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Capacity Building in the Congo Basin: rich resources requiring sustainable development

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The Congo Basin is a unique freshwater ecosystem on a grand scale, and it provides multiple services to hundreds of millions of people within the basin. It is also a crucial part of regulating the Earth's water cycle, ultimately affecting all of those outside of the basin. Increasing international attention on its resource potential brings worrying pressures on this understudied region. As researchers, we are racing against time to understand this complex, interconnected system before we lose it, and equitable collaboration is the key to enabling its sustainable development.

A unique system with unique services

The Congo Basin is an especially important ecosystem, not only because it is very large, but also because we are only now beginning to understand the uniqueness of this interconnected ecosystem. This is the second largest river system in the world and supports millions of livelihoods through transport, fishing and timber, and yet we know relatively little about how it functions. As human pressures on the basin's resources grow and international expectations increase, we are in danger of losing this system before we have really begun to understand it. So how can we protect this important system, without holding back the improvement of the lives of those who live within the basin? Sustainable development going forward will rely on a much-improved understanding of the science of the Congo Basin as well as equitable inclusion of those who live in the basin in the decisions being made about the basin.

The Congo river and its interaction with its floodplain is central to the functioning of the basin, as it is in many large river systems. However, the Congo is unique in having one of its steepest reaches near the river mouth rather than the headwaters. The whole river cascades energetically 270 m down to the sea over its last stretch, rather than lazily winding its way to the sea like most river systems. This impressive energy produces plunge pools up to 165 m in depth, creating the deepest river system in the world (Jackson et al 2009). Despite this impressive depth, much of the main river system is also one of the shallowest and widest rivers in the world, as it flows through the Cuvette Central, a large shallow depression in the middle of the African Continent. This depression results in a river through this area that is multi-channelled, ~10 km wide and less than 5 m deep for much of this 1,760 km distance.

This hydrological uniqueness leads to complementary unique ecosystem services within the Basin. While the cascades to the sea prevent ocean going shipping from accessing the centre of the Congo, the vast shallow sloped river running through the Cuvette Central provides incredible transport opportunities throughout the river basin, with more than 25,000 km of navigable rivers. This is especially important in a region with few functioning roads. These transport routes allow connectivity of people who live in the region with the wider ecosystem services provided by the basin, for example, through access to fish and timber for charcoal many hundreds of kilometres from the large population centres such as Kinshasa and Brazzaville, sustaining a combined population of

around 15 million. These services provide livelihoods for hundreds of millions of people who live within the nine countries that form the basin. Reliance on charcoal from the huge forests of the Cuvette Central is especially important due to the high levels of poverty within the basin and the lack of access to electricity.

While we are still working to understand how and when water fluxes transfer between the river and the Cuvette Central (Carr et al 2019), we do know that they are closely coupled and that changes to the river system affect navigation as well as the river's role in sustaining the Cuvette Central wetlands. The tropical rainforest and wetlands of the basin are of major importance, with many unique species and critical ecosystems that are highlighted to be at risk from potential changes to the river system, for example through poorly planned hydropower projects (Winemiller 2016). The World Wildlife Fund estimate that the mosaic of rivers, forests, savannas, swamps and flooded forests, that make up the Congo Basin, support approximately 10,000 species of tropical plants, 30 percent of which are unique to the region. They estimate there are 400 species of mammals, 1,000 species of birds and 700 species of fish. Endangered wildlife include forest elephants, chimpanzees, bonobos, and lowland and mountain gorillas that inhabit the lush forests.

The most extensive peatland complex in the tropics has recently been discovered in the forests of the Cuvette Centrale. The carbon stored in these peat deposits are estimated to be equivalent to the carbon stored in the entirety of above ground rainforest biomass (Dargie 2017). This increases the importance of this region's carbon sink as a vital global asset in mitigating climate change. This also illustrates the wider ecosystem benefits of the basin internationally. Another example of these services is the basin's role in the global water cycle. Tracking moisture flow through the atmosphere using computer models and remote sensing shows that the Congo Basin's moisture recycling, due to its vast forests, plays an important role in sustaining rainfall and thus the provision of freshwater vital for crop irrigation and drinking water in many arid regions outside the basin, for example in the Ethiopian Highlands (Spracklen et al 2012).

Sustainable and Equitable Development is a challenge

Of course, many would argue that the conflicts and political instabilities within in the region have provided some protection for the basin's valuable freshwater ecosystems and therefore development should be prevented. However, the reality is that unsustainable and inequitable exploitation of the region's resources, for example through minerals extraction, has led to continuing instability and drives much of the poverty that we see today. There is no doubt that development is happening one way or another, but it comes down to how we want this to happen and how we ensure it is sustainable.

United Nations population data shows a population growth rate of around 3% per year in the region of the Congo Basin, with a potential to double in 25 – 30 years. The majority of the population have low incomes, relying on rain-fed, subsistence agriculture for their living with slash-and-burn cultivation. There is strong evidence that a cause of a significant proportion of the deforestation in the Congo is somewhat different to other rainforest, driven instead by small scale agricultural clearance (Tyukavina et al. 2018). These practices are linked to the lack of equitable development, rather than just a lack of development, and has resulted in some of the poorest countries on the planet. The reasons behind this poverty are complex and multifaceted, however, external international interests, armed conflict and colonial history, all play a role in holding back equitable development in the region (Olaopa and Ojakorotu, 2016).

Minerals are a well known source of conflict in the region and this has led to notable environmental degradation in parts of the Basin and even measurable impacts on, for example, sediment transport in this great river system (Mushi et al 2019). Timber extraction in the Basin has also become an international focus of resource extraction and illustrates the complex global community chains that

drive these demands. For example, research from *Fuller et al 2019* suggests that US demand for Chinese furniture is correlated with Chinese imports of timber from the basin.

Energy and water within the Congo Basin are also now a strong focus of a variety of “visions” of its future natural resource potential. For example, the plans for the Grand Inga Dam with the potential to have twice the power output of the Three Gorges dam in China. There is also the much talked about inter-basin water transfer from the Oubangui tributary to sustain the water resources in the Lake Chad Basin (Alsdorf 2016).

While these challenges to sustainable development are significant and it is easy to frame them from a negative viewpoint, there are also many positive initiatives and programmes that are making headway. For example, the Brazzaville Declaration in March 2018, is an historic agreement signed to protect the world’s largest tropical peatland. This was signed between the Democratic Republic of Congo (DRC), the Republic of Congo and Indonesia in a declaration that promotes better management and conservation of this globally important carbon store. While a declaration does not automatically confer protection, it is a clear sign that national authorities are committed to a sustainable future in the region. (<https://www.unenvironment.org/news-and-stories/press-release/historic-agreement-signed-protect-worlds-largest-tropical-peatland>)

Another positive example, in March 2019, was the UN announcement of a new conservation programme “Six countries, one forest, one future” for the Congo Basin. The aim of the programme is to create a better enabling environment for forest governance, support land use planning, strengthen the management and financing of protected areas, and decrease the impacts of natural resource use by local communities and the private sector. (<https://www.unenvironment.org/news-and-stories/story/six-countries-one-forest-one-future>)

The important aspect of these positive news stories is their founding on evidence from recent scientific research undertaken within the Basin. Clearly there remains a lot of scientific understanding to be gained by more extensive and interdisciplinary research of the Congo Basin, and that this should be happening sooner rather than later. With the increase in development pressures being brought to bear on this critical river basin, time could be running out to ensure it is developed and managed sustainably.

Given the obvious importance that recent discoveries clearly bestow on the Congo, it is therefore somewhat surprising that earth science research on the Congo Basin has been very limited compared to, for example, the Amazon Basin, with an order of magnitude less earth scientific journal publications (Alsdorf 2016). But why is this? While the remoteness of the basin and GDP make a contribution to the level of scientific knowledge in a basin (Praskievicz 2020), there are also many other factors at play.

A UNESCO investigation into the status of science in the Republic of Congo identifies some key factors: (i) some science governance structures existed only in theory and are poorly funded nationally; (ii) research organisations and wider industry remained isolated from one another and the entire system suffers from a lack of networking and intersectoral cooperation; (iii) research institutions suffered from a severe shortage of facilities, equipment, logistics and administrative and technical personnel; (iv) most importantly since the end of the civil war, Congolese scientists had enjoyed little interaction and only rare exchanges with foreign scientists, as well as limited involvement in regional and international cooperation; and finally, (v) the capacity of science policy-makers and managers was very low. (<http://www.unesco.org/new/en/natural-sciences/science-technology/sti-policy/country-studies/congo/assessment-of-the-state-of-science-and-technology-in-congo/>)

These challenges to home grown science lead to many disparities in terms of opportunities and recognition for local scientists (Atickem and Stenseth 2018). It also results in a very strong bias in the

authorship of scientific publications, and a tendency to relegate a collaborative partner's role to that of a means of conducting fieldwork (Boshoff 2009). Some argue this shows a continued influence of colonialism in science that we must be aware of and address when we practice science in this context (Deb Roy, 2018).

Fortunately, this position is beginning to change with major shifts on policy towards capacity building in order to enable more scientific independence, which is more in line with governments' needs than the past focus on national science institutions (Anderson 2016). Encouragingly there are also Congo specific examples of capacity growth, such as the creation of the "Congo Basin Water Resources Research Center (CRREBaC)", an independent home-grown research body that has developed out of several international and national research collaborations focused on water. (<http://crrebac.org/>)

The way forward and its benefits

While there are obviously some very major challenges to ensuring sustainable development in the Congo Basin, there are equally good reasons to hope for step changes in research investment and output to address these in the future. Based on our own positive experience working on the Congo River users Hydraulics and Morphology project (CRuHM), funded by the Royal Society-DFID, we see some key focus areas in order to achieve this positive outcome for the future.

First, there needs to be an increase in international awareness and therefore research funding, both nationally and internationally. This science funding should be investing in research "in" the Congo and not just research "about" the Congo. To be most effective, these research funds need to primarily increase local research capacity through equal partnership collaborations, as well as deliver high quality research. If there is to be a long-term change in policies and behaviour towards sustainable practices, these research collaborations must be truly equitable. African scientists need to be at the centre of developing this new understanding, so that it is not just "wisdom" provided from afar and is therefore more likely to have impact on local policy makers.

Secondly, international scientists need to truly engage with the region. We need to accept that we have an unfair advantage in terms of resources and opportunities and address this in our research with our partners within the region. We should not be driven by attaining the accolades of science, but by scientific curiosity and friendship. There needs to be a recognition that our partners are not just there to do fieldwork, but have knowledge and expertise that we should respect and engage with, even if this is not always easy due to language or cultural barriers. We must be cognisant of the political and cultural history of the region and how colonial attitudes still affect our view and approach to the region. Collectively we can make a positive contribution to this complex interdisciplinary and multi-national challenge, but it requires respect.

Thirdly, the research needs to engage with those it affects if it is to be sustainable and equitable. Using easily accessible global datasets and models is almost essential for science research in the region due to the vast scale of the basin and the data availability challenges. These can be seen as a tempting route to a quick paper, but we need to remember that these methods have well documented limitations without using ground truthing and a local system understanding. If we are bypassing local institutions due to the challenges of interacting and travelling to the region, we are undermining the development of local capacity to undertake the very measurements that are required by high quality science, and thereby undermining the credibility of our findings.

Finally, we need to make sure our projects and networks are sustained, otherwise all these efforts are self-limiting. This is a huge scientific challenge and we need to be in this for the long term, which means looking and sourcing continued funding for our collaborative efforts. As researchers we must ensure our research is inclusive if we wish it to have impact and this means valuing equally, all those working on this complex system.

This is an exceptionally exciting time for scientific research within this unique basin, as we increase our understanding of how it functions and the links with the ecosystem services it provides. However, we know that the development that is already happening has the potential to irreparably degrade this unique river system and in many cases is not equitable. However, with a collaboratively developed understanding, we will find ourselves in a position where we can provide credible scientific knowledge that can underpin truly sustainable and equitable development within this rapidly changing region.

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