FutureDirections international

INDEPENDENT STRATEGIC ANALYSIS OF AUSTRALIA'S GLOBAL INTERESTS

Strategic Analysis Paper

2 August 2018

Dams in Africa: Balancing Food, Water and Energy Security

Mervyn Piesse
Research Manager
Global Food and Water Crises Research Programme

Key Points

- Electrification rates are low across Africa, with electricity demand much larger than supply. The continent holds enormous hydroelectric potential, less than ten per cent of which is exploited.
- Two countries in particular, Ethiopia and the Democratic Republic of the Congo, have plans to construct large-scale hydroelectric plants. If those dams are not diligently managed, however, they could create more problems than they solve.
- While well-planned dams can bring considerable economic benefits and improve water, food and energy security, they can also have the opposite effect if they are poorly planned or maintained.
- Africa could also learn lessons from the twentieth century dam-building boom and minimise the deleterious effects of reliance on dams.

Summary

For the most part, Africa did not experience the dam-building boom of the late twentieth century, which helped to increase the global food supply, drive industrialisation and improve health outcomes. As a result, it has also avoided the deleterious effects that often accompany large-scale dam projects. As parts of the continent seek to increase their electricity supply, however, hydropower dams are becoming an attractive source of energy. Consideration needs to be given to the interaction between food, water and energy security if the continent is to achieve a sustainable balance between those three resources.

Analysis

Dams and Hydroelectricity in Africa

The world undertook a dam-building boom in the latter half of the twentieth century. The cheap hydroelectricity and freshwater provided by dams helped increase food production through irrigation, provided power for industrial expansion and improved health outcomes through the provision of healthy drinking water and sanitation services.[1] Dams were also partly responsible for the massive increase in the global food supply. In the 50 years to 2000, irrigation nearly tripled, in part due to the construction of storage dams. Irrigated land then covered about 17 per cent of the world's arable land, but produced 40 per cent of its food.[2] For the most part, however, Africa did not participate in this boom, despite an abundance of potential dam sites.

Electrification is currently the main argument for the construction of dams in Africa. Electrification rates are low across the continent and the supply is not able to meet demand. Importantly, that demand continues to grow as the population increases and economic development continues. The continent currently has an installed electricity generation capacity of 147,000MW (for comparison, 1,000MW is enough to power nearly one million European homes), which is only enough to guarantee access to modern energy for one-third of the African population. Access to electricity is high in some African countries, such as Egypt, but across most of the continent access remains low. The divide is most pronounced in rural settlements, where less than 30 per cent of the population has access to electricity. The Programme for Infrastructure in Africa estimates that the African electricity supply will need to increase by at least six per cent each year to 2040, if it is to keep pace with rising demand. Increasing the availability of hydroelectricity is seen as a means of rapidly expanding the African electricity supply.

Hydropower has great appeal to planners as a way of quickly increasing the electricity supply as there are many fast-flowing rivers, such as the Nile, Congo, Niger, Orange and Senegal, which could be harnessed for electricity generation. Hydropower is a major source of electricity for many African countries, particularly in the eastern and southern parts of the continent. About 90 per cent of the electricity generated in Ethiopia, Malawi, Mozambique, Namibia and Zambia comes from hydroelectric plants. In some African countries, such as Egypt, Ghana and Mozambique, hydroelectricity has been used since the 1960s.

During that decade, Egypt built the largest operational hydroelectric plant in Africa, the High Aswan Dam. The dam produces 2,100MW of electricity, which accounted for half of the Egyptian power supply at the time it became fully operational in 1975. It also increased the amount of cultivable land by 20 per cent.[3] One side-effect is that it slows the flow of the Nile to a trickle by the time it reaches the important rice-growing delta, a situation that poses a number of problems. The rising salinisation of the delta and the spread of water hyacinth, an invasive plant that clogs waterways, are the two largest dam-related issues facing the

[1] Steven Solomon, *Water: The Epic Struggle for Wealth, Power, and Civilization*, (Harper Perennial, New York: 2011), p. 357.
[2] *Ibid*, p. 360.
[3] *Ibid*, p. 390.

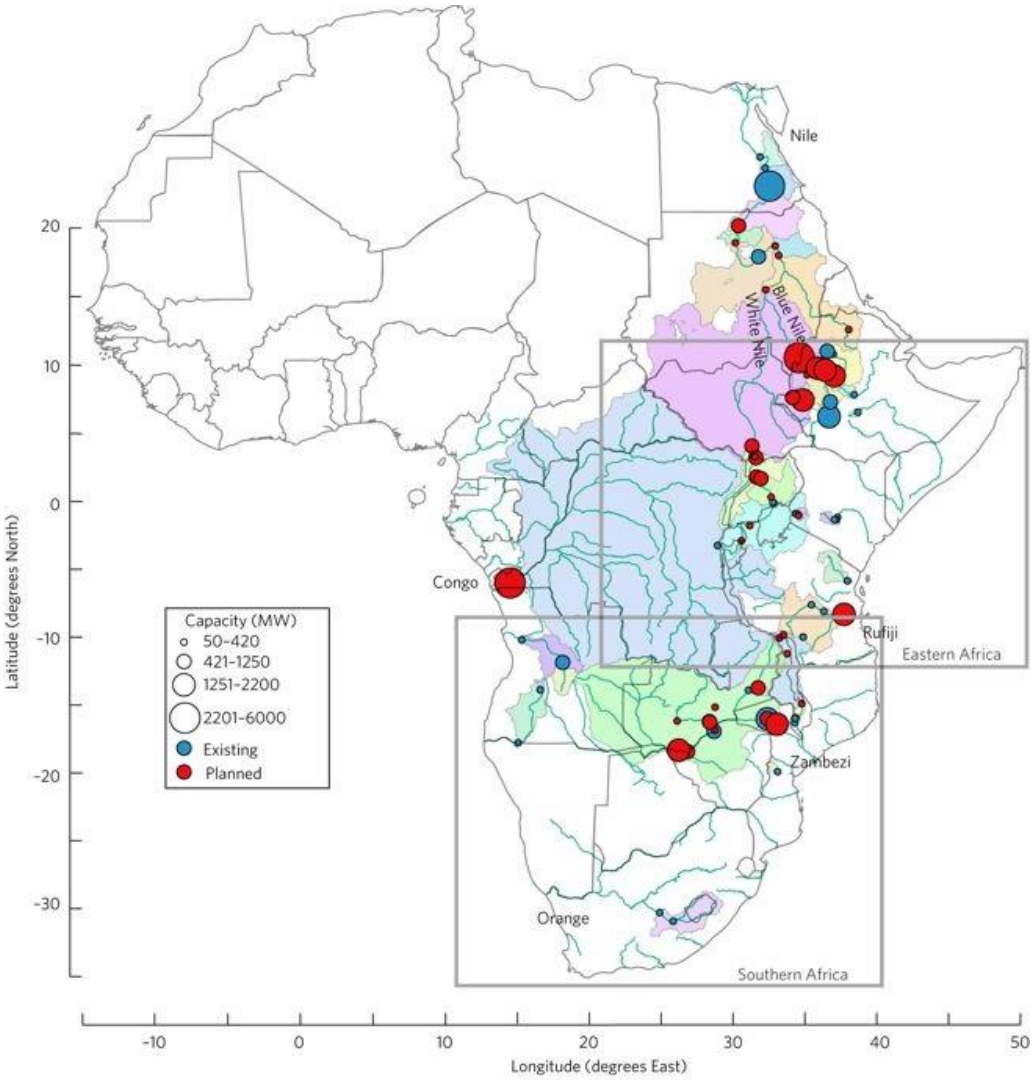
region. The dam also creates more pollution in irrigation channels and slows the flow of sediment, which is vital for the replacement of nutrients in agricultural plots downstream.

Ethiopia views itself as the "water tower of Africa", due to the enormous hydropower potential held in its rivers. That potential is estimated at 45,000MW, enough to meet the demand for almost all of sub-Saharan Africa. It is developing at least 15 new dams on the Nile and Omo Rivers. The Gilgel Gibe project, a cascade of five dams on the Omo River, alone is expected to produce at least 4,700MW of electricity. As the Ethiopian power grid was only able to supply up to 800MW when construction began, it is clear that this project will bring considerable development opportunities to Ethiopia. It could also increase tensions with Egypt, however, which relies on the downstream flow of the Nile for its own dams.

The Gibe III Dam was inaugurated in December 2016, and has the capacity to more than double the country's electricity output. The Ethiopian Government is currently negotiating with Tanzania, South Sudan and Yemen on plans to export some of that electricity to them. The Kenyan Government has already entered into an agreement to purchase 400MW of electricity each year, but, as it is likely to reduce the amount of water flowing into Lake Turkana, that arrangement could present problems for those Kenyans that rely on the lake for their food and water security, and their livelihoods.

The Omo River supplies 80-90 per cent of the water in Lake Turkana and is the only tributary that does not dry out completely during the dry season. There are fears that the dam will reduce the amount of water flowing into the river, increasing salinity and reducing fish stocks. Since the Gibe III reservoir began to fill in 2015, the lake's water level has reportedly fallen by 1.5 metres and fish stocks have declined. There are also fears that the amount of water flowing in the Kenyan portion of the Omo River could fall, as up to half the water could be diverted to Ethiopian sugar plantations. The builders of the dam maintain that once it is fully operational it will reduce the effect of seasonal rainfall variations on agriculture and allow for more stable food production. That is likely to come at a cost to Kenyan producers, however.

The Democratic Republic of Congo is keen to exploit the flow of the Congo River. The flow of the river is consistently strong and, in some parts, the gravitational flow of the water is sufficient to drive turbines to produce electricity, reducing the need for large storage dams. Projects to exploit its hydropower potential have been planned since the 1970s. Two projects, the Inga I and Inga II, were developed in the 1970s and 80s, but have fallen into a state of disrepair due to the long-running civil war and political instability. A long-mooted project, the Inga III, which is partly financed by Chinese construction companies, will generate more power than the High Aswan dam in Egypt, if it is built. The cost of the project, at least US$80 billion ($108 billion), could be prohibitive, particularly as the DRC is a particularly risky country for investors. The project is located in the west of country, far away from the unstable east, which could improve prospects for its eventual construction. Under a deal with Eskom, the South African energy utility, most of the electricity generated by Inga III would be sold to South Africa; although some of it would also be sold to companies that operate in the lucrative DRC mining industry.



Source: D. Conway *et al*. 'Hydropower Plans in Eastern and Southern Africa Increase Risk of Concurrent Climate-Related Electricity Supply Disruption', *Nature Energy*, 2 (2017), pp. 946-953.

Inga III is planned as the third in this series of seven dams. If the DRC builds all seven, they are expected to produce a total of 42,000MW – almost double the electricity produced by the world's largest power station, the Three Gorges Dam in China.

A remarkable amount of hydroelectric potential remains unutilised in Africa. The World Bank estimates that less than ten per cent of its hydropower potential has been harnessed, compared to more than 30 per cent in Europe and 65 per cent globally. Harnessing that unutilised resource would help to increase both the continent's electricity supply and access to irrigated agriculture, but at a cost. Industries and communities that rely on the flow of river water could be disrupted by the changes to the natural flow of water in rivers that are caused by dams.

Challenges to Dams and Hydroelectricity in Africa

The rapid spread of dams in the late twentieth century was not without its problems. Intensive irrigation and inadequate drainage led to increased salinisation, waterlogging and

silt erosion. Increased demand for irrigation water exceeded the supply available from rivers and dams. This led some irrigators to tap into groundwater supplies, in some cases depleting the reservoirs at a much faster rate than they recharged. As a result, about ten per cent of the world's agriculture is believed to be unsustainable in the long term.[4] The 2000 report of the World Commission on Dams also found that, when compared to the projections made prior to their construction, most large dams built during that time ended up: costing far more; profitably irrigating less cropland; producing less hydroelectricity; and delivering less water to cities.[5]

African climatic conditions are not always well suited to dams. African rivers generally carry a high level of sediment, the result of heavy seasonal rains. That heavy sediment load means that dams have shorter lifespans and require more frequent maintenance than those in other parts of the world, where rivers and dams are often filled with snowmelt.

A recent study, suggests that if all the dams that are planned to be built in eastern and southern Africa by 2030 are constructed, 70 per cent of the total hydropower generating capacity in eastern Africa and 59 per cent in southern Africa, will depend on rain in areas that share similar rainfall variability characteristics. That will put the electricity networks of those regions under severe strain during times of drought.

A reliance on hydroelectricity poses problems during times of drought. In December 2017, for instance, the Malawi state-owned electricity company was forced to close a hydropower plant after a severe drought. During the 2015-16 El Niño event, Malawi, Tanzania, Zambia and Zimbabwe also experienced widespread electricity shortages due to reduced rainfall. The economic cost of that shortfall was estimated at 5-7 per cent of gross domestic product. A reliance on hydroelectricity is therefore unlikely to be a panacea for the lack of electricity in Africa.

The water-energy-food nexus recognises the inextricable links between the three resources. To increase the availability of one of these resources, requires a trade off with at least one of the other two. Resource managers understand that food production practices, energy generation and water use must be integrated, if they are to remain sustainable during times of increasing demand.[6]

Conclusion

The planned increase in hydroelectricity generation in Africa presents both significant opportunities and also challenges. On the one hand, it will assist the further economic development of the continent, as greater electrification will help drive industrialisation and support the creation of more secondary and tertiary industries.

An increase in water storage capacity will also assist the agricultural industry, by reducing its reliance on rainfed agriculture. On the other hand, however, an over reliance on dams could

[4] *Ibid*, p. 361-362.
[5] *Ibid*, p. 420.
[6] David L. Feldman, *Water Politics: Governing our most Precious Resource*, (Polity Press, Cambridge: 2017), p. 83.

threaten food, water and energy security during times of drought. It could also present challenges to communities that rely on the natural flow of water in rivers.

Dams present the continent with many opportunities, particularly as many African rivers display the characteristics that make them well suited for the construction of dams. Those opportunities and the accompanying challenges need to be assessed with the water-energy-food nexus in mind. If those African countries discussed above seek to harness the opportunities that their rivers provide, they must also learn from past mistakes and minimise the deleterious effects of a dam building frenzy.

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Published by Future Directions International Pty Ltd.
Suite 5, 202 Hampden Road, Nedlands WA 6009, Australia.
Tel: +61 8 9389 9831 Fax: +61 8 9389 8803
Web: www.futuredirections.org.au