Quantifying the Economic Impact of the Grand Ethiopian Renaissance Dam on the Nile River Basin

(Technical Report)

Politics of the Grand Ethiopian Renaissance Dam: The Role of Egyptian Farmers

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Introduction

The Grand Ethiopian Renaissance Dam (GERD) is the newest and largest hydroelectric dam being built in the Nile River Basin in Ethiopia near the border of Sudan. Filling this dam could restrict water availability to Egypt and to a lesser extent Sudan (Yang et al., 2021). Ethiopia, Sudan, and Egypt rely on the waters of the Nile River Basin to sustain their populations' water, food, and energy security to varying degrees (Heggy et al., 2021). 85% of the Nile originates in Ethiopia, but very little actually is needed or used there (Mbaku, 2020). Alternatively, Egypt relies on the Nile for 90% of its water needs (Heggy et al., 2021). It could also damage downstream water quality, affecting crop yield (Elagib et al., 2021). While challenging downstream water security, it generates electricity for millions of unelectrified residents of Ethiopia (Heggy et al., 2021), leading to heightened tensions between the three nations (Mbaku, 2020).

The region is likely to experience extended drought in the near future during the filling period of the dam which compounds to increase water scarcity downstream (El Bastawesy et al., 2015). Particularly, the crux of this shortage lands on Egyptian farmers, the primary utilizers of Egypt's Nile water supply through extensive irrigation, on whose labor the burden of supplying Egypt's food and subsequently upholding the national Gross Domestic Product (GDP) rests (USAID, 2020). When the lifeblood of Egypt's agriculture dries up, the first to feel the effects are the farmers.

Management of the over-utilized Nile waters is a contentious issue, requiring careful expression of scientific findings. Researchers have struggled to identify an optimized GERD operation system that balances physical water budget needs as well as political interests of the three nations involved (Wheeler et al., 2018). To properly address this multifaceted issue, efforts must be made to understand the history of water-politics unfolding during the last century which

inform stakeholders' various perspectives on water rights. Concurrently, the hydrologic challenge of fair water distribution must be investigated through optimization and modeling of the GERD system and its effects.

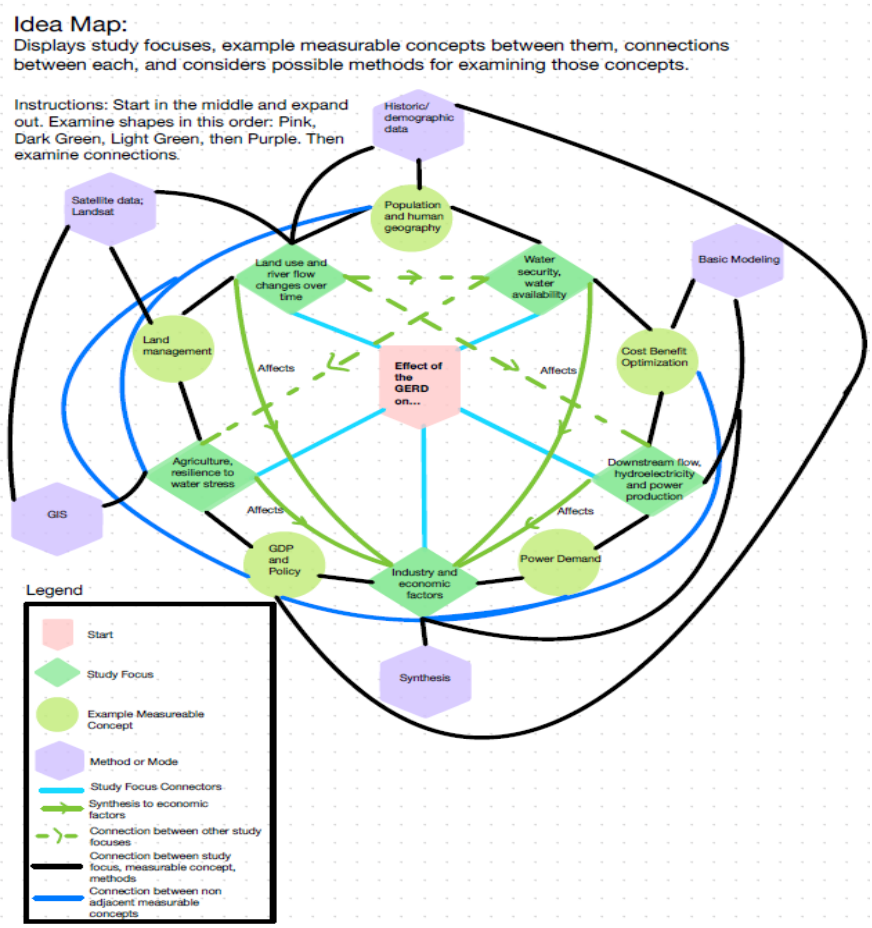
The GERD is a political artifact (Abdelhady et al., 2015), created, controlled and shaped by political entities, and such effects on Egyptian farmers cascade from the politics of the GERD. Egyptian farmers are an important yet vulnerable and overlooked social group in the water resources system. This paper seeks to illuminate the role of Egyptian farmers in relation to the GERD in the wider Nile River Basin context, ultimately illustrating the possibility of equitable water utilization given a thorough understanding of the social dynamics of the Nile River Basin in addition to practical modeling efforts.

Modeling and Optimization

The project team is focused on forming a descriptive and predictive approach to addressing the complex problems posed by the GERD through documentation and modeling. Primarily, the team will be analyzing and documenting data to support the hypothesis that the GERD's operation will have negative effects on downstream water security, land use and agricultural change, agriculture and resilience, power production, and ultimately economy and human wellbeing, while presenting possible solution frameworks around these factors. The team will be delivering recommendations for an updated operation of the GERD or management of water resources in the Nile River Basin. Evidence will be gathered by analysis of spatial, hydrologic, and economic data for each factor to paint a picture of the GERD's impacts. Findings generated will feed into a basic economic modeling effort that will to quantify human impacts and outline solutions, based off of modeling techniques that co-evolve hydrologic conditions and Egypt's macroeconomy (Basheer et al., 2021). Figure 1 summarizes each study

focus and the connections between each study focus area. Following is a deeper description of `this approach, possible solutions, and existing modeling approaches.

Figure 1. Idea Map illustrating the connections between focus areas and methods of studying those areas for each project team member. (Created by: O'Neill, 2021)



Hydrologic models will be useful in simulating rainfall, land use and agriculture changes, river flow, power production, and reservoir filling scenarios that inform strategies for equitable utilization of the Nile's resources. The project team will be relying on published models, such as those from El Bastawesy et al. (2015), Heggy et al. (2021), and Wheeler et al. (2018), for some data and conclusions. These authors conclusions help direct the project team's model. In regards to water security, El Bastawesy et al. (2015) presents hydrologic data analysis and makes predictions that the variability in rainfall in conjunction with the filling of the GERD would pose

challenges to Egypt and Sudan due to potentially major abstractions in flow (El Bastawesy et al., 2015). The authors showed that a 20% annual rainfall variability could be expected which in a period of low rainfall and high filling rate could hinder downstream flows significantly (El Bastawesy et al., 2015).

Heggy et al. (2021) reached similar conclusions with albeit wider reaching implications informing the investigation into water security, agricultural land use change, and economics. The authors accomplish this through economic modeling of seven different GERD filling scenarios, showing the worst and best-case scenarios in terms of their impact on Egypt's water budget. In worst-case scenarios in which Egypt and Ethiopia do not cooperate at all, filling the GERD would increase Egypt's water deficit by 31 billion cubic meters per year ($BCMyr^{-1}$) during the filling period, a third of their water budget, resulting in a loss of agricultural land by 72% and GDP of $51B, which is 8% of national GDP (Heggy et al., 2021). The study then pivots to economic feasibility modeling, in which it suggests better irrigation practices on Egypt's end, without suggesting Ethiopia adjust its operations or cooperate (Heggy et al., 2021). Irrigation is a key factor uniting investigations into land use and agriculture change, agriculture and resilience, and water security. Possible solutions include alternatives to intensive irrigation such as perennial cover crops as suggested by Bashe and Edelson's (2017) review of agricultural and land use data through GIS analysis.

The team aims to report deeper analysis of these solutions using a model of economic factors. This model will need to be informed by each focus area, such as land use and water availability, and it will need to be politically sensitive. Most models, according to Wheeler et al. (2018), are developed using hypothetical infrastructure configurations that do not or could not reflect the actual dams in use or planned. They argue that that the effects of increased hydrologic

variability can be managed best by solutions in which Ethiopia cooperates and shares water with downstream nations – solutions which this model facilitates, rather than new, costly, or unrealistic infrastructure configurations (Wheeler et al. 2018). Wheeler et al. (2018) suggests cooperation as a best-case scenario, though it is worth noting that Heggy et al. (2021) claims that Egypt could mitigate the negative filling effects without international cooperation.

The model produced by the project team will emphasize the negative effects of the dam sans international cooperation. It will attempt to draw socioeconomic conclusions using these prior models' findings as a starting point. Incorporating the question of cooperation and equitable utilization into the model will be best informed by sociotechnical analysis. Necessitating the introduction of less predictable factors such as national governments and social groups into a model of the GERD implies that its creation and use depends on political factors. Hence, attempting to model the GERD requires careful attention to the humans that win or lose when it fills up and the politics behind it.

Techno-Politics of the GERD

Three nations vie for control over their water and implement different water governance structures. Engineers manage reservoir releases, controlling for hydropower, downstream erosion, and water quality. Farmers divert water into their canals with or without conscious permission or participation in larger scale water governance structures. Water is produced as an interplay between social groups at different scales.

A multiscale issue requires a multiscale analysis. First, the nations and their governance structures can be framed using review of large-scale social interplay with regards to water rights and governance. Second, the technical review presented above informs the possibilities available to the actual operation of dam technology. Third, at the scale of the end-user, an ethnographic

account of Egyptian farmers' role in water use establishes a connection between the large and the small scale, illuminating the harm caused by the politics of the GERD. Each scale will be considered within the framework of techno-politics (Winner, 1980).

Underlying and framing this discussion is techno-politics. The notion that an artifact such as the GERD can have politics, (i.e., power structures) of its own comes from Winner (1980). Winner (1980) argues artifacts are embedded with politics in part due to the designer's purposeful employment of technology for political reasons. The GERD and its relation to Egyptian farmers is comparable to Winner's (1980) example of the tomato harvester, which was developed with specific intention and yielded positive results, but left human tomato farmers without work. Similarly, the Ethiopian designers of the GERD intend for it to provide access to electricity and water for their nation, yet implicitly deny downstream users such as Egyptian farmers access to Nile waters, imprinting the politics of access denial onto the GERD as much as they imprint the politics of national growth.

Why does nation-scale water governance look this way in the Nile River Basin? The refusal to cooperate is a reflection of hydro-egoism, as described by Rossi (2021). Rossi (2021) describes the political arena around the Nile River Basin as a result of history and present water law philosophies governing Egypt, Sudan, and Ethiopia's management of the GERD. The author argues that Ethiopia and Egypt stubbornly appeal to their hydro-egoism while perpetuating hegemonial water management, all of which contributes to the slowing and disabling of cooperative agreements. The evidence used to support these claims are the colonial treaties and declarations regarding water ownership that form the context of each nation's claim to the Nile, which produces hydro-egoism, a kind of uncompromising belief in entitlement to the Nile's resources (Rossi, 2021). Hydro-egoism is then borne into techno-politics. Ethiopia is "enacting

the techno-politics of national identity," as Edwards and Hecht (would describe South Africa's apartheid state's employment of nuclear technology as a power pawn and national identifier.

At the scale the operation of the GERD, the models described previously and the solutions available support cooperative management (Wheeler et al., 2018). Opening the door to Egypt and Sudan to hear their concerns and operate the dam at an optimized level would then re-imprint new politics on the GERD, politics of cooperation. It would create a new channel from Egyptian farmers to the Ethiopian water governance structure. The relation of farmers to larger scale groups is summarized in the Behavior Influence Assessment (BIA) (Jeffers et al., 2015). The model showed that increased food prices would cause the most unrest (Jeffers et al., 2015). This shows that Egyptian farmers are placed into a position of relative responsibility and importance as their food production ultimately drives social reaction to the GERD.

The GERD is one technology in a vast array of dams, pumps, canals, irrigation, water governance structures, national and international water ministries, and so on. According to Barnes (2014), only by asking how the water used by the Egyptian farmer is produced from rain to river, from governance structure to engineer, from dam to pump, from canal to farmer can the nature of the multi-scale issue at hand be properly understood. Barnes (2014) posits that water is made, not given, in that it travels through so many decision nodes dictated by different social groups. The next step, investigated through this research, is to understand how water for the Egyptian farmer is made by a critical decision node, the GERD.

Normative Research Approach

How does the imprint of Nile River social groups' politics on the GERD produce water in a way that causes harm to Egyptian farmers? Furthermore, what role do Egyptian farmers play in readjusting these politics in favor of equitable utilization? An Egyptian farmer's water rights

must be considered from multiple social groups' perspectives to discover how those rights are manipulated, challenged, ignored, or honored.

Egyptian farmers have been given an important role in using the Nile's waters to produce food for Egypt and turn a profit at the same time, and they are the most vulnerable to reduced water availability caused by the filling of the GERD. Discovering the patterns of harm through the framework of techno-politics and the social construction of technology is the first step to informing equitable utilization, defined as the reasonable and fair sharing of a resource's benefits (Kandeel, 2018). Information exists about the sociotechnical relationship of Egyptian farmers to water, and plenty of information exists about the possible positive and negative effects of the GERD. This research seeks to synthesize the two within techno-politics by developing a case study that draws out normative conclusions.

The primary evidence to be gathered will be prior literature such as the ethnography, *Cultivating the Nile* (Barnes, 2014), policy documents that outline international water law like the UN Convention (1997), and existing treaties like those dating back to 1929 that still affect new agreements today (Kimenyi et al., 2015) and describe the history of politics in water management. The evidence collected will be formed into the aforementioned case study into Egyptian farmer's relationship to water, discovering in what ways Egyptian farmers have been harmed by the GERD's construction and operation.

Conclusion

The Grand Ethiopian Renaissance Dam is halting the flow of the Nile, the lifeblood of Egypt, while it fills. The risk of filling the GERD during a drought to downstream nations incites high tensions, yet the three nations that use the Nile's waters are unable to reach a consensus as to how to manage the waters equitably (Basheer et al., 2021). The project team seeks to illustrate

the negative effects of the GERD and possible mitigations to those effects through modeling. Understanding how the GERD may impact downstream metrics such as food insecurity and GDP is expedient to cooperative management (Allam et al., 2019). Furthermore, the GERD's politics are mixed into the water, carried downstream hundreds of miles to arrive in the canal of an Egyptian farmer. The GERD is perhaps the political entity with the most power in the system. The quantity and quality of the water it produces are the measure of that power. This research seeks to understand the misuse of that power by illuminating the role of Egyptian farmers. The end goal is two-fold: to give visibility to an invisible and overlooked social group, and to illustrate and inform equitable water utilization by cooperative management of the Nile River Basin resources. Cooperation will require recognition of the GERD's embedded politics.

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