Global Freshwater Use & Withdrawals

TRENDS, PATTERNS AND INSIGHTS

COURSE: DATA VISUALIZATION
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Introduction

- Freshwater is essential for human survival, agriculture, and global economic development.
- We analyze two datasets from *kaggle*:
  - Global freshwater use (1901–2014)
  - Country-level water withdrawals (1962–2021)
- Goal: Visualize trends, compare countries, and understand how reporting coverage influences interpretation.
- The project focuses on long-term patterns and modern water-use variation across countries.

Research Questions

- How has global freshwater use changed from 1901–2014?
- Which decades experienced the fastest or slowest growth?
- Which countries use the most freshwater, and how does this change over time?
- How do top water-using countries compare across decades?
- How has the distribution of withdrawals changed as data coverage improves?

Data Sources

- **Dataset 1:** Global Freshwater Use (1901–2014)
  - One value per year
  - No missing values
- **Dataset 2:** Annual Freshwater Withdrawals by Country (1962–2021)
  - Withdrawals measured in cubic meters
  - Includes ISO3 country codes
  - Missing country-year entries in early decades
- **Source: Kaggle DataSets**

Data Preparation

- Converted all country-level withdrawals to *billions of cubic meters (BCM)* for cleaner visualization.
- Verified and corrected ISO3 country codes.
- Removed rows with no usable withdrawal values.
- Added a derived variable: **number of reporting countries per year**.
- Inspected global dataset for anomalies; confirmed stable historical progression.

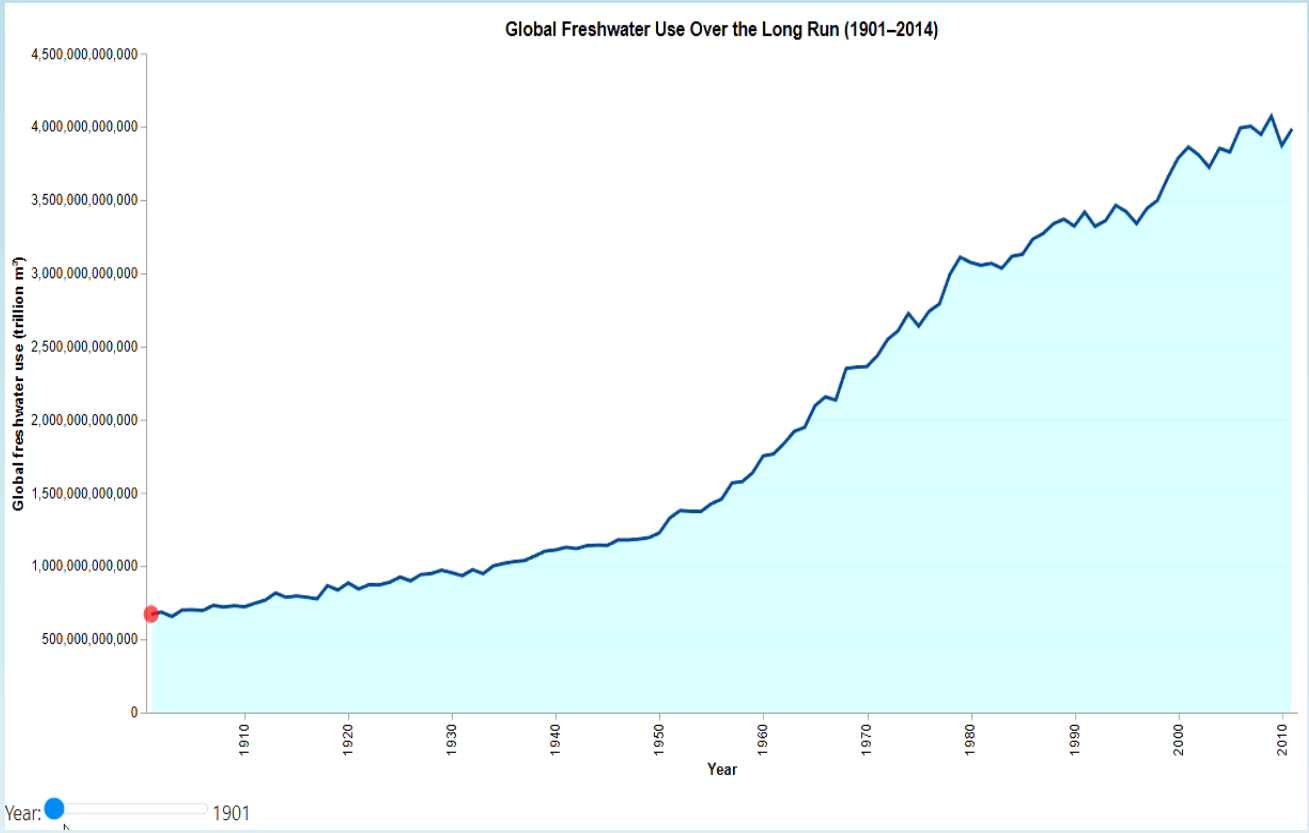
EDA Overview

- Cleaned & standardized dataset (Country, Year, ISO3, Withdrawal_BCM)
- Dropped missing/invalid rows (e.g., zeros for log scale).
- Removed regional aggregates (e.g., “World”, “Upper-middle income”).
- Verified dataset spans **1962–2021**.
- Conducted EDA: summary stats, missing values, distribution checks.

Motivation

- Global freshwater demand is rapidly increasing due to population growth and agriculture.
- Understanding trends helps policymakers address water scarcity and sustainability.
- Identifying which countries use the most water highlights economic and agricultural drivers.
- Investigating reporting coverage avoids misinterpretation of early-century values.

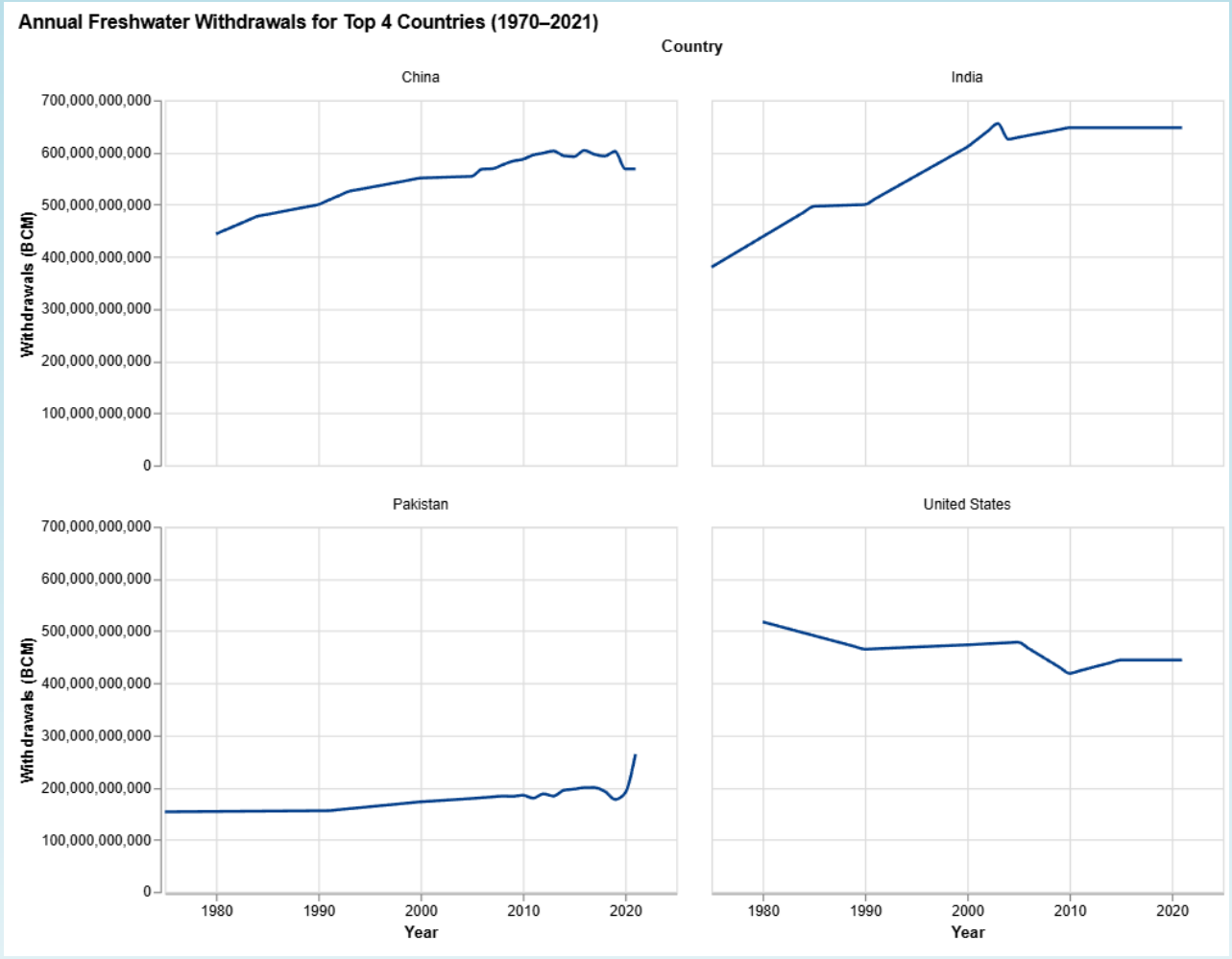
Global Freshwater Use Over Time (1901-2014)



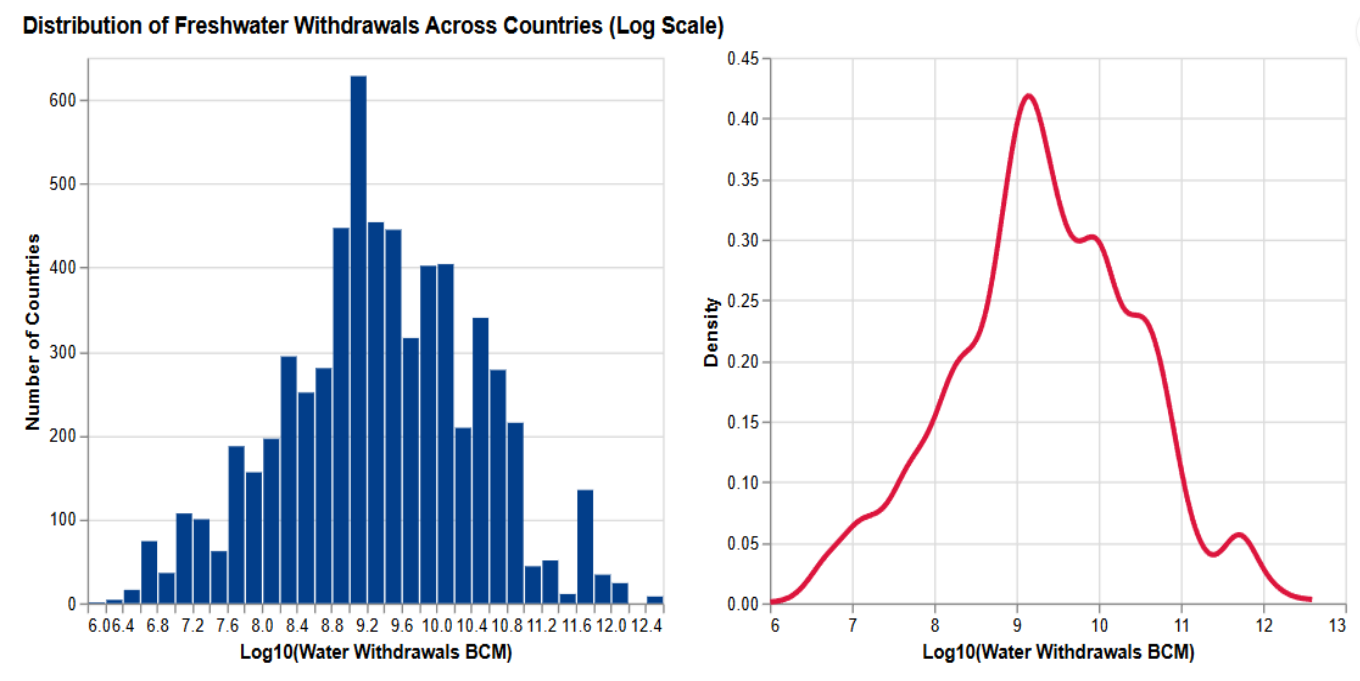
- **Chart Type:** Interactive Area Chart
- Global freshwater use increased from ~600 BCM (1901) to ~4,000 BCM (2014).
- Major acceleration occurred post-1950, aligning with industrial and agricultural expansion.
- Area chart effectively communicates cumulative growth and magnitude.

Top 4 Countries (Small Multiples, 1962–2021)

- **India**: largest and fastest-growing consumer.
- **China**: rapid industrial growth from 1970–2005, stabilizing recently.
- **USA**: declines after 1980 due to efficiency gains.
- **Pakistan**: steady increase driven by agriculture.
- Each country shows unique patterns shaped by population, agriculture, and industry.

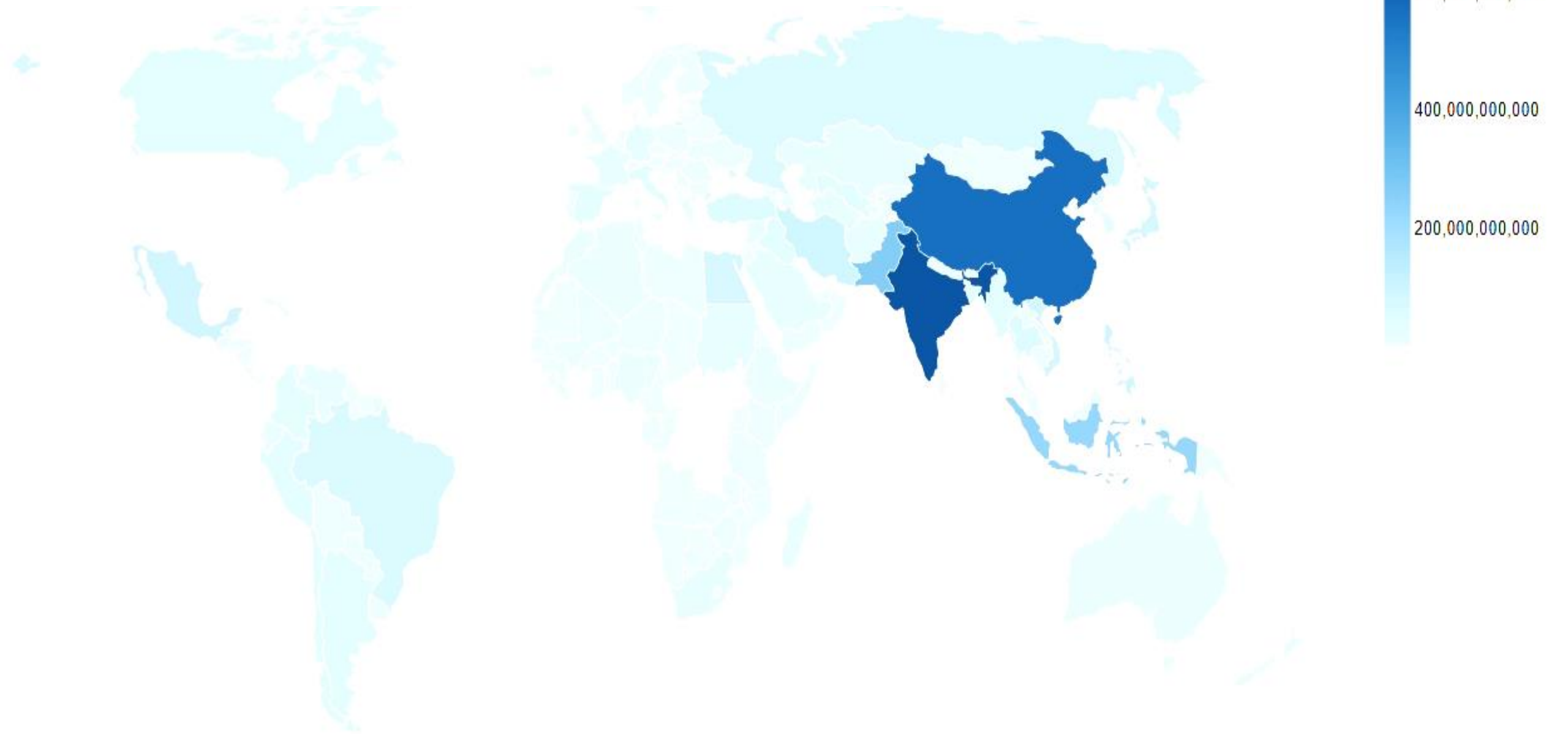


Distribution of Withdrawals (Histogram + Density)



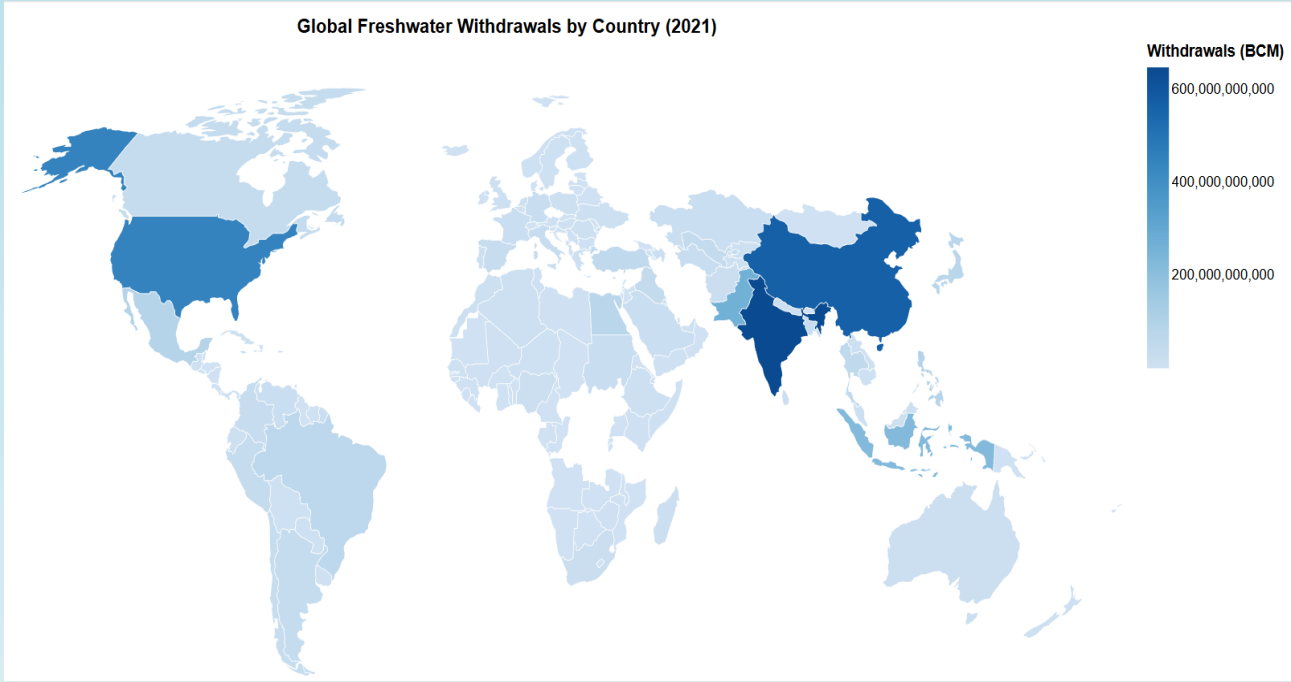
- Withdrawals are **extremely skewed** (log scale needed).
- Most countries withdraw **300M–3B m³** per year.
- Only a few countries (India, China, U.S.) lie in the **extreme right tail**.
- Highlights global inequality in freshwater use.

Global Freshwater Withdrawals by country 2021

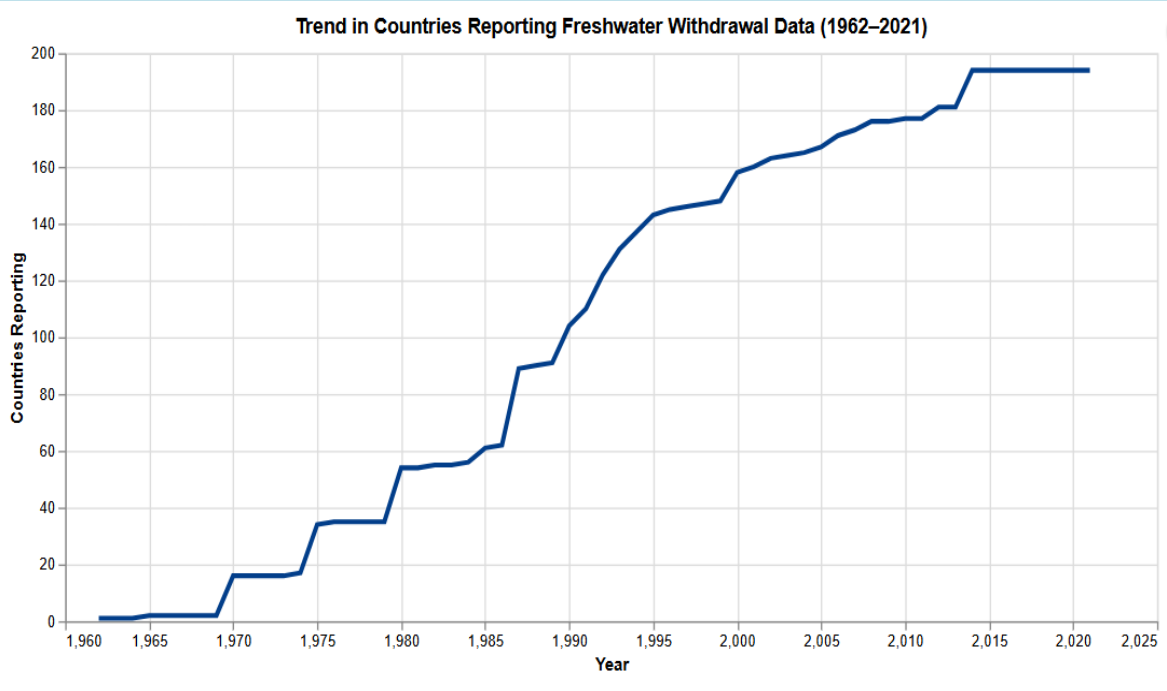


Choropleth Map (2021)

- India, China, and the U.S. dominate global withdrawals.
- Large portions of Africa and Europe withdraw relatively little.
- High-use regions correspond to population density and agricultural intensity.
- Geographic disparities highlight potential vulnerability to water stress.



Trend in Countries Reporting (1962–2021)



- Reporting grows from a few countries in 1962 to nearly all UN countries by 2021.
- Indicates improved global data standards and monitoring capacity.
- Modern estimates of global water use are far more reliable than earlier decades.

Conclusion

- Global freshwater use has risen dramatically over the past century.
- The decades **1950–1980** saw the fastest growth.
- A small group of countries dominate global water use.
- Distribution is highly unequal and geographically concentrated.
- Reporting coverage has improved significantly, enabling better global assessments.
- Future work: sustainability, water efficiency, climate impacts.

Future Work Recommendation

ADD MORE WATER STRESS INDICATORS
ANALYZE FORECASTS & PREDICTIVE TRENDS
EXPLORE SECTOR-SPECIFIC WATER USE
INTEGRATE CLIMATE CHANGE VARIABLES
IMPROVE GEOGRAPHIC DETAIL
STUDY WATER POLICIES & CONSERVATION IMPACT


THANK YOU!