

POLICY BRIEF

LIVING LABORATORIES:

WHY DRC BIOSPHERE RESERVES ARE OF VITAL IMPORTANCE FOR CLIMATE CHANGE

THIS BRIEF

This policy brief is part of the POLCARTIM project coordinated by the Royal Museum for Central Africa (Tervuren, Belgium) and executed in collaboration with the Belgian Science Policy (BELSPO). The project is funded by BELSPO under the BRAIN-be Programme. POLCARTIM focuses on providing policy support concerning rainforest carbon stocks and timber trade.

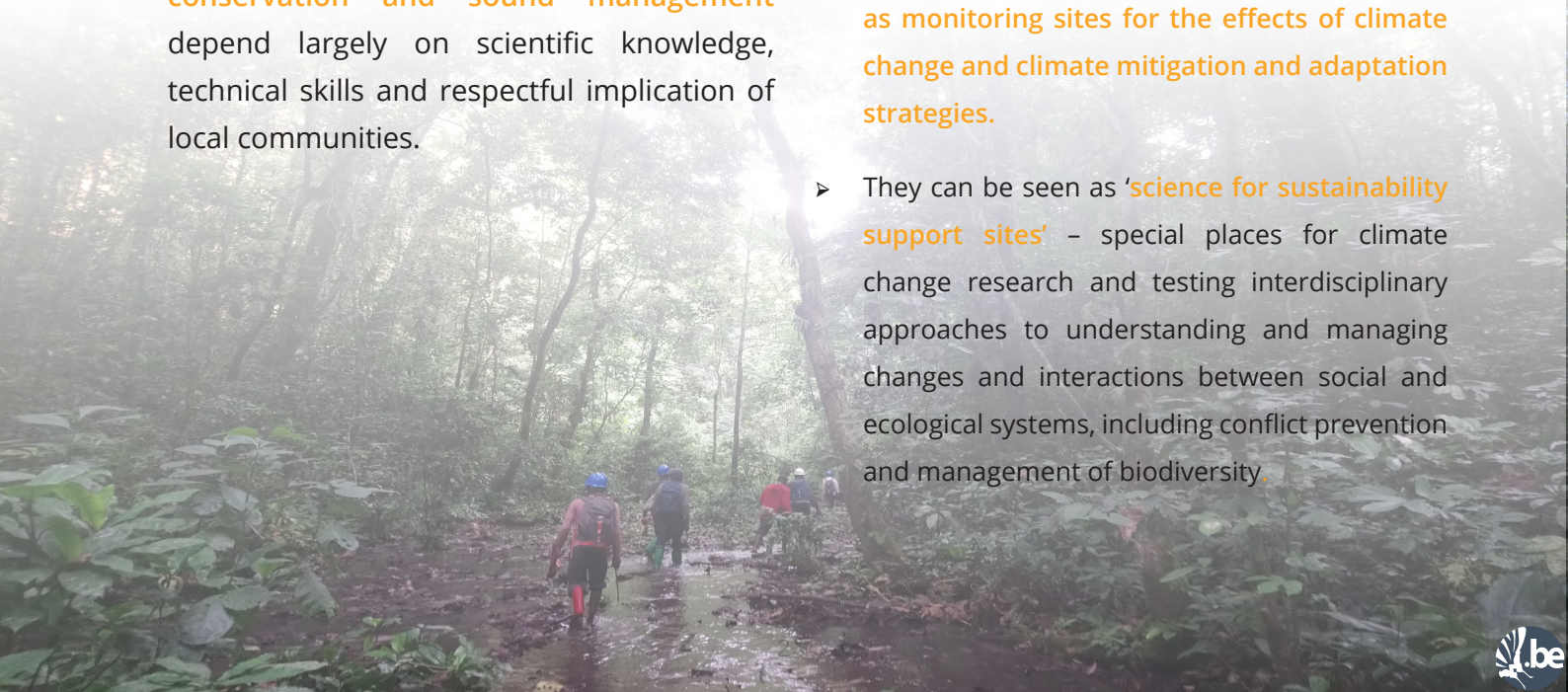
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KEY POLICY RECOMMENDATIONS

- Increased protection of existing Biosphere Reserves and strengthening of their role in climate change research.
- Increased investments in research infrastructure within Biosphere Reserves. Special focus on the establishment of Permanent Sample Plots, experimental set ups and weather and atmospheric observation stations.
- Increase international collaboration projects for research in Biosphere Reserves.

MAN AND BIOSPHERE RESERVES

- Tropical intact forests account for about half of the terrestrial sink in established forests ([Brienen et al., 2015](#); [Lewis et al., 2009](#)), storing about 55% of terrestrial carbon ([Pan et al., 2011](#)), yet covering only 7 to 10% of the global land area ([Lewis et al., 2009](#)). The carbon sink in undisturbed African forests is about 0.66 tonnes of carbon per hectare per year and has been fairly stable until recently ([Hubau et al., 2020](#)). Sequestration of carbon emission by tropical forests is declining as a consequence of lower carbon absorption in intact forests (more outspoken in the Amazon compared to the Congo Basin), deforestation and degradation and rising emissions.
- Tropical forests will continue to occupy a key position for the mitigation of climate change and for economic development. They are carbon stocks and sinks that are vital for the planet and have a more profound influence on weather patterns, freshwater, natural disasters, biodiversity, food, and human health than any other terrestrial biome ([Brandon, 2014](#)). **The Central-African tropical dense moist forests play a key role in buffering global climate changes. Their conservation and sound management depend largely on scientific knowledge, technical skills and respectful implication of local communities.**
- The **Man and Biosphere (MAB) Programme** (UNESCO, 1971) is an intergovernmental scientific program that aims to establish a scientific basis to enhance the relationship between people and their environments. It combines the natural and social sciences to improve human livelihoods and to safeguard natural and managed ecosystems. As such it promotes innovative approaches and economic development that are socially and culturally appropriate and environmentally sustainable. **The implementation of the MAB programme is through the network of Biosphere Reserves.** Biosphere Reserves are areas comprising terrestrial, marine and coastal ecosystems that are recognized by the MAB Programme.
- The MAB Programme considers Biosphere Reserves as **live laboratories** for the study of climate change and monitoring of biodiversity in interaction with programs of sustainable development and education.
- Biosphere Reserves are internationally recognized sites, promoting solutions reconciling the conservation of biodiversity with its sustainable use. They provide local solutions to global challenges, and **play a crucial role as monitoring sites for the effects of climate change and climate mitigation and adaptation strategies.**
- They can be seen as '**science for sustainability support sites**' – special places for climate change research and testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity.



BIOSPHERE RESERVE LAYOUT AND ROLE IN SDGS

A typical Biosphere Reserve consists of three zones, each with their own unique function ([UNESCO](#)):

- The **core area** consists of strictly protected ecosystems and contributes to the conservation of landscapes, species and genetic variation. For Biosphere Reserves within the tropical forest biomes, this area is essential for monitoring forest dynamics as a result of growth, regeneration and mortality of trees, which is strongly linked to forest carbon dynamics and, after upscaling, to the global carbon cycle.
- The **buffer area** which surrounds or adjoins the core area is used for activities compatible with sound ecological practices that can reinforce scientific research, monitoring, training and education. It is a key zone for establishing scientific experiments for reforestation and forest management and for training.
- In the **transition area** the most diverse activity is allowed and it offers the context for fostering economic and human development and environmental education that is socio-cultural and ecological sustainable.

According to the Lima Action Plan 2016-2025 (A1, [UNESCO](#)), Biosphere Reserves are recognized as models contributing to the implementation of the **Sustainable Development Goals (SDG's - UN)** and Multilateral Environmental Agreements (MEAs). This involves making Biosphere Reserves priority sites/observatories to conduct research on monitoring, limiting and adapting to climate change, in particular in support of the UNFCCC COP 21 [Paris Agreement](#) (A1.4 in Lima Action Plan).

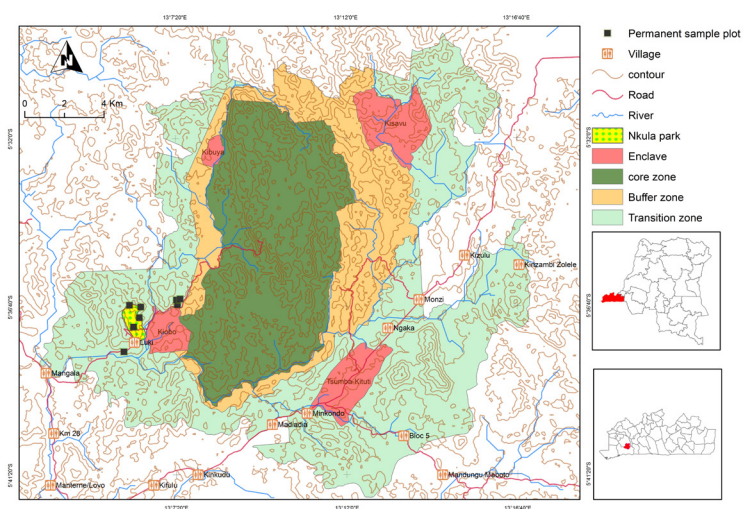


Figure 2: The Luki Biosphere Reserve with the location of the permanent sample plots

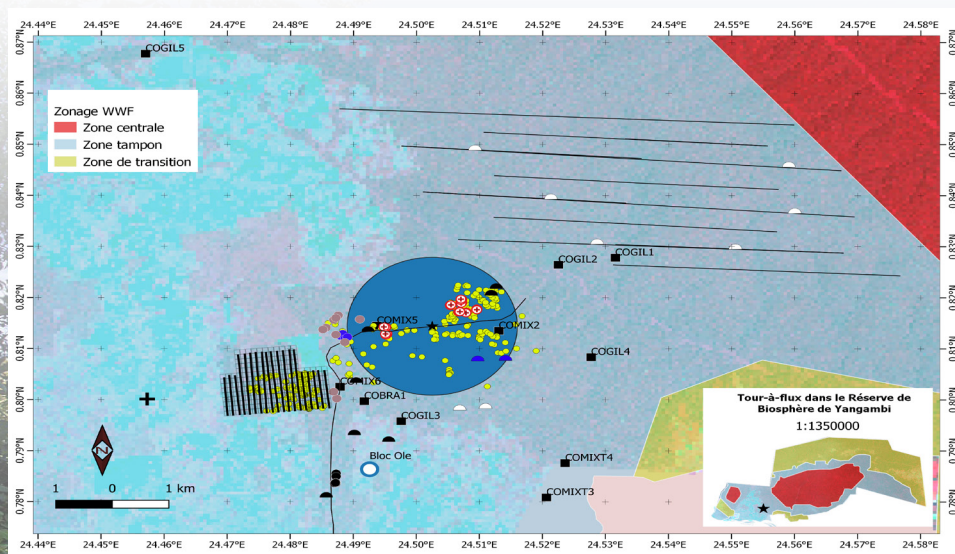


Figure 1: The Yangambi Biosphere Reserve (zone centrale = core zone, zone tampon = buffer zone, zone de transition = transition zone). The 8 parallel black lines: location of the Muni river system; black/blue/white semicircles: anthropological pits dug in 2010/2015/2017; black squares: the 11 COBINTO plots; yellow circles: the trees of the interannual monitoring circuit and monthly observation of the phenology of *Pericopsis elata*; white circle with blue outline the Ole block; black straight lines: the transects opened by the RMCA to monitor the interannual growth of *Pericopsis elata* in the development blocks of the Yangambi Biosphere Reserve; white circles with red outline and red cross in the center: the trees followed by dendrometers; black star: the flux tower; blue circle of 1.5 km radius: footprint of flux tower; black cross: the mini climate station; red/blue black circles: the individuals of *Pericopsis elata* using a rectorolase in monthly monitoring. The small black line represents the path that leads to the forest. A Sentinel-1 image taken on February 3, 2018 is used in the background to highlight the forest areas (dark) and the non-forest areas (light). The development areas are also shown on the map.

BIOSPHERE RESERVE LAYOUT AND ROLE IN SDGS

Biosphere Reserves should act as pilot regions for establishing relevant research and reconciliation of nature conservation and (sustainable) socio-economic development. They are ideal model regions to achieve the Sustainable Development Goals ([Kratzer, 2018](#)).

In particular:

- **SDG 2 (Zero hunger):** Biosphere Reserves contribute to the conservation of biodiversity and the promotion of sustainable management options to benefit local people. Forest management aiming at a sustainable production of goods and services are key for development. Forests assure environmental protection and are resources for food, energy (wood fuel, charcoal) and timber. These products can be extracted from the wild in a potentially sustainable way, provided that there is reliable information on carrying capacity of the forest ecosystem (e.g., data on productivity, so that harvesting will not remove more biodiversity (fruit, bark, game, wood) than is needed to maintain the populations and the ecosystem as a whole).
- **SDG 4 (Quality education):** Biosphere Reserves offer the opportunity to strengthen the scientific capacity, organize trainings and provide education for students and professionals on management practices, sustainability aspects, wildlife and climate change. Management and conservation of ecosystem services improve when knowledge of ecosystem functioning, including the role of human interference, and global change dynamics improve.
- **SDG 13 (Climate action):** The UNESCO MAB reserves are observatories for climate change research, monitoring, mitigation and adaptation, including support of the UNFCCC COP21 Paris Agreement. Targeted research efforts increase the understanding of the effects of climate change on the African rainforest and help to identify and disseminate good practices. MAB reserves offer the opportunity for climate change monitoring. This can be done while creating Permanent Sample Plots (PSP's) and Global Environmental Monitoring (GEM) plots which allow detailed measurements in relation to climate change. These are key input data for the vegetation and climate models that underpin the international policy on climate change.
- **SDG 15 (Life on Land):** Biosphere Reserves ensure the long-term conservation of the socio-ecological systems (human-forest interactions), in particular through their potential for research on how to understand processes that contribute to the restoration and appropriate management of deforested ecosystems. Biosphere reserves contain still vast areas of intact forests that should be maximally preserved, but include also re-growing forests, that could be managed aiming at sustainable production of forest products, and degraded land that could be reforested (see interview [Robert Nasi, Director General CIFOR](#)).



THE BIOSPHERE RESERVES IN THE CONGO BASIN

The Congo Basin contains the second largest rainforest in the world and its role in climate change mitigation means that research on forest ecosystem processes and forest resilience are crucial to understand global effects and changes and to establish relevant policy. This was recently emphasized in the work by [Hubau et al. \(2020\)](#) in *Nature*, the Congo Basin plays a key role in climate mitigation as it might be more resilient to the warming effects compared to the Amazonian counterpart. Moreover, the intact tropical forest in the Congo Basin is a stable carbon sink, rich in biodiversity and an important provider of ecosystem services. The Democratic Republic of the Congo is currently home to three Biosphere Reserves (Figure 2): **Yangambi** (since 1976, 235000 ha), **Luki** (1976, 33000 ha) and **Lufira** (1982, 14700 ha). The Yangambi Biosphere Reserve is situated within the Congo River Basin west of the City of Kisangani in the Democratic Republic of Congo. It is typical for the Congolese rainforest. The Luki Biosphere Reserve is located in the south-west of the Democratic Republic of Congo and about 120 km east of the Atlantic coast. It is as such typical for the Mayombe rainforest and is part of the Lower Guinea vegetation. The Lufira Biosphere Reserve is located in the south-east of the Democratic Republic of Congo and typifies the Miombo woodlands.

Both Yangambi and Luki have a particularly rich history of research and they can be considered as the cradle for research in Central-African botany, forest ecology, tree physiology, climatology, tropical agronomy and silviculture ([Beeckman, 2019](#)). Some experimental plots are still present after their establishment, 70 years ago, and offer unique research material, in a region where there is a dire need for long term observations of vegetation dynamics and environmental fluctuations. In recent years, conditions have been favorable enough to initiate numerous climate change research activities in the Biosphere Reserves of the Congo Basin. [Hubau et al. \(2019\)](#) discussed the persistence of carbon in the understory (which is between the canopy layer and the forest floor layer) and its role in climate mitigation, based on measurements in Permanent Sample Plots (of which a part of them are found in Biosphere Reserves). [Deklerck et al. \(2019\)](#) determined the forest and carbon recovery rate when the annual burning practice in anthropogenic savannas is halted in the outstretch of the Luki Biosphere Reserve. They discovered that natural regeneration is significant, and forest is returning combined with an increased uptake of carbon. [Hubau et al. \(2020\)](#) assessed trends in the carbon sink using 244 plots in structurally intact African tropical forests (11 countries, some plots in Biosphere Reserves). They compared these with 321 published plots from Amazonia and investigated the underlying drivers of the trends. They concluded that the carbon sink in live aboveground biomass in intact African tropical forests has been stable for the three decades to 2015, in contrast to the long-term decline in Amazonian forests. Other research has for example focused on population genetics ([Vanden Abeele et al., 2019](#)) and the monitoring of atmosphere-ecosystem exchange of greenhouse gasses via a fluxtower in the Yangambi Biosphere Reserve ([CONGOFLUX](#)).

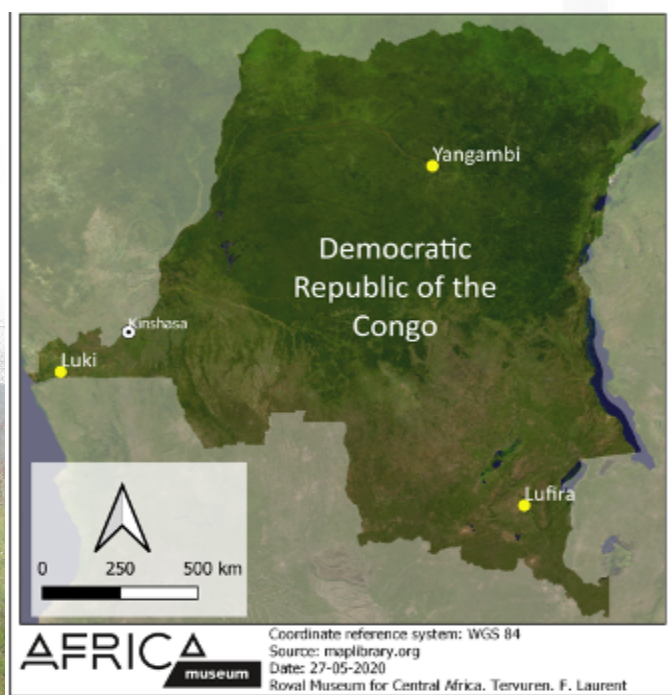


Figure 3: Location of the Luki, Yangambi and Lufira UNESCO MAB reserves in the Democratic Republic of Congo

CONTINUED EXISTENCE AND EXPANSION

The **MAB strategy** for 2015-2025

- Supports the member states to conserve biodiversity, enhance ecosystem services and foster the sustainable use of natural resources,
- Facilitates sustainability science, education for sustainable development and capacity building and
- Supports mitigation and adaptation to climate change and other aspects of global environmental change.

Potential threats

Despite their economic, social and environmental importance, preserving tropical rainforests is not easily achieved. They are under a constant threat of illegal logging and possibly climate change in the future. Almost 90% of West Africa's coastal rainforest has already been destroyed and deforestation in the Congo Basin has doubled since 1990. Even more important is the gradual forest degradation under high population pressure. From 1930 onwards there has been intensive logging (80% of the exported timber from the Congo at that time came from the Mayombe), resulting in gradually diminishing stocks of precious timber species ([Beeckman, 2019](#)).

Luki is now the only forest in the southern Mayombe of some importance and is a target for illegal logging for both charcoal production and timber, mainly for local or regional markets.

This is a serious threat towards its existence and conservation, and puts the spotlight on the dire need for developing science-based forest management outside of the core area aimed at the sustainable production of wood. This also emphasizes the need for increased protection of Biosphere Reserves, as they are a natural gem that offer a wide range of opportunities. Their **evidence-based management** improves the sustainability of human-forest interactions and provides continued sustenance for human populations dependent on this natural resource.

International effort

National and international actors are intervening in the development of the Luki and Yangambi Biosphere Reserves, in order to reconcile nature conservation and the economic development of the populations living in and around these Biosphere Reserves, in coherence with the present research activities. For example, in Yangambi, local development activities are carried out in particular by CIFOR (Center for International Forestry Research) and its partners. In Luki, WWF has been active for more a decade. **This multifunctional complementarity means that these two Biosphere Reserves have become model examples in the DRC to achieve the objectives of sustainable development (especially SDGs 2, 4, 13 and 15). Another positive signal is that the Democratic Republic of the Congo offers other forested areas, with the opportunities and assets favorable to create a new Biosphere Reserve.**

The Lufira Biosphere Reserve is based outside of the moist rainforest, and contains drier forests surrounding the rainforest. These forests are less resilient and more sensitive to climate change. Monitoring their response to these changes is vital in accurately assessing the overall effects. It is important to keep, protect, maintain and expand the research activities in this Biosphere Reserve.

POLICY RECOMMENDATIONS

The importance of Biosphere Reserves lies in the opportunities for transdisciplinary research that is directly related to supporting the policy concerning climate control and biodiversity management ([Beeckman, 2019](#)). One of the strengths of Biosphere Reserves is the presence of **Permanent Sample Plots** (see for example [AfrITRON](#)), which provide key data for

- Continuous monitoring of carbon fluxes
- Tree regeneration, growth and mortality
- Biogeochemical processes
- Tracking the impacts of accelerated environmental change

As such these Biosphere Reserves act as living labs, enabling in situ research on climate change effects, mitigation and adaptation that can be translated to patterns all over the tropical region. **There are appealing opportunities to upgrade some of the plots with more detailed observation so that they can be incorporated in the Global Ecosystem Monitoring network (GEM)**. This is an international effort to measure and understand forest ecosystem functions and traits, and how these will respond to climate change. This network is active in three continents and aims to capture both ecosystem-level properties and the functional composition of the community. The GEM network measurements take place in GEM-plots, which prove invaluable to obtain the aforementioned information.

We offer the following recommendations to strengthen the opportunities of the MAB reserve network of the DRC as living climate change laboratories:

- Increased investments are needed for the installation and maintenance of **Permanent Sample Plots** and GEM plots in the Biosphere Reserves, this especially for monitoring climate change effects, and in support of mitigation and adaptation strategies.
- Increased investments for **reforestation and afforestation projects in the transition zones** and just outside the Biosphere Reserves borders. As indicated in [Deklerck et al. \(2019\)](#), there are opportunities to restore the disturbed areas surrounding Biosphere Reserves.
- Increased international efforts towards **collaborations and training of local scientists** and establishing participatory research and try outs of sustainable development projects with de local population.