

POLICY POINTS

Assess the needs of the local community and local habitat before planning & implementation of large hydropower projects - including relocation and compensation programs.

Hydropower facilities should concentrate in urban regions with larger populations while rural areas should adopt alternative generation methods.

Stakeholders need to establish malaria prevention programs to prevent dam-induced increase in malaria rates.

Chinese companies investing in Africa should take a more proactive approach when engaging with local workers and communities.

Do China-Financed Dams in Sub-Saharan Africa Improve the Region's Social Welfare? A Case Study of the Impacts of Ghana's Bui Dam

Keyi Tang and Yingjiao Shen

LACK OF ACCESS TO ELECTRICITY IN SUB-SAHARAN AFRICA is a major impediment to the region's economic growth. The scarcity of power generation capacity, transmission, distribution networks, and well-established utility frameworks poses significant challenges to sub-Saharan Africa's socio-economic development. As of 2015, more than 635 million sub-Saharan Africans still lived without electricity.¹

In recent years, China has become an important source of financing and has contributed significantly to generation and transmission capacity in sub-Saharan Africa's power sector, especially hydropower. In spite of the large amount of financing that China has poured into Africa, little research has been done regarding what socio-economic impacts China-financed dams have brought to local households.

In this policy brief, we use an evidence-based approach to analyze the environmental and micro-level socio-economic impacts of China-financed hydropower projects in sub-Saharan Africa. Through the case study of Ghana's Bui Dam, we find that the Bui Dam has improved local urban households' access to electricity and increased their ownership of electric appliances.

BACKGROUND

SUB-SAHARAN AFRICA IS GROWING RAPIDLY, and so is its demand for electricity. Since the early 2000s, the region's gross domestic product (GDP) has doubled.² According to the International Energy Agency's New Policies Scenario in the World Energy Outlook, by 2040, sub-Saharan Africa's electricity demand is expected to triple. To ameliorate the current situation and to meet this rapidly growing energy demand, greater access to capital and technology is urgent for the region.

China has become a major financier of sub-Saharan Africa's energy infrastructure. Chinese power-generation projects include nearly all primary sources, both fossil fuels and renewables, but excludes nuclear. Between 2010 and 2015, Chinese contractors were responsible for 30 percent of the new capacity additions in sub-Saharan Africa.³

China's engagement in the power sector is quite different from its Western counterparts, where donors and contractors from the Organization for Economic Co-operation and Development (OECD) countries tend to shy away from financing large

dams or coal-fired power plants. While traditional Western investors are being scrutinized more strictly, Chinese companies' market share in energy and infrastructure markets in Southeast Asia, Latin America, and Africa has sharply increased.⁴ Hydropower projects are important in this investment transition since Chinese companies are experienced in building dams, and other developing countries perceive hydroelectric dams as cost-effective and clean electrical generators that build up their energy capacity.⁵ Between 2010 and 2020, 56 percent of the total capacity added by Chinese projects will be from renewable sources rather than fossil fuels, and hydropower accounts for 49 percent of these renewable additions. China's active engagement in the power sector has not only brought greater access to electricity but also promoted the diversification of sub-Saharan Africa's power capacity mix along with more renewable energy deployment in the region.

Although the number of China-financed hydropower projects has surged in recent years, few have conducted research on the socio-economic impacts of these energy infrastructures. This is due to several reasons, (1) the Chinese government is not transparent about information regarding how many hydropower projects China has financed and what they are; (2) it is hard to make a macro-level assumption that China-financed large-scale hydropower projects have direct causation with the growth of an African country's per capita GDP because of potential selection bias; and (3) many of the China-financed dams have only recently been completed and put into use, and there are few dams that can actually be used to observe their socio-economic effects.

DATA AND METHODOLOGY

WE SELECTED GHANA'S BUI DAM AS OUR CASE study by reviewing data on Chinese infrastructures in Africa, provided by SAIS-CARI. Among the 34 large-scale China-financed hydropower projects implemented from 2000 to 2015, only 13 have been completed. Of the 13 completed, we found that only three had been completed in the past five years. Bui Dam is among those recently completed which allowed us to observe how socio-economic household indicators differed before and after the dam was constructed. The government of Ghana has also published information regarding the Bui Dam through the Bui Dam Authority, which makes it easier to identify the final destination of the electricity generated by the Bui Dam. We compare region-level data of household characteristics with what the government claims to determine whether they were right about these projects bringing positive socio-economic effects to local households.

Focusing on the Bui Dam, we analyze Ghanaian households' living standard indicators using data from the Demographic and Health Surveys (DHS) program. We compare the living standards of households living within and outside the regions where the Bui Dam transmitted electricity to, before, and after the Bui Dam was built, as well as between urban and rural households. The key social welfare indicators we focus on include: the rate of households' access to electricity; the rate of households' possession of electric appliances such as refrigerators, computers, televisions, radios, telephones, and mobile telephones; as well as households' ownership of preventative measures against malaria, such as mosquito bed nets.

To make a comparison between regions with and without electricity transmitted from the Bui Dam, we set our treatment group to include households located in the four regions that receive electricity transmitted from the Bui Dam: Brong-Ahafo, Northern, Upper West, and Upper East. Because Ghana only has ten administrative regions, and to ensure that we can compare more observations to achieve significant results, we include households living in all of the remaining six regions as the control group: Western, Ashanti, Central, Eastern, Greater Accra, and Volta.

Because the Bui Dam was completed in 2013, to make a comparison of the period before and after the dam, we use DHS 2008 indicators before the Bui Dam's completion, and DHS 2014 and MIS 2016 for indicators after completion.⁶ We chose these years because the most recent DHS program data on Ghana was collected in 2008, 2014, and 2016. Altogether, there are 29,454 observations in this repeated cross-sectional database.

We use two difference-in-differences (DiD) models to evaluate the Bui Dam's socio-economic impacts. The first DiD estimator shows the aggregate changes of influences in different regions over time, while the triple DiD model adds an urban dummy variable to show the urban-rural disparity in the influences of the Bui Dam.

Lastly, we also address the major concern that has been raised regarding the Bui Dam and other China-financed large-scale hydropower projects in Africa. These projects may have negative environmental impacts by changing the environment and affecting land use, relocating and failing to resettle communities, and harming natural habitats in the dam area.

MAIN FINDINGS AND DISCUSSION

1. After the Bui Dam's completion, the likelihood of all households in the treatment group having access

to electricity has been enhanced, increasing by 4.16 percent in comparison to before the Bui Dam's establishment. However, increased access to electricity is larger if we only consider urban households, which saw their access to electricity increase by 14.7 percent after the treatment. This implies that Bui Dam-generated electricity may have been largely transmitted to urban households.

2. The rural-urban disparity in the improvement of access to electricity may be related to the lack of rural electrification infrastructure and the so-called last-mile problem. Ghana's electricity transmission system consists of an interconnected system of lines, distribution centers, control plants, and substations connecting urban areas. Under the framework of Ghana's Universal National Tariff, rural households have to pay a large portion of their income for high-priced electricity to subsidize the cost of extending rural extension transmission lines if they want access to electricity. Due to the high cost of connecting individual households to the grid, small-scale or rural communities may choose to substitute expensive grid-based electricity with more affordable directly generated electricity through solar panels and batteries.
3. We do not find significant results in the Bui Dam's impact on the rate of using electricity to cook. Cooking using electricity requires some electric implements, such as electric cooktops, which are relatively more expensive and may be unaffordable for Ghanaians, especially those from less developed Northern Ghana (the treatment regions).
4. We find that urban households alone enjoyed an increase of 4.83, 12.3, and 20.8 percent respectively in the ownership of computers, refrigerators, and TVs. However, when we consider both urban and rural households, the overall rate of household ownership of computers, refrigerators, and TVs decreased by 2.37, 3.31, and 2.85 percent respectively. This may indicate that urban households had a higher consumption and ownership of these appliances after the construction of the Bui Dam.
5. While urban households witnessed a faster increase in computer, refrigerator, and television ownership, rural households saw a higher increase of telephone and mobile phone ownership. This might be because

urban households have a relatively higher income to afford comparatively more expensive and high-energy-consuming appliances. In contrast, low-wattage appliances, such as radios, telephones, and mobile phones may be more affordable and accessible for rural households due to their lower cost of use.

6. A further breakdown of ownership by households' wealth of computers, refrigerators, and TVs shows that the decreasing trend of overall ownership of these appliances might be caused by the fact that the rich are far more likely to have the means to buy these appliances. The relatively smaller increase of ownership among richer households in the dam areas offsets the relatively faster increase of their ownership among poor households. Part of the relatively low impact on high-income households may be explained by the fact that they already owned many of these appliances, so the dam had a relatively small effect on them.
7. On average, in the dam regions, the likelihood for an urban household to have a mosquito bed net has increased by 10.3 percent after the Bui Dam's construction, and the number of mosquito bed nets an urban household possessed increased by 0.23 percent. The improvement in ownership of mosquito bed nets shows that household malaria prevention may be related to the Bui Dam Authority's efforts to improve the healthcare of local communities.
8. Compared to other previously built dams, Sinohydro, the Chinese Communist Party, and the Bui Dam Authority designed and prepared for the Bui Dam project in better ways, including a more comprehensive resettlement program, activities that helped expatriates and local workers to have a more harmonious relationship, and creation of medical facilities for combating malaria and other waterborne diseases.

POLICY RECOMMENDATIONS

1. Before the planning and implementation phases of large hydropower projects in Africa, it is critical to assess the local habitats as well as to inquire about the needs of local communities. Relocation and compensations programs should be curated and discussed at an early stage to minimize the potential conflicts among different stakeholders.

2. Large hydropower facilities, by their nature, are more cost-effective in urban regions with larger populations. On the contrary, rural areas with sparser populations should be encouraged to adopt alternative generation methods that require lower connection costs, such as solar panels and wind turbines.
3. To prevent a dam-induced increase in malaria rates in dam regions, stakeholders need to establish malaria prevention programs, including educational programs and malaria-targeted subsidiaries to facilitate a higher usage of mosquito nets. In addition, communities should have local health facilities to offer necessary treatments.
4. When Chinese companies decide to invest in or build large infrastructure projects based in Africa, they should take a more proactive approach to better engage with the local workers and communities. Resettlement programs and activities should be designed to boost mutual relationships among different interest groups.★
3. “Boosting the Power Sector in Sub-Saharan Africa,” International Energy Agency, 2016.
4. Oliver Hensengerth, “Chinese Hydropower Companies and Environmental Norms in Countries of the Global South: The Involvement of Sinohydro in Ghana’s Bui Dam,” *SpringerLink*, Springer, Dordrecht, 2 Nov. 2012, link.springer.com/article/10.1007/s10668-012-9410-4.
5. G.R. Timilsina, Gouvello, C., Thioye, M., & Dayo, F. B, “Clean development mechanism potential and challenges in Sub-Saharan Africa,” *Mitigation and Adaptation Strategies for Global Change*, 2010.
6. DHS and MIS are both conducted by the DHS program, the difference is that the Demographic and Health Surveys (DHS) provides data of monitoring and impact evaluation indicators in the areas of population, health, and nutrition, while Malaria Indicator Surveys (MIS) include not only household traits data similar to DHS, but extra information on prevention of malaria.

ENDNOTES

1. “Boosting the Power Sector in Sub-Saharan Africa-China’s Involvement,” International Energy Agency, 2016, www.oecd.org/publications/boosting-the-power-sector-in-sub-saharan-africa-9789264262706-en.htm.
2. “Regional Economic Outlook: Sub-Saharan Africa,” International Monetary Fund, 2015, www.imf.org/en/Publications/REO/SSA/Issues/2017/05/03/sre00517.

AUTHORS

KEYI TANG is a M.A. student of International Economics at the Hopkins-Nanjing Center. As a Nanjing Scholar at SAIS D.C., she conducted empirical and field research on China’s hydropower projects in Ghana and China’s special economic zones in Ethiopia and Vietnam. She holds a B.A. from Nanjing University in English Language and Literature.

YINGJIAO SHEN is currently an Arabic and Chinese research analyst at Duff and Phelps. From 2016 to 2018 she worked at CARI as a research assistant where she mainly focused on the North Africa region and conducted research in English, Chinese, Arabic, and French. Shen earned her M.A. from Johns Hopkins SAIS in the Spring of 2018.

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SAIS China-Africa Research Initiative
1717 Massachusetts Ave NW, Suite 733
Washington, DC 20036
www.sais-cari.org
Email: sais-cari@jhu.edu

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