Optimal Power Production of GERD with and without Upstream Irrigation

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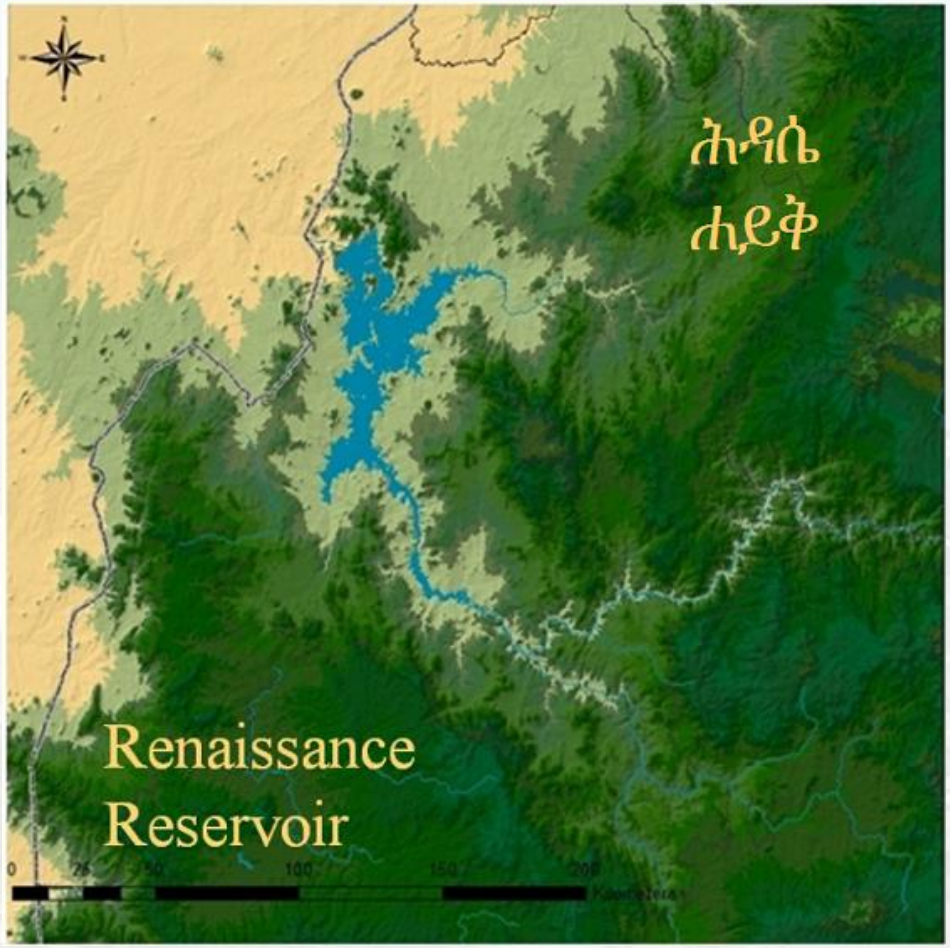
Grand Ethiopian Renaissance Dam (GERD)

- Located near Ethio-Sudan boarder



- Expected to generate a total annual energy of 15,692 GWh and yield an average annual power of 1791 MW

Driving factors for Irrigation

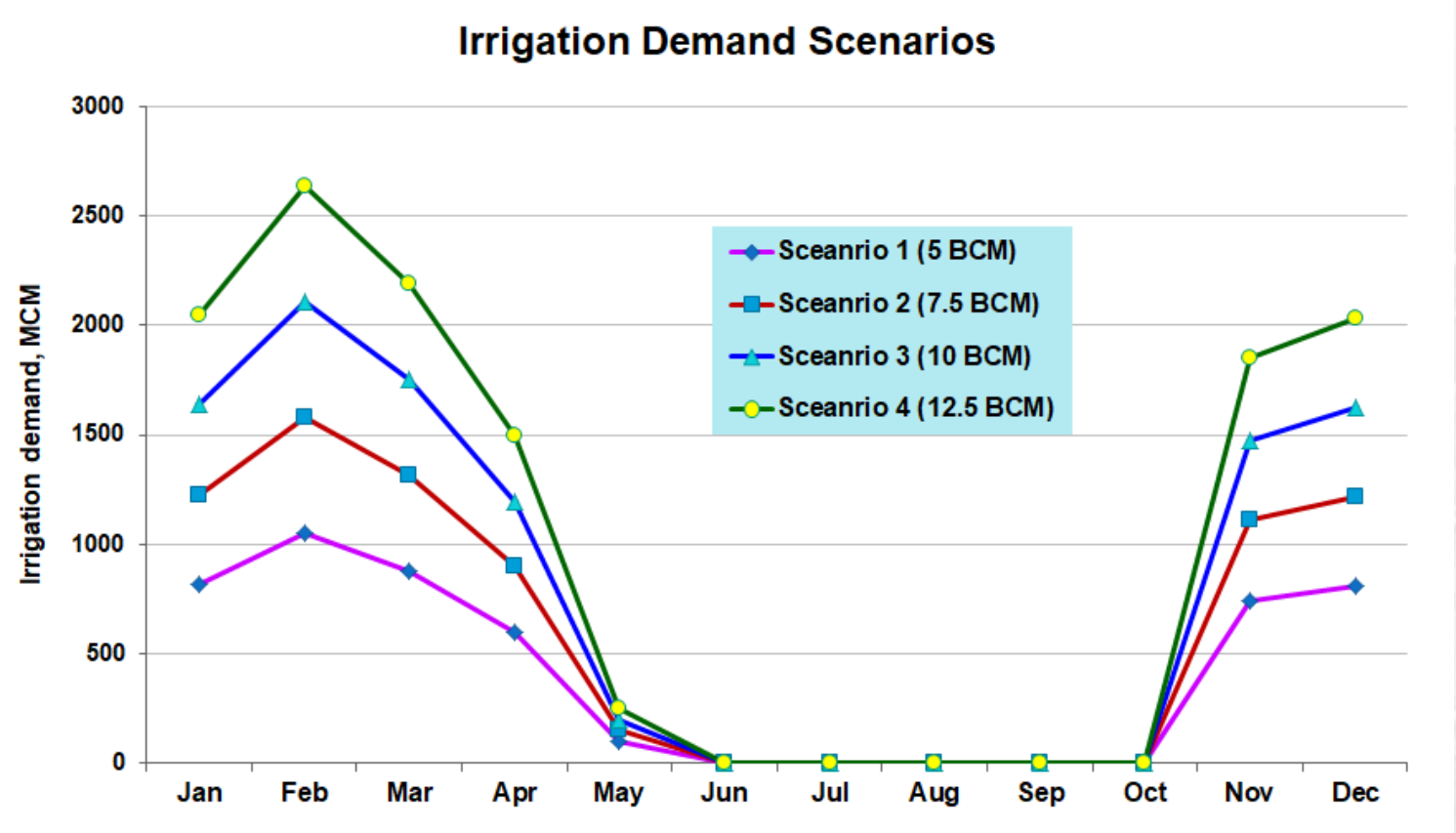
- Agriculture is the backbone of Ethiopia:
  - Crucial to economic growth and long-term food security
  - Supports 85 percent of the population's livelihoods
  - Shares about 40% of the country's gross domestic product
  - More than 80 percent of export value
- Rainfall in Ethiopia:
  - Highly erratic, and extreme spatial and temporal variability
  - Most rain falls intensively, often as convective storms, with very high rainfall intensity

Driving factors …

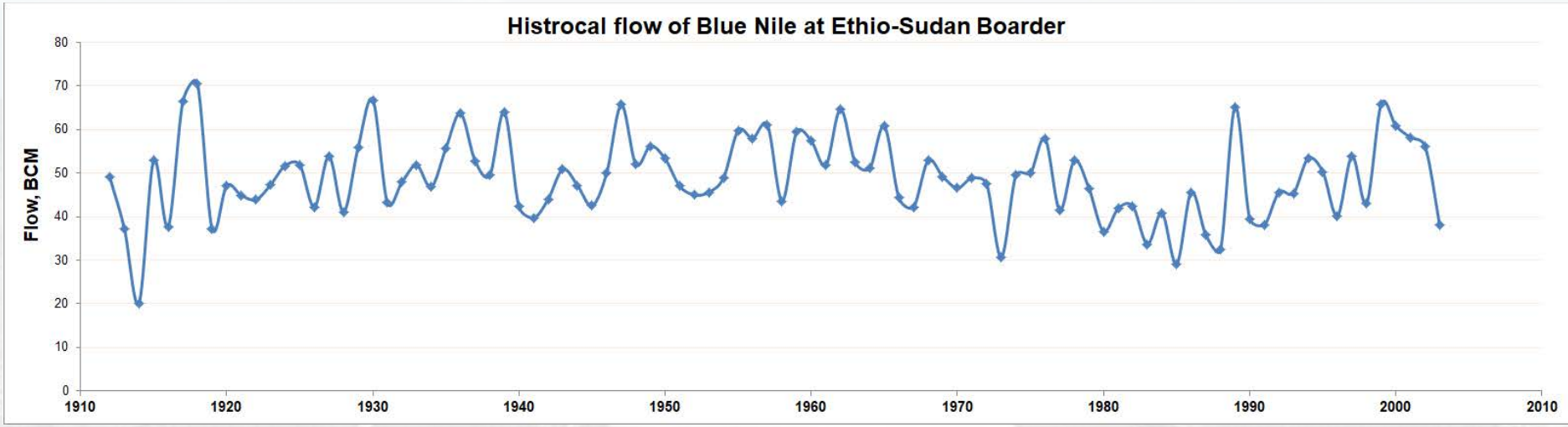
- High population growth (nearly 115 M)
- Soil and land degradation
- Very high risk of annual droughts and intra-seasonal dry spells – rainfed agriculture is insufficient to ensure food security
- Beside hydropower generation, development of modern irrigation schemes is **no-choice option** for Ethiopia to overcome these challenges
- So it is important to investigate the impact of upstream irrigation on GERD power production

Method

- Assume hypothetical annual abstraction of 5 to 12.5 BCM for irrigation upstream of GERD



- The historical inflow at Ethio-Sudan boarder since 1910 has been used as an input to perform the analysis



- Reservoir operation is modeled with and without drought mitigation conditions

Assumption

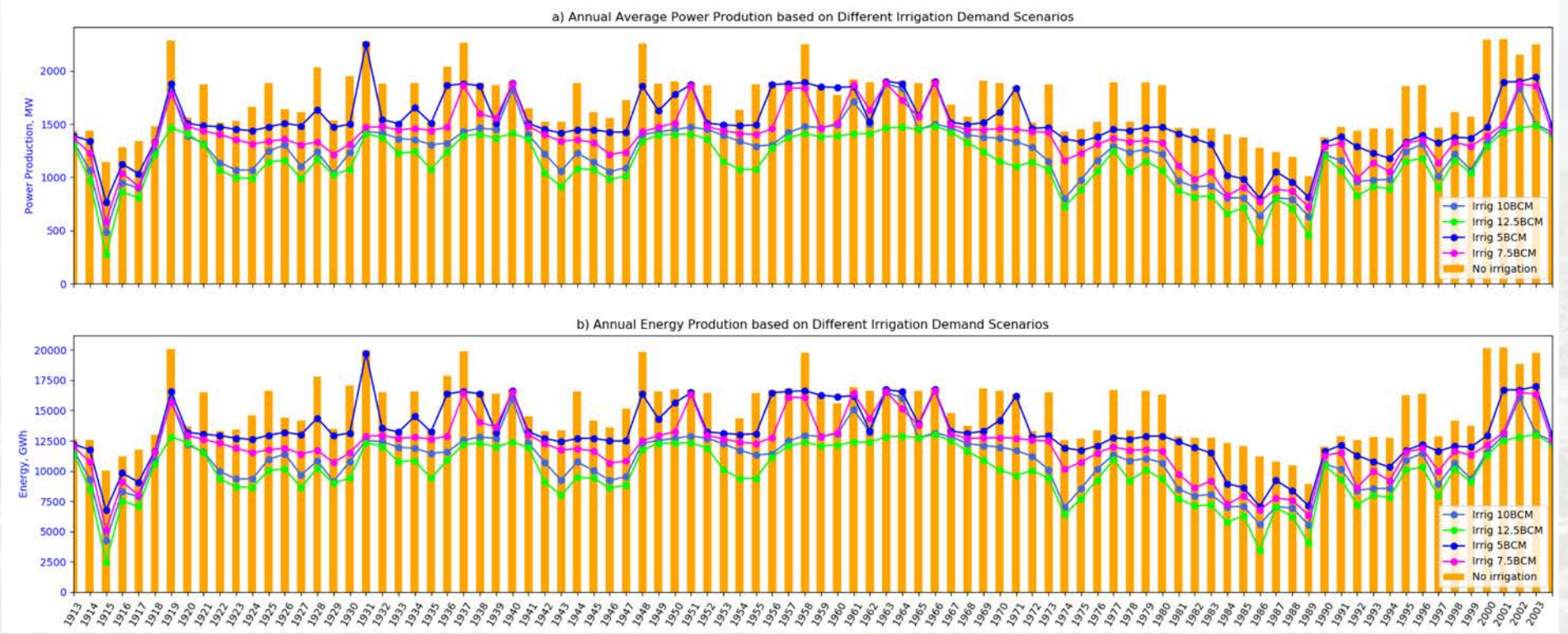
- The existing operation rule in the GERD report has been generated based on optimal average power and annual total energy without upstream irrigation consideration.
- This analysis assumed that **operation rules** remain the same regardless of upstream **abstractions**

Result

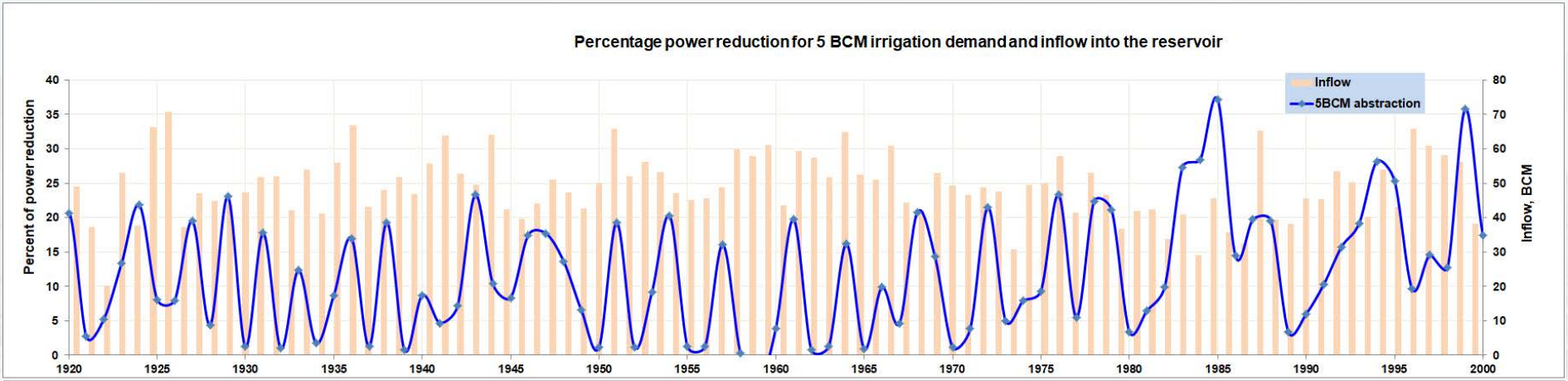
- Summary of average power and energy production for different upstream irrigation demands

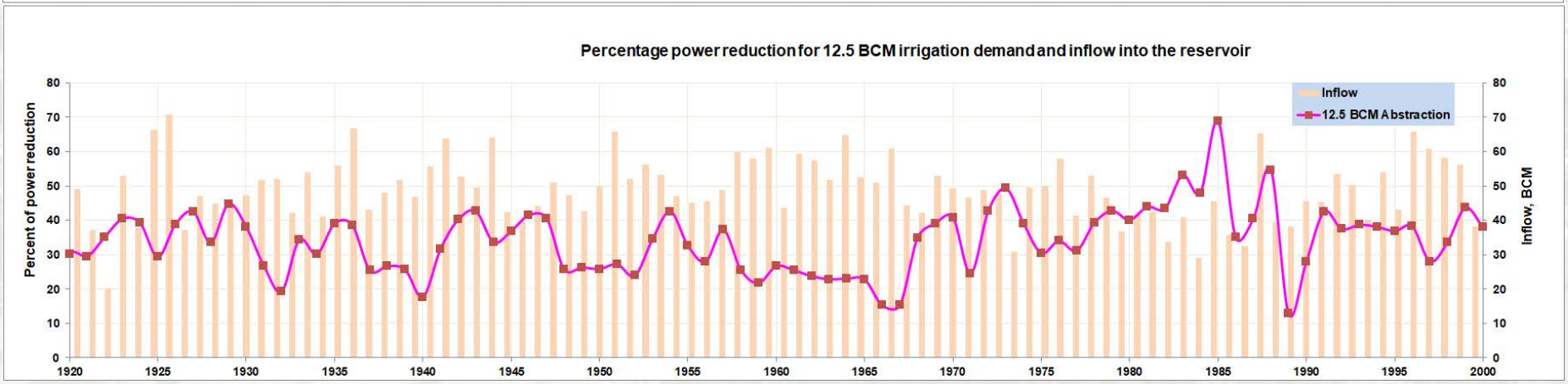
Scenario	Qin, BCM	Qout, BCM	Power, MW	Energy, GWh
No Irrigation	48.9	47.2	1713	15030
5 BCM Irrigation demand		42.4	1505	13199
7.5 BCM Irrigation demand		40.1	1374	12047
10 BCM Irrigation demand		37.7	1251	10958
12.5 BCM Irrigation demand		35.2	1140	9985

Impact of upstream irrigation on **yearly average power and total energy production**

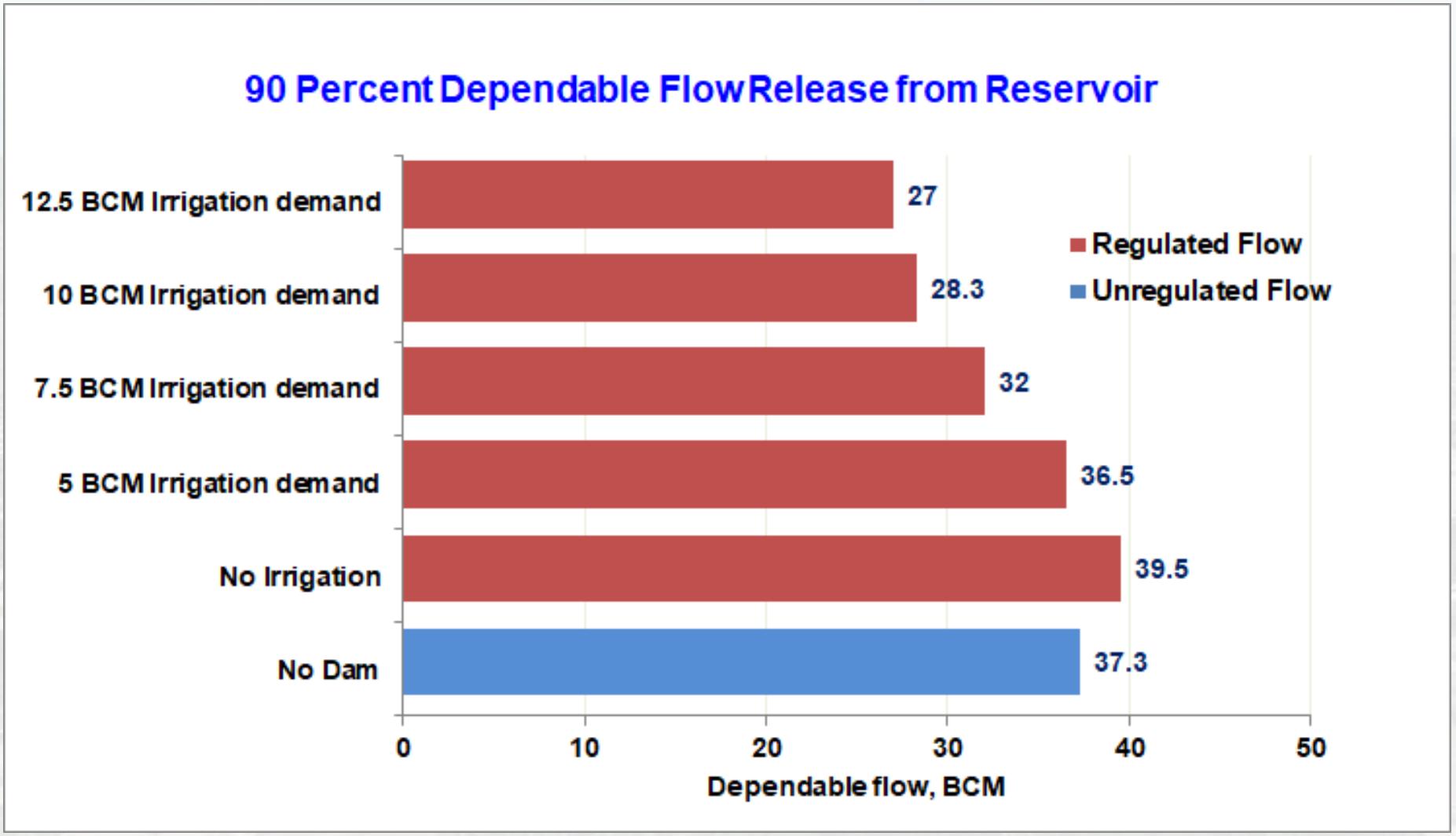


The variation of percent of power reduction is not directly match the variation of inflow. The lag effect is attributed to reservoir operation rules and storage role in power generation





Dependable flow



Summary and recommendation

- The study indicates upstream irrigation abstraction between of **5 BCM** to **12.5 BCM** may reduce average annual power production from **1,713 MW** to **1,140 MW** and the total annual energy production from **15,030 GWh** to **9,985 GWh**
- Annual power production and total energy generation may reduce within the range of **12%** to **33%** regardless of the hydrological condition.
- This study may help contribute in determination of **dependable flow releases** and set threshold flows on the ongoing negotiation in the long term operation of the dam

Summary …

- Regardless of irrigation demand, the GERD will contribute **6%** increase to **90 percent dependable flow** as compared to natural flow
- With potential upstream irrigation, a new optimized **reservoir operation rules** should be generated based on a combined irrigation-power production scenario.
- **Diversifying power sources** may compensate the power and energy loses from potential irrigation abstraction upstream of GERD.

Thank you