Investing in Congo Basin Science

Concise Science & Training Plan

"*We know so little about the majestic forests of central Africa. A lack of investment is the barrier to safeguarding these precious ecosystems. Surmount this, and the future of Earth's second 'great green lung' will be brighter.*"

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Summary

The Congo Basin provides valuable local, regional and global services to people. Yet, how the world's second largest extent of tropical forest functions, and how it might function in a rapidly changing world, is very poorly understood. There is major untapped capacity in the region, but there is a lack of training and resources for scientists.

The Congo Basin Science Initiative will, if funded, change that.

By taking new measurements to gain an integrated understanding of the climate-forest-water-society system, and training a new generation of scientists, we will provide the data and expertise needed to manage the Congo Basin for the benefit of local people and all of humanity.

Development without destruction is widely desired within the region and beyond it. Investing in generating robust scientific knowledge to show the value of the Congo Basin, its vulnerabilities, and evaluating differing futures for the region, is one critical component of charting a new development pathway. This Concept Note presents the Congo Basin Science Initiative (CBSI) science and capacity building plan to drive and direct the investments needed to better understand this globally iconic region of the world, an essential precursor to wisely managing the region.
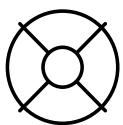
CBSI is low-risk

The scientists involved all have long track records of producing the science that has shown the value of the region and its vulnerabilities, and the model has been used to transform scientific understanding and capacity in the Amazon region in the past.

CBSI is high-reward

The protection of the Congo Basin region and its sustainable development relies on good data, sound analysis and the prompt delivery of knowledge to policy makers and civil society, which our research and capacity building program will provide.

Science & Capacity Plan

The Congo Basin and its contiguous forests represent the second largest tropical forest and river network on Earth. Spanning more than 240 million hectares of central Africa, this tropical forest and associated ecosystems directly supports the livelihoods of some 80 million people, many of them income-poor and vulnerable to economic and environmental shocks. Regionally, growing evidence suggests that these forests generate rainfall that falls as far away as the Sahel and Ethiopian highlands, supporting a further 300 million rural Africans.

Central African forests are also home to hundreds of mammals species, thousands of tree species, and hundreds of thousands of insects and other small organisms, many yet to be described by scientists. This rich biodiversity includes iconic species such as forest elephants, gorillas, and our closest relatives, chimpanzees and bonobos. Globally, these forests play a crucial role in regulating Earth's climate, with intact central African forests being more efficient at removing carbon from the atmosphere than any other ecosystem on Earth.

Nonetheless, these forests are often threatened as communities and countries develop, with the Democratic Republic of the Congo now having the world's second highest level of tropical deforestation. Development without destruction is widely desired within the region and beyond it. One critical component of achieving this is investment in generating robust scientific knowledge to show the value of the Congo Basin, its vulnerabilities, and the impacts on people in the region. These insights must be well-disseminated and understood by decision-makers and stakeholders. This requires investing in people, equipment, infrastructure and institutions.

Despite its importance to people and the planet, the Congo Basin receives little attention compared to the Amazon and Southeast Asian tropical forest regions. There is a chronic underinvestment in science and scientists. For example, according to the latest IPCC report, Central Africa was one of only two regions worldwide without the data needed to assess past trends in extreme heat events. For the future, it is unknown how deforestation and climate change may interact, and if it could drive widespread forest dieback, as shown for the Amazon. New datasets and analyses are urgently required.

The lack of investment in scientific capacity meant that only four experts chosen as IPCC authors during the current sixth assessment cycle were from central African countries, just

0.5% of the total (none were women). Furthermore, it is typically scientists from outside of Africa that lead major analyses on the people, climate, forests or biodiversity of the Congo Basin. New programs to train MSc and PhD level scientists from the Congo Basin region are urgently needed.

Photo credit: Fiston Wasanga HQ/CongoFlux

In response to these needs, central African Environment Ministers and leading scientists called for major investment in Congo Basin science and building scientific capacity. Their inspiration was the Large-scale Biosphere-Atmosphere Experiment in Amazonia (LBA). This $200+ million decade-long programme of 120 coordinated projects transformed Brazilian rainforest science and our understanding of the Amazon, by investing in climate and forest-related measurements across the region and training hundreds of South American scientists.[1]

In February 2023, scientists from the Congo Basin met with the LBA architects in Libreville, Gabon. The 49 scientists agreed to form the **Congo Basin Science Initiative** to drive investment into understanding how the Congo Basin functions and into training hundreds of scientists from Congo Basin countries.[2]

A new generation of professionals is needed to provide the scientific inputs necessary to deliver the innovative policies and actions needed for Congo Basin countries to develop without destruction, including achieving the Sustainable Development Goals, country Nationally Determined Contribution covering climate-related action, country plans to protect 30% of land and oceans under the Global Biodiversity Framework, and improving human health policies, such as avoiding zoonotic diseases.

This Concept Note presents the Congo Basin Science Initiative (CBSI) science and capacity building plan in order to drive and direct the investments needed to better understand the climate, hydrology, vegetation, wildlife and cultures of the Congo Basin. This knowledge of the Congo Basin as a socio-ecological system that functions as a regional entity within the Earth system is a critical input for decision-making and action at local, national, regional and international levels, to better manage this globally iconic region of the world.

The vision of the CBSI is to provide leadership, coordination and a framework within which governments, universities, philanthropists, NGOs, and other investors can tailor existing programs and fund new projects to work in synergy to transform our understanding of the Congo Basin ecosystem and its people, and feed this new knowledge into existing institutions to improve policy-making and action across the region and globally to support development without destruction.

Key Questions

The Libreville Congo Basin Science meeting achieved <u>consensus</u> on the priority questions for the CBSI multidisciplinary scientific agenda:

① *How does the Congo Basin function as a regional physical entity and how is it impacted by, and how does it influence, the changing Earth system?*

② *How have the terrestrial and freshwater ecosystems, their biodiversity, and the climate of the Congo Basin changed in the past, what is their current status, and how will they change in the future?*

③ *How do these dynamic ecosystems, their biodiversity, and the climate of the Congo Basin interact with global, regional and local human activity?*

④ *How can scientific data inform climate-resilient sustainable land-use to improve health, eradicate poverty, increase economic prosperity, and achieve other sustainable development goals across the region?*

Science Plan Overview

To address these questions, we require an understanding of what we call the climate-forest-water-society system, including the key processes affecting the system. We need to assess the past and current physical, chemical and biological environment, biogeochemical cycling, and socio-economic environments of the Congo Basin. This will be followed by modelling different possible futures for the region. By visualising different future scenarios or storylines, including the benefits and drawbacks of each, our scientific work can assist policy-makers and stakeholders to make better informed management decisions.

The Science Plan can be summarised in three parts: (1) extensive measurements across the region, and remotely sensed data and models to scale these measurements to the region, in order to describe the system and its behaviour; (2) intensive measurements at a small number of sites to gain a better mechanistic understanding the system, which includes less disturbed areas and more intensively used social-ecological production landscape; (3) combine the extensive measurements and detailed mechanistic understanding from the intensive measurements to test different futures for the region to deliver to policy-makers, stakeholders and wider civil society.
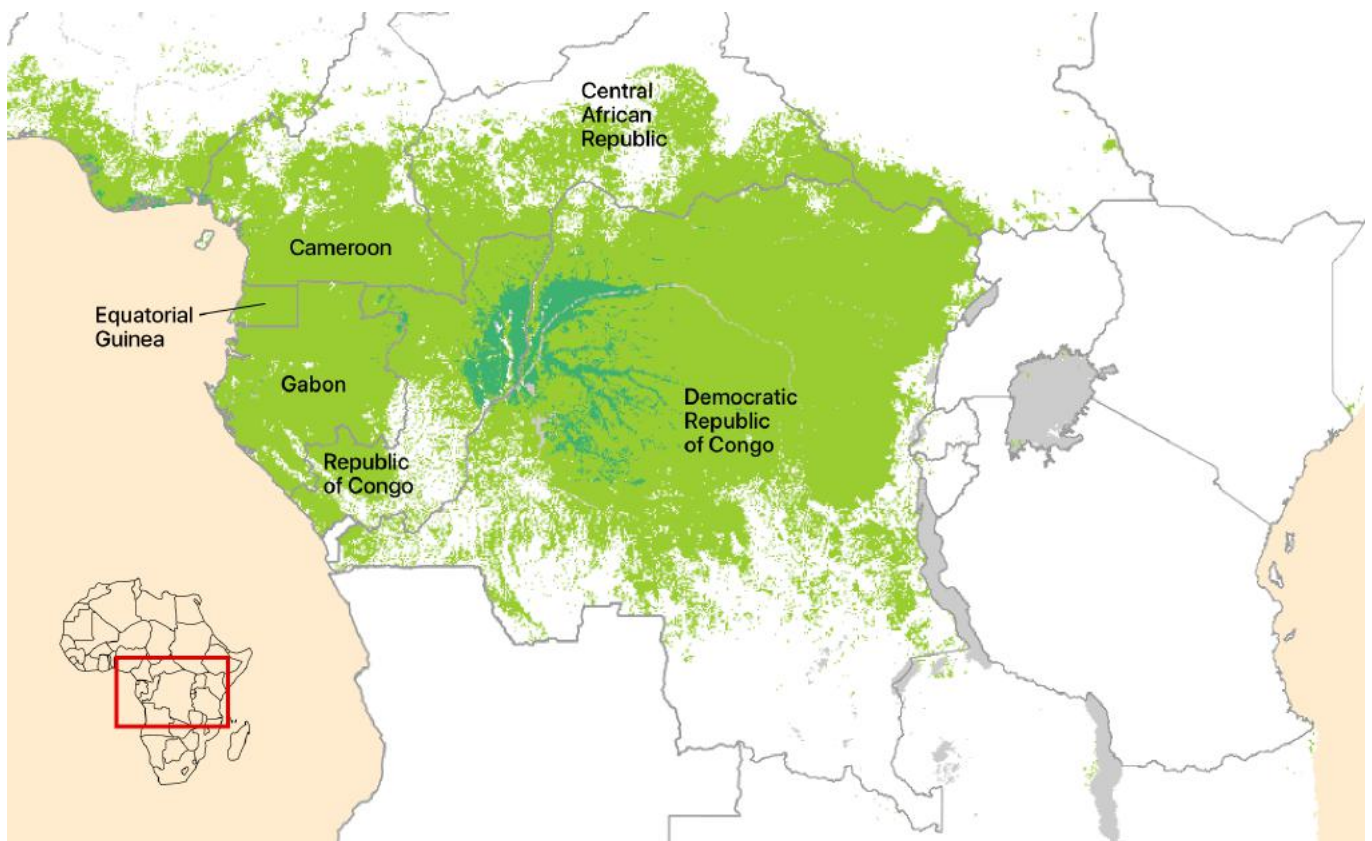
Our use of the term 'Congo Basin' is inclusive, referring to the contiguous humid tropical forests of central Africa, savannas, peatlands, wetlands, mangroves, rivers, lakes, and other ecosystems of the region. We often use 'forests' to mean all the Congo Basin ecosystems. We are inclusive geographically, with climate and some hydrological study regions being much larger than the Congo Basin region itself. The countries with human tropical forest in central Africa are, in order of humid forest area are: Democratic Republic of the Congo, Gabon, Republic of the Congo, Cameroon, Central African Republic and Equatorial Guinea. Our scope of interest is not limited to these countries because of regional-to-global influences of Congo Basin processes, including, river basin drainage, atmospheric moisture transport and biogeographical affinities.

Our understanding of the region's ecosystems, economy and people will be built from new measurements of climate, forests, rivers, biodiversity, land cover, and the socio-ecological systems people have developed, from across the region. We collectively term these systematic new datasets 'The Congo Basin Regional Observatory'. The measurements will cover the major environmental gradients of the region alongside differing levels of anthropogenic disturbance, and include all the major types of land use in the region.

The extensive data will be combined with more intensive measurements at a small number of flagship research sites where we will develop a detailed mechanistic understanding of the climate-forest-water-society system, spanning both largely intact areas and more intensively utilised socio-ecological production landscapes. The mechanistic understanding from the

flagship sites and Congo Basin Regional Observatory data will be used together to model aspects of the system to enable scientists to explore different policy options and the resulting different futures for the region.

Technically, we are proposing harmonised data collection in space and time, with nested locations where we collect more detailed information. This is a hierarchical observation network with cross-sectional and longitudinal data collection (i.e. repeat measurements over time) across sites.

All data will be made free and open access and accessible to accelerate progress, using best practice from elsewhere in the tropics, such as MapBiomass, and disciplines that follow open data policies, including to make all the data machine AI readable. Access will be via internationally recognised repositories and indexed on the CBSI website, or directly on the CBSI website.

We will build on the three-decades of learning on integrating physical, biogeochemical, biological, and human socio-ecological sciences to understand the interactions with and impacts of people on ecosystems, and vice versa, from the International Geosphere–Biosphere Programme, and its successor Future Earth. Specifically, to build databases and networks of researchers to understand the individual parts of these complex systems, recognise and integrate the central role of people in driving environmental change, and work at the science-policy interface to co-produce research questions in order to maximise societal benefits.

A. The Congo Basin Regional Observatory

The Congo Basin Regional Observatory is composed of widely distributed observations across the region under six themes and overarching observatories. These are:

1. Climate – Congo Basin Climate Observatory,

2. Hydrology – Congo Basin Hydrological Observatory,

3. Vegetation, soil and carbon – Congo Basin Vegetation Observatory,

4. Biodiversity – Congo Basin Biodiversity Observatory,

5. Land Cover and Land Use – Congo Basin Land Cover and Land Use Observatory and

6. Socio-ecological and Economic – Congo Basin Socio-ecological and economic Observatory.

These observatories will provide the critical data needed to understand the contemporary status of the region as well as changes in the recent past and insights into sub-regional dynamics. Some important topics, for example, the impacts of fires, may logically fit into more than one category, are allocated to an observatory by experts, in this case land cover and land use, as most fires are anthropogenic.

These extensive datasets will build upon existing networks of ground and remotely sensed observations, to leverage historical data, scientific knowledge and understanding of the newly collected data in the longer-term context. The plan is to create ongoing Observatories that produce standardised quality controlled databases that are open access, freely available and in an integrated platform making them simple to use. We will semi-automate data collection and processing for all observatories to make routine and reduce ongoing costs.

Where relevant we will collect data that are consistent with data from Amazonia and Southeast Asia, for cross continental comparisons and new insights. Datasets will be cross-validated, where possible, particularly using remotely sensed data.

1

Congo Basin Climate Observatory

The *Congo Basin Climate Observatory* would monitor at least 50 locations across the region, generating consistent, quality controlled, and reported meteorological (temperature, rainfall etc) and bioclimatic data that is directly relevant to forests, biodiversity and agriculture (humidity, net radiation, evapotranspiration, etc). This observatory would also include measurements of air quality and particulate black carbon as these can affect human health. This would transform our understanding of the region's climate and our ability to model the future climate of the region. These sites will be used to calibrate and validate satellite measurements of climate parameters locally, in order to improve bassin-wide satellite measurements.

The Congo Basin Climate Observatory would build on national efforts, particularly research strengths in Cameroon in this field, existing ongoing climate data collection reported to the World Meteorological Organisation, pan-Africa efforts, particularly TAHMO (Trans-African Hydro-Meteorological Observatory), and integrate currently independent existing weather stations at field sites, such as at Lopé, Gabon and Yangambi, DRC, and add new locations to improve and balance sampling across the region.

The Congo Basin Climate Observatory will provide an understanding of the climate variability across the region, including heatwaves, flooding events and droughts that can affect tens of millions of people in the region. The new observations also directly link to the Congo Basin Vegetation Observatory enabling us to, for example, assess if the intact forest carbon sink, a high-value ecosystem service that high-emissions countries rely on as part of their net-zero commitments, will increase, remain stable, or decline in the future.

2

Congo Basin Hydrology Observatory

The *Congo Basin Hydrology Observatory*, would install and maintain flow gauges on smaller as well as larger rivers and integrate regionally, building on existing measurements from the <u>Congo Basin Catchment Information System</u>, with stations at locations including near Kisangani, Zinga/Bangui, Ouesso, Kutumuke, Mbandaka (Ruki) and Kinshasa/Brazzaville. This builds understanding of the climate-water part of the system. Continuous monitoring of streamflow and sediment transport into and out of the Cuvette Centrale will help reveal the environmental water requirements required to maintain peatland and other freshwater ecosystems.

Both surface and subsurface measurements will be collected, including surface water extent, groundwater table depths, and water storage volumes, as these are critically important to understand and evaluate the impacts of ongoing and future river basin management and engineering initiatives. Carbon transport and flux measurements from rivers are a critical and often overlooked component of the carbon balance of the Congo Basin region. Localised high-accuracy field measurements will be used, for the first time, to validate and calibrate remotely sensed data (e.g. SWAT), in order to scale the measurements from selected rivers to all the region's 100+ larger rivers.

Given that many communities are susceptible to flooding, including large urban populations, these data are essential to assess the impacts of climate change and are needed to formulate robust climate adaptation plans. This data will also allow the careful assessment of proposed major changes in the region such as the building of hydroelectric dams.

3

Congo Basin Vegetation Observatory

The *Congo Basin Vegetation Observatory*, would include the long-term monitoring of vegetation at a minimum of 1,000 sites across the region, and include some soil and carbon monitoring. This observatory would build on 400 sites of the African Tropical Rainforest Observatory Network, AfriTRON, the Central African Plot Network and others, including intact, logged, fire-impacted, regenerating and secondary forests.

We would extend monitoring to specialised vegetation, including forested peatlands, woodlands, and savannas, such as at Lopé. Soil data would also be collected at sites, alongside soil moisture measurements at the sites with climate measurements, to build an understanding of the climate-vegetation part of the system. Localised high-accuracy field measurements will be used to validate and calibrate remotely sensed data (e.g. BIOMASS), in order to better scale biomass and carbon fluxes to the region.

The Vegetation Observatory data, in combination with the Land Cover and Land Use Observatory data, will enable the quantification of carbon losses from deforestation and forest degradation, and uptake from intact and regenerating forest, and the overall carbon stocks and carbon sink or source for the region, critical data needed to understand the evolution of climate change.

4

Congo Basin Biodiversity Observatory

The *Congo Basin Biodiversity Observatory*, would monitor selected groups from the roughly one million species in Congo Basin, at the same sites where we collect climate, vegetation and soil data. Biodiversity monitoring relies on high-quality taxonomic reference databases. We propose to establish regional reference collections of vertebrates, selected invertebrates and plants, through the reinforcement of existing institutions. A regional database of presence/absence locations of species will be built to allow the production of species distribution models and predict their responses to anthropogenic and climatic changes.

Longitudinal monitoring will include integrated monitoring of elephants, using DNA tracking to reduce cost and increase accuracy; array camera trapping for larger mammals, live trapping for small mammals, regular bird surveys, and newer techniques such as acoustic monitoring for amphibians. For invertebrates, dragon-flies provide a relatively well-known and tractable insect group for monitoring. For freshwater systems fish surveys are essential, particularly given their importance as food across the region, and their economic importance. In addition, data on hunting and 'offtake' rates will help understand hunting pressure levels and inform wildlife management strategies, particularly for endemic species. We will also investigate other innovative technologies, such as DNA barcoding for microbial and fungal diversity, and citizen science approaches where local people monitor biodiversity.

Biodiversity monitoring will help us understand the impacts of changing land use (e.g. logging) and more diffuse threats such as higher temperatures that affect the whole basin. We will also link our monitoring to programs on the emergence of infectious diseases of animal origin (zoonoses), particularly PREZOD (Preventing ZOonotic Disease Emergence), to warn society on how these risks may change in relation to land-use and climatic change, to help avoid future pandemics.

5

Congo Basin Land-Cover and Land-Use Observatory

The *Congo Basin Land-Cover and Land-Use Observatory*, would utilise remotely sensed data, in combination with the Vegetation and Climate Observatories. Given that there are no easily accessible and widely accepted numbers on the area of forest, area of deforestation, carbon stocks of the ecosystems, or carbon fluxes from deforestation, degradation or forest regeneration for the Congo Basin, consensus-based remotely-sensed estimates of the numbers is a central aim of the Land-cover and Land-Use Observatory. Specifically, we aim to produce standardised annual land cover and land use classifications for the region, based on the successful MapBiomass network methodology used in Brazil, and the attribution of land cover changes to land uses, such slash-and-burn agriculture. This can then combine with the Congo Basin Vegetation Observatory to produce state-of-the-art carbon flux assessments.

6

Congo Basin Socio-ecological and Economic Observatory

Finally, creating the *Congo Basin Socio-ecological and Economic Observatory* of consistent, quality controlled, and reported data on household incomes, nutrition, health and how people interact with, value, and utilise natural resources will incorporate the often-neglected human dimension. This would build on existing and underutilised datasets, including Demographic and Health Surveys and household and individual-level (microdata) programs, adding new data on how people interact with, value, and utilise natural resources, particularly forest resources and agriculture, as this link to the environment is often missing from most existing socio-economic data collection, but is essential to understand the Congo Basin region and its future.

The Congo Basin Regional Observatory and its six component Observatories will include major data collection and analysis by regional scientists as part of the Capacity Building Plan (see below), providing a synergistic win-win, by both increasing our understanding of the Congo Basin via high quality data collection, and training a new generation of science leaders.

Further detail on the core data to be collected under each of the six Climate, Vegetation, Hydrological, Biodiversity, Land Cover and Land Use Change, and Socio-Ecological and Economic Observatories can be obtained from the CBSI Secretariat. We will publish more detailed plans for each Observatory and how they interact in a scientific journal in the near future. If you would like to be involved please contact the CBSI Secretariat.

B. Intensive measurements

The extensive *Congo Basin Regional Observatory* measurements are complemented by more detailed observations and experiments at the landscape-scale to gain a mechanistic understanding of the climate-forest-water-society system. This mechanistic understanding is needed to develop representations of parts of the system as mathematical models. These models will be used to make predictions about possible futures for the region.

We also need models to make statements at spatial and temporal scales that matter to people, which might be different from the data we collect. For example, high temperature extremes, measured using infrared cameras, may negatively impact tree photosynthesis, measured at intensive sites on a second-by-second basis, but only for individual leaves at certain times. To estimate what impact this may have, for example, on the forest carbon sink, requires models to scale our observations from individual tree leaves to the whole Congo Basin, and from seconds to decades.

The core of the intensive measurement program is collecting detailed biophysical, biogeochemical, socio-ecological and economic data at a small number of long-term flagship research landscapes. These will be in each major Congo Basin country and include a range of different land cover types and management plans. For example, we expect some sites will compare intact and selectively logged forest, and others include small-scale subsistence agriculture and large-scale commercial agribusinesses. We will build on existing field sites with established research capabilities and infrastructure, and add new sites to balance sampling across the region, to produce standardised quality-controlled datasets across sites that are open access and simple to use. These sites then operate as 'living labs' where we gain detailed insights on these landscapes.

The flagship landscape sites are all part of the Congo Basin Regional Observatory, as part of our nested hierarchical design, but with additional and more detailed measurements. For example, we would add upper-air meteorological measurements to complement surface measurements taken as part of the Climate Observatory. Similarly, we would add an eddy covariance flux tower at each intensive site, to complement inventory datasets collected as part of the Vegetation Observatory, to better understand forest carbon fluxes. And additional real-time measurements of carbon transport and their fluvial fluxes, oxygen, pH and other measurements will complement the Hydrology Observatory extensive measurements.

The additional social, cultural, and economic data will help understand landscape social dynamics, including livelihood dependence on natural resources, access and management of natural resources, and their interactions with other resource users, such as large-scale permit holders (e.g. logging companies). These will help

understand the opportunities and barriers to improving livelihoods and how future changes to the climate-forest-water-society system may impact local communities.

If better management practices are assessed in the region, such as using improved logging or higher-yield agricultural practices, we will target these locations with our standardised intensive measurements protocols to understand their impacts on the wider landscape and wider social dynamics. This new understanding will also allow us to better model future scenarios.

Further details of current field landscape locations as candidate sites, and the core biophysical and socio-economic data to be collected can be obtained from the CBSI Secretariat.

Photo credit: Molly Bergen/WCS, WWF, WRI

Different Futures for the Congo Basin

Interdisciplinary models that investigate different potential futures for the region, sometimes termed 'scenario planning' will address policy options, co-designed by policy advisors and civil society, including addressing the impacts of land-use planning, payments for ecosystem services, and specific policy reforms, such as regulations to allow only low-impact logging. Critically, what policy appraisal needs is high-resolution models, which do not currently exist in the context of the Congo Basin.

These models can also provide early warnings, such as identifying the conditions for potential violent conflicts as the provision of natural resources and other dynamics change under climate change. This will allow timely interventions to avoid destabilising stresses on the region and its people.

Potentially more far-reaching policy options will also be addressed, including implementing suites of measures to advance a greener economy, plus ideas around creating a bio-economy, to investigate development without destruction pathways, and assist informed policy decisions and action at local, national, regional and global levels.

Enhancing the Uses of Science

Science matters. Science allows society to see the present more clearly, and make predictions about the future. The stakes are high, with the fates of millions of people, a global epicentre of biodiversity and the world's second largest rainforest are in danger. Without data, decision-makers face an almost impossible task of avoiding dangerous vulnerabilities if they do not know that these vulnerabilities exist.

CBSI is committed to enhancing the utilisation and impact of science, via wide dissemination and integration into decision-making processes. Our data and analyses will contribute to and strengthen the Central Africa Forest Observatory (OFAC), the technical and scientific unit of the Central African Forests Commission (Commission des forêts d'Afrique centrale – COMIFAC). COMIFAC promotes regional convergence to better manage central Africa's forests, as the body of the Economic Community of Central African States (CEEAC), with responsibility for forests and the environment. As CBSI is a research organisation, data input into OFAC will be via CBSI membership of the Congo Basin Forest Partnership (CBFP).

We recommend investing in CBSI Science-Policy Interface Fellowships, where for the five years of the Fellowship, the recipient scientist sits in a relevant Ministry, such as the Environment Ministry and translates science into meaningful knowledge for policy makers and their advisors, turning scientific evidence into operational knowledge. These Interface Fellows turn complex science into policy action.

Findings will also be presented at annual CBSI science meetings held in the region (see below), and in national forums, to foster a more effective science-policy dialogue within the region. We hope, in time, that the number of trained scientists and ease of access to data and analyses will mean robust scientific knowledge becomes a routine input when decisions are to be made about the management of central African ecosystems.

Capacity Building Plan Overview

CBSI will increase scientific capacity by strengthening existing partnerships and building new ones, to enable long-term investment in institutional capacity, including training scientists and developing improved career pathways for current and future central African scientists, by addressing the unique needs of the region. Researchers in the region have identified the barriers to training more students, retaining more researchers and enabling established academics to do more impactful research analysis.

1. Training Scientists

Our overarching goal is to train hundreds of students across the region to Masters and PhD level to enable them to become experts in their fields. These students will co-create their research and collect the data and analyse it under the Science Plan, providing a synergistic win-win, both transforming our understanding of the Congo Basin and training a new generation of science leaders. CBSI will focus on gaining funds to train hundreds of students through a variety of models from training in the global north, to 'sandwich PhD' with time in two countries, and internationally supported local PhD training. Training students is the base of the capacity building program.

Funders should always include an investment in capacity building and take a proactive role in promoting the inclusion of women and Indigenous Peoples. For Global North universities and their funding agencies this means funding the training of MSc and PhD students, including at Centres of Excellence in the region. Additionally, fee waivers for central African students at Global North universities can help remove one barrier to training.

General scientific and transferable skills (advanced statistics, scientific writing, scientific computing) should be a central part of training. A common learning platform with materials to efficiently transmit knowledge can increase the amount of training small pools of experts can give.

For funders of scientific data collection and analysis, this should include clauses in programs, and commensurate funding, to provide training. Furthermore, they should fund the training and the equipment needed for scientists in the region to repeat or extend all technical activities after external funding finishes. Congo Basin counties could mandate this training in order of overseas funders and researchers accessing field sites.

For students studying in the region, one highly cost effective measure is to provide stipends to local MSc and PhD students to allow them to focus exclusively on their studies. These could be implemented by Congo Basin country governments. These projects can have links to Global North universities via joint supervision of students, or to increase regional mobility and integration, joint supervision in different Congo Basin countries. Adding short-courses, often abroad, to assist with training, and visits to partner institutions.

Similarly, one modest request by scientists in the region that can quickly release existing capacity is for researchers and students in the region to have access to a fund where they can speedily and efficiently apply for small amounts of funding for field data collection, buy equipment, or visit another institution to learn a skill or carry out an analysis. This allows central African researchers to have autonomy to do science, and not be constrained by only participating in projects funded and managed from the Global North.

As with the Science Plan we will build on existing training programs, particularly the Network of Forestry and Environmental Training Institutions of Central Africa (RIFFEAC), comprising twenty-three institutions, and the Research Network on the Forests of Central Africa (R2FAC), of twelve regional universities and international partners.

Photo credit: Jean–Grégoire Kayoum/Vulcar Fate, Belmont Forum

2. Researcher Mobility, Regional Integration, Breaking Silos

Annual CBSI network science meetings, always in the Congo Basin region, will present results to other scientists, policy advisors and civil society. These meetings will break down barriers to central African scientists working together, increase researcher mobility, foster mentorship, encourage cross-disciplinary collaboration, synthesise across disciplines, and disseminate good scientific practices. These annual meetings will also assess further observation, sampling and training needs of the region, providing annual improvements to the CBSI Science Plan and the CBSI Capacity Building Plan.

The travel to annual CBSI meetings can also be used for other activities. A prior CBSI Early Career Researcher (MSc, PhD, post-doctoral researcher) conference, would allow the next generation of researchers to organise themselves, identify their needs, and to raise them at the CBSI meeting. Specific workshops, such as professional development workshops, or field schools or other in-country field visits to allow scientists to see more of the region, could be added to make the most of scientists' travel to the CBSI meeting. We would learn from the experience of global health programs which have experience in these areas.

The annual meeting will give CBSI awards, with modest prize money. For example, a CBSI prize for best student-led publication in various disciplinary categories, and a prize for the best piece of science communication to a broad audience. This engages both senior scientists who judge the prizes as well as Earth Career Researchers. One key outcome of the annual CBSI meetings and associated activities, is a shared sense of purpose and shared community for central African researchers studying the Congo Basin region.

3. Invest in Research Intensive Universities and Institutes

CBSI recommends focussing investments on research-intensive universities and institutes in the region, as these have track records of delivery. These should include funds for research groups to allow them to do more research, and to develop attractive and prestigious posts in central African Universities for academics from the region.

Investments are needed for post-doctoral researchers, given that post-PhD opportunities for research in central African universities only rarely exist. This is a key barrier to overcome. CBSI Future Leaders Fellowships, to provide 5 years of salary and some research and development funding will provide a career pathway to allow the most talented central African researchers to keep doing active research after completing a PhD. This will allow the most gifted African researchers to further their careers after their training at PhD level.

At the career stage of Lecturer or Professor the major barriers to research output are twofold. First, low salaries result in talented researchers either moving abroad, leaving the university sector (often to NGOs), or engaging in paid consultancy at the expense of time spent doing

science. Second, the lack of time (due to the pressures of teaching very large classes), research funding, and facilities to do excellent research. CBSI Research Professor Fellowships, would provide five years of payments to universities to reduce their teaching load, enhanced salary (in agreement with universities), funds for essential research facilities, and funds for a small research group (two PhD students and one post-doctoral researcher), all orientated to tackle important analyses as part of the Science Plan. This will enable the most able senior researchers to produce world-class outputs.

The region's most research-intensive universities, and those best placed to host CBSI Future Leaders Fellowships and CBSI Research Professor Fellowships and postdoctoral research fellows, include University of Yaounde I, University of Dschang, University of Buea, Cameroon; University of Kinshasa, University of Lubumbashi and University of Kisangani, DRC; Marien Ngouabi University, Brazzaville and National Institute of Forestry Research (IRF), Republic of Congo; CENAREST, Institute for Research in Tropical Ecology (IRET) and the University of Science and Technology of Masuku, (USTM) Franceville, Gabon; University of Bangui, Central African Republic, alongside institutions that maintain herbaria and zoological collections that are essential in order to monitor and understand biodiversity.

Photo credit: CRREBaC/CRuHM

4. Invest in Centres of Excellence

Major investments should be made in Centres of Excellence that are well-equipped to conduct training and build research capacity. These should include all the tools needed for productive and high-quality research, including well-equipped office and laboratory space, high-speed internet, necessary software and library subscriptions. Centres of Excellence train

students from anywhere in the region, and internationally, to enable mobility and foster connections across the region and globally.

There should be at least one Centre of Excellence in at least each of the most research intensive Congo Basin countries, DRC, Gabon, Cameroon and the Republic of the Congo. These should build on existing strengths and ideally include one Centre of Excellence that broadly maps onto each of the six Observatories (Climate, Hydrology, Vegetation and Soils, Biodiversity, Land Cover and Land Use, Socio-ecological and Economic Centres of Excellence). This will encourage the pooling of resources, mobility of researchers, and avoid duplication.

Centres of Excellence will be funding-dependent and based on the existing strengths of different countries, and the overall needs of the region. For example, the Centre for Environmental Biogeosciences, due to open in 2025, in Yaoundé, Cameroon, is a joint venture of the Ministry of Scientific Research and Innovation of Cameroon and France's Research Institute for Development, to improve scientific capacity in biogeochemical cycling in pursuit of economic development. A similar proposal for a Peatlands Institute in Brazzaville, Republic of the Congo, is looking for funding to build on national strengths.

CBSI Role

CBSI was formed in response to a _call_ from central African Environment Ministers at the Libreville Congo Basin Science _meeting_ in February 2023. CBSI was formally launched at the Summit of the Three Basins in October 2023. The role of CBSI is to provide consensus research and capacity building plans that are developed by a large community of active research scientists. This will allow many different funders, researchers and research institutions to all play a part in achieving a transformation of our understanding of the Congo Basin while strengthening science capacity in the region. The role of CBSI is a catalyst for increased investment in the region, and not a major holder of funds.

Synthesising Existing Research

The Libreville Congo Basin Science _meeting_ that agreed to form the **Congo Basin Science Initiative**, also agreed to form the **Science Panel for the Congo Basin**. This is a parallel but linked independent platform for scientists from the region to undertake an authoritative and comprehensive multi-disciplinary synthesis of the existing scientific knowledge on the Congo Basin region, its ecosystems and challenges. The Panel will generate a first assessment report by the end of 2025, and throughout the process closely coordinate with the CBSI and its activities.

The **Science Panel for the Congo** is a platform for scientists to synthesise existing knowledge, and to identify the gaps in data, analyses and understanding of the basin; the **Congo Basin Science Initiative** is a platform to drive the investment needed to meet those gaps via new data collection, new analyses and training scientists to do this.

All studentships, fellowships, grants and awards will be open competitions, with clear rules and limited bureaucracy. CBSI will operate in French and English equally. Most of the Congo Basin is Francophone, while English is the language of science because all major science journals are published in English.

CBSI will pursue open science, ensuring that all data and training materials collected under CBSI will be made open access. Data and materials will be stored in an internationally recognised repository, with an index of their availability on the CBSI website, or directly on the CBSI. We will ensure that the different datasets can easily be joined together and are as simple to use as possible. All CBSI projects will archive data, model code and other documentation needed to independently replicate results. We will publish in peer-reviewed

journals, with open access, or open access versions on our website, to ensure that all results can be accessed in Congo Basin countries.

CBSI is managed by a Science Steering Committee composed of 22 leading scientists from Congo Basin countries, specifically, Gabon, Cameroon, DRC, Republic of Congo, Equatorial Guinea, Central African Republic, and international experts, including those from the transformative Amazon Long-Term Biosphere-Atmosphere Experiment Program. Their expertise spans climate, forest, wildlife, carbon, water, soil, social sciences and capacity building. This Concept Note received input from approximately 100 scientists, following circulation to researchers who had published on some aspect of the Congo Basin within the past five years in the peer-reviewed literature.

The Committee is Co-Chaired by **Professor Raphael Tshimanga**, Director, Congo Basin Water Resources Research Center, University of Kinshasa, DRC, and **Professor Simon Lewis**, Chair in Global Change Science, University of Leeds and University College London, UK.

The other twenty members are

- **Dr Wilfried Pokam Mba** *Lecturer, University of Yaoundé, Cameroun;*

- **Professor Lucie Temgoua**, *Lecturer, University of Dschang, Cameroon*;

- **Professor Cyriaque-Rufin Nguimalet**, *Senior Lecturer, University of Bangui, Central African Republic*;

- **Dr Lydie-Stella Koutika**, *Director, Centre de Recherche sur la Durabilité et la Productivité des Plantations Industrielles (CRDPI), Republic of the Congo*;

- **Professor Jean Joël Loumeto**, *Professor, Marien N'GOUABI University, Republic of Congo*;

- **Mr Teodyl Nkuintchua**, *Congo Basin Strategy and Engagement Leader, World Resources Institute Africa, Republic of Congo*;

- **Professeur Michel Bisa Kibul**, *Professor of Political Geography and Political Sciences, University of Kinshasa, Democratic Republic of the Congo*;

- **Professor Corneille Ewango**, *Professor, University of Kisangani, Democratic Republic of the Congo*;

- **Professor Bila-Isia Inogwabini**, *Researcher and Professor, Swedish University of Agricultural Sciences, Sweden; Catholic University of Congo, Democratic Republic of Congo*;

- **Professor Maximiliano Fero Meñe**, *Research Director and Professor, National University of Equatorial Guinea, Equatorial Guinea*;

- **Mr Gaspard Abitsi**, *Country Director – Wildlife Conservation Society (WCS) Gabon programme, Gabon*;

- **Professeur Alfred Ngomanda**, *Commissaire Général (Executive Director), Centre National de la Recherche Scientifique et Technologique (CENAREST) du Gabon*;

- **Dr Georges-Noel Longandjo**, *Research Fellow, University of Cape Town, South Africa and Senior Lecturer, Institut Supérieur des Techniques Appliquées (ISTA), Democratic Republic of Congo*;

- **Professor Carlos Nobre**, *Co-Chair, Science Panel for the Amazon, Professor of Earth System Science, University of Sao Paulo, Brazil*;

- **Dr Gilvan Sampaio De Oliveira**, *Earth Sciences General Coordinator, National Institute for Space Research (INPE), Brazil*;

- **Dr Jean-Jacques Braun**, *Senior Scientist / Director of Research, IRD, French National Research Institute for Sustainable Development, France*;

- **Dr Symphorien Ongolo**, *Research Fellow, IRD, French National Research Institute for Sustainable Development, France*;

- **Professor Nicola (Nicky) Anthony**, *Professor, University of New Orleans, USA*;

- **Dr Michael Keller**, *Research Physical Scientist, USDA Forest Service, International Institute of Tropical Forestry, USA*;

- **Ms Emma Torres**, *Vice President for the Americas, Sustainable Solutions Development Network (SDSN), New York, USA*.

The CBSI website gives short biographies of the Science Steering Committee members.

Contact the Secretariat: info@congobasinscience.net

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Footnotes

1. Inflation-adjusted, because LBA began in 1988, and includes US, EU, UK and Brazilian contributions ↩

2. The meeting also endorsed the establishment of a **Science Panel for the Congo Basin**, a parallel but linked independent platform for scientists from the region to undertake an authoritative and comprehensive multi-disciplinary synthesis of the existing scientific knowledge on the Congo Basin region, its ecosystems and challenges. The Panel will generate a first assessment report by the end of 2025, and throughout the process closely coordinate with the CBSI and its activities, with the Science Panel and Science Initiative providing mutual support. ↩