

The Grand Ethiopian Renaissance Dam (GERD) Project in Northeast Africa

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Abstract

The development and construction of the Grand Ethiopian Renaissance Dam (GERD) stands as a geopolitical conflict in Northeast Africa, including mainly Ethiopia and Egypt, two regional powers that depend economically and socially on the Nile River for their development. Ethiopia endorses the dam as necessary for promoting economic growth, producing energy, reducing poverty, and providing electricity to its expanding population, generating approximately 5,150 megawatts of hydroelectric power. Egypt, conversely, whose daily essentials are heavily dependent on the Nile, especially to satisfy its freshwater needs, views the dam as a threat to its water security because it fears that it will limit the amount of water flowing into Egypt from upstream. In addition to being a source of energy production, the GERD presents significant challenges to the environment and agriculture. A prominent example is the changes in water flow, which could negatively impact ecosystems, soil fertility, and agricultural practices in other downstream countries such as Sudan and Egypt. Furthermore, the dam has increased tension regarding past water agreements that did not include upstream countries and therefore highlights inequities in how resources are distributed. These unresolved tensions have also drawn in the wider international community, with organizations such as the United Nations and the African Union, as well as major powers like the United States and China, becoming increasingly involved in efforts to mediate the dispute. In conclusion, while the GERD presents considerable opportunities for regional energy development, it also poses significant challenges to environmental sustainability and diplomacy. The GERD's impacts illustrate the necessity for collaboration, dialogue, and effective water governance amongst the Nile basin countries. Ultimately, this paper argues that the GERD's long-term benefits outweigh its risks, provided that all riparian states commit to cooperative and transparent water management.

Introduction

The Nile River is the primary water source for northeastern Africa, sustaining agriculture, drinking water supply, and economic activity across several countries in an otherwise arid region. Because it is shared by multiple riparian states, its waters are central to regional cooperation and tension, making it a critical geopolitical lifeline in the context of projects like the Grand Ethiopian Renaissance Dam. Egypt relies almost entirely on the Nile River for its freshwater supply, making the river essential for agriculture, drinking water, and national survival. Colonial-era agreements in the 20th century, particularly those made in 1929 and 1959, allocated the vast majority of Nile waters to Egypt and Sudan, while excluding upstream states from meaningful participation. As a result, Ethiopia historically had limited formal rights over the river despite contributing most of its water through the Blue Nile, creating long-standing tensions in Nile Basin governance.

The Grand Ethiopian Renaissance Dam is a multi-year project in Northeast Africa. It was completed in 2023 but officially inaugurated in 2025, having taken 12 years to build and costing approximately $4-5 billion. The GERD was constructed for a variety of reasons. Primarily, it enables Ethiopia to regulate its water supply, ensuring sufficient access to water for its population of approximately 139 million people. A further key objective of the dam is the generation of hydroelectric power (HEP), which refers to electricity generated by the movement of water through turbines in the dam. Ethiopia requires increased electricity production to support economic development and improve the quality of life for Ethiopians, as fewer than 55% of the population had access to electricity as of 2022 (World Bank, 2025). Ethiopia presented the GERD as a developmental milestone aimed at poverty reduction and energy self-sufficiency. For Egypt and Sudan, however, the project's unilateral management is perceived as a significant risk to water security, particularly due to concerns over changes in Nile water flow.

The dam is located in the Benishangul-Gumuz Region of Ethiopia, on the Blue Nile River. GERD is a 5,150 MW hydropower plant, located about 30 km upstream of the border with Sudan. Owned and operated by the Ethiopian Electric Power company, the 145-m-tall roller-compacted concrete gravity dam floods 1,874 km2 at a normal pool elevation of 640 m, and has a tributary catchment of 172,250 km2. With a volume of 74 km3 (of which 14.8 km3 is dead storage), the reservoir can hold about 1.6 years' worth of average flow of the Blue Nile - 48.5 km3/yr - at the El Diem gage station, just below the border in Sudan. The Grand Ethiopian Renaissance Dam (GERD) is a major infrastructure project and Africa's largest hydropower plant, aiming to address Ethiopia's electricity shortages and support long-term industrial development. It therefore becomes evident that, while the Grand Ethiopian Renaissance Dam represents a major opportunity for energy production and economic development in the Nile Basin region, it also poses significant environmental, legal, and geopolitical challenges, making regional cooperation and effective water governance essential for long-term stability.

This research paper examines both the potential benefits and drawbacks of the development of the Grand Ethiopian Renaissance Dam (GERD), focusing on its implications for Ethiopia, Egypt, and Sudan. In doing so, it investigates how the project influences energy development, water security, and diplomatic relations among these states. This paper ultimately argues that the GERD's benefits outweigh its risks when supported by cooperative water management among riparian states.

Key terms and definitions

Dam: A dam is a structure built across a river or stream to control or redirect the flow of water, typically for purposes such as irrigation, flood control, or electricity generation. The GERD dam is the largest hydroelectric power plant in Africa and among the 20 largest in the world. Unlike smaller

dams built for local use, GERD's scale allows it to regulate the flow of an entire transboundary river system, which is precisely why its construction has become a matter of national security for downstream countries rather than a purely domestic infrastructure project.

Reservoir: A natural or artificial body of stored water. GERD's reservoir stores water for hydropower generation, making its filling process a key issue for downstream countries. If Ethiopia fills the reservoir rapidly, it temporarily reduces the flow of the Nile to downstream countries like Sudan and Egypt, which rely heavily on that water for agriculture, drinking supply, and energy. A slower, staged filling spreads that impact over more years, reducing the immediate strain but delaying full power generation from the dam.

Riparian states: Sovereign countries, or regional entities, that share a common border along a transboundary watercourse, such as a river, lake, or aquifer. The Nile Basin includes eleven riparian states. However, in the context of the Grand Ethiopian Renaissance Dam, the primary riparian actors are Ethiopia, Sudan, and Egypt. These states must coordinate water allocation and infrastructure development along the Nile River, particularly regarding the management and filling of the GERD reservoir.

Basin: A hydrological system consisting of a land area where all precipitation and surface water drain into a common outlet, such as a river, lake, or sea. River basins are often transboundary, meaning they extend across multiple countries and require shared management of water resources.

Sahel Region: The Sahel is a 6,000-kilometer-long semi-arid transition zone spanning from the Atlantic Ocean to the Red Sea, separating the Sahara Desert to the north and the savannas to the south. The Grand Ethiopian Renaissance Dam is not directly connected to the Sahel geographically or hydrologically, but both regions face similar challenges of water scarcity, climate variability, and resource management. The GERD also serves as a key example of transboundary water governance, which is relevant to addressing shared water issues across African regions, including the Sahel.

Nile River: The Nile River, traditionally considered the world's longest river at roughly 6,650 kilometers (4,130 miles), is a vital lifeline in Northeastern Africa, flowing through 11 countries before emptying into the Mediterranean Sea. The dam directly regulates the Nile system by controlling flow on the Blue Nile, its primary tributary.

Blue Nile River: A major tributary of the Nile River, originating at Lake Tana in Ethiopia and flowing approximately 1,450 km (900 mi) through Ethiopia and Sudan. It contributes around 59% of the Nile's total annual flow on its own, though this rises to roughly 80–85% when combined with other Ethiopian tributaries such as the Atbara River.

White Nile River: One of the two main tributaries of the Nile River, the White Nile flows approximately 3,700 km (2,300 miles) from Lake Victoria through Uganda and South Sudan into Sudan, where it joins the Blue Nile at Khartoum. Only after this confluence does the main Nile continue northward into Egypt. The White Nile is characterized by a relatively steady and consistent year-round flow, although its discharge is lower than that of the Blue Nile. Unlike the Blue Nile, the White Nile is not affected by the GERD's filling and operation, making it a stable water source regardless of the dam's management.

Potential benefits from the development of the Grand Ethiopian Renaissance Dam (GERD)

The Grand Ethiopian Renaissance Dam (GERD), Africa's largest hydroelectric power plant with a capacity of over 5,000 MW, serves a pivotal role in transforming the energy production and distribution sector. By significantly expanding electricity supply, it enables Ethiopia to meet growing domestic demand while exporting electricity to neighbouring countries such as Sudan and Kenya. Such regional energy integration has the potential to foster stability and deepen economic cooperation. For Ethiopia specifically, access to affordable and reliable electricity is expected to accelerate industrial development and attract foreign investment. Sudan and other neighbouring states similarly stand to benefit from access to affordable electricity, reducing their dependence on more costly energy sources. These direct benefits, such as electricity generation and distribution, lead to significant indirect benefits. Increased availability of electricity supports job creation and the growth of small and medium enterprises. This growth in employment, in turn, directly strengthens essential public services such as healthcare facilities, schools, and infrastructure, all of which depend on a reliable energy supply to function effectively. As a result, living standards are expected to improve significantly, particularly in rural areas, where, as of 2022, fewer than 55% of Ethiopians had access to electricity, through greater access to lighting, communications technology, and modern services.

Beyond energy production, the GERD plays a significant role in regulating the flow of the Nile River, especially in reducing the risks of both floods and droughts across the region. This control of water release provides a more reliable source of water for irrigation, which is essential for agricultural productivity. Furthermore, farmers in Sudan and Ethiopia can benefit from more predictable planting and harvesting cycles, reducing seasonal uncertainty and improving overall agricultural efficiency. As a result, agricultural output and crop yields are expected to increase, contributing to greater food security across the region. Sudan in particular benefits from flood prevention, which protects agricultural land and infrastructure while also reducing soil erosion. Apart from Sudan, the GERD also

enables Ethiopia to store water reserves, strengthening the country's resilience to climate change and seasonal droughts. On the other hand, Egypt gains future advantages in the event of cooperative management of water, potentially gaining more predictable water flows from regulated dam releases. These direct benefits lead to indirect outcomes, such as improved economic stability and livelihoods for farming communities.

The construction of the GERD has the potential to foster cooperation among Nile Basin countries, particularly Ethiopia, Sudan, and Egypt, through energy trade and shared water management. Energy trade can lay the foundation for collaboration as Ethiopia's export of electricity to neighbouring countries creates economic interrelations and promotes ongoing communication. Such economic interdependence can build trust, as all parties share a vested interest in maintaining stable energy access. The second factor promoting cooperation between Ethiopia, Sudan, and Egypt is the necessity to manage their water resources. Sustained dialogue and the pursuit of mutual agreements have the potential to deepen collaboration and reduce the misunderstandings that have historically fuelled tensions. Moreover, should the parties reach a formal agreement on water distribution in the Nile River, this would make future conflicts over water usage significantly less likely. Over time, these processes of energy exchange and water diplomacy could establish a framework of mutual interdependence, in which all parties recognize that cooperation, rather than conflict, offers the most viable path to long-term economic and social stability.

Potential negative impacts from the development of the Grand Ethiopian Renaissance Dam (GERD)

One of the most significant concerns surrounding the Grand Ethiopian Renaissance Dam (GERD) is its potential impact on downstream water availability. Alterations in the Nile River's flow, whether during the reservoir's filling phase or its ongoing operation, might heighten the risk of water shortages and, as a result, food insecurity in nations that rely heavily on its waters. The construction of the GERD might limit water flow to countries downstream, especially during the reservoir filling phase or extended dry spells. Egypt mainly depends on the Nile River for its freshwater needs, such as drinking water, agriculture, industrial uses, and electricity generation. Given that a large part of Egypt consists of desert, and most of the populace resides in the Nile Valley and Delta, there are limited additional water sources accessible. This reliance is heightened by the dry conditions of the Sahara Desert and the Sahel area, which face very low precipitation, regular droughts, desert expansion, and escalating effects of climate change. If Ethiopia fills or operates the GERD reservoir without adequate coordination, reduced water may flow to downstream nations, particularly in drought periods. Decreased water levels could dramatically hinder agricultural output in Egypt,

where crops like wheat, rice, cotton, and vegetables rely on regular irrigation from the Nile. Decreased harvests may elevate food insecurity, lead to a higher dependence on imported food, and result in escalating food prices. As Egypt's population surpasses 100 million and Sudan's population grows quickly, the need for water and food keeps rising. As a result, even minor decreases in Nile water flow might exacerbate poverty, add pressure on national economies, and heighten the threat of famine in at-risk populations. Lower downstream water levels may result in diminished water storage in Lake Nasser, causing a drop in electricity production at the Aswan High Dam and increasing strain on Egypt’s energy resources. Due to its significant reliance on the Nile, Egypt perceives the GERD as both an environmental and economic concern as well as a national security issue. A considerable decrease in water supply can impact food production, energy production, and overall economic stability. As a result, Egyptian officials have consistently raised alarms that sole control of the dam might jeopardize the nation’s long-term stability and heighten conflicts among the Nile Basin’s riparian states.

The possibility of Ethiopia using the GERD to gain political power over its neighboring countries is a major concern. Since the GERD sits atop the Blue Nile, whose waters, originating in the Ethiopian Highlands, ultimately supply the majority of Egypt's Nile flow, Ethiopia effectively gains significant political leverage over the entire region. This dynamic is often discussed through the concept of hydro-hegemony, a framework describing how a state can gain political and strategic influence by controlling shared water resources. Many analysts argue that the GERD significantly strengthens Ethiopia's hydro-hegemonic position in the region. For Egypt specifically, this raises a concrete fear that Ethiopia could manipulate water releases during future disagreements, potentially forcing Egypt into diplomatic concessions or policy changes under the implicit threat of water restrictions. Sudan's position is similarly difficult. While it stands to benefit from improved flood control, it also shares Egypt's concerns about unpredictable dam management. The situation is made worse by the absence of a valid, legally binding long-term agreement on water distribution and dam management. Despite the 2015 Declaration of Principles signed by Ethiopia, Egypt, and Sudan, there are no established methods for ensuring compliance or independent international monitoring. As a result, diplomatic pressure is amplified and trust between the parties is reduced. This combination of concentrated control and weak legal oversight leaves both Egypt and Sudan vulnerable to unpredictable water policy, raising the risk of deepening regional competition and further disputes over water in Northeast Africa.

Impact on the International Community

Both the United Nations and the African Union have primarily focused on encouraging dialogue among Ethiopia, Sudan, and Egypt over the construction, operation, and filling of the GERD. More

specifically, the UN Security Council, which Egypt formally petitioned on June 19, 2020, has called for further negotiations regarding the dam's functioning. Although the matter has been discussed within the UN, a binding resolution is yet to be adopted, reflecting the broader difficulty of applying international law to transboundary water disputes and calling for a regional, African-led solution. The African Union has made more attempts to mediate the disagreement by organizing numerous negotiating sessions involving all three countries. The AU has consistently advocated that there should be a "cooperative, African-led solution," which is based on a compromise and a search for joint interests, rather than conflict and competition among the nations. Finally, both organizations have emphasized the importance of information sharing about the dam's activities, transparency concerning the processes involved, and the adoption of enforceable international agreements on the issue. In March 2015, Ethiopia, Egypt, and Sudan signed the Declaration of Principles, formally acknowledging their shared reliance on the Nile and committing to a set of guiding principles for the GERD's development (Agreement on Declaration of Principles, 2015). Ultimately, both the UN and the AU have stressed that confidence-building measures and sustained multilateral engagement remain essential to preventing further escalation of one of Africa's most consequential transboundary disputes.

Alongside the United Nations and the African Union, the GERD conflict has garnered significant focus from the broader international community, particularly from major powers like the United States and China, which possess strategic, political, and economic interests in the Nile Basin and the Horn of Africa, rendering regional stability a critical priority. The United States has consistently encouraged Ethiopia, Egypt, and Sudan to achieve a peaceful, legally binding agreement regarding the dam's filling and operation. It has been involved in mediation initiatives, including discussions conducted in Washington, D.C., and has emphasized diplomacy, international law, and collaboration instead of conflict. The US worries that ongoing tensions might threaten regional security, increase instability, and, given the broader importance of the Horn of Africa, potentially spill over into concerns about nearby trade routes like the Red Sea and the Suez Canal. In contrast to the United States' direct diplomatic mediation, China has taken a fundamentally different approach to the dispute, prioritizing economic collaboration and infrastructure funding over political intervention. As a major investor in Africa, China has financed and aided numerous energy, transport, and development initiatives across Ethiopia and the broader region via its Belt and Road Initiative. Because Ethiopia is a key partner within this framework, China has a direct financial incentive in maintaining regional stability, since ongoing conflict could jeopardize its existing investments and future economic access to the region. As a result, while China has largely refrained from taking sides in the dispute itself, it has repeatedly encouraged discussion and peaceful negotiation among the three nations. Various global entities, such as the European Union, the World Bank, and numerous development organizations, have similarly promoted discussions and collaborative water

management. The World Bank, for instance, approved a $30 million grant in March 2021 to the Nile Basin Initiative for the Nile Cooperation for Climate Resilience Project, supporting broader regional cooperation mechanisms such as dam safety and flood forecasting (World Bank, 2021). These organizations acknowledge the GERD's capability to boost renewable energy generation and stimulate regional economic growth, yet they are also aware of the dangers linked to one-sided decision-making. Overall, the global community views the GERD as beyond a mere regional conflict. It is progressively recognized as a worldwide illustration of the difficulties in managing shared water resources amid climate change and sustainability issues.

Conclusion

The Grand Ethiopian Renaissance Dam is both a transformative development project and a source of significant regional tension in Northeast Africa. Throughout this paper, its potential benefits have been examined, including increased hydroelectric power generation, economic growth, improved energy access, enhanced water regulation, as well as opportunities for regional cooperation. At the same time, the paper has highlighted important concerns regarding water security, environmental impacts, and geopolitical tensions, particularly for Egypt and Sudan. While the risks associated with reservoir management and transboundary water governance cannot be ignored, the evidence suggests that the GERD's long-term benefits outweigh its disadvantages when supported by effective cooperation and transparent management. Therefore, although the project presents substantial challenges, it also offers a unique opportunity to promote sustainable development and regional integration within the Nile Basin. As argued throughout this paper, the success of the GERD ultimately depends on balancing national development goals with the shared interests of all riparian states.

The Grand Ethiopian Renaissance Dam marks a historic turning point for regional energy independence, achieved predominantly through domestic funding. However, its long-term success will continue to depend on reaching a unified water-sharing agreement that safeguards downstream nations and secures regional stability. Given that no such binding agreement currently exists, this topic remains highly relevant for continued research and monitoring in the years ahead, particularly now that the dam is fully operational and long-term water management decisions will begin to shape the region's future.

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