes in the Congo Basin: Campo Ma'an-Rio Campo (CMRC), Monte Alén-Monts de Cristal (MAMC), Sangha Tri-National (TNS), and Lac Télé-Lac Tumba (LTLT) (Figure 1). These landscapes span six countries— Cameroon, Central African Republic (CAR), the Democratic Republic of Congo (DRC), Equatorial Guinea, Gabon, and the Republic of Congo (RoC) —and a range of ecosystems, including grasslands, peatlands, and dense forests.

These remaining expanses of tropical forest are home to large forest mammals that are critical to ecosystem functioning, and many of which are threatened or endangered, including the African forest elephant and six of the seven great apes.

Despite their unique vulnerabilities, these landscapes share a number of threats from human activity, including logging, mining, illegal poaching, agriculture, and the downstream impacts from nearby infrastructure and development projects.

Figure 1. Map of the four transboundary landscapes: CMRC, MAMC, TNS, and LTLT.

Climate impacts compound existing human-induced pressures, and signs of climate change have already been observed in the Congo Basin. Multi-decadal observational records have shown an increase in average daily temperature ranging from 0.18 to 0.39 °C per decade (Beekman et al., 2025; Kasongo et al., 2023).

Significant trends in annual average precipitation have not been observed, but extreme precipitation rates and precipitation seasonality have both been found to intensify, leading to wetter wet seasons and longer and drier dry seasons (Jiang et al., 2019; Kasongo et al., 2023).

In recent years, extreme precipitation events have led to a number of devastating floods and landslide events, exacerbated by land use change and inadequate planning. The following section examines how these climate trends are projected to continue in the future.

2. Technical climate analysis

This analysis examined climate impacts on the four transboundary landscapes in the Congo Basin, focusing on five key climate indicators: the annual number of dry days, extreme precipitation rate and frequency, heat (specifically as related to carbon stocks in tropical forests), and precipitation seasonality. Additionally, we analyzed how precipitation seasonality differs within the MAMC and LTLT landscapes, focusing specifically on two localized protected areas within each landscape: Monte Alén National Park (MANP) and Monts de Cristal National Park (MCNP) within MAMC, and the Lac Télé Community Reserve (LTCR) and Tumba-Lediima Nature Reserve within LTLT.

Although coastal landscapes, such as CMRC, also face rising sea levels which threaten mangrove ecosystems, this analysis focuses on widespread climate impacts that are applicable to all landscapes within the geographic scope. The analysis looks into three 21-year time periods: "present"/recent past (2000-2020), and near-term (2020-2040) and mid-term (2040-2060) projections.

2.1. Dryness

Across the Congo Basin, the annual average number of dry days ranges from 100 to 250 at present (2000-2020) (Figure 2).

This range stays constant in the near-term (2020-2040), although specific locations within the region will see an additional 0 to 12 dry days on average each year (Figure 2). In the western subregion, CMRC and MAMC presently experience between 100 and 150 dry days each year, with that range increasing up to 10 additional days each year to 160 dry days (Figure 3).

In the eastern, inland subregion where dry conditions are more prevalent, TNS and LTLT presently experience between 160 and 200 dry days each year, with that range increasing up to 8 additional days each year to up to 210 dry days, with the most drying occurring in the southern portion of LTLT in the DRC (Figure 4).

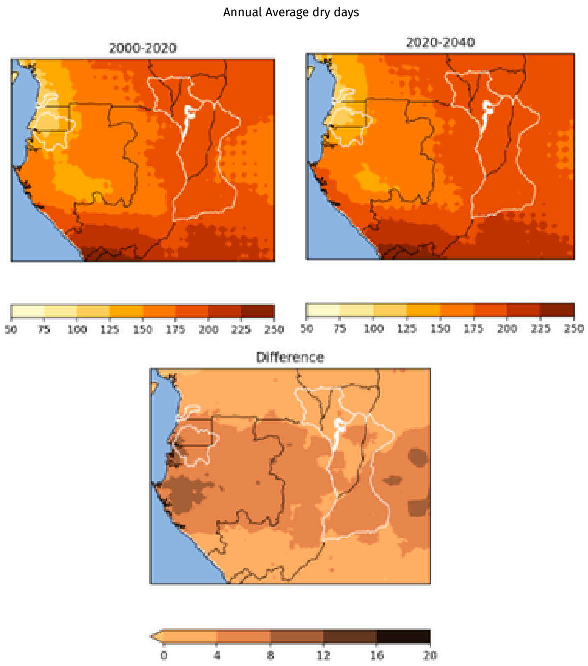

Figure 2. Annual average dry days in the Congo Basin in 2000-2020 (op left), 2020-2040 (top right), and the difference between the two periods (bottom).

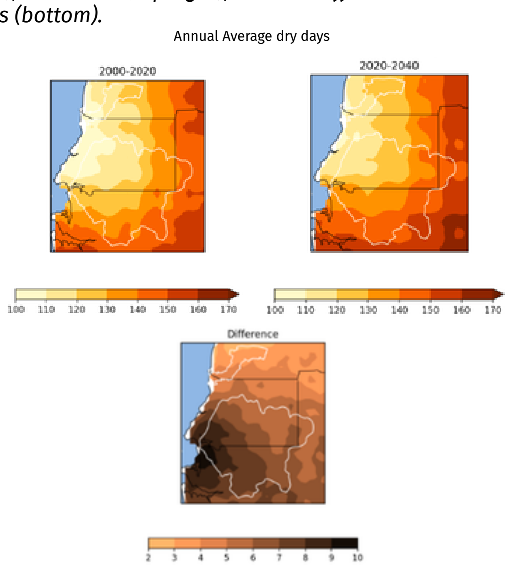

Figure 3. Annual average dry days in the western subregion in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

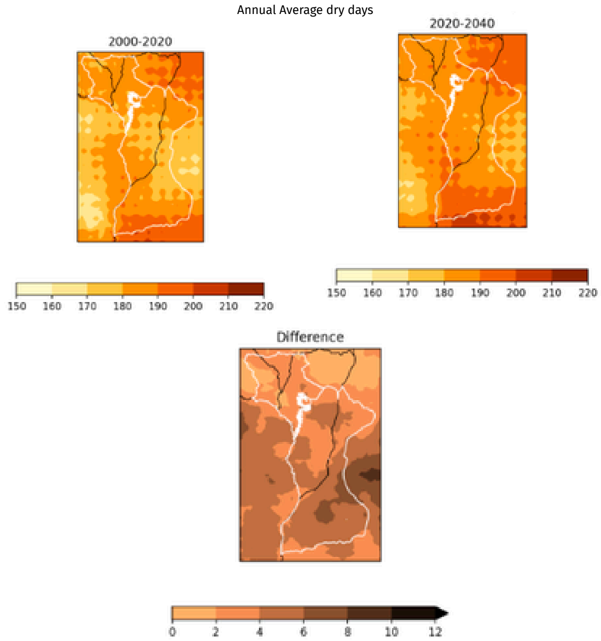

Figure 4. Annual average dry days in the eastern subregion in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

Looking forward to the mid-term (2040-2060) projections, the region will experience up to 20 additional dry days each year (Figure 5). In the western subregion, parts of CMRC and MAMC will see up to 18 additional dry days each year totaling up to 170 dry days (Figure 6). In the eastern subregion, parts of TNS and LTLT will see 15 or more additional dry days each year, totaling up to 210 dry days annually, with the largest change occurring in the southern portion of LTLT in the DRC (Figure 7).

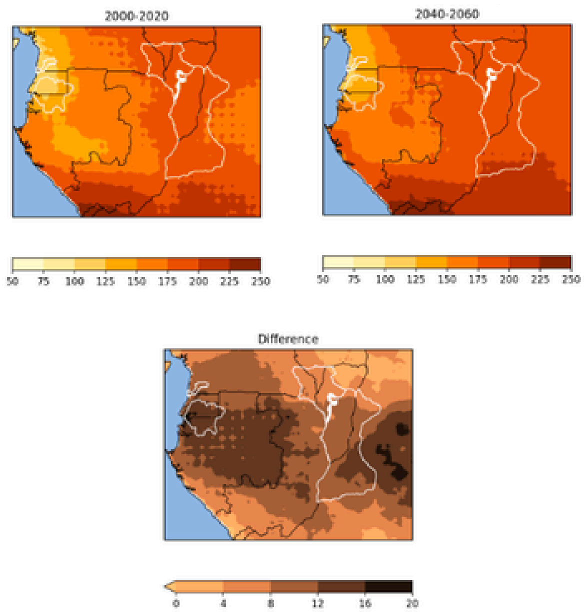

Figure 5. Annual average dry days in the Congo Basin in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

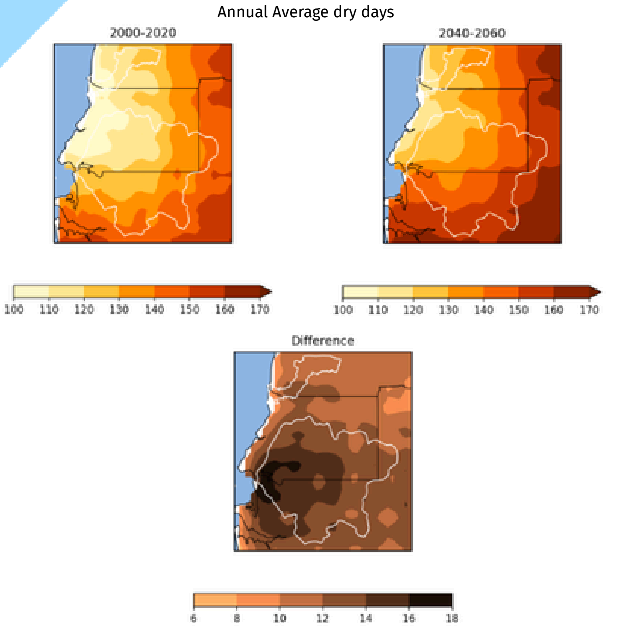

Figure 6. Annual average dry days in the western subregion in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

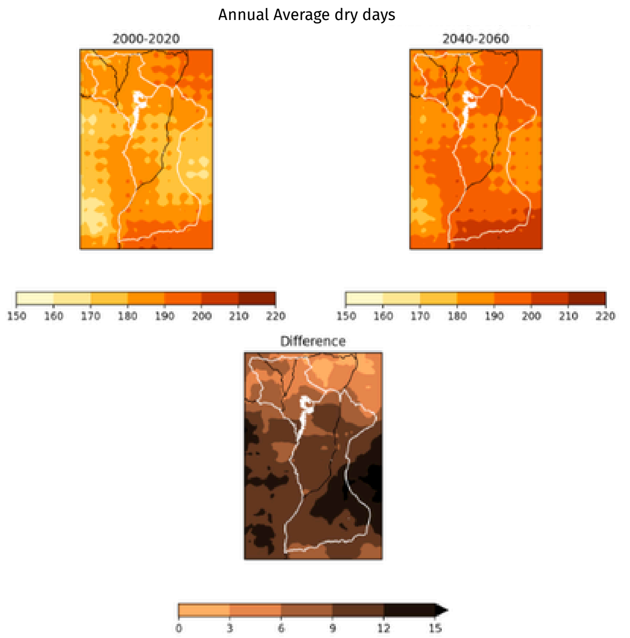

Figure 7. Annual average dry days in the eastern subregion in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

2.2. Heat

Not only does excessive heat impact human health, but it also impacts ecosystem health and the ability of forests to provide natural climate solutions. Here we examined the number of days over 32.2°C (referred to as "hot days")—the threshold above which the relationship between carbon stocks and maximum daily temperature became more negative (Sullivan et al., 2020). Across the Congo Basin, the annual average number of hot days ranges from 0 to 300 at present (2000-2020) (Figure 8).

In the near-term (2020-2040), some locations will see up to 60 additional hot days on average each year (Figure 9). In the western subregion, MAMC and CMRC presently experience between 0 and 150 hot days each year, with that range increasing by nearly 50 additional days each year (Figure 9). The eastern, inland subregion experiences more hot days on average, with most locations within TNS and LTLT presently experiencing between 100 and 150 hot days each year, with that range increasing between 24 and 50+ days; the most warming occurs in the southern portion of LTLT (Figure 10).

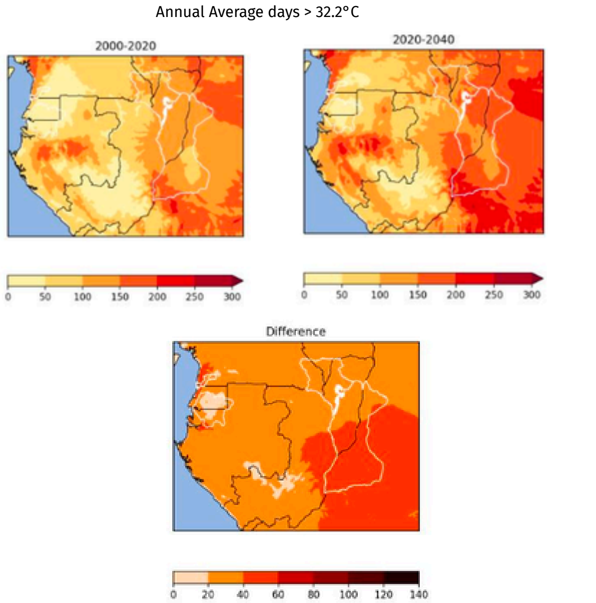

Figure 8. Annual average hot days in the Congo Basin in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

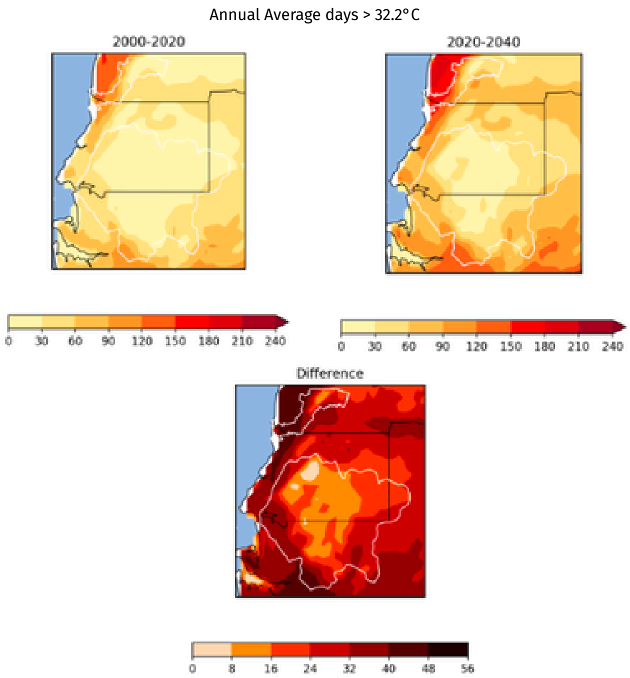

Figure 9. Annual average hot days in the western subregion in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

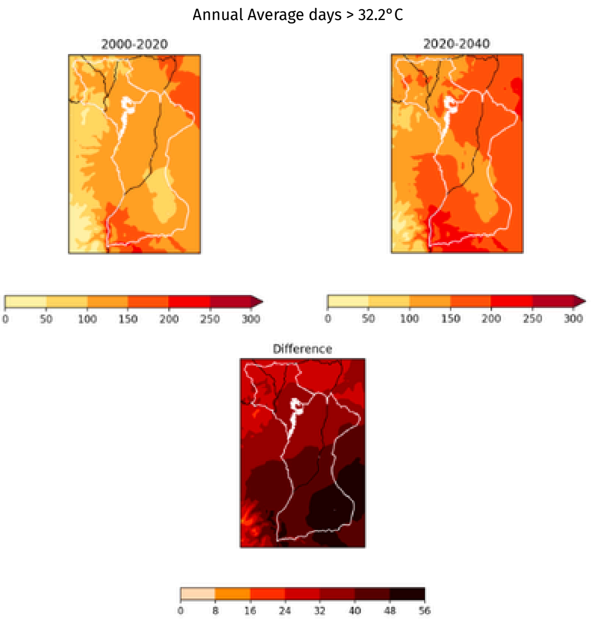

Figure 10. Annual average hot days in the eastern subregion in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

Looking forward to the mid-term (2040-2060) projections, the region will experience up to 140 additional hot days each year (Figure 11). In the western subregion, parts of CMRC and MAMC will see up to 120 additional hot days each year (Figure 12).

In the eastern subregion, the spatial pattern is not only stronger, but more uniform, with nearly all of TNS and LTLT projected to experience between 80 and 120 additional hot days each year, totaling up to 300 hot days annually in the southern portion of LTLC (Figure 13).

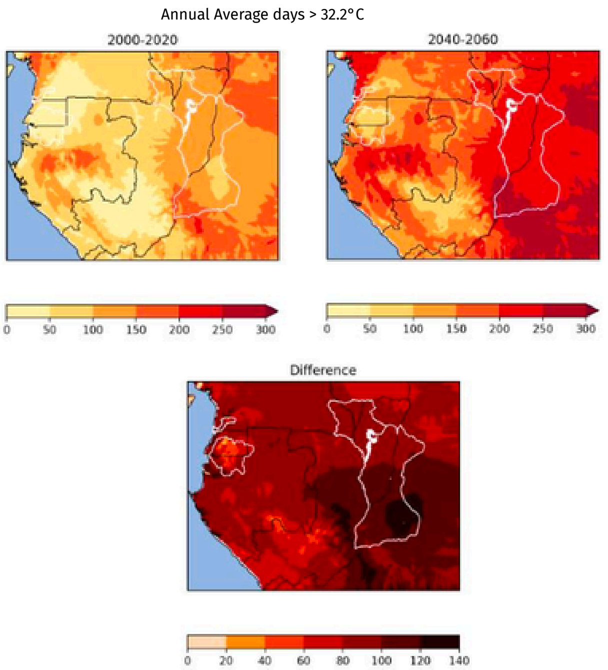

Figure 11. Annual average hot days in the Congo Basin in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

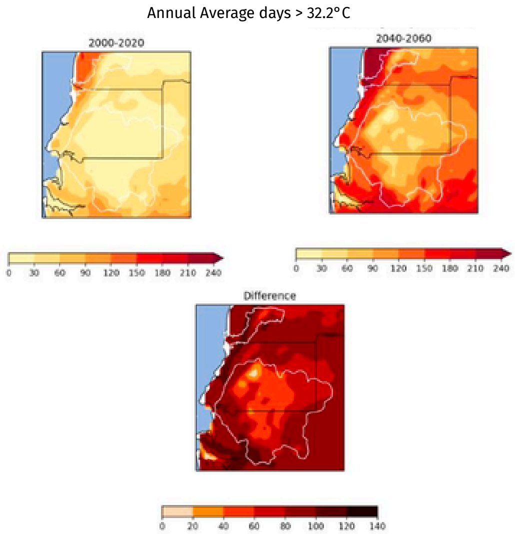

Figure 12. Annual average hot days in the western subregion in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

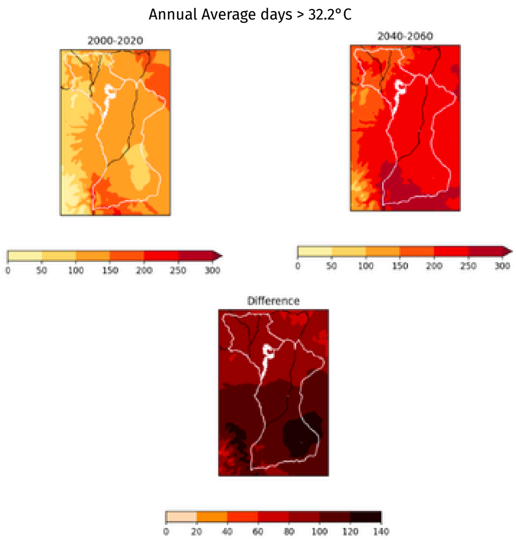

Figure 13. Annual average hot days in eastern subregion in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

2.3. Extreme precipitation intensity

Looking to the other end of the wet-dry spectrum, we analyzed the change in extreme precipitation by looking into changes in 95th percentile daily precipitation rates (mm/day). Across the Congo Basin, extreme precipitation rates range from 15 to 65 mm/day at present (2000-2020), with the heaviest precipitation rates concentrated in and around Gabon and Equatorial Guinea (Figure 14). This range stays mostly constant in the near-term (2020-2040), with extreme precipitation rates increasing by about 1 mm/day throughout most of the region, but by 2-3 mm/day around Gabon and Equatorial Guinea.

In the western subregion, MAMC and CMRC presently experience extreme precipitation rates between 20 and 40 mm/day, with that range increasing around 1-2 mm/day to up to 45 mm/day in the near-term (2020-2040) (Figure 15). In the eastern, drier, and more inland subregion, TNS and LTLT presently experience extreme precipitation rates between 12 and 18 mm/day, with that range increasing up to 1 mm/day (Figure 16).

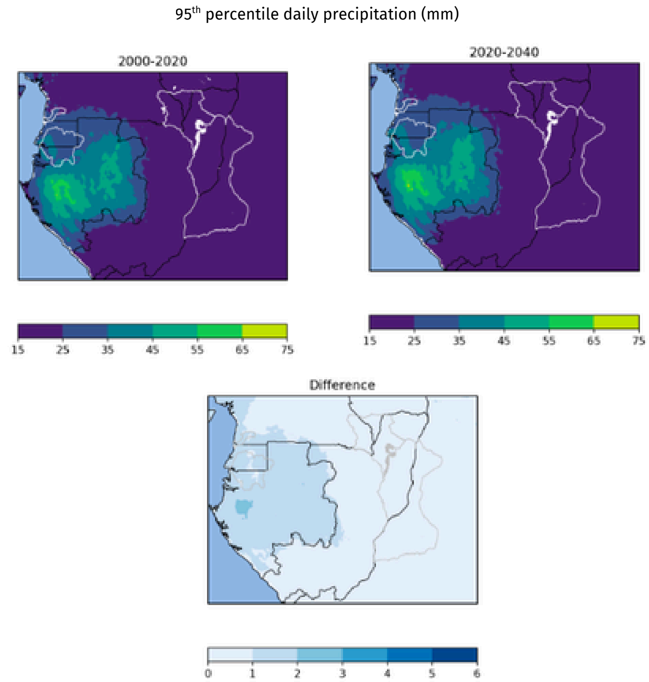

Figure 14. Extreme precipitation rates in the Congo Basin in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

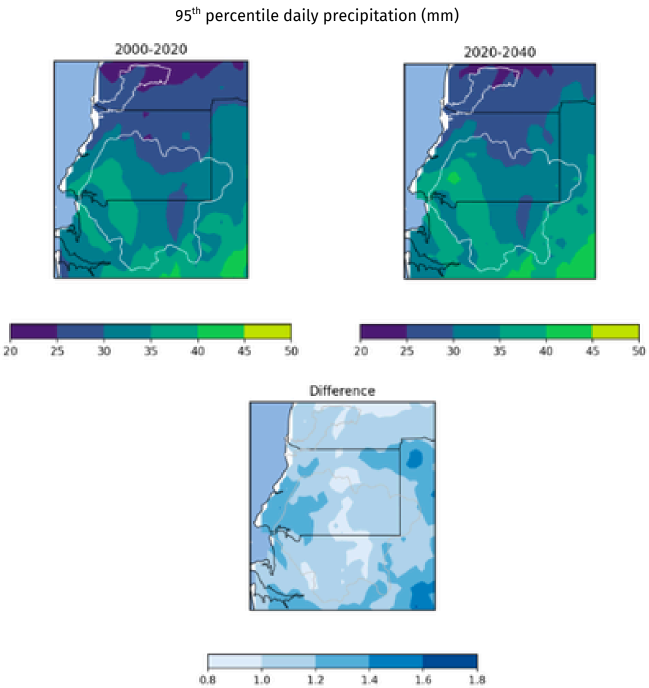

Figure 15. Extreme precipitation rates in the western subregion in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

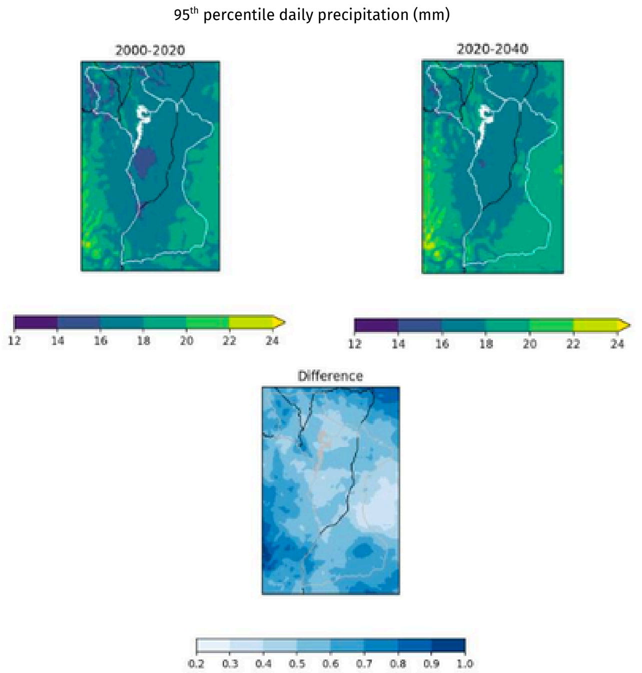

Figure 16. Extreme precipitation rates in the eastern subregion in 2000-2020 (top left), 2020-2040 (top right), and the difference between the two periods (bottom).

Looking forward to the mid-term (2040-2060) projections, the region will see extreme precipitation rates increase by up to 6 mm/day, with the largest increases occurring in Gabon and Equatorial Guinea (Figure 17). In the western subregion, parts of CMRC and MAMC will see extreme precipitation rates increase by up to 3 mm/day (Figure 18).

In the eastern subregion, parts of TNS and LTLT will see extreme precipitation rates increase by up to 1 mm/day to 22 mm/day (Figure 19).

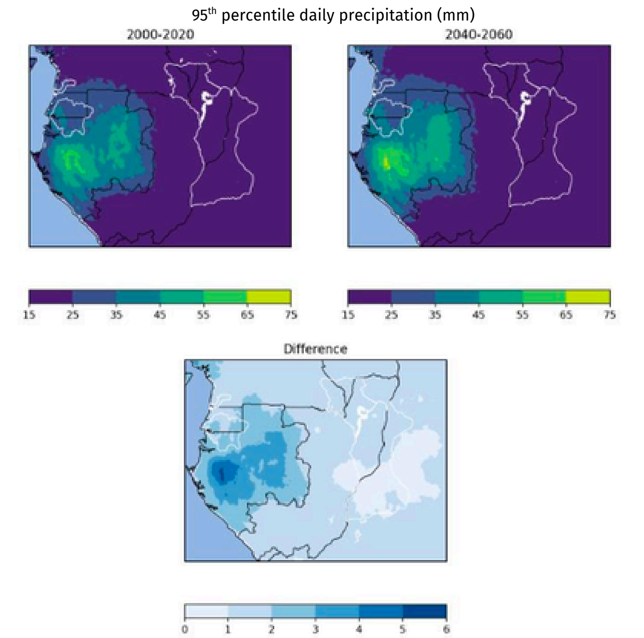

Figure 17. Extreme precipitation rates in the Congo Basin in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

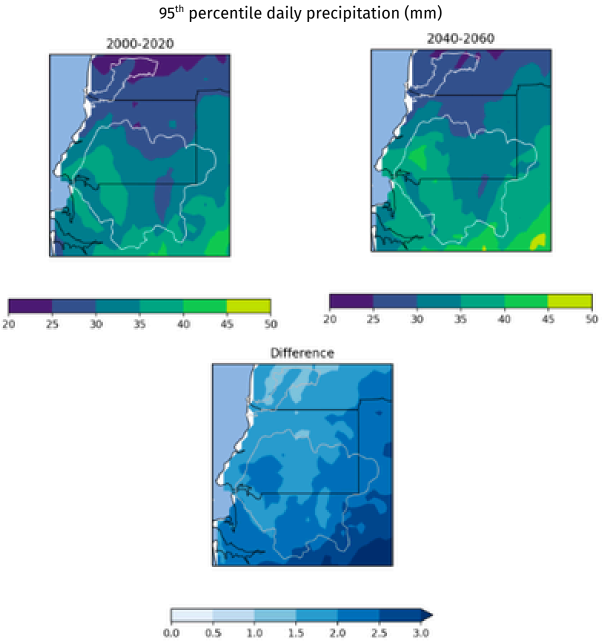

Figure 18. Extreme precipitation rates in the western subregion in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

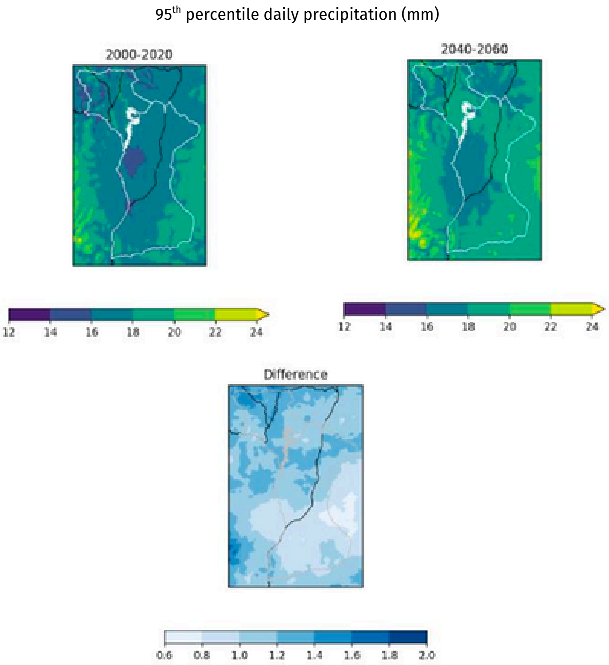

Figure 19. Extreme precipitation rates in the eastern subregion in 2000-2020 (top left), 2040-2060 (top right), and the difference between the two periods (bottom).

2.4. Extreme precipitation intensity

In addition to examining the change in extreme precipitation intensity, we can look into the change in extreme precipitation frequency. Here, we show the additional number of days with precipitation rates above the present-day 95th percentile (corresponding to approximately 18 days annually) precipitation rate.

No distinct spatial pattern is observed in the near-term. Most areas within the four priority landscapes will see up to 21 days annually with historically extreme precipitation rates; CMRC is the exception, with up to 22 days annually (Figure 20). In the mid-term projections, these numbers increase to up to 24 days each year in parts of TNS and LTLT, equating to an additional 5 days annually (Figure 21).

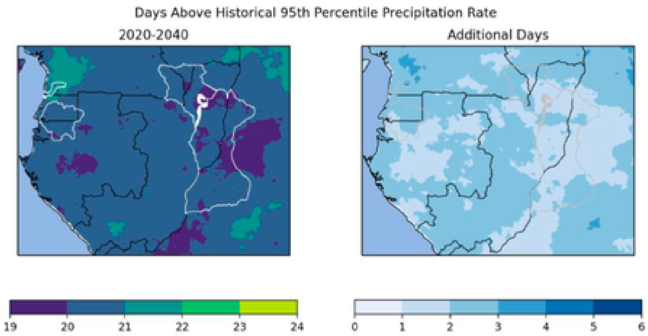

Figure 20. Days above the present-day 95th percentile precipitation rate (2020-2040) (left), and the additional days relative to the present period (right).

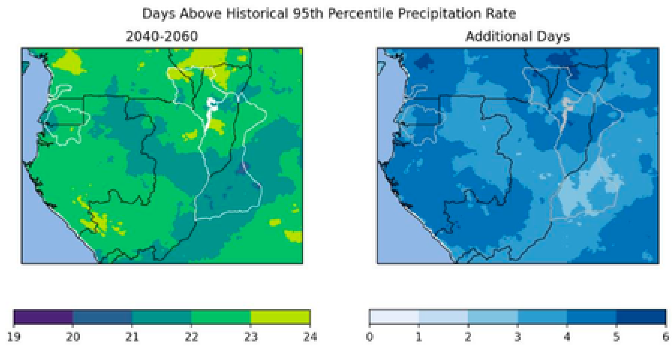

Figure 21. Days above the present-day 95th percentile precipitation rate (2040-2060) (left), and the additional days relative to the present period (right).

2.5. Precipitation seasonality

By considering precipitation seasonality in addition to the spatial distribution of dry days and extreme precipitation, we can gain a better understanding of how the temporal distribution of precipitation is changing. In this section, we investigated how monthly precipitation totals and daily precipitation rates change in each of the four transboundary landscapes due to climate forcings.

Additionally, for the MAMC and LTLT landscapes, we examined two distinct ecosystems within each landscape: Monte Alén National Park (MANP) in Equatorial Guinea and the Monts de Cristal National Park (MCNP) in Gabon; and the Lac Télé Community Reserve (LTCR) in the ROC and the Tumba-Lediima Nature Reserve (TLNR) in the DRC.

All landscapes are characterized by bimodal precipitation distributions, with two wet seasons (*approximately* March – May (MAM) and September – November (SON)) and two dry seasons (*approximately* December – February (DJF) and June – August (JJA)). Within each landscape, the two wet (and dry) seasons have distinct intensities.

The western landscapes of CMRC and MAMC receive the most rainfall and have the heaviest wet seasons. In CMRC, the two wet seasons peak in May and October (Figure 22); the SON wet season is the more intense of the two, with October precipitation totaling over 500 mm and increasing in the near- and mid-term projections.

April and May precipitation totals also increase in the early wet season, and there is a slight shift toward a later SON wet season, with September totals trending downward, and December totals trending upward (Figures 22 and 23).

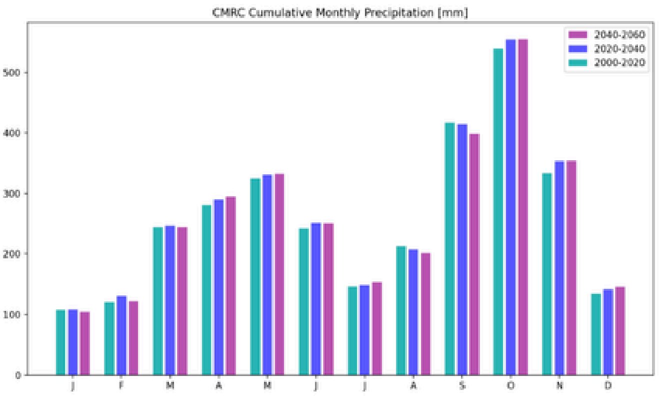

Figure 22. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in CMRC.

In MAMC, the two wet seasons are more prolonged, with heavy rainfall throughout the MAM season and both October and November (Figure 24).

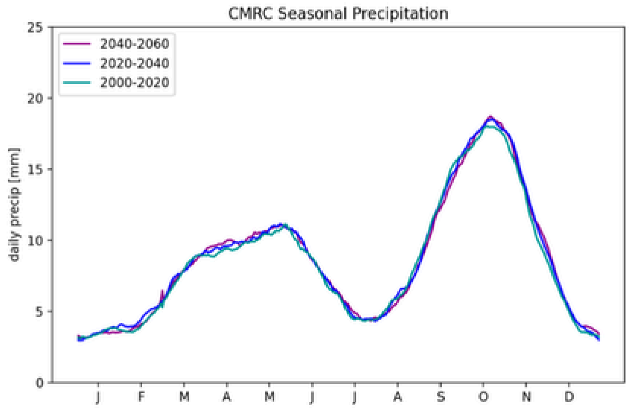

Figure 23. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020(green), 2020-2040 (blue), and 2040-2060 (purple) in CMRC.

The October-November wet season is the more intense of the two, with October and November precipitation totals near 600 mm; both months are projected to see a significant increase in cumulative precipitation in the future, although the MAM season is also projected to see more intense rain events (Figures 24 and 25). July is a notably dry month, and January is projected to become drier.

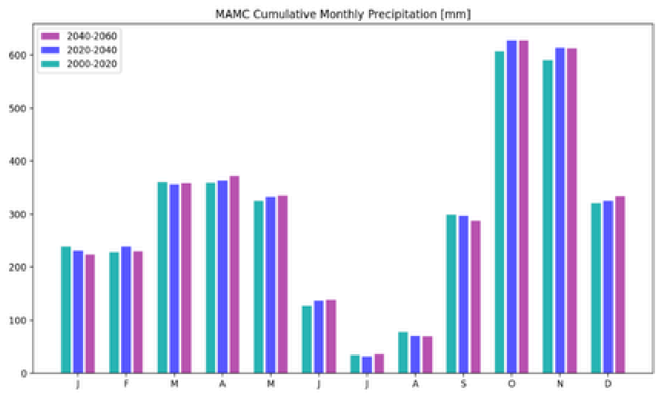

Figure 24. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in MAMC.

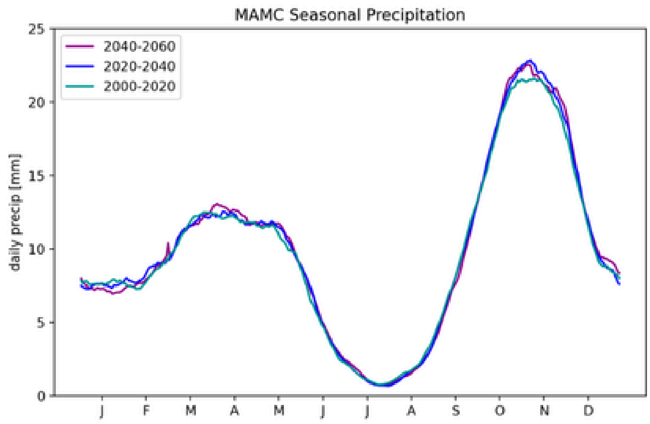

Figure 25. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in MAMC.

Comparing the two parks within MAMC, starting with the late wet season, MANP has a more pronounced peak of over 700 mm in October, whereas MCNP receives about 650 mm in both October and November (Figures 26 and 27). Both late wet seasons are projected to receive more rainfall, and December and January rainfall is projected to decrease (Figures 26-29).

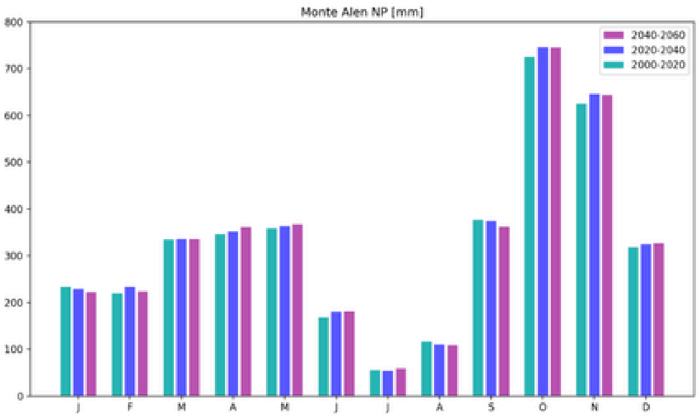

Figure 26. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in MANP.

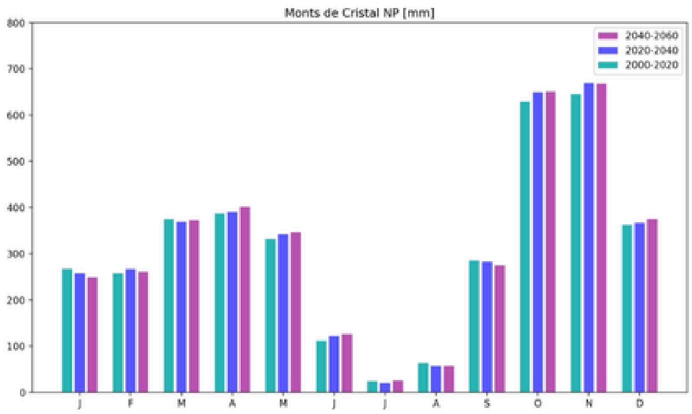

Figure 27. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in MCNP.

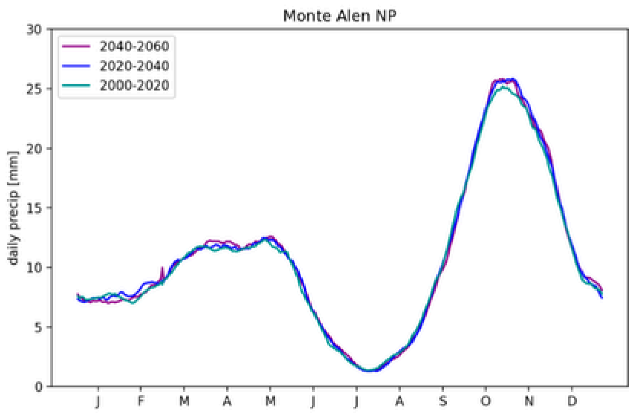

Figure 28. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in MANP.

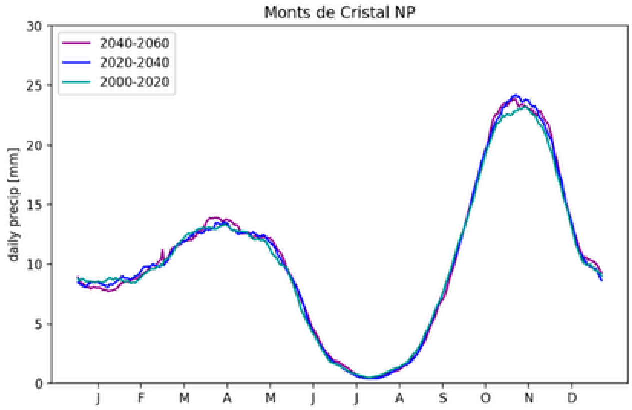

Figure 29. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in MCNP.

Moving inland, the two eastern landscapes of TNS and LTLT are noticeably drier, with the rainiest months receiving close to 200 mm of rainfall. As with the western landscapes, the late wet season is the heavier of the two, but the difference between the MAM and SON wet seasons is less pronounced. Additionally, the transition between wet and dry seasons is more impacted by climate change than in the western landscapes.

The wet seasons are less pronounced in TNS, with consistent rainfall from March through November (Figure 30). That said, there is a distinct broadening of the late wet season, with precipitation rates increasing in both August and December, as well as during the rainiest months of SON (Figure 31). Whereas rainfall is minimized in July and August in the western landscapes, the driest months are DJF in TNS (Figures 30 and 31).

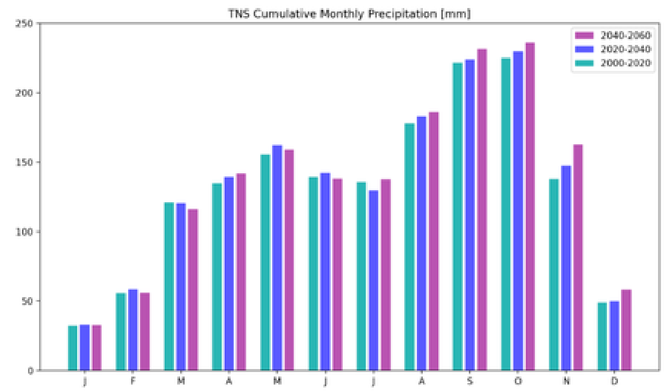

Figure 30. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in TNS.

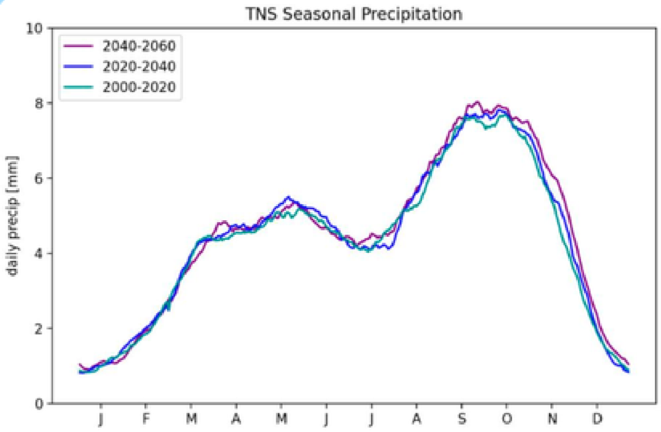

Figure 31. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in TNS.

LTLT has more distinct wet and dry seasons, with the driest months being JJA, and the wettest months being October and November (Figures 32 and 33). A noticeable increase in precipitation is projected in both November and December, with more variable changes—and many months projected to receive less precipitation—throughout the rest of the year.

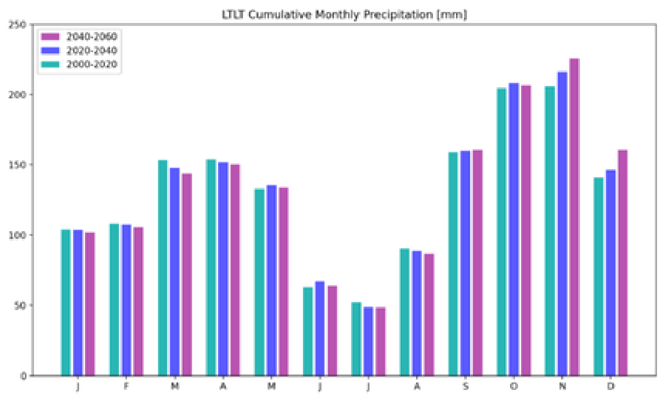

Figure 32. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in LTLT.

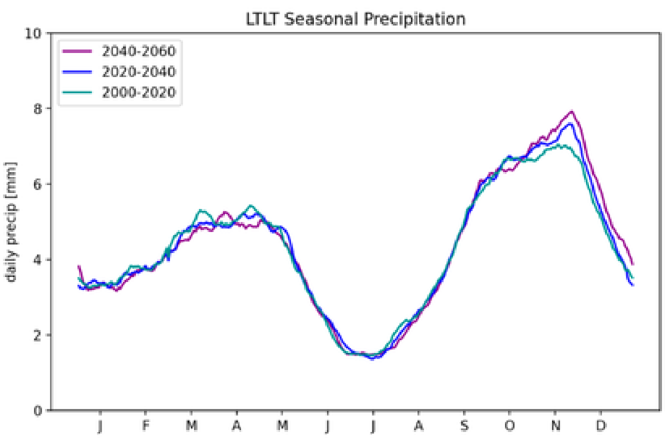

Figure 33. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in LTLT.

Comparing the two parks within LTLT, the seasonal precipitation pattern of LTCR more closely mirrors that of TNS, with relatively uniform precipitation falling most months, except for the driest months of DJF. The most noticeable trend is an increase in late-year precipitation rates, from September through December (Figures 34 and 35). Moving south, TLNR experiences more distinct wet and dry seasons, with the most precipitation falling September through December, and the least JJA (Figures 36 and 37).

As is also reflected in LTLT as a whole, a noticeable increase in precipitation is projected in both November and December, with many reductions in precipitation projected throughout the rest of the year.

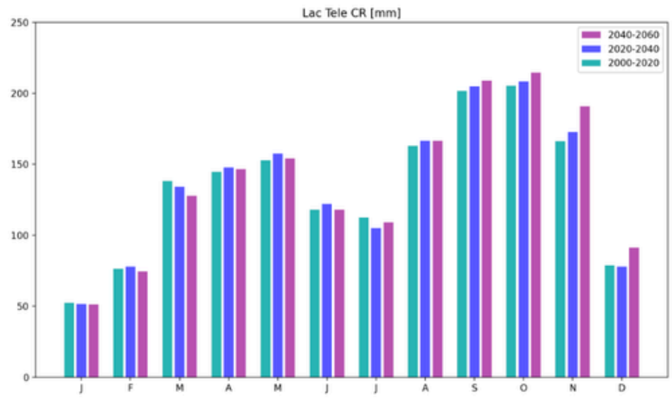

Figure 34. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in LTCR.

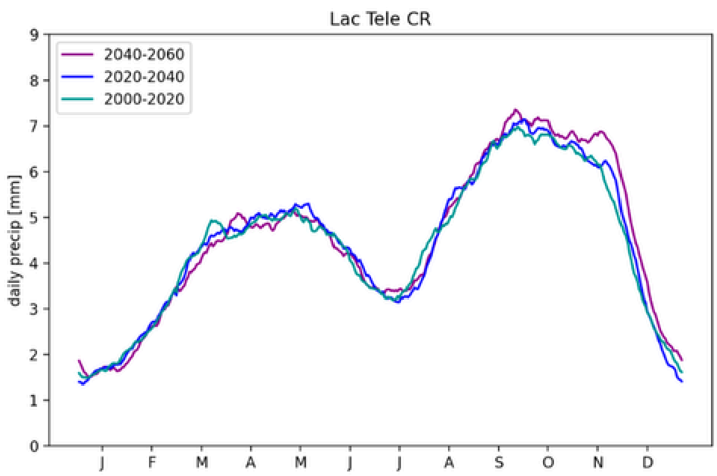

Figure 35. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in LTCR.

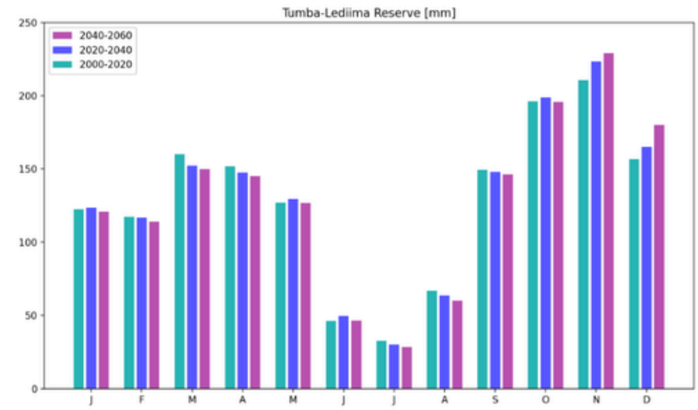

Figure 36. Cumulative monthly average precipitation for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in TLNR.

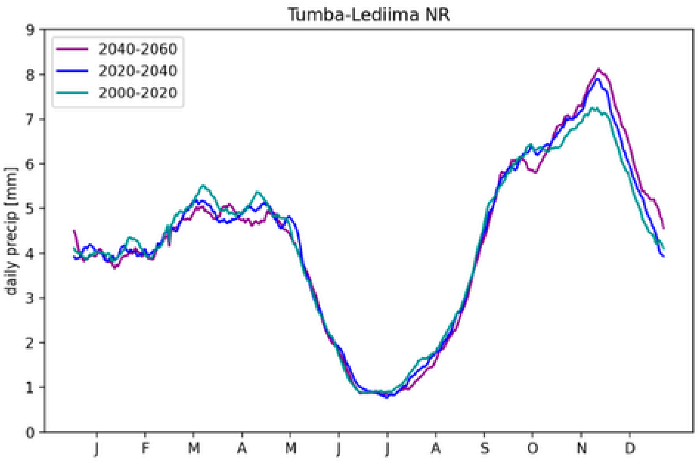

Figure 37. Daily average precipitation rate (10-day running mean) for three periods: 2000-2020 (green), 2020-2040 (blue), and 2040-2060 (purple) in TLNR.

2.6. Climate change implications

Taken together, these changes in temperature and precipitation have significant impacts on the forests, wildlife, and people in the Congo Basin.

a. Impacts on Forest Health and Carbon Storage

LTLT shows the greatest magnitude in the change in the number of days above 32.2°C and the most geographically widespread change. Maximum daily temperature has been identified as the most important predictor of aboveground biomass in tropical forests, with a maximum daily temperature of 32.2°C as a threshold for steep reductions in tropical forest carbon stocks; below 32.2 °C, carbon stocks decreased with temperature at a rate of -3.8% per °C, but warmer thanthis threshold, that rate jumped to -14.7% per °C (Sullivan et al., 2020). A higher threshold of 46.7 °C has been found as the critical temperature beyond which photosynthesis begins to fail in tropical forests, but these two thresholds can be considered to apply to distinct circumstances of acute and chronic conditions (Doughty et al., 2023). A shift to a regime of sustained extreme heat (i.e., an additional 100 days above 32.2 °C) could trigger a rapid decline the capacity of tropical forests to store carbon.

Of course, these impacts may be offset by growth stimulation from CO2 fertilization and other physiological adaptations, but the risk remains that as the Congo Basin warms, the ability of its tropical forests to act as a global carbon sink is compromised.

b. Impacts on Forest Health and Carbon Storage

Fruit tree yields, a critical food source for large forest mammals, have been in decline for decades and have been linked to changes in temperature and precipitation. This “fruit collapse” has been observed in Lopé National Park (Gabon), evidenced as an 80% reduction in fruit production from a range of fruiting trees (Bush et al., 2020). This reduction in yield and biodiversity has profound impacts on forest megafauna; while some primates will shift their diets, others (namely chimpanzees) do not show dietary flexibility. Additionally, in recent decades, an observed 11% reduction in forest elephant body mass has been linked to precipitation decline and a reduction of fruiting events (Bush et al., 2020).

Similar reductions in forest fruits, fish, birds, and elephants have been observed in the LTCR and linked to rising temperatures (Beekman et al., 2025). Not only do declining food resources impact endangered species like gorillas and forest elephants, but they impact people as well, forcing them to shift agricultural calendars and increase hunting frequency, putting additional pressures on already vulnerable wildlife species (Beekman et al., 2025).

3. Regional policy context

The Congo Basin and Guinean Forests, home to the world’s second-largest tropical rainforest and globally significant biodiversity, form a critical ecological buffer against accelerating climate change.

Yet these ecosystems face rising temperatures, shifting rainfall regimes, more intense droughts, and increased fire risk—threatening species, water systems, peatlands, and livelihoods. Regional and national policy frameworks already exist to manage forests and biodiversity, but they were largely conceived before the full scale and speed of current climate shifts were understood.5 At the regional level, the Central African Forest Commission (COMIFAC) provides the foundational governance structure for forest and biodiversity policy through its Convergence Plan, emphasizing sustainable forest management, biodiversity conservation, climate mitigation, and community participation. Climate risks—such as increased tree mortality, fires, and disrupted carbon cycles—now challenge the effectiveness of these pillars, requiring updated guidance on climate-responsive management and monitoring.

All Central African countries have REDD+ strategies, which seek to reduce emissions from deforestation and enhance carbon sinks. Climate change affects these strategies by altering forest carbon dynamics, increasing fire risk, and transforming agricultural frontiers. National Biodiversity Strategy and Action Plans (NBSAPs) in Central Africa increasingly acknowledge climate-related threats, but the depth and quality of integration vary widely. Earlier, first-generation NBSAPs—particularly those developed before 2010—tend to focus on direct pressures such as deforestation, hunting, and land use change, with limited or implicit treatment of climate change. More recent revisions, especially in countries such as Cameroon, the Democratic Republic of Congo, and the Republic of Congo, explicitly recognize climate change as a cross-cutting driver of biodiversity loss and, in some cases, promote ecosystem-based adaptation and climate-resilient management approaches.

However, the empirical foundation of these plans remains uneven. While most NBSAPs draw on national biodiversity inventories, sectoral studies, and stakeholder consultations, they frequently acknowledge major data gaps, particularly regarding long-term ecological monitoring and climate–biodiversity linkages.

As a result, climate considerations are often conceptual rather than quantitatively grounded. Overall, Central African NBSAPs show growing awareness of climate risks, but their effectiveness is constrained by limited empirical evidence and weak monitoring systems.

Continental frameworks, such as the African Union’s Agenda 2063 and the African Forest Landscape Restoration Initiative (AFR100), reinforce commitments to ecosystem restoration, resilience, and sustainable land management.

Globally, Central African states participate in the Paris Agreement, the Convention on Biological Diversity (and its Kunming-Montreal Global Biodiversity Framework), RAMSAR, and theConvention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), each of which now emphasizes climate-linked biodiversity vulnerabilities. Despite this comprehensive policy architecture, climate change considerations remain insufficiently embedded in ILUMPs, leaving countries poorly prepared for the ecological transformations now underway.

The state of the science, critical to ILUMP developments, is reviewed in the Science Panel for the Congo Basin (SPCB) assessment report (White et al., 2025). The SPCB identifies a set of structural data limitations that directly constrain the preparation of Integrated Landscape Land Use4 Management Plans (ILUMPs), not because planning is impossible, but because it must be undertaken under persistent uncertainty. At the most basic level, spatial baseline data remain incomplete and uneven. Land use and land-cover maps are often outdated, inconsistent in resolution, and weak at distinguishing intact forests from degraded or selectively logged areas.

As a result, ILUMP zoning decisions frequently rely on coarse proxies rather than robust condition assessments.

Beyond extent mapping, the SPCB highlights major gaps in ecosystem condition data. Long-term ecological monitoring is sparse, soil and hydrological data are limited, and linkages between remote sensing and field observations are weak.

These shortcomings are particularly acute for peatlands, where incomplete extent mapping, poor hydrological data, and limited understanding of degradation thresholds pose serious risks for land use decisions with potentially irreversible consequences.

Climate-related data gaps further complicate ILUMP preparation. Sparse meteorological networks and high uncertainty in downscaled climate projections limit the ability to anticipate future rainfall patterns, forest–savanna transitions, and climate impacts on agriculture and livelihoods. Since the late 1980s, the number of operational weather and hydrological stations has fallen nearly fivefold, leaving the Congo Basin among the least gauged regions globally, and one of only two regions in the world with observational data so limited that a trend in hot extremes could not be determined in the most recent Intergovernmental Panel on Climate Change (IPCC) Assessment Report (Beekman, 2025; IPCC, 2021; Washington et al., 2013).

Consequently, climate integration in ILUMPs must be directional and precautionary rather than predictive. Socio-economic and governance data gaps are equally significant. Customary land tenure is poorly mapped, informal livelihoods are under-documented, and overlaps between legal concessions and community lands are widespread, undermining conflict-sensitive zoning.

Biodiversity data are biased toward protected areas, leaving large portions of the Basin under-surveyed. Across all themes, the SPCB frames these issues as symptoms of chronic underinvestment in regional science, requiring ILUMPs to be adaptive, transparent about uncertainty, and grounded in both scientific and local knowledge.

Strengthening data governance and management at regional (e.g., l'Observatoire des forêts d'Afrique centrale (OFAC)) and state (e.g., national institutes of statistics and other national research and data collection and management agencies) levels is essential to support credible and investible ILUMPs.

This requires establishing clear institutional mandates for data stewardship, harmonizing land use, forest, climate, and socio-economic datasets across sectors, and adopting common data standards for spatial resolution, metadata, transparency, and update cycles.
Alignment with internationally recognized standards— such as SEEA-EA for ecosystem accounting, IPCC and UNFCCC guidance for land and carbon data, and safeguards frameworks for Indigenous and local rights—enhances consistency and credibility. Certification and verification systems (e.g., jurisdictional REDD+ standards, third-party monitoring, reporting, and verification (MRV) audits) further build confidence, enabling comparability, accountability, and access to results-based finance and private investment.

4. Pathways to integrating climate risk in policy management

Biodiversity and land management are partially but unevenly integrated into national development plans in the Congo Basin. They are usually acknowledged rhetorically, incorporated sector-by-sector, and treated as enablers of growth, but they are not yet structurally embedded in the core economic and poverty-alleviation models that guide public investment and macroeconomic decision-making.
While biodiversity and land management are recognized, they are not yet internalized in Central African development models. Economic growth and poverty alleviation strategies still operate largely on a land-conversion paradigm.

Meaningful integration will require:

a. Binding, cross-sectoral land use planning

b. Fiscal reforms that reward forest stewardship

c. Recognition of biodiversity as productive capital

d. Stronger links between rural livelihoods, ecosystems, and national growth strategies

4.1 Binding, cross-sectoral land use planning

a. Climate-responsive spatial planning and zoning

Governments should integrate climate hazard projections—including heat stress, floodplain mapping, drought likelihood, and wildfire risk—into all land use classifications. Climate-sensitive ecosystems such as peatlands (LTLT), mangroves (CMRC), montane forests (MAMC), and riparian corridors (TNS) should receive upgraded conservation or restricted-use status.
Zoning should become dynamic, allowing boundaries and land use categories to evolve with changing climate conditions.

b. Strengthening protected areas and ecological corridors

Protected areas must be redesigned to anticipate climate-driven species movements and protect critical habitats for elephants, gorillas, and endemic species. Mapping climate refugia, identifying future migration pathways, and establishing ecological corridors — particularly transboundary corridors across Cameroon– CAR–DRC–ROC and Gabon–Equatorial Guinea — will enhance biodiversity resilience and will support CBD 30x30 targets. A particular challenge Will be the coordination of ILUMP in critical transboundary landscapes (including Tri-national Dja-Odzala-Minkébé (TRIDOM)). Coordinating ILUMPs in transnational landscapes presents complex challenges that reflect differences in governance, law, capacity, and political priorities across national borders. Because land use planning and natural resource management are sovereign functions, neighboring countries often pursue distinct development pathways, legal frameworks, and institutional arrangements. Aligning ILUMPs therefore depends on voluntary cooperation, which can be constrained by competing economic interests, security concerns, or uneven political commitment.

Legal and policy fragmentation further complicates coordination. Climate, forestry, wildlife, mining, and land tenure regulations frequently differ between countries, resulting in inconsistent rules for conservation, enforcement, and land allocation within shared ecosystems such as forest corridors, peatlands, and river basins. These differences make it difficult to apply harmonized zoning, safeguards, and management standards across borders.

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Data and monitoring challenges are equally significant. Countries often rely on different data standards, classifications, and monitoring systems, and sensitivities around sharing concession, land tenure, or security-related information can limit transparency. This undermines the development of shared baselines, joint monitoring, and coordinated reporting needed for effective transboundary planning.

Capacity and financing asymmetries also shape outcomes. Neighboring states may have unequal access to technical expertise, institutional capacity, and finance, increasing the risk of uneven implementation and benefit distribution. These challenges are amplified by social complexity, as Indigenous Peoples and local communities frequently span borders but experience different levels of legal recognition and participation. Finally, sustaining coordination requires durable regional platforms, long-term financing, and conflict-resolution mechanisms—elements that are often lacking, leaving transnational ILUMPs vulnerable to fragmentation and short-term project cycles.

4.2. **Fiscal reforms that reward forest stewardship**

Fiscal reforms are most effective when they shift incentives across the entire economy —making forest conservation and sustainable land use the financially rational choice for governments, communities, and investors —while being spatially guided and monitored through ILUMPs.

a. Climate-smart forestry, REDD+, and restoration as fiscal foundations

Forest management plans must incorporate projections of changing species productivity, carbon storage patterns, and drought tolerance. REDD+ baselines and MRV systems should be updated to reflect climate-driven changes in biomass and emissions patterns, particularly considering the impacts of extended heat (above 32.2 °C) on aboveground biomass in tropical forests.

Restoration efforts under the African Forest Landscape Restoration Initiative (AFR100) must prioritize mixed-species, drought-resistant plantings as well as the protection of Congo Basin peatlands, which store approximately 30 billion tons of carbon and are vulnerable to drying and fire.

Additionally, REDD+, jurisdictional carbon credit revenues, and results-based climate finance must be integrated into medium-term expenditure frameworks, with earmarking for forest governance, community benefits, and climate adaptation investments.

b. Performance-based incentives and fiscal transfers for forest stewardship

Payments for Ecosystem Services (PES) schemes that reward communities, local governments, and concession holders for maintaining forests, peatlands, riparian buffers, and wildlife corridors should be established. Payments can be linked to watershed protection, hydropower reliability, urban water supply, and disaster risk reduction.

Additionally, intergovernmental fiscal transfers should be reformed to reward provinces, districts, or municipalities that reduce deforestation, protect high-carbon and high-biodiversity areas, or restore degraded lands, using ILUMP-aligned indicators.

c. Fiscal, tax, and sovereign finance reforms aligned with forest outcomes

Tax exemptions, reduced royalties, or accelerated depreciation for investments in sustainable forestry, agroforestry, restoration, and forest-based value chains, while increasing taxes or fees on land-clearing, illegal logging, and peatland drainage would favor positive forest outcomes.

Likewise, concession fees, lease rates, and land use charges should be adjusted to reflect ecosystem values, with lower fees for sustainable management and higher costs for conversion or high-risk land uses. The use of forest and land use performance indicators in debt-for-nature swaps, sustainability-linked bonds, and credit enhancement instruments would ensure that fiscal space is reinvested in forest stewardship.

4.3. Recognition of biodiversity as productive capital

Treating biodiversity as productive capital creates a shift from conservation cost to economic asset, enabling countries to align growth, resilience, and poverty reduction with long-term ecosystem stewardship.

a. Integrate biodiversity values into economic, land use, and infrastructure planning

Widespread adoption of ecosystem and natural capital accounting (e.g., SEEA-EA) is recommended to reflect the economic value of forests, wetlands, and biodiversity in national accounts, public investment planning, and cost-benefit analyses. Major land use, infrastructure, and extractive projects should require an assessment of biodiversity impacts using ILUMP zoning, biodiversity offsets (where appropriate), and avoidance hierarchies that prioritize protection of high-value ecosystems.

b. Protect biodiversity as strategic natural infrastructure for climate and water security

ILUMPs should integrate watershed protection, including restoration of upstream forests to regulate water flows and protect hydropower and urban supplies. Rapid urbanization across Central Africa demands climate-aware planning: green infrastructure, wetland protection, and strict no-build zones in flood-prone areas will reduce disaster risk while relieving pressure on forest margins. Designate peatlands, intact forests, wildlife corridors, wetlands, and climate refugia as strategic national assets with enhanced legal protection and long-term management financing.

c. Strengthen biodiversity data systems and biodiversity-based economic opportunities

This includes the investment in biodiversity monitoring systems, open spatial data platforms, and indicators that support ILUMPs, finance eligibility, and private-sector disclosure requirements. Supporting nature-based tourism, sustainable forest products, agroforestry, and bioeconomy enterprises generates income while maintaining ecosystem integrity.

4.4. Stronger links between rural livelihoods, ecosystems, and national growth strategies

a. Community-based adaptation and land governance

Secure land tenure is vital as climate pressures intensify competition over land, forests, and water. ILUMPs offer a pathway to formally recognize and protect community and Indigenous land rights, reducing conflict, enabling long-term stewardship, and strengthening access to climate and conservation finance.
Secure tenure encourages investment in sustainable land use practices and supports communities as active partners in landscape governance.

b. Integration of Indigenous and local knowledge into climate risk management.

Grounded in the long-term observation of ecosystems and seasonal change, knowledge from Indigenous Peoples and local communities (IPLC) informs effective fire management, flood and drought responses, soil and water conservation, and ecosystem restoration. Incorporating Indigenous and local knowledge into ILUMPs improves climate-resilient agroforestry systems—including cocoa, palm, and fruit-tree mosaics—across scales, and strengthens community-based fire management and early warning systems. By linking secure tenure with locally rooted knowledge, ILUMPs reduce deforestation drivers, strengthen local governance of forests and wetlands, and support diversified, climate-adapted rural economies, while meeting social safeguard and equity requirements of climate and biodiversity finance.

4.5. Integrating economic and social cost-benefit analysis in ILUMPs

Targeted Scenario Analysis (TSA) is a policy-focused economic analysis tool to support decision-makers in comparing alternative development and land use pathways under conditions of climate, environmental, and economic risk that is a critical extension of the ILUMP process (Alpizar & Borvanick, 2013). At its core, TSA answers a simple but critical question: What are the economic, social, and environmental consequences of continuing with current practices versus shifting to more sustainable alternatives? TSA does this by constructing and comparing two or more scenarios over a defined time horizon:

- Business-as-usual (BAU): what is likely to happen if existing policies, land uses, and practices continue unchanged?
- Sustainable Ecosystem Management (SEM) or alternative scenarios: what could happen if targeted policy reforms or investments—such as climate-smart agriculture, forest conservation, restoration, or improved governance—are implemented?

Unlike complex macroeconomic models, TSA is intentionally pragmatic and decision-oriented. It uses available data, expert knowledge, and stakeholder inputs to estimate changes in:

- incomes and livelihoods,
- ecosystem services and natural capital,
- public and private costs and benefits,
- climate and environmental risks over time.

TSA is not designed to predict the future with precision. Instead, it provides comparative, credible evidence that helps policymakers understand trade-offs, identify no-regret and low-regret options, and justify policy shifts, investments, or financing strategies—especially in data-constrained contexts.

When embedded in tools such as ILUMPs, TSA functions as the economic and social cost-benefit engine that links spatial planning, climate risk, biodiversity, rural livelihoods, and finance into a coherent, policy-relevant framework.

TSA strengthens the alignment of biodiversity conservation into economic growth and poverty reduction strategies by providing the economic and social evidence needed to integrate climate risk, biodiversity, and land management into core policy and investment decisions. While ILUMPs establish the spatial and governance framework for climate-responsive planning, TSA translates alternative land use and policy pathways into quantified outcomes that decision-makers can compare.

By systematically contrasting BAU trajectories with Sustainable Ecosystem Management scenarios, TSA makes visible the long-term economic costs of continued land conversion and ecosystem degradation, as well as the benefits of coordinated, climate-resilient land use strategies. This supports binding, cross-sector land use planning by identifying high-risk and high-value areas, informing dynamic zoning, and strengthening the case for protected areas, ecological corridors, and transboundary coordination.

TSA also underpins fiscal reforms that reward forest stewardship by quantifying ecosystem services such as carbon storage, water regulation, and disaster risk reduction, enabling performance-based transfers, payments for ecosystem services, and results-based climate finance to be credibly designed and monitored. By valuing biodiversity as productive capital, TSA helps internalize ecosystem contributions within public investment planning, cost-benefit analysis, and natural capital accounting frameworks.

Finally, TSA strengthens links between rural livelihoods, ecosystems, and national growth strategies by demonstrating how secure land tenure, community-based adaptation, and Indigenous and local knowledge contribute to economic resilience and poverty reduction. In data-constrained contexts, TSA functions as a pragmatic decision-support tool—supporting precautionary, adaptive policy choices that align climate risk management with long-term development and financing objectives.
To illustrate the potential of TSA to strengthen climate-informed, development-relevant decision-making we draw some highlights from a recent study in the Bwindi Ecosystem of SW Uganda (Bush et al., 2024). The study compares a BAU pathway—characterized by low-input, climate-vulnerable farming and continued ecosystem degradation—with a Sustainable Ecosystem Management (SEM) pathway centered on climate-smart agriculture (CSA), conservation, and improved institutional support.

Under BAU, the analysis shows that farming systems surrounding Bwindi Impenetrable Forest National Park are highly vulnerable to climate change, soil erosion, and declining fertility. Climate-adjusted yield modeling projects an average 30% reduction in total factor productivity, compounding existing poverty, food insecurity, and pressure on protected areas. TSA quantifies these risks in economic terms, estimating annual soil degradation costs of approximately USD 531 per household—equivalent to more than USD 40 million per year at the district level. These losses remain largely invisible in conventional planning but are made explicit through TSA.

By contrast, the SEM scenario demonstrates how targeted investments in CSA and ecosystem stewardship can generate substantial economic and social returns despite climate stress. Across six major crops, SEM adoption increases average farm-level revenues by 117%, with particularly strong gains for food-security crops such as climbing beans and matooke bananas. At the household level, SEM consistently outperforms BAU in both current and future climate scenarios, improving income resilience even though climate change continues to impose overall constraints. When aggregated to the district scale, SEM adoption results in a 17% increase in total economic value relative to BAU and avoids an estimated USD 310 million in cumulative losses between 2024 and 2040.

Crucially, TSA goes beyond identifying benefits to assess the costs of transition. The report shows that an estimated USD 56 million investment over 17 years — primarily for agricultural extension, institutional support, and market access — could generate returns comparable to the avoided losses, with an implied annual return of approximately 17%. This framing transforms CSA and conservation from aspirational goals into bankable development choices. These findings demonstrate how TSA functions as the economic and social cost-benefit engine of ILUMP. By quantifying trade-offs, valuing ecosystem services, and linking livelihood outcomes to land use decisions, TSA enables ILUMPs to move beyond spatial plans toward credible, finance-ready strategies that align climate risk management, biodiversity conservation, and poverty reduction in data-constrained contexts.

5. Accessing finance

ILUMPs play a critical enabling role in unlocking forest and landscape finance because they translate fragmented data and policy objectives into coherent, jurisdiction-scale investment propositions. The Unlocking Forest Finance Roadmap (2025) makes clear that finance does not flow to forests primarily because of a lack of ambition, but because of weak enabling conditions—specifically limited planning coherence, insufficiently credible data, and poor alignment between land use decisions and financial instruments. ILUMPs directly address these constraints:

First, ILUMPs provide the spatial and institutional coherence that the Roadmap identifies as essential for mobilizing large-scale finance. By integrating land use priorities across conservation, restoration, agriculture, and development, ILUMPs create the jurisdictional platforms needed for solutions such as JREDD+, the Tropical Forests Forever Facility (TFFF), and sustainable value chain finance. These mechanisms require credible, spatially explicit baselines, transparent zoning, and clear governance arrangements—precisely the functions ILUMPs are designed to deliver.

Second, ILUMPs help convert imperfect data into finance-relevant confidence, even under uncertainty. The Roadmap emphasizes that investors and public financiers do not require perfect data, but they do require clarity on risk, additionality, safeguards, and implementation capacity. ILUMPs meet this need by framing data gaps as managed risks, documenting confidence levels, and embedding adaptive monitoring systems. This makes them suitable foundations for results-based payments, blended finance, and fiscal incentives, even in data-constrained contexts.

Third, ILUMPs support the Roadmap's emphasis on development-compatible and inclusive finance. By explicitly incorporating customary tenure, Indigenous and local knowledge, and livelihood systems into land use planning, ILUMPs help satisfy the social safeguards and equity criteria that underpin access to international public finance, carbon markets, and emerging disclosure-driven private investment.

In this sense, ILUMPs are not financing instruments themselves, but financial infrastructure. They lower transaction costs, align multiple finance streams, and enable countries to sequence public, philanthropic, and private capital. When reconciled with the Forest Finance Roadmap, ILUMPs emerge as a cornerstone mechanism for moving from fragmented projects to scalable, jurisdictional forest finance capable of supporting long-term forest and landscape conservation.

A climate-informed ILUMP agenda requires substantial investment. Key finance sources include Global Climate funds, regional initiatives, and national and private mechanisms. Global climate funds include the Green Climate Fund (for adaptation, land use planning), the GEF (for biodiversity, integrated landscapes), adaptation funds (community adaptation), and the Forest Investment Program (FIP) (for forest resilience). Regional initiatives include CAFI (land use governance, REDD+, peatlands), and COMIFAC programs. Finally, national and private mechanisms include environmental trust funds, payment for ecosystem services (PES) schemes (watersheds, hydropower utilities), carbon markets (REDD+, peatland carbon, agroforestry credits), and green and blue bonds for sustainable forestry and coastal protection. These blended mechanisms can finance spatial planning reforms, community adaptation, ecological corridors, and climate-smart restoration.

Methodological guidance to integrate climate challenges and natural capital accounting in ILUMP exists (USDA FS, 2024). However, given the issues of data scarcity (SPCB, 2025) on critical underlying climate, biodiversity and socio-economic processes, caution is needed in how ILUMPs are prepared and identified outcomes are treated. The ILUMP framework is intentionally structured to function in data-limited environments such as the Congo Basin. Rather than relying on comprehensive or high-resolution datasets, the approach emphasizes iterative and adaptive planning, participatory processes, and spatially explicit analysis that focuses on trends, risks, and trade-offs instead of precise forecasts. Core design features—including the use of existing datasets and proxies, the emphasis on defining desired future conditions rather than exact predicted outcomes, and the selective integration of climate and Natural Capital Accounting (NCA) information—explicitly acknowledge that data availability is partial, uneven, and evolving. As a result, ILUMPs are framed as decision-support instruments rather than scientific prediction models.

The Science Panel for the Congo Basin (SPCB) underscores the relevance of this approach by documenting structural data deficiencies across the region. Biophysically, long-term ecological monitoring is sparse, forest dynamics are poorly attributed to specific drivers, and critical thresholds—particularly for peatlands and forest–savanna transitions—remain poorly understood. Socio-ecological data gaps are equally significant, including limited spatial information on customary land tenure, mobility, and livelihoods, under-representation of Indigenous and local knowledge in formal datasets, and weak documentation of informal economies such as non-timber forest products, hunting, and artisanal mining. These challenges are compounded by high uncertainty in regional climate projections, weak downscaling capacity, and limited integration between climate models and land use decision frameworks, which constrain the reliability of future-oriented scenarios.

Despite these limitations, ILUMPs can still be developed with sufficient accuracy to support practical decision-making. They are well suited to identifying high-risk and high-value areas for biodiversity, carbon, and hydrological functions; mapping conflict-prone overlaps among concessions, protected areas, and customary lands; defining no-regret and low-regret strategies such as peatland protection and riparian buffers; and embedding adaptive monitoring systems that improve plans over time. However, ILUMPs cannot reliably deliver fine-grained spatial optimization, precise climate-impact attribution, or low-uncertainty monetary valuation of ecosystem services. Consequently, credible ILUMPs must explicitly limit claims of precision and be framed as adaptive, precautionary planning tools operating within clearly stated data constraints rather than as definitive spatial optimization models.

6. Conclusions and recommendations

The tropical forests of the Congo Basin face intensifying climate risks that threaten biodiversity, ecosystem services, and community livelihoods. While strong policy frameworks exist, they are not yet calibrated to meet the scale or urgency of climate change.

At the national level integrating climate considerations into ILUMPs —through climate-responsive zoning, ecological connectivity, community-led adaptation, climate-smart forestry, watershed protection, and resilient urban planning— is critical for safeguarding these globally significant landscapes.

At subnational levels, strengthening local technical and administrative capacities ensures effective implementation.

Enhanced cooperation on data sharing and environmental surveillance improves transparency and early warning. Finally, systematically integrating climate considerations into PLUPs, PATs, and landscape plans embeds resilience and mitigation objectives into territorial development decisions.

Strengthening transboundary landscape governance in Central Africa requires coordinated institutional, legal, and technical actions. The adoption of integrated management models for cross-border areas can align conservation, land use, and development objectives across national boundaries, particularly in shared forest and wildlife corridors. Harmonizing climate, forestry, and wildlife laws is essential to reduce regulatory fragmentation and enable coherent enforcement. Establishing cross-border climate committees can support joint planning, risk management, and information exchange.

Mobilizing a diverse portfolio of international, regional, national, and market-based financing instruments will ensure that climate-resilient land governance becomes both feasible and sustainable. Enhanced data collection and governance are central to maximizing the financial value of ILUMPs. By improving the consistency, transparency, and credibility of spatial, ecological, climate, and socio-economic data—while clearly documenting uncertainties — ILUMPs reduce investment risk and strengthen confidence among public and private financiers.

Robust data governance frameworks, aligned with international standards and safeguards, enable jurisdictions to meet eligibility requirements for results-based payments, blended finance, and climate and biodiversity funds. Even in data-scarce contexts, well-governed, adaptive data systems allow ILUMPs to function as trusted planning and coordination platforms, lowering transaction costs and unlocking scalable, long-term finance for forest and landscape conservation. By embedding climate risk into planning today, Central African countries can secure ecological integrity, enhance climate resilience, and protect the social and economic foundations of the region for future generations.

The COMIFAC Convergence Plan 2015–2025 provides a comprehensive regional framework for the conservation and sustainable management of forest ecosystems in Central Africa, explicitly linking biodiversity conservation, climate action, economic development, and poverty reduction. Its six strategic axes and cross-cutting pillars already establish strong foundations for integrated land use planning, climate change mitigation and adaptation, sustainable forest-based value chains, and inclusive socio-economic development.

The COMIFAC Convergence Plan provides a comprehensive framework for regional governance by integrating ecological preservation with socio-economic development. Under Axis 1 and Axis 2, the Plan mandates the harmonization of national policies and the integration of forest zoning into territorial land-use frameworks, which facilitates the coordination of forestry, agriculture, and infrastructure objectives, even though ILUMPs are not explicitly mentioned.

Axis 3 establishes quantitative targets for biodiversity monitoring and protected area integrity, framing conservation as a strategic contributor to national GDP through ecotourism, sustainable wildlife management, and the development of rural livelihoods. Climate change is addressed as a dedicated sectoral priority under Axis 4, which utilizes REDD+, reforestation, and explicit indicators for deforestation and adaptive capacity to manage mitigation and adaptation efforts.

The socio-economic dimension is articulated in Axis 5, which embeds conservation within a development framework by linking community-based forest management to measurable improvements in the Human Development Index and poverty reduction. Finally, Axis 6 focuses on establishing sustainable financing mechanisms—such as payments for ecosystem services and international climate finance—while utilizing monitoring systems like OFAC to ensure evidence-based decision-making across all thematic areas.

Building on these foundations, the post-2025 Convergence Plan would benefit from a more explicit climate risk–driven and territorially operational approach. While climate change is addressed under Axis 4 in the current Plan, future iterations should elevate climate risk as a structuring parameter across all land use and development decisions, rather than treating it as a primarily sectoral concern.

In this context, ILUMPs can be formally recognized as national and subnational operational instruments that translate COMIFAC's strategic objectives into spatially explicit, climate-responsive zoning and investment frameworks. By embedding climate vulnerability analysis, ecological connectivity, watershed protection, and scenario-based planning into ILUMPs—and cascading these principles into PLUPs, PATs, and landscape plans—member states can reduce land use conflicts, enhance resilience, and align conservation with long-term economic productivity.

Post-2025 reforms should also strengthen transboundary landscape governance. While the current Plan promotes transboundary protected areas, future iterations could institutionalize cross-border climate and land use coordination mechanisms, supported by harmonized forestry, wildlife, and climate legislation. This would improve enforcement coherence, protect shared ecological corridors, and facilitate sustainable cross-border value chains.

From a financing perspective, the next Convergence Plan should explicitly position high-quality planning and data governance as enabling conditions for investment readiness. Strengthening the consistency, transparency, and credibility of spatial, ecological, climate, and socio-economic data—while clearly documenting uncertainty—would reduce investment risk and enhance access to results-based payments, blended finance, and emerging biodiversity and climate markets. Even in data-scarce contexts, adaptive and well-governed information systems can allow ILUMPs to function as trusted coordination platforms. With these recommendations in mind, the next Convergence Plan would represent a climate-resilient, biodiversity-positive, and economically inclusive territorial governance framework.

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Appendix: Methods

Scenario

The SSP5-8.5 scenario was used for all analyses. Cumulative greenhouse gas emissions through 2020 have tracked closely with the Coupled Model Intercomparison Project Phase 5 (CMIP5) RCP8.5 scenario (analogous to the CMIP6 SSP5-8.5 scenario), highlighting its utility for near band mid-term time horizons. Although it is considered an aggressive emissions scenario, meaningful divergence between scenarios is not realized until after mid-century. Additionally, most general circulation models (GCMs) do not adequately represent biotic feedback processes, such as permafrost thaw, thereby underestimating cumulative emissions and supporting the use of a higher emissions scenario to capture these underestimated emissions.

Data

Gridded daily maximum temperature and precipitation data from 19 CMIP6 GCMs were bilinearly interpolated to a 10-km grid and then bias-adjusted using phase 3 of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) version 2.5 methodology (ISIMIP3BASD v2.5). CHELSA-W5E5 reanalysis data were selected as the observation dataset for bias-adjustment. These models included: ACCESS-CM2, ACCESS-ESM1-5, CanESM5, CNRM-CM6-1-HR, CNRM-CM6-1, CNRM-ESM2-1, EC-Earth3, EC-Earth3-Veg-LR, GFDL-CM4, GFDL-ESM4, INM-CM4-8, INM-CM5-0, IPSL-CM6A-LR, MIROC6, MIROC-ES2L, MPI-ESM1-2-HR, MPI-ESM1-2-LR, MRI-ESM2-0, and UKESM1-0-LL. The ensemble mean is used in all figures and maps.

Data

Gridded daily maximum temperature and precipitation data from 19 CMIP6 GCMs were bilinearly interpolated to a 10-km grid and then bias-adjusted using phase 3 of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) version 2.5 methodology (ISIMIP3BASD v2.5). CHELSA-W5E5 reanalysis data were selected as the observation dataset for bias-adjustment.

These models included: ACCESS-CM2, ACCESS-ESM1-5, CanESM5, CNRM-CM6-1-HR, CNRM-CM6-1, CNRM-ESM2-1, EC-Earth3, EC-Earth3-Veg-LR, GFDL-CM4, GFDL-ESM4, INM-CM4-8, INM-CM5-0, IPSL-CM6A-LR, MIROC6, MIROC-ES2L, MPI-ESM1-2-HR, MPI-ESM1-2-LR, MRI-ESM2-0, and UKESM1-0-LL. The ensemble mean is used in all figures and maps.

Analyses

Spatial analyses of four climate indicators were conducted:

1. Dry days, defined as days with precipitation rates < 1mm/day.
2. Hot days, defined as days over 32.2°C.
3. Extreme precipitation intensity, calculating the 95th percentile daily precipitation rate for each time period.
4. Extreme precipitation frequency, calculating the number of days above the historical 95th percentile daily precipitation rate.

Temporal analyses were conducted for each of the four transboundary landscape to show precipitation seasonality (i.e., the distribution of precipitation throughout the year). Cumulative monthly precipitation totals were plotted, as well as the 10-day running mean for daily precipitation rates.

All analyses were conducted using daily data over three 21-year time periods: "present"/recent past (2000-2020), near-term (2020-2040), and the mid-term (2040-2060) projections. The temporal average for each time period is shown.

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