Economy-wide assessment of the impacts of Nile sediment reduction on the Sudanese construction sector

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Background

In 2011, Ethiopia started constructing the Grand Ethiopian Renaissance Dam (GERD) on the Nile River. The GERD has a reservoir storage capacity of 74 km^3 equivalent to 1.5 times the average annual flow of the Nile tributary on which the dam is being constructed, i.e., the Blue Nile. The GERD has a power capacity of 5150 MW, the largest hydropower capacity in Africa and among the largest globally. The GERD triggered significant political tension between Ethiopia on one side and Sudan and Egypt on the other side due to the expected hydrological and environmental impacts of the dam. On the one hand, GERD's long-term operation is expected to reduce the intra-annual variability of the Blue Nile flow and benefit irrigated agriculture and hydropower generation in Sudan (Basheer et al., 2018; Wheeler et al., 2016). However, Blue Nile flow regulation could induce adverse downstream environmental impacts and result in a loss of recession agriculture along the Nile in Sudan (Elagib and Basheer, 2021). On the other hand, GERD's long-term operation is anticipated to reduce hydropower generation in Egypt. The dam could also result in irrigation water deficits in Egypt during multi-year droughts, but that depends on how the dam will be operated (Wheeler et al., 2020).

The natural flow of the Blue Nile carries a significant sediment load that ranges between 111 and 140 million ton/year (Gebremicael et al., 2013). The GERD is estimated to trap up to 86% of this sediment load, resulting in positive and negative impacts on Sudan (Tesfa, 2013). Reduced sediment load results in a longer lifetime of the Roseires, Sennar, and Merowe dams and reduces the maintenance cost of irrigation canals and water pumping stations (Ahmed and Ismail, 2008). However, the reduction in the Nile sediment load could have adverse environmental impacts, reduce the fertility of agricultural lands, and impact fired clay brick production along the Blue Nile and the Main Nile (Mohammed, 2015).

Objectives

This study is a first attempt to quantify GERD's economy-wide impacts on Sudan due to the anticipated reduction in fired clay brick production. We use results from previous studies on sediment load reduction because of GERD's long-term operation as an estimate for the reduction in fired brick production in Sudan. We conduct a structured survey among construction engineers in Sudan to estimate the importance of fired clay brick to the construction sector of Sudan's economy. We then develop a Computable General Equilibrium (CGE) model for Sudan to investigate the economy-wide effects of GERD-induced changes in the production and use of fired clay brick.

Description of method and simulations

To comprehensively depict the construction sector in the CGE model, we disaggregate the sector to include a fired clay brick component in the Social Accounting Matrix (SAM). This allows representation of the sector's cost structure, including labor, natural clay, and other production inputs. The labor force component of the SAM includes labor categories that are engaged in clay brick production. These labor categories are linked to households in regions of the country where clay brick production is practiced. The SAM depicts the economy of Sudan in 2018 based on statistics from the Central Bureau of Statistics of Sudan including national account tables for 2018, the latest available household and housing characteristics survey from 2014, and the trade data. In addition, we use the latest available labor force survey from 2015 from the Ministry of Human Resources Development and Labor. Household and labor force disaggregation would consider the location dimension (i.e., rural and urban), in addition to the state dimension in which we depict the different states of the country. Additionally, for the households, we include the income dimension by considering five income quintiles as reported by the Household and Housing Characteristics Survey. Because most of the workers active in fired clay brick production are uneducated or at least with low education levels, we disaggregate labor in the SAM based on education levels.

The reduction in the flow of sediment load carried by the Blue Nile is expected to be gradual; hence, the impact on clay brick production is also expected to follow suit. Therefore, we use a recursive dynamic CGE model to implement the reduction in the production of fired clay brick over several years. We calibrate the baseline of the recursive dynamic model to domestic data from the Central Bureau of Statistics, the Central Bank of Sudan, and other data from the Ministry of Agriculture and the Ministry of Finance and Economic Planning. In addition, we use projections on the overall economic growth from the International Monetary Fund's World Economic Outlook database as well as sectoral (agriculture, industry, and service as aggregate) growth from the World Development Indicators of the World Bank. Labor force and population growth are guided by the World Population Prospects of the United Nations Population Dynamics.

The model solves through the first three years (2018-2020), replicating the observed economic structures followed five years associated with GERD initial filling (expected to be completed in 2025). We implement the reduction in clay brick production starting from 2026, and the results are to be reported for the period 2020-2035.

Presentation of results

We report results on changes in the production of the clay brick and the construction sector, changes in income to labor, especially the categories active in brick production, changes in the income to the different household groups, and the impact on the overall aggregate economic indicators such as the gross domestic product, final consumption expenditure, total investment, and international trade.

Keywords: clay brick, GERD sediment load, construction, economy-wide impact analysis.

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