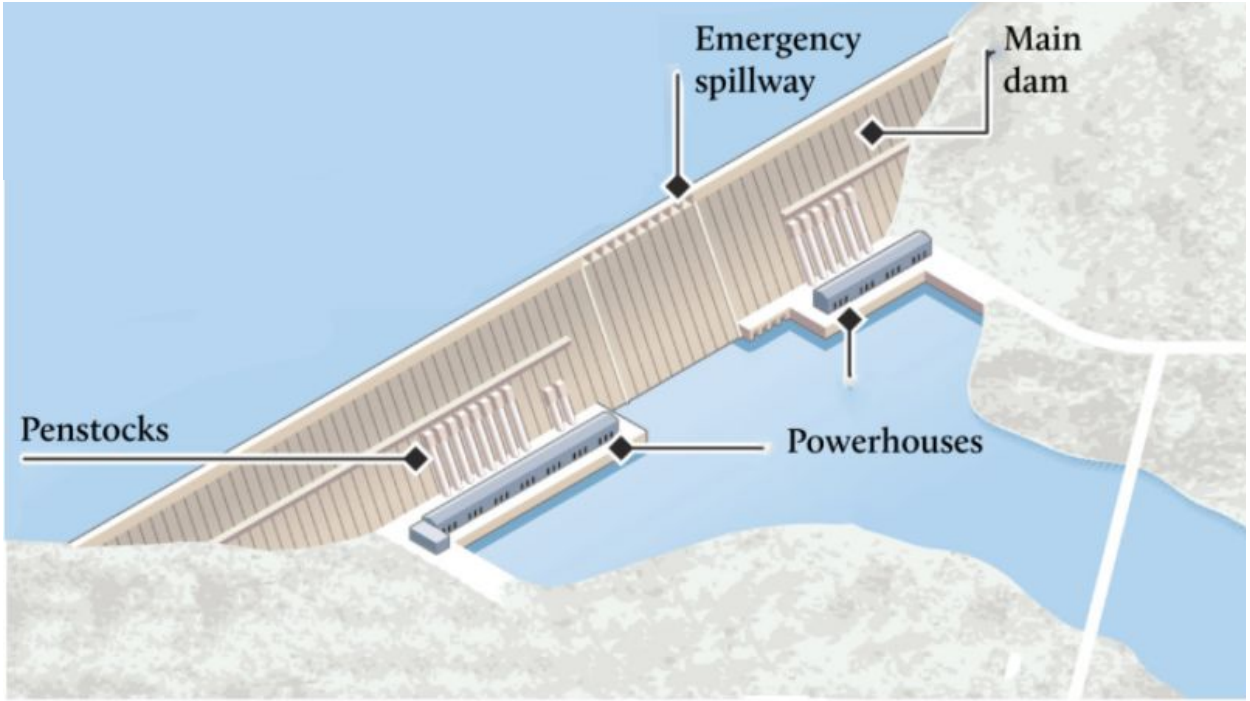
Grand Ethiopian Renaissance Dam: Conflict, Mitigation, and Solutions

Group 1:
Maddie Stokes, Daniel Batanau, Lakshay Goyal, Karman Kour, Roshanne Sihota

Background: Grand Ethiopian Renaissance Dam



Source: Google maps, Ethiopian government

MEE

middleeasteye.net

Location:
Benishangul-Gumuz region of Ethiopia; Blue Nile.

Construction started: 2011.

Estimated cost: 5 billion.

Jobs created: 12,000.

Energy: capable of generating 6+ GW of electricity.

Dimensions: 1.8km long; 0.14km deep.

Reservoir: Covers an area of 1,874km2; storage volumes of 74 billion cubic metres.

Background: Pre-Colonial History

Egypt fears the loss of the Nile's water

- Threats since the 13th century

Conquest of Sudan

- Labor, land, and water
- Cultivation of cotton

Construction Of Suez Canal

Image from Wikipedia Commons

Background: Colonial History

British empire occupied Egypt in 1882

British policy = No development upriver

- Anglo-Italian treaty (1891)
  - Restricted construction of upstream project in the Nile
- Anglo-Ethiopia treaty.
  - Boundary between Ethiopia and Sudan
- Anglo-Egyptian Treaty (1929)
  - Recognizes hydrological rights of Egypt
  - Restricts irrigation work or the creation of electric generators

Suez Canal

Image from Wikipedia commons

Background: Post colonial history

11 states independent of colonial powers (1953-1963)

Nile Waters Agreement (1959)

- Allocated water to Sudan and Egypt

Egypt continues to enforce water hegemony

Nile basin cooperation

- Nile Basin initiative
- Cooperative framework agreement

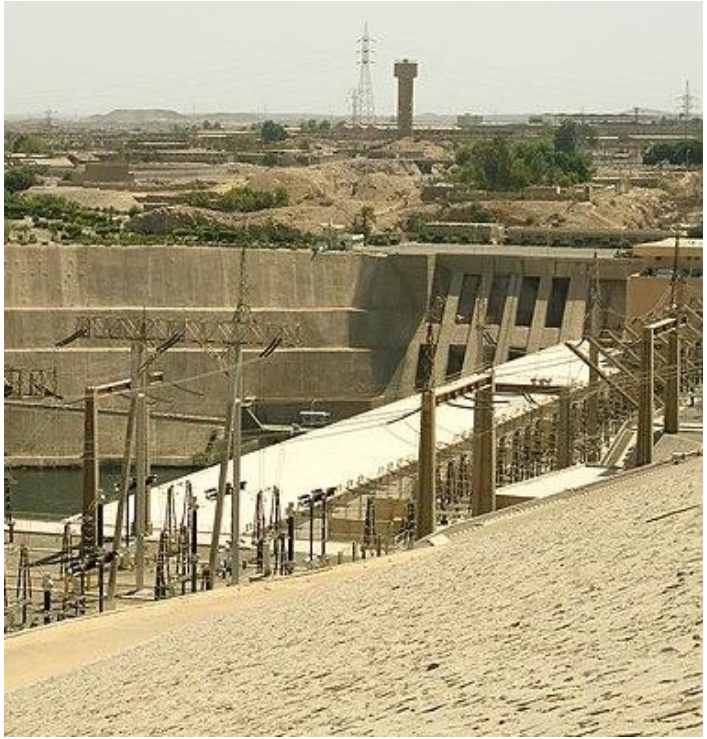


Image from Wikipedia Commons

Solution One: Equilateral Negotiation

1) Exclude any mention of previous treaties, and explicitly state that no content in the current treaties act as a recognition of previous agreements
2) Downstream nations must sign the Cooperative framework agreement to establish water sharing
3) Negotiations must be mediated by a third party with no biases to one party
   - African union has been raised as a possible mediator

Image from Wikipedia Commons

Background: Power and Governance

"Governance extends to the ways **problems and issues** are **framed**, terms of debate are set, and **particular ways of thinking and speaking** come to be **privileged over others**. These dimensions of framing and language also affect notions of who has the **expertise**, **authority** and **responsibility** to govern" (Hurlbut, 2020, pp. 178).

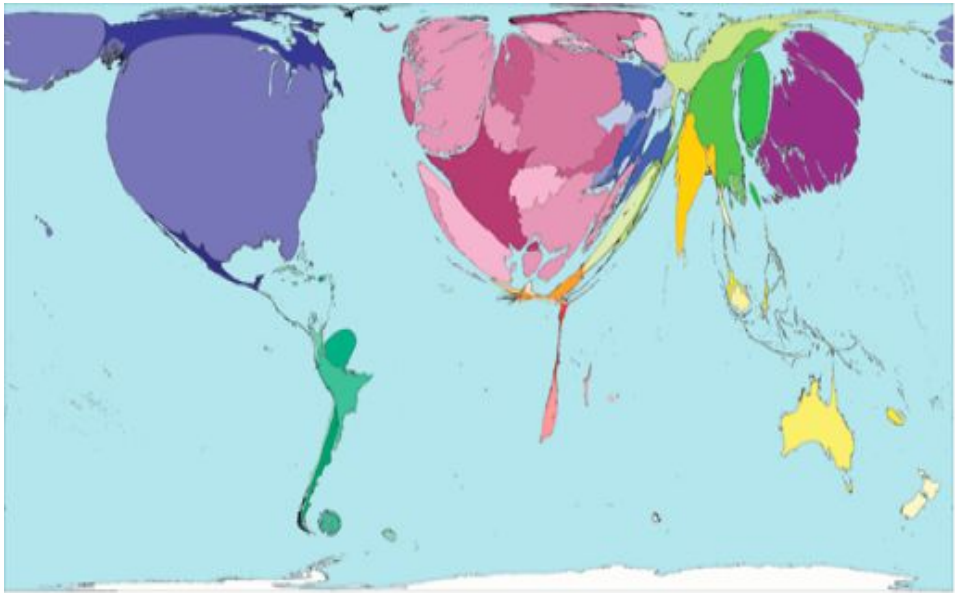
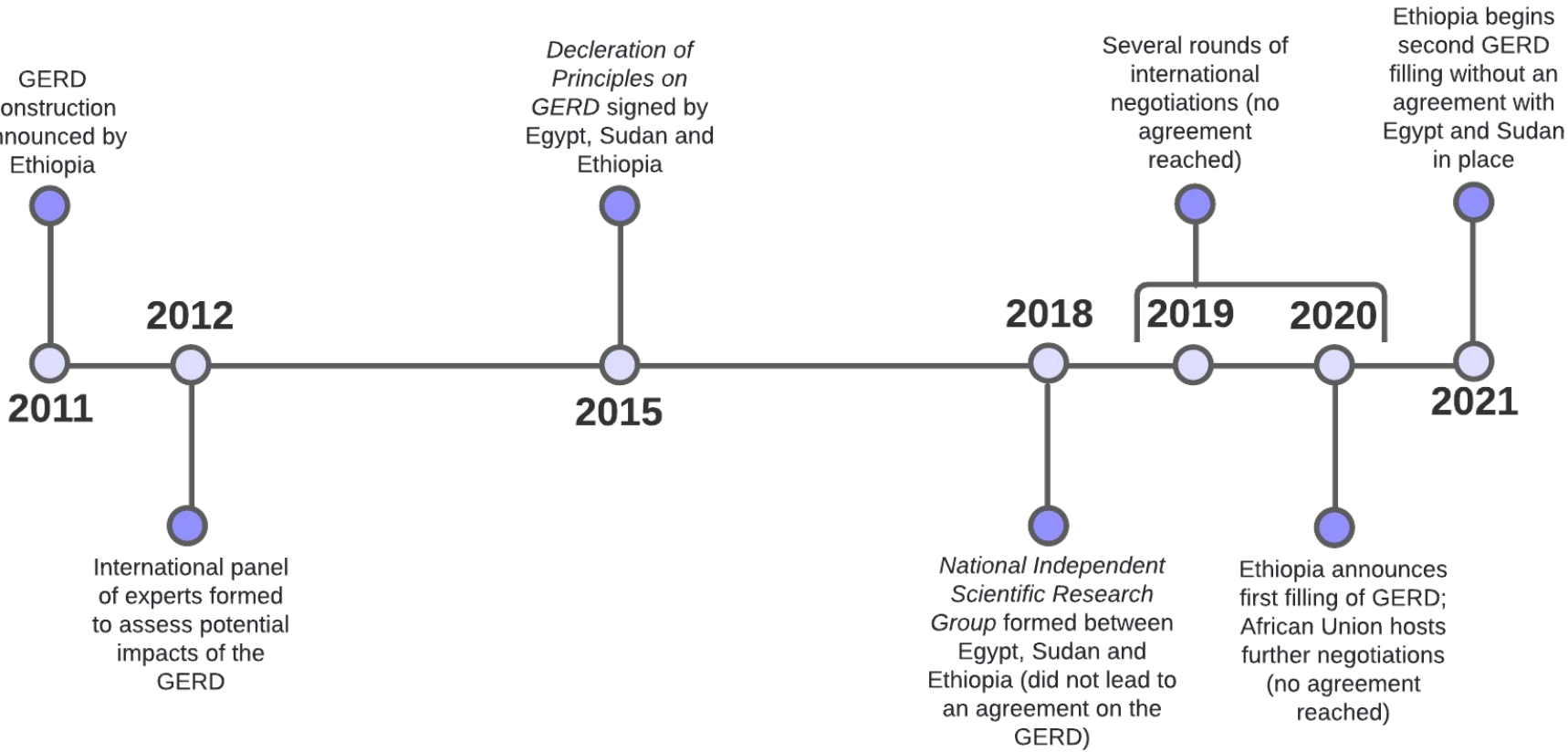


Image: Distorted world map - territory size of each region corresponds to proportion of published scientific papers in 2001 (Bryant, 2014).

Background: Where Are We Now?



Timeline informed by International Crisis Group, 2020; and El-Gundy, 2021.

Solutions: Co-Evolutionary Modeling

CO-EVOLUTIONARY

Describes the **co-evolution** of the **Nile river** and **Egypt's macroeconomy** through multi-year simulations (Basheer et al., 2021).

COORDINATED OPERATION

A **cooperative policy framework** that values "'neighbors looking out for each other,' especially during multiyear hydrological droughts" aiming for "**hydro-solidarity** … [and] **transboundary collaboration**" (Basheer et al., 2021, pp. 3-4)

Solutions: Co-Evolutionary Modeling

Unit of Analysis	**Predicted Impact**
Egypt's total water deficits	Decrease
Egypt's irrigation deficits	Decrease
High Aswan Dam hydropower gen.	Decrease
GERD hydropower gen.	Initial decrease (~5 yrs.) followed by increase
GERD cumulative electricity gen.	Increase
Water loss from evaporation and seepage	Decrease

Table: Results of co-evolutionary modeling summarized from Basheer et al., 2021.

Solutions: Negotiation Supports - Multilateral Priorities

5-part Agenda summarized from Badré and Tiberghien, 2020.

Image: CGTN, 2020.

Solutions: Negotiation Supports - Inclusion Strategies

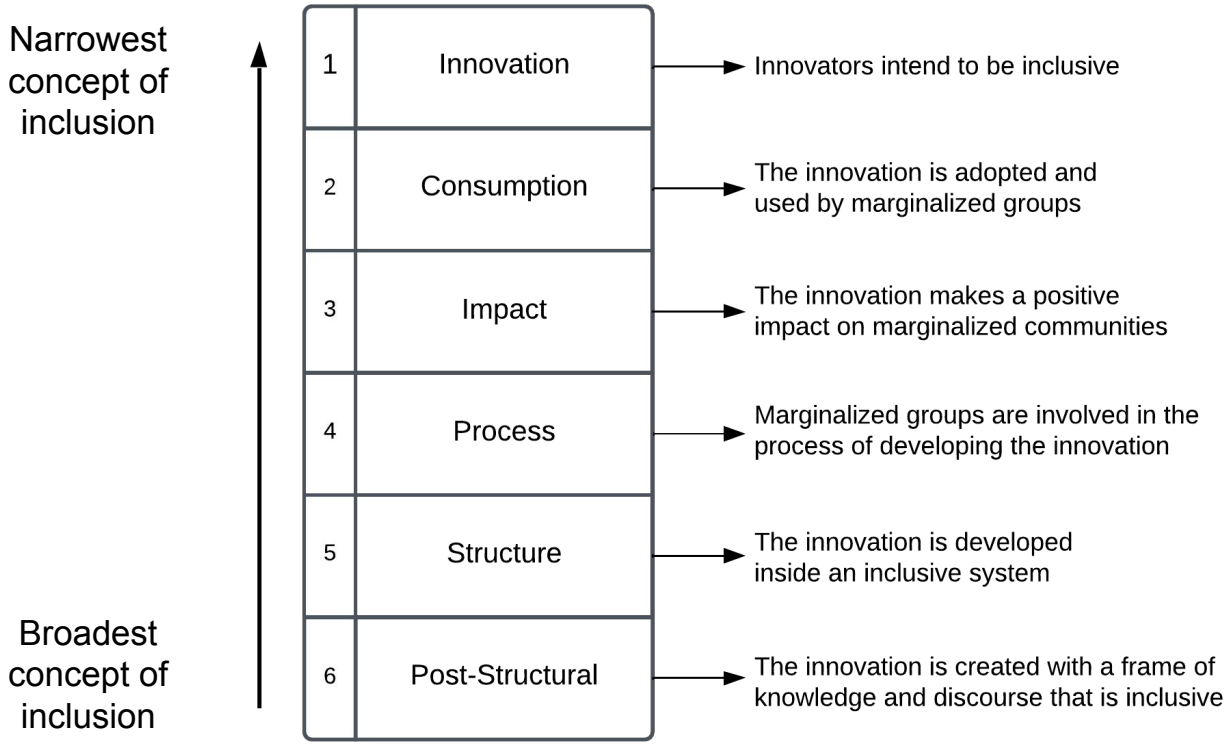
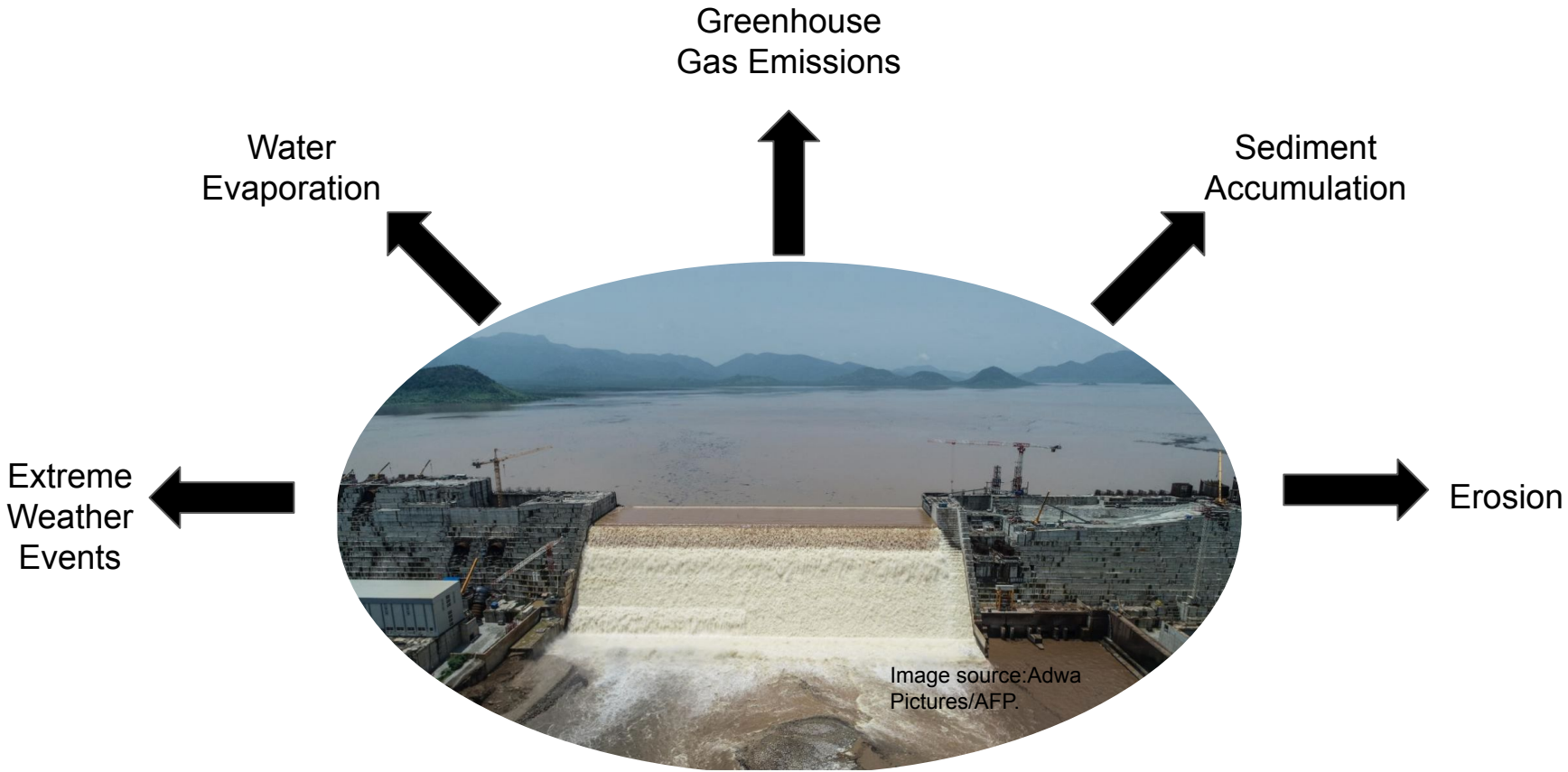
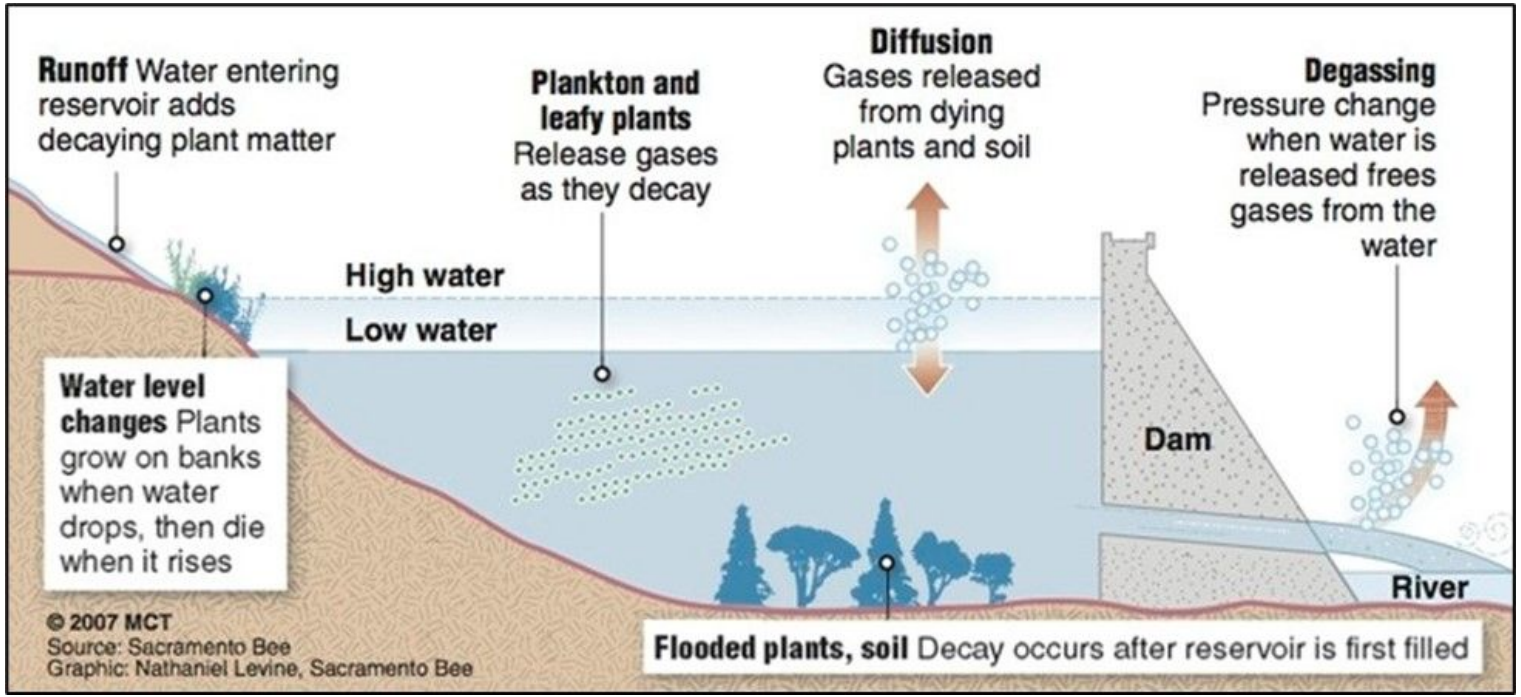


Image: Reversed ladder of inclusion adapted from Breslau et al., 2019

Environmental Impacts of Dams



Greenhouse Gas Emissions



GHG released: methane, carbon dioxide.

Water Evaporation

- Evaporation from a dam primarily comes from its reservoir.
  - Larger surface area = more evaporation.
- The GERD is located in a hot, dry climate → high rates of evaporation.

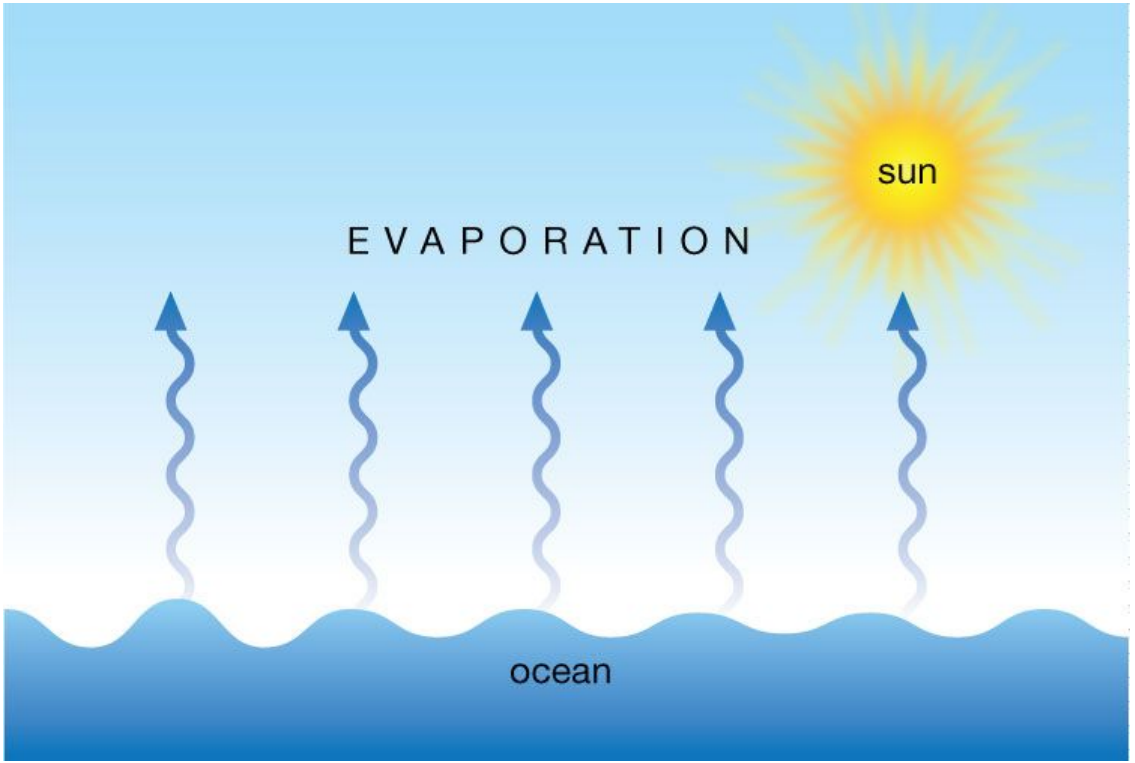


Image source: https://sites.google.com/site/thewatercyclebid/evaporation

Land Degradation

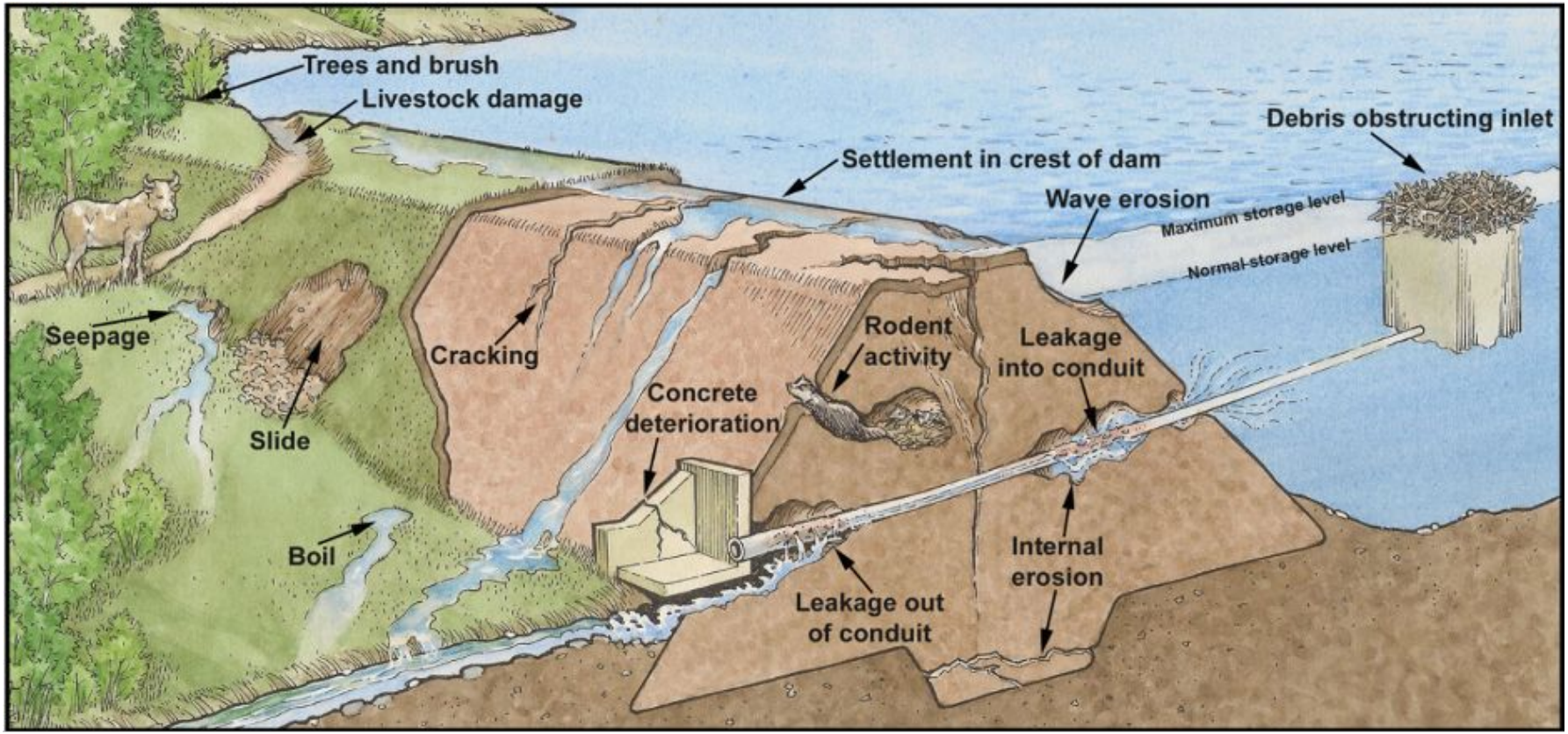
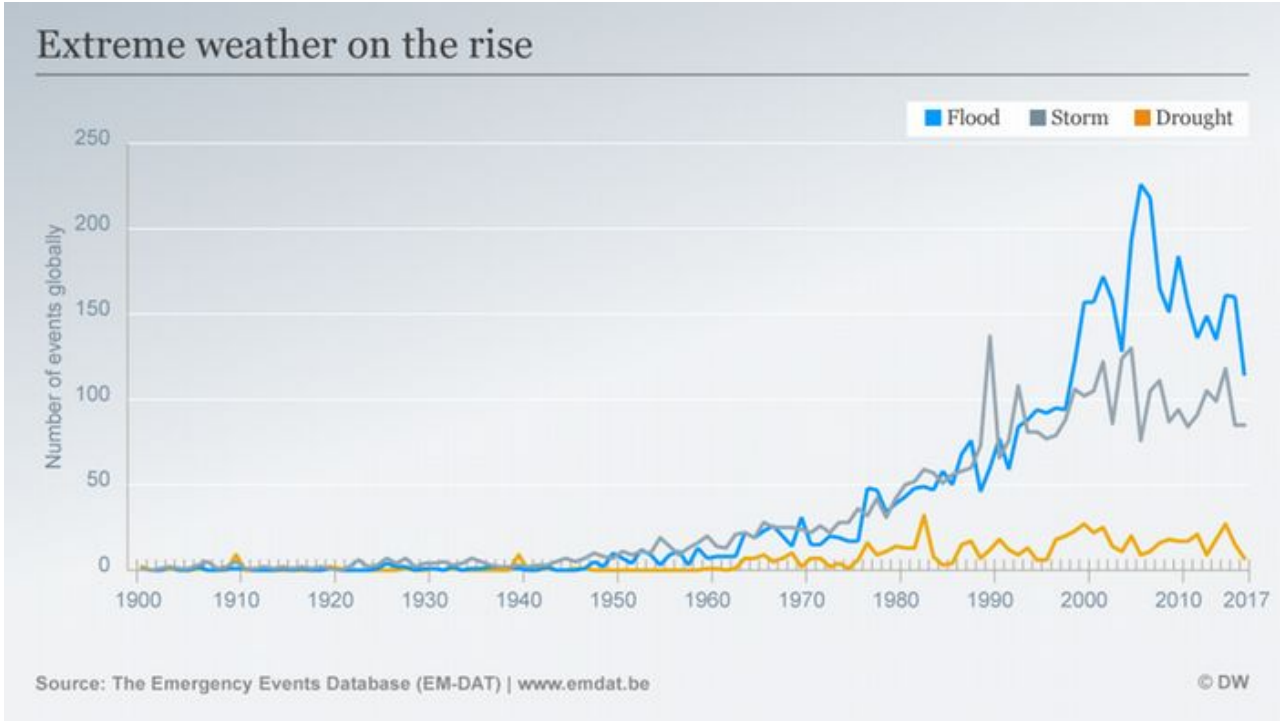


Figure: Common problems found on dams (Nebraska Dept. of Natural Resources, 2022).

Extreme Weather Events



- Extreme weather increases risk of dam failure or flooding.
- Climate change has increased the number of extreme weather events.

ENVIRONMENTAL IMPACTS OF GERD

CONCERNS

- Increase in evaporation rate, salinity and water pollution
- Depletion of ground water in Nile basin of Egypt
- Destruction of terrestrial natural ecosystem in these inundated areas
- Displacing people living in the area of the proposed reservoir.
- Flooding of the area in case of GERD failure

Environmental impacts of GERD

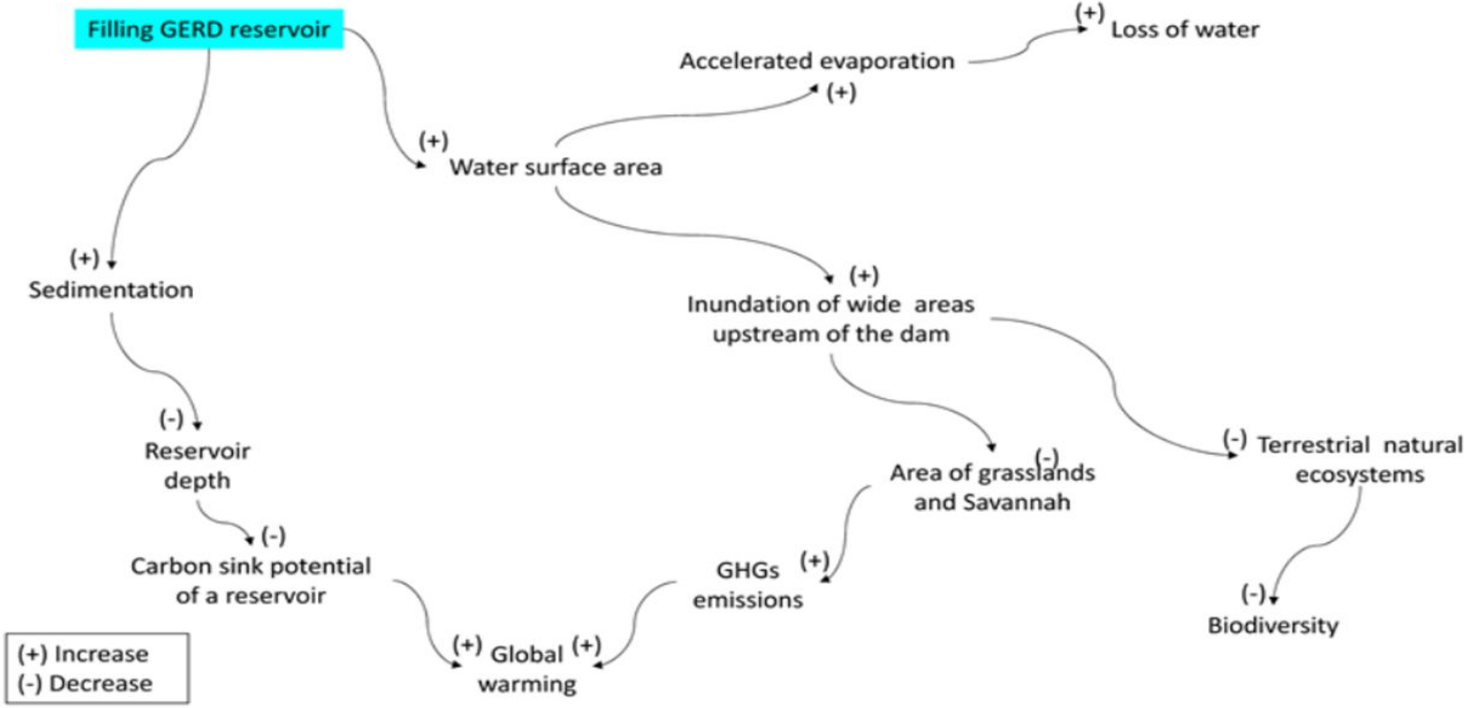


Figure 5. Schematic diagram of potential environmental impacts of GERD reservoir.

Impacts of dam reservoir on the host country

- Displacing people living in the area of the proposed reservoir
- Death and decomposition of plants
- Inhibiting fish migration in a river

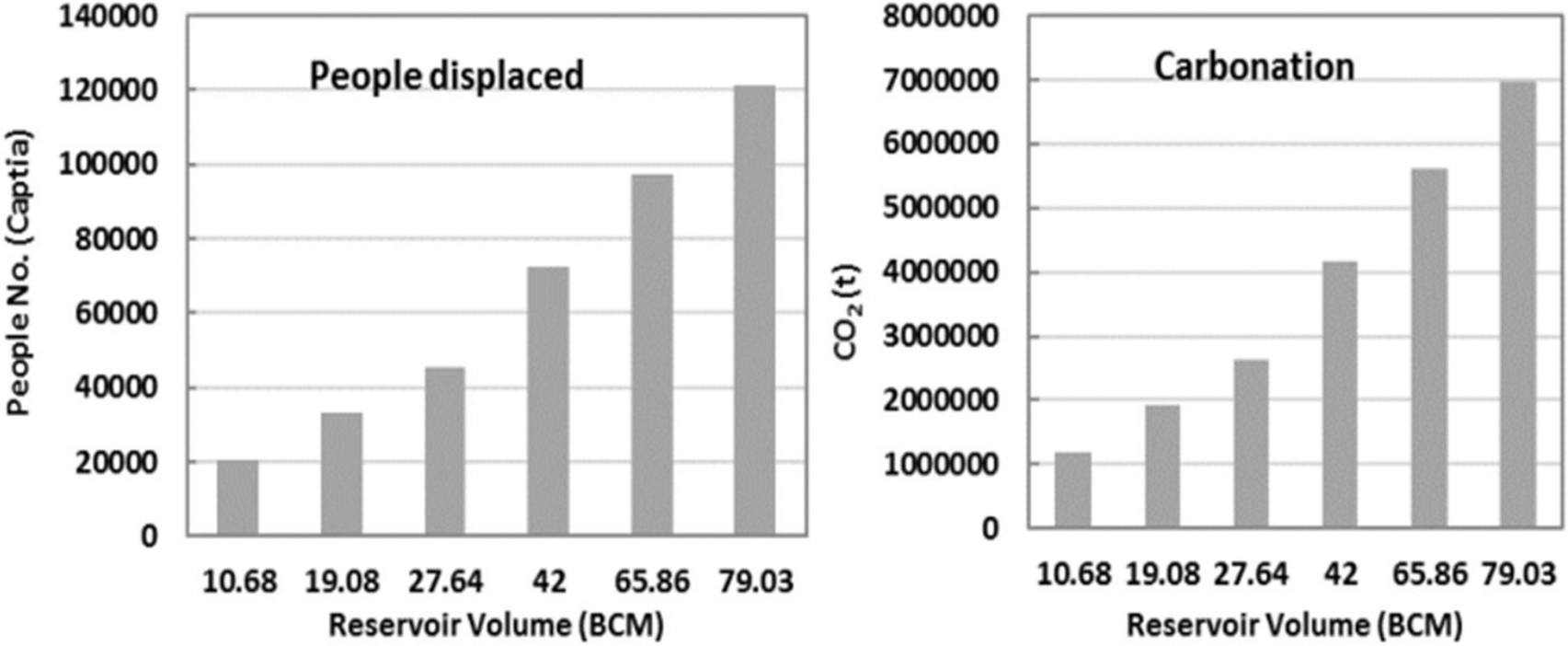


Figure 8. Environmental impact assessment of the GERD on, a) people displaced and b) carbonation at different scenarios of reservoir volumes

Impact on Sudan and Egypt

- **GERD will reduce sediment loads that travel downstream and interfere with the performance of dams in Sudan and Egypt: leading to power failures, and reduce hydropower output overall.**
- **Dams serving irrigation purposes, sediment buildup can block irrigation channels and reduce agricultural production (Swanson, 2014).**
- **The Benishangul-Gumuz region, is one of the few places in Ethiopia that has remnant forest vegetation. The Dam's reservoir will flood: 1,680 km2 (90% of the forest area). Construction of roads to the Dam's site: impacts the forests, which are a source of livelihood for the local community.**

- **The Egyptians, in particular, are not satisfied with the Dam project, because the Dam means to them considerable reduction of the amount of water flows to Egypt through the Nile River (Eckstein, 2010; Ashok, 2011; Salman, 2013; Tawfic, 2016; Wheeler et al., 2016; EZEGA, 2017).**
- **This project will also interrupt Egypt's electricity supply by 25 to 40%, which would leave upper part of Egypt in darkness.**
- **Other studies have attributed increased seismic activity in the region due to the weight of the Dam and the huge amounts of water stored behind it. (Conniff, 2017).**

Environmental impacts of GERD failure

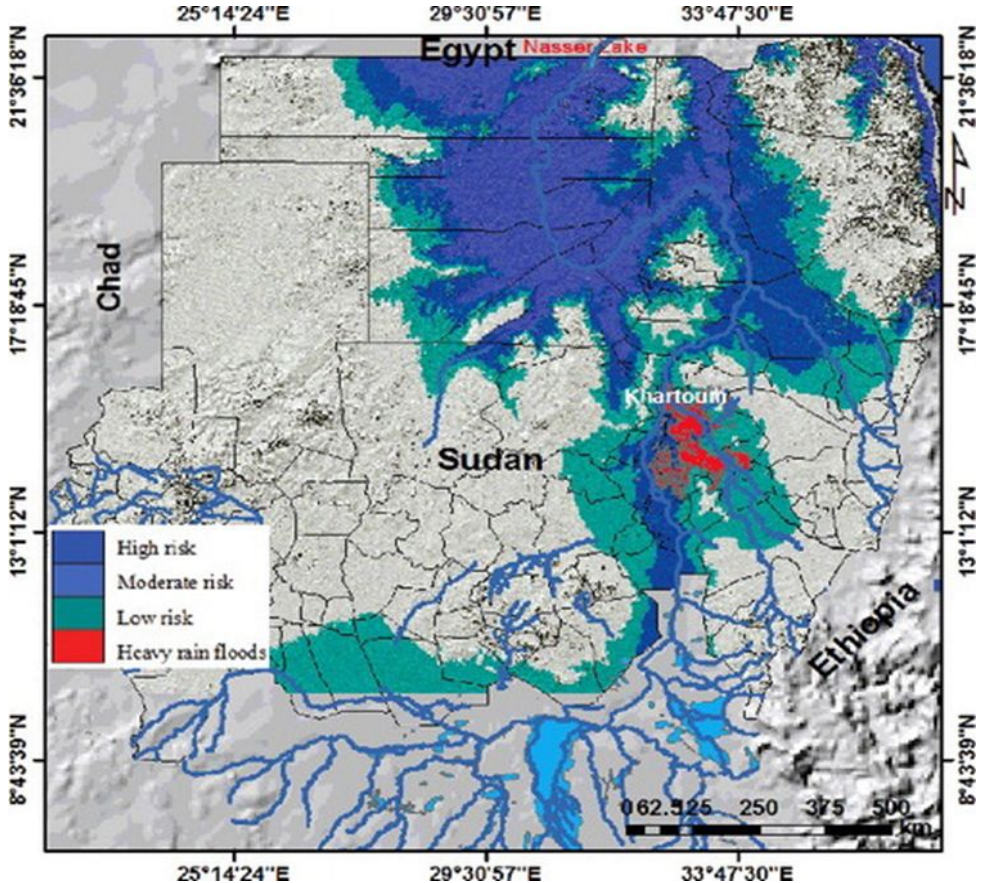


Figure 8. The flood basin model shows the areas that will be affected by flood in the case of the GERD failure. The red polygons highlight the flooded areas by rainfall water during wet seasons (Mohamed et al., 2017).

Solutions: GHG Emissions

Methane released from a dam can be recovered for later energy production:

- Methane-rich, pressurized, deep waters are transported to surface ambient conditions, where the dissolved gas can be extracted by bubbling or by spraying into a sealed vessel (Ramos et al., 2009).

Aerating Devices	Increase dissolved oxygen; reduces methane emissions downstream.
Multi-level water intake	Addition of a secondary intake (i.e., multi-level intake) to circulate oxygenated water through turbines to reduce rates of degassing.

Table: technologies to reduce GHG emissions.

Solutions: Evaporation Mitigation

- Store water underground.
- Implement vegetation.

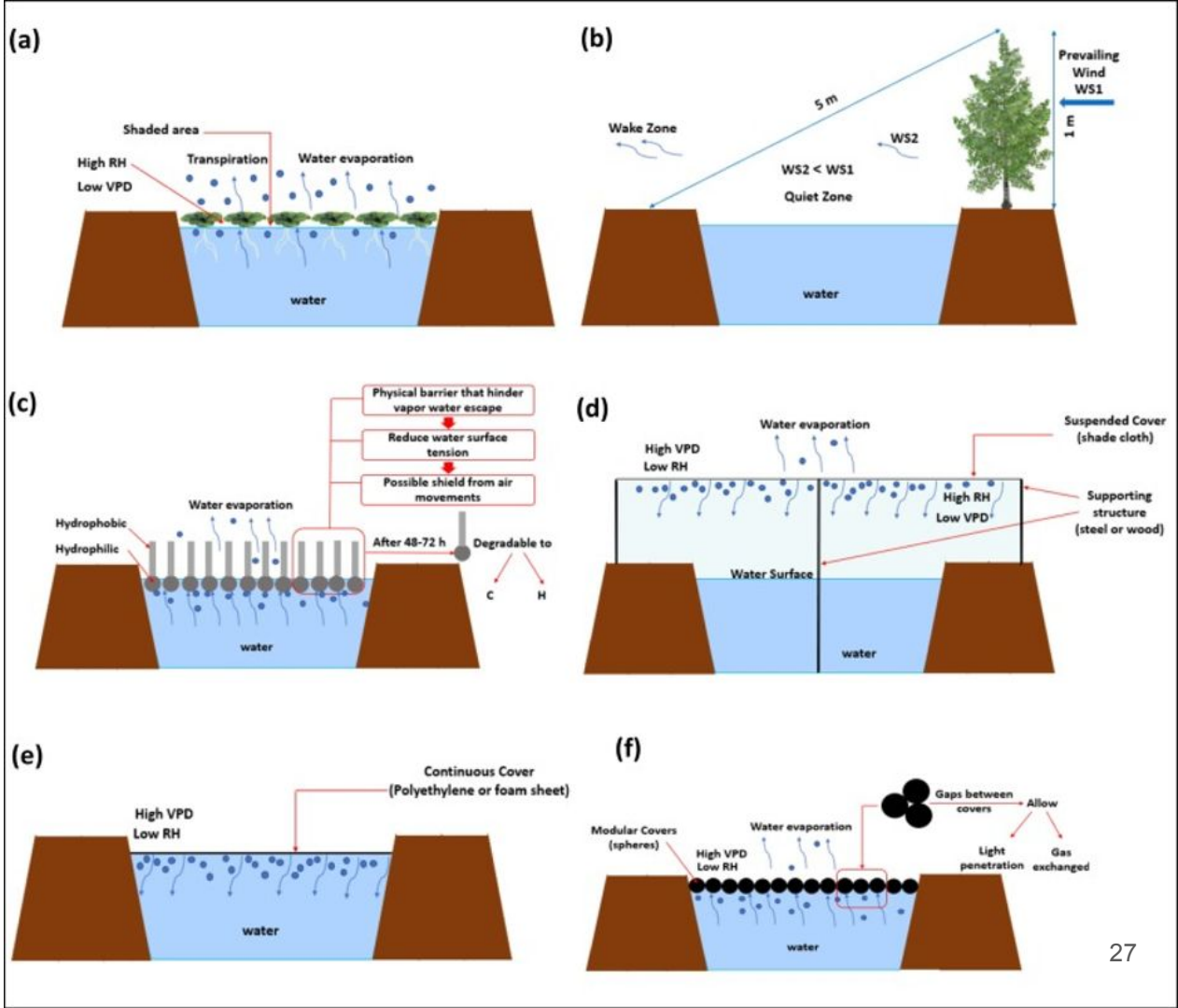


Figure: Schematic diagram of different covers for suppressing evaporation from the water surface by Abdallah et al. (2021): (a) floating plants; (b) windbreakers; (c) chemical cover; (d) suspended cover; (e) continuous floating cover and (f) modular floating cover.

Solutions: Sustainable Watershed Management

- Increase vegetation
  - Decreases runoff; enhances soil infiltration capacity and structure.
- Decrease land use from feeding and grazing livestock
  - Utilizes high resources; increases erosion and land degradation.

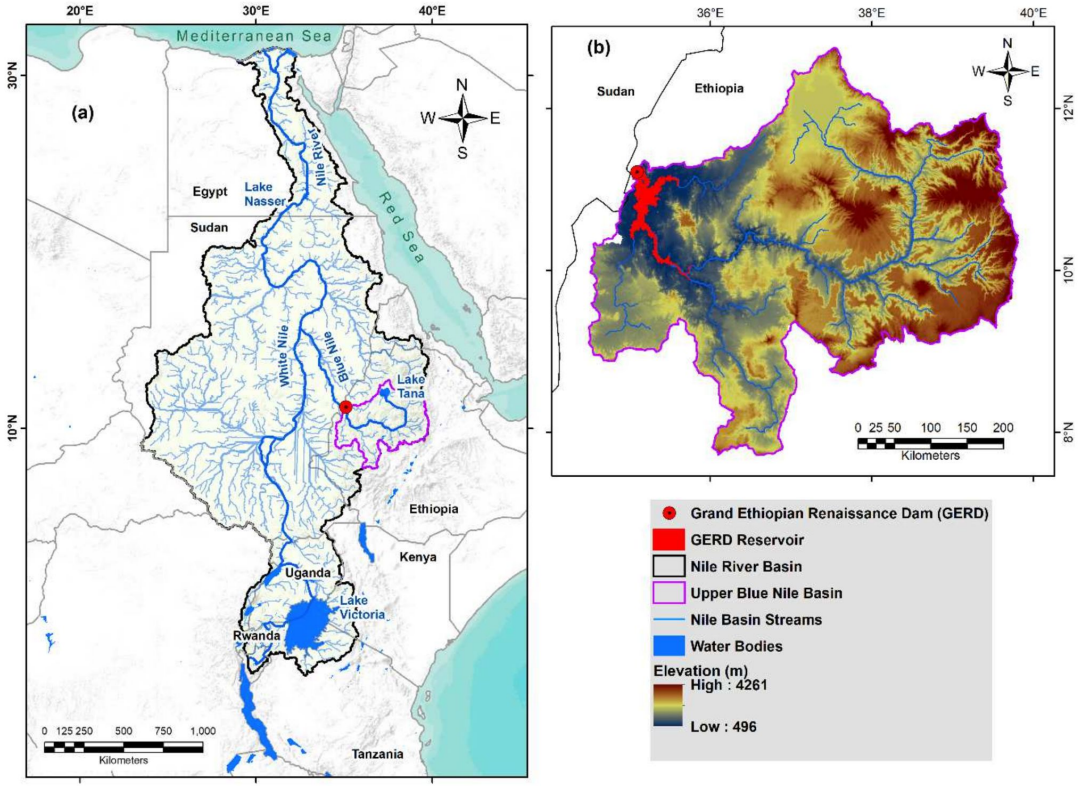


Image: Nile River Basin and location of GERD and major lakes/tributaries (Kamara et al., 2022).

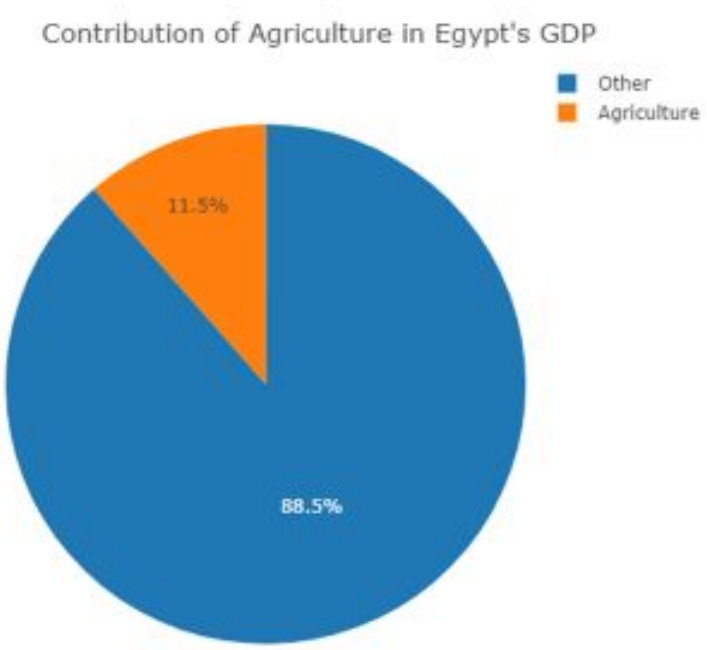
Solutions: Extreme Weather Events

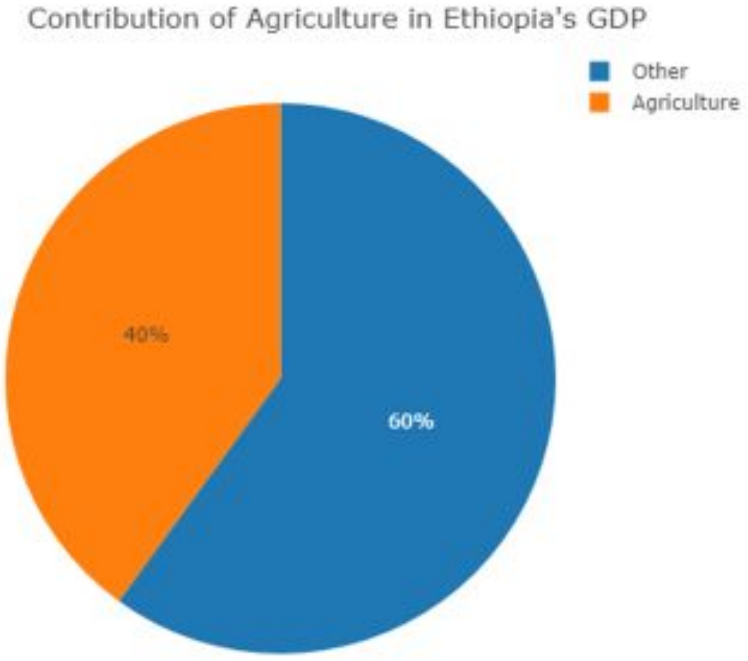
Dam Owners	· Invest in routine maintenance and repair. · Adhere to regulations (no shortcuts or exemptions). · Have a plan for emergencies of different severities.
Policy Makers	· Promote proactive dam safety programs. · Provide funding mechanisms.
Downstream Communities	· Know areas most at risk. · Know who emergency manager is. · Work cooperatively to minimize risk to public.

Table: Different parties and their responsibilities related to ensuring safe and secure use of a dam in a watershed region.

FATE OF AGRICULTURE IN POST-GERD ERA: PROBLEMS AND SOLUTIONS

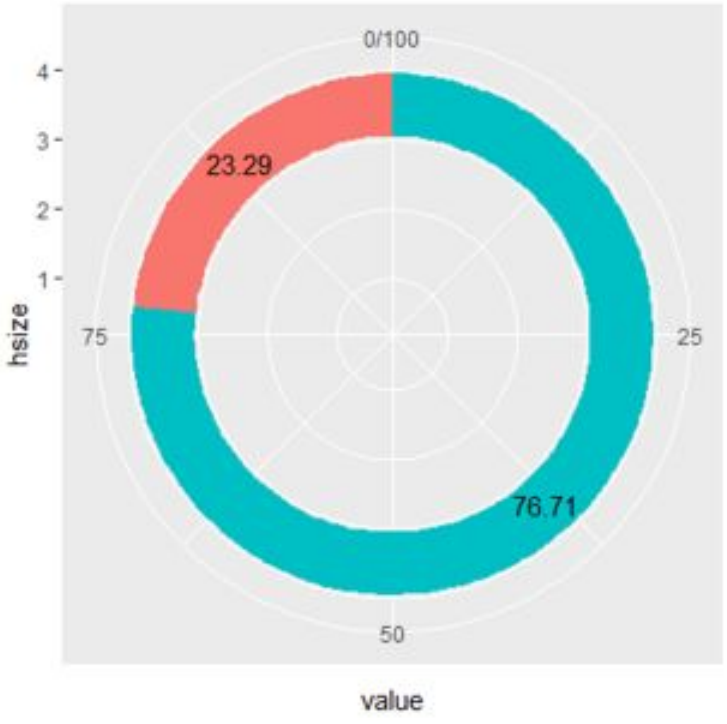
Contribution of Agriculture in GDP of Egypt and Ethiopia



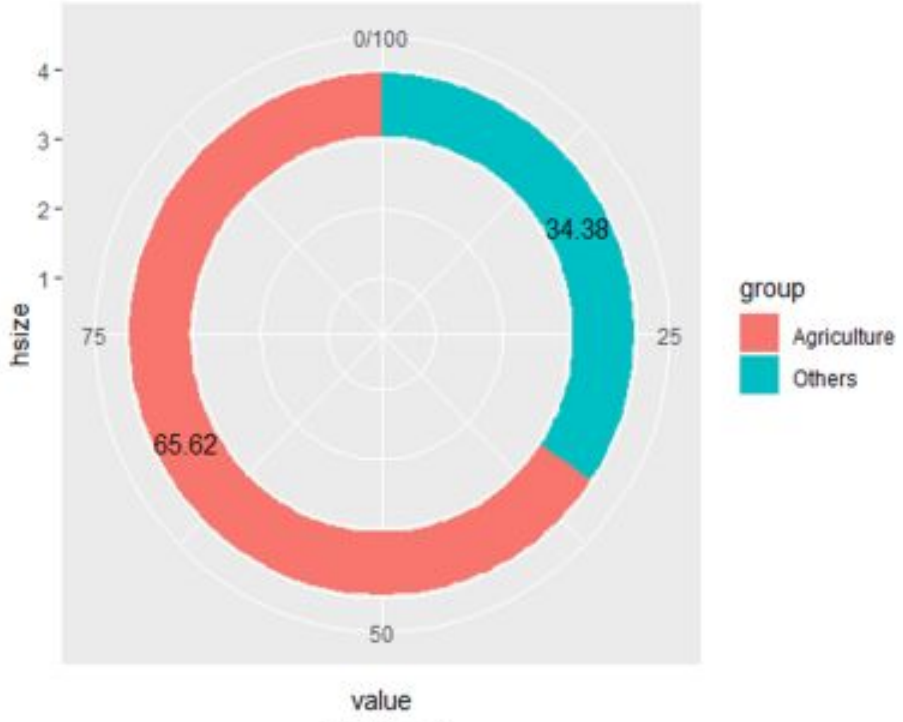


Graph made in Rstudio based on the data retrieved from https://knoema.com/atlas

Contribution of Agriculture in total employment generation in Egypt and Ethiopia



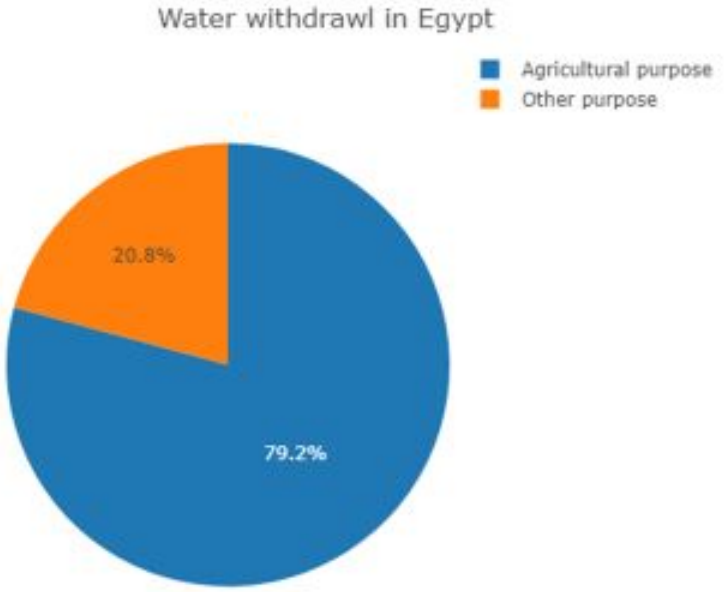
Egypt

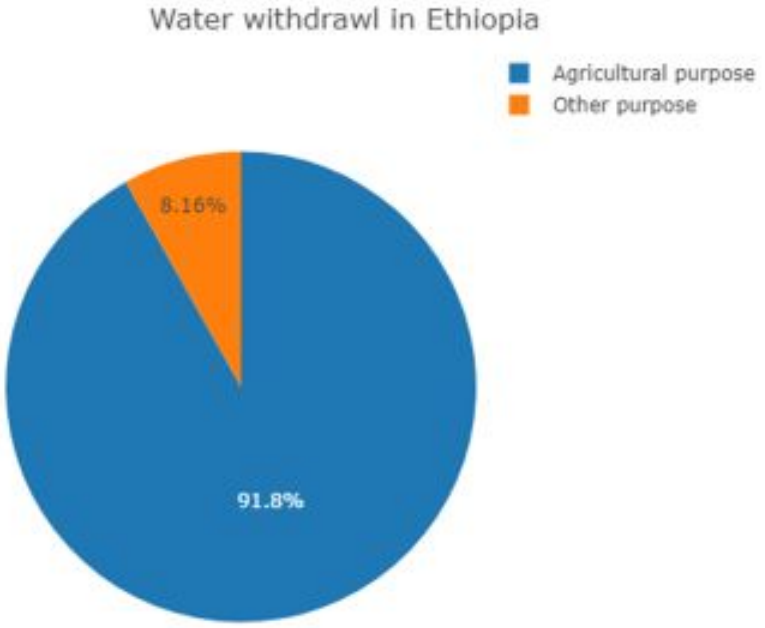


Ethiopia

Graph made in Rstudio based on the data retrieved from https://knoema.com/atlas

Water withdrawal for agricultural purpose as percentage of total water withdrawal in Egypt and Ethiopia





Graph made in Rstudio based on the data retrieved from https://knoema.com/atlas

POST-GERD IMPACT ON EGYPT AND ETHIOPIAN AGRICULTURE

EGYPT

Reduced water supply and drought like situation

Low agriculture production and fall in GDP

Less employment for people engaged in agriculture sector

ETHIOPIA

Improved water supply and prosperity from agriculture

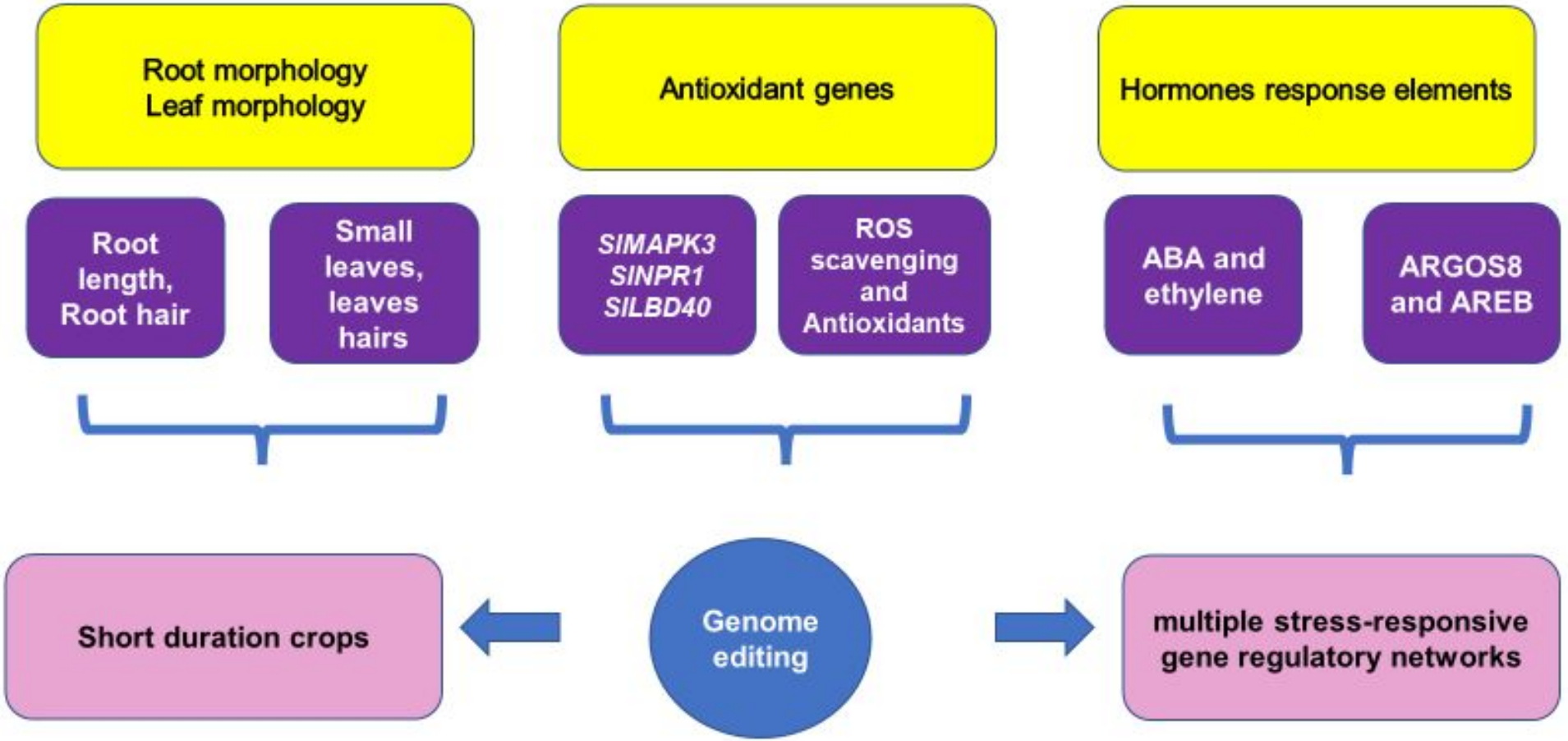
Increased agriculture production and GDP

More employment for people engaged in agriculture and allied fields

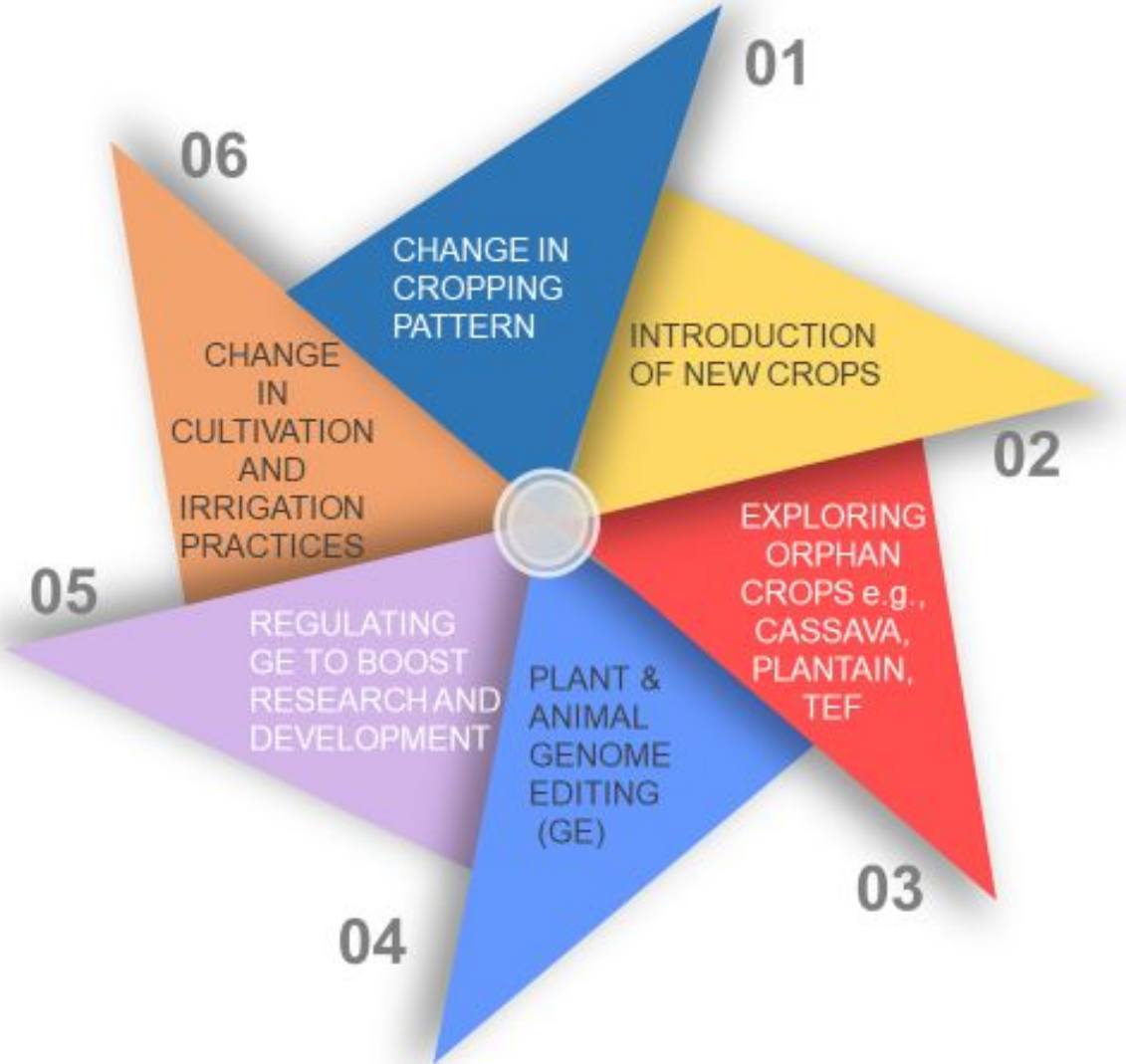
Overview of agriculture in Egypt and Ethiopia in terms of crops, land use and irrigation methods.

S. No.	Crops	Egypt	Ethiopia	Year
1.	Cereals	22.3 Mt	30.2 Mt	2020
2.	Rice, Paddy production	4.89 Mt	0.18 Mt	2020
3.	Sugarcane	14.9 Mt	1.35 Mt	2020
4.	Vegetables primary production	16.1 Mt	1.62 Mt	2020
5.	Arable land	2,911 Th hec	16,187 Th hec	2019
6.	Agricultural area under organic farming	116 Th hec	210 Th hec	2019
7.	Total area equipped for irrigation	3,823 Th hec	858 th hec	2019

Source: https://knoema.com/atlas; Mt = million tones, Th hac = thousand hectares


Root morphology
Leaf morphology
Antioxidant genes
Hormones response elements
Root length, Root hair
Small leaves, leaves hairs
SlMAPK3
SlNPR1
SlLBD40
ROS scavenging and Antioxidants
ABA and ethylene
ARGOS8 and AREB
Short duration crops
Genome editing
multiple stress-responsive gene regulatory networks

Ways to combat post GERD effects



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Questions?