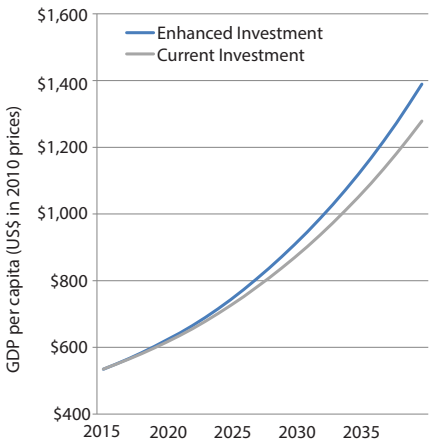
Investment in Water Resource Development and Environmental Management Will Enhance Uganda's Economic Growth

THE ECONOMIC VALUE OF WATER AND ENVIRONMENT TO UGANDA

Water and environmental resources are understood to be important in a general sense, but what is their value to Uganda in economic terms? Results of a national integrated biophysical and economic modeling framework show that from 2015 to 2040 enhanced investment in water resource development and environmental management can increase per capita GDP by 9% in 2040 over current investment.



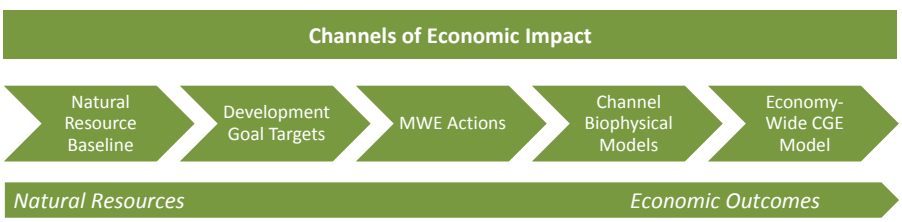
What's more, the impacts of enhanced development come at costs well below the benefits. GDP benefits of these enhanced investments are 8 times higher than their costs, and when discounted at 10 percent, the benefits are still 3 times the costs. The results clearly show that the investments provide direct GDP benefits well in excess of their costs.

9%

GDP per capita is 9% higher in 2040 under enhanced investment in rural and urban water supply and sanitation, sustainable wetlands, and forest and catchment management. That is equivalent to an extra $111 per person in that year.

MEASURING VALUE THROUGH CHANNELS OF ECONOMIC IMPACT

This analysis uses channels of economic impact to demonstrate the value of water resource development and environmental management to the economy. The channels represent the pathway from natural resources to economic outcomes through MWE actions. Two investment scenarios based on national development goals, one representing business as usual investment and one representing high investment (Vision 2040), are compared to estimate the benefit of enhanced investment. The effect of management actions on these natural resources are modeled using a suite of biophysical and reduced form models. The results of these models are then input in a Computable General Equilibrium (CGE) model of the Ugandan economy to analyze the effects on the macro-economy, including GDP and consumption effects.



CHANNELS OF ECONOMIC IMPACT

The Ministry of Water and Environment (MWE) is responsible for water resource development and environmental management. For this analysis, ten channels of economic impact are defined to represent the pathway from natural resource to the economy, through MWE management.

WATER RESOURCES DEVELOPMENT

- **Crop Production:** Expanded irrigation improves crop yields.
- **Livestock Production:** Livestock water supply improves livestock yields.
- **Water Available for Production:** Water supply for industry and services allows for economic growth.
- **Water Supply and Sanitation:** Accessible clean water reduces illness and frees up time for education and employment.
- **Hydropower Generation:** River management promotes efficient generation.

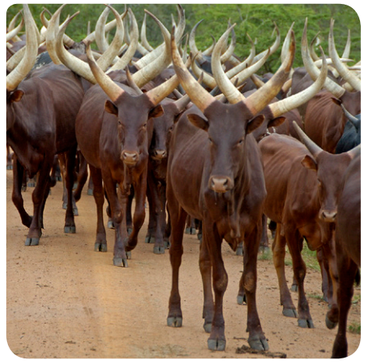
ENVIRONMENTAL MANAGEMENT

- **Flood Damages to Infrastructure:** Mitigating flood risk through land management reduces infrastructure maintenance costs.
- **Timber Production:** Promoting timber plantations increases production.
- **Water Quality:** Managing wetlands for natural filtration improves fishery yields.
- **Fuelwood:** Enforcing against forest encroachment for fuelwood makes households switch to more efficient fuel sources, reducing respiratory illness and freeing up time for education and employment.
- **Ecosystem Protection:** Maintaining natural resources is important for eco-tourism growth.

Impact Channel Modeling Results

The effect of MWE management related to the ten channels of impact was modeled using a suite of biophysical and reduced form models. These impacts are used to modify the CGE to understand the macroeconomic effects of investment; however on their own they provide important information about the impacts of enhanced management. The graphic below presents a selection of the estimated benefits of enhanced investment in water resource development and environmental management.

WATER RESOURCE DEVELOPMENT*



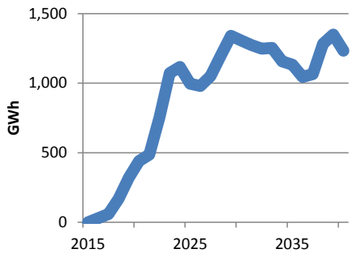
LIVESTOCK PRODUCTION

By 2040, livestock production increases 5% due to enhanced water supply.

HYDROPOWER

Sound river management leads to an annual increase in generation of over 1000 GWh by 2030.

ADDITIONAL GENERATION



WATER SUPPLY AND SANITATION

The government saves $1 billion in health care spending over 25 years due to reduced water-borne illness.

ENVIRONMENTAL MANAGEMENT*

WATER QUALITY

The five most productive fisheries in Uganda will increase productivity by almost 60% by 2040 due to water quality improvements.

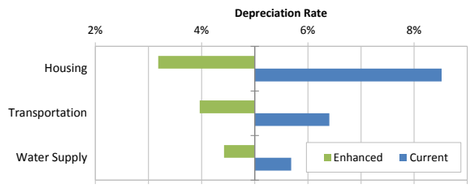
$8B

FUELWOOD

The government saves $8 billion in health care spending over 25 years due to reduced respiratory diseases

FLOOD DAMAGE

Depreciation rates are set to rise under current flood risk mitigation investment, but enhanced investment can avoid this and even lower depreciation rates across many sectors of the economy.



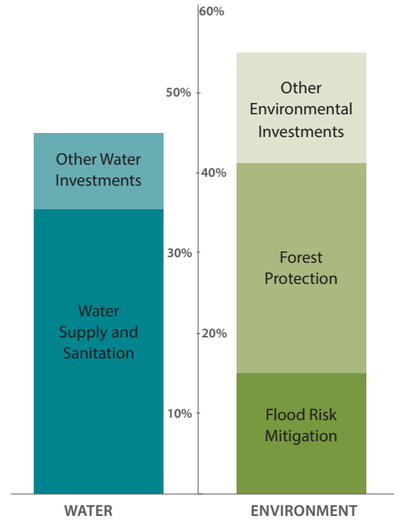
** Channels not pictured in this graphic include: Crop Production; Water Available for Industry and Services; Timber Production; and Ecosystem Protection.*

Economy-Wide Modeling Results

Water and Environmental Investments impact the economy via a complex interconnection of the economic production factors of labor, capital, and natural resources. Investments that enhance these factors of production ripple throughout all sectors of the economy. The results of the biophysical channel models are input in the CGE to estimate these effects.

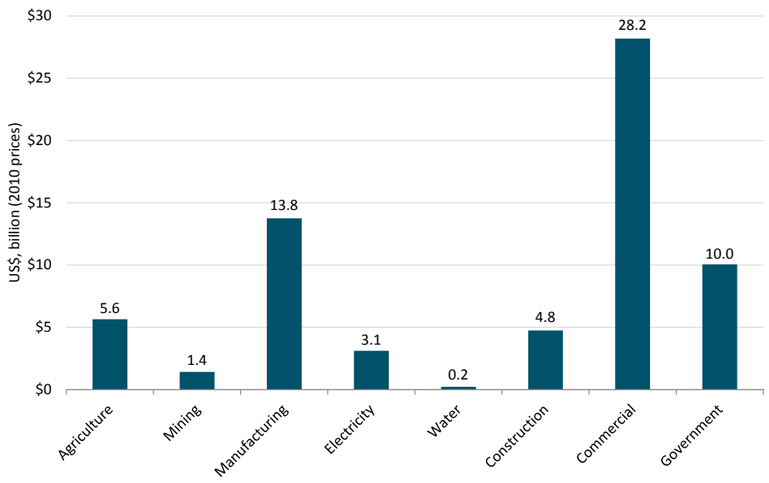
SHARE OF GDP BENEFITS BY MWE INVESTMENT

The water development and environmental management components of the MWE investment plans are comparable in magnitude of impact on the economy, with the water supply and sanitation component of the water development investments having the greatest GDP impact, and the forestry and firewood replacement investments of the environmental management component having the greatest GDP impact among investments in that category.



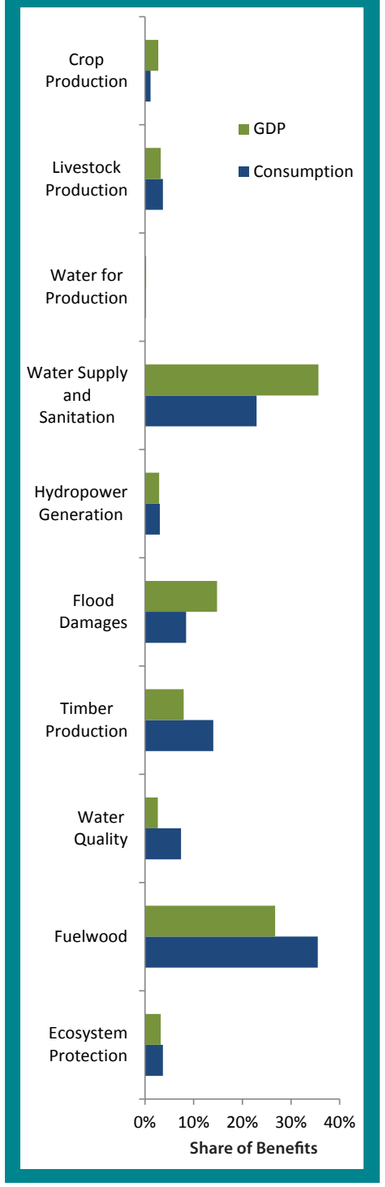
GDP BY ECONOMIC SECTOR UNDER FULL INVESTMENT

When enhanced investment is made in each of the ten channels, many sectors that are not necessarily direct beneficiaries of MWE investments, such as manufacturing and commercial economic sectors, account for the largest share of the cumulative GDP gains. The agriculture sector is among the largest direct benefactors of MWE investment, but the gains of a more productive agriculture sector filter through the entire economy causing agriculture's share of total GDP to decline as other sectors grow (precisely as envisioned in Uganda's National Development Plan). The commercial sector is further enhanced by the growing labor supply due to the WASH and fuelwood channels.



ECONOMY-WIDE CONSUMPTION BENEFITS

GDP is a widely used metric for measuring economic benefit, but it does not directly relate to benefits of households. Consumption is the measure of impact on consumers. Full investment in the ten channels results in $39 billion in consumer benefits.



Methods and Models

This analysis models the GDP effects of MWE investment across ten channels of economic impact. First, biophysical and reduced form models are employed to understand the impacts of management decisions. The results of these models are then input to an economy-wide model to estimate the overall economic impacts of MWE investment.

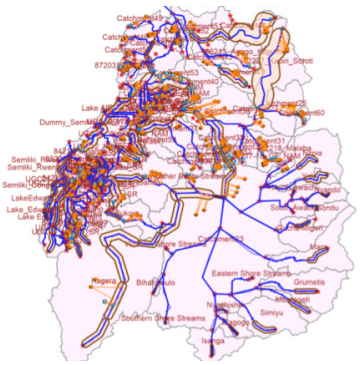
BIOPHYSICAL MODELS

The primary biophysical model used in this assessment is Mike Hydro, a decision support tool for water resource analysis. Demand nodes, supply infrastructure, and natural water availability are defined to model water availability at the catchment level. Water is allocated across competing demands based on a set prioritization level. The output of Mike Hydro includes spatially defined water shortage estimates by demand use.

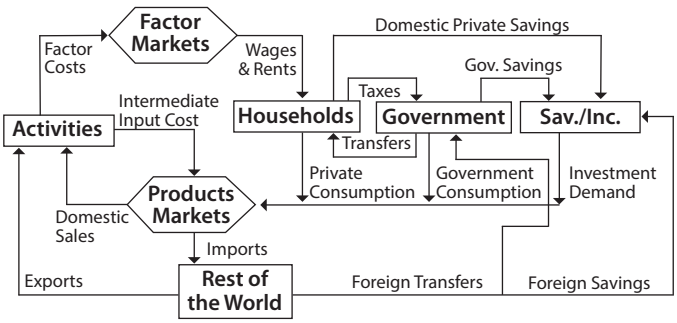
Other biophysical models used in this analysis include:

- NAM river runoff model
- Lake-Basin Water Quality (LBWQ) model
- Universal Soil Loss Equation (USLE) erosion model
- FAO56 irrigation water requirement model
- Infrastructure Planning Support System (IPSS) flood damages model

Overview of Mike Hydro Model for Uganda



STRUCTURE OF PAYMENT FLOWS IN THE STANDARD CGE MODEL



ECONOMY WIDE MODEL

For this study a Computable General Equilibrium (CGE) macroeconomic model of the overall economy was used to estimate how the size and structure of the economy might be different under the scenarios analyzed. The model simulates the flow of commodities and factors of production (i.e., labor, capital, and natural resources) among producers and households to assess how a change in policy or an economic shock affects the size and composition of the economy (see figure above). Economic models like this capture behavioral changes among households and firms in response to changes in prices. Our model simulates the substitution of inputs as the price of one input, such as energy or labor, rises or falls relative to the price of other inputs. Based on these changes, the model then simulates changes in consumption of goods by firms and households.

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