

# Alternative Futures for Sub-Saharan Africa Water and Food

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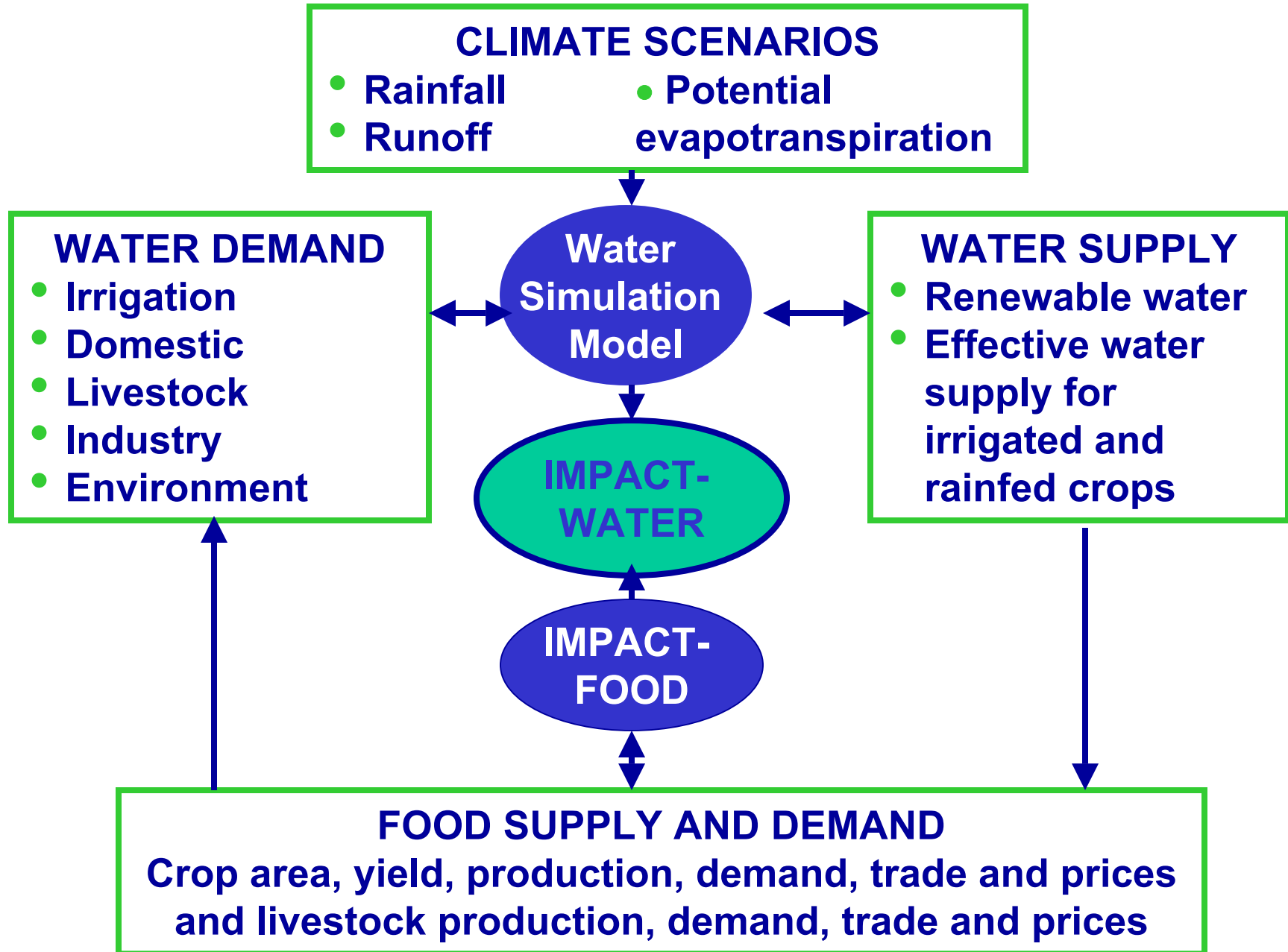
# Overview of the Presentation

- **Model Overview**
- **Scenario Description**
- **Scenario Results**
- **Policy Conclusions**

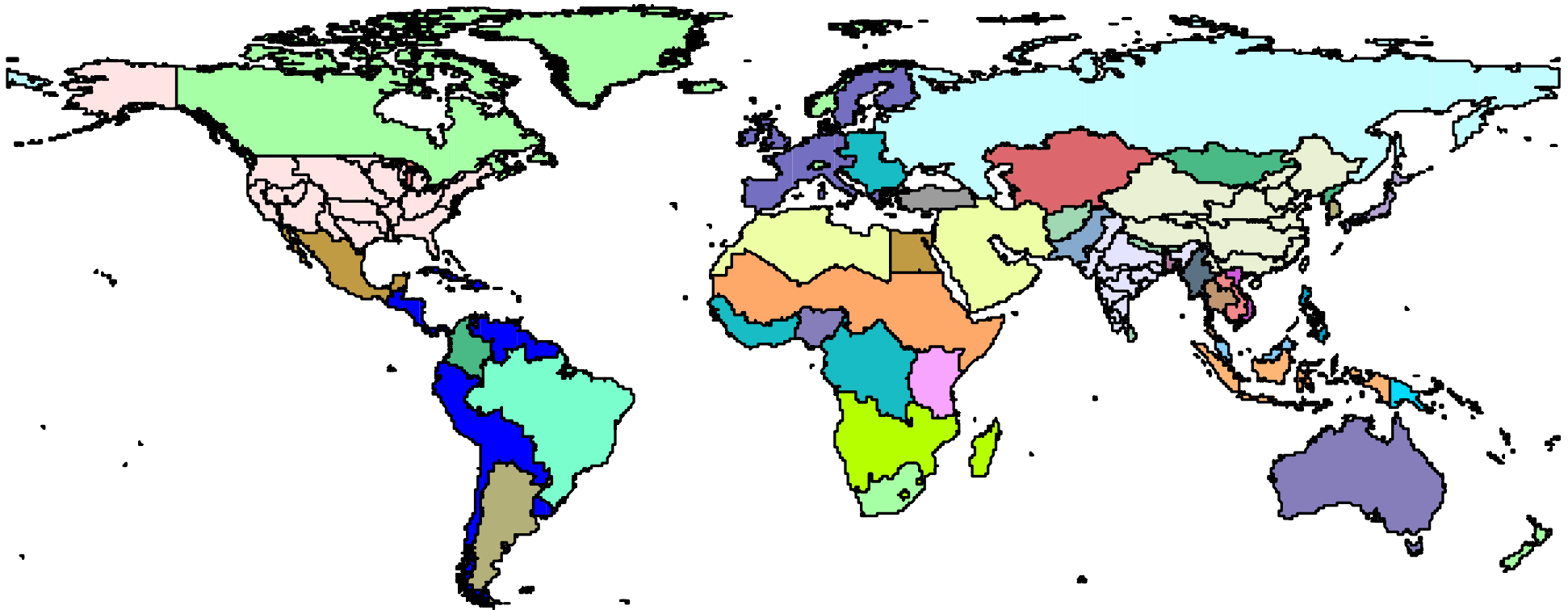
# Key Challenges for Water Resources

- **Rapid growth in domestic and industrial water demand**
- **Increasing Costs of Water Development**
- **Wasteful Use of Existing Water Supplies**
- **Groundwater Overdrafting and Degradation of Irrigated Cropland**
- **Threats to Ecosystems, Declining Water Quality**
- **Subsidies, Distorted Incentives, and Poor Cost Recovery**
- **Low Rainfed Crop Yields**

# IMPACT-WATER Model



# IMPACT-WATER Model Spatial Units



# **IMPACT-WATER Methodology**

**Water Simulation Model (WSM), simulates effective water for irrigation and rainfed production based on climate parameters, infrastructure, and policy inputs, considering**

- **Aggregate storage and water demands at the basin scale, and year-to-year storage transfers**
- **Monthly water balance with storage regulation and committed flow constraints**
- **Water supply and demand calibrated by spatial units in the base year**

# Variables Influencing Agricultural Water Supply

## Climate and Hydrologic Parameters

- Precipitation
- Evapotranspiration
- Runoff
- Groundwater Recharge

## Infrastructure

- Reservoir storage
- Withdrawal facility
- Water distribution and use systems

Effective  
Water Supply for  
Irrigated and  
Rainfed Crops

## Water Policies

- Water allocation among sectors
- Water Prices
- Committed flow for environment
- Investment in infrastructure

## Water Pollution

- Industrial pollution
- Agricultural pollution  
(salinization, pesticides, etc.)

# Water Demand for Different Sectors

## Water Demand for Different Sectors

**Irrigation Water Demand = f(Irrigated Area, ET, Irrigation Efficiency, Water Price)**

**Livestock Water Demand = f(Livestock Population, Water Demand per Animal, Water Price)**

**Industrial Water Demand = f(GNP, Water Use Intensity, Technological Change, Water Price)**

**Domestic Water Demand = f(Income per Capita, Population, Technological Change, Water Price)**

# Water-Food Linkages in the Model

**IMPACT- WATER simulates annual food production, demand, prices, and trade for irrigated and rainfed production, and agricultural sector model covers 16 commodities**

- **Food demand =  $f(\text{prices, income, population})$**
- **Separate area and yield functions for rainfed and irrigated crops**
- **Crop area and yield functions including water availability as a variable**
- **Water allocation among crops**

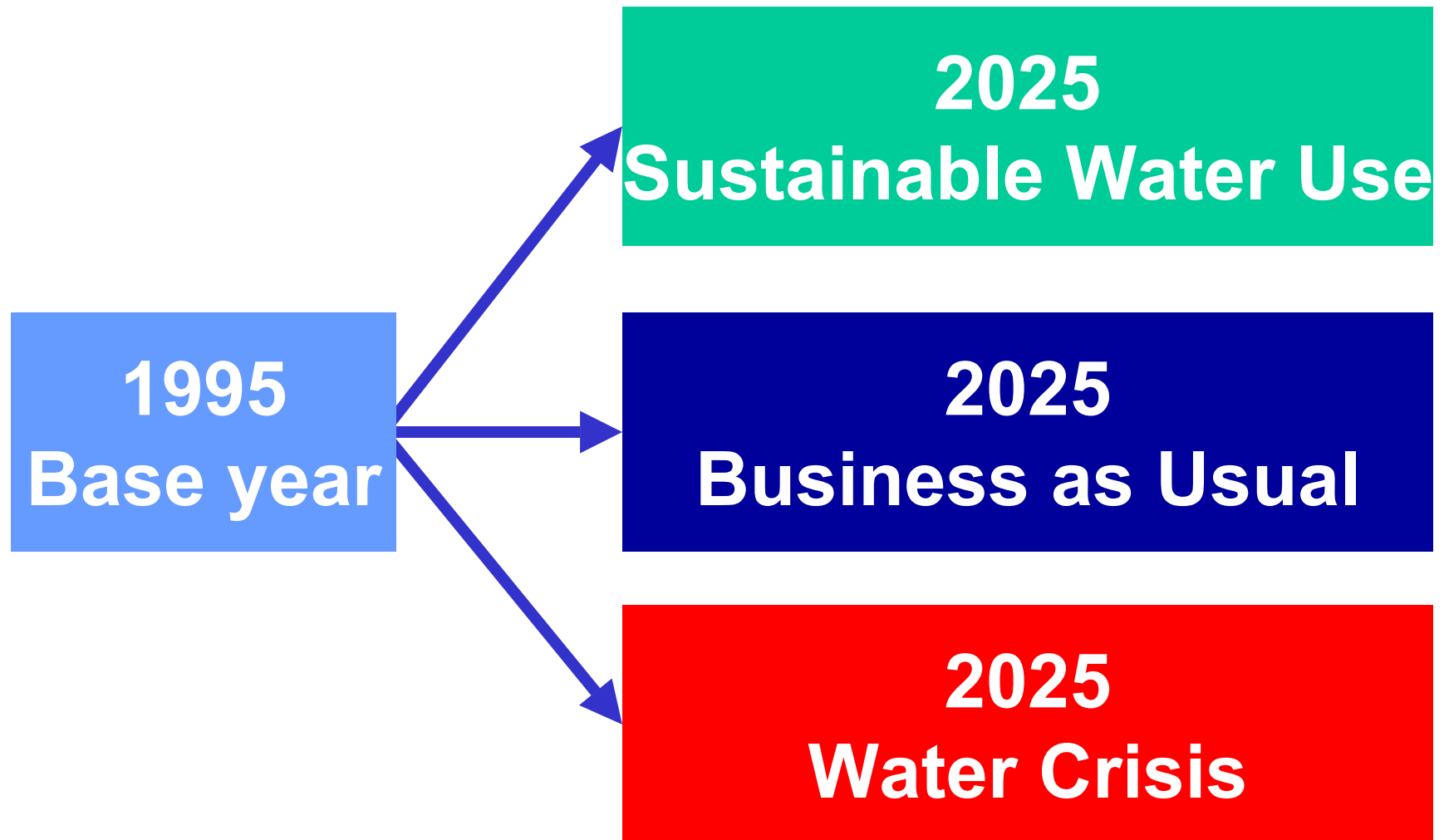
# Production, Area, and Yield Equations

**Production = Area \* Yield**

**Area = A [crop prices, irrigation investment, (beneficial water consumption/ potential evapotranspiration)]**

**Yield = Y [crop prices, input prices, agricultural research investment, (beneficial water consumption/ potential evapotranspiration)]**

# Scenario Approach



# Description of Scenarios

- **Business as usual (BAU):** Current trends in water and food policy, management, and investment remain continue. International donors and national governments continue to cut their investments in these sectors. Policy, institutional and management reforms are limited.
- **Water crisis scenario (CRI):** Further deterioration of current trends in investments and policies in the water sector.
- **Sustainable water use scenario (SUS):** Improvements in these water sector policies and trends compared to business as usual.

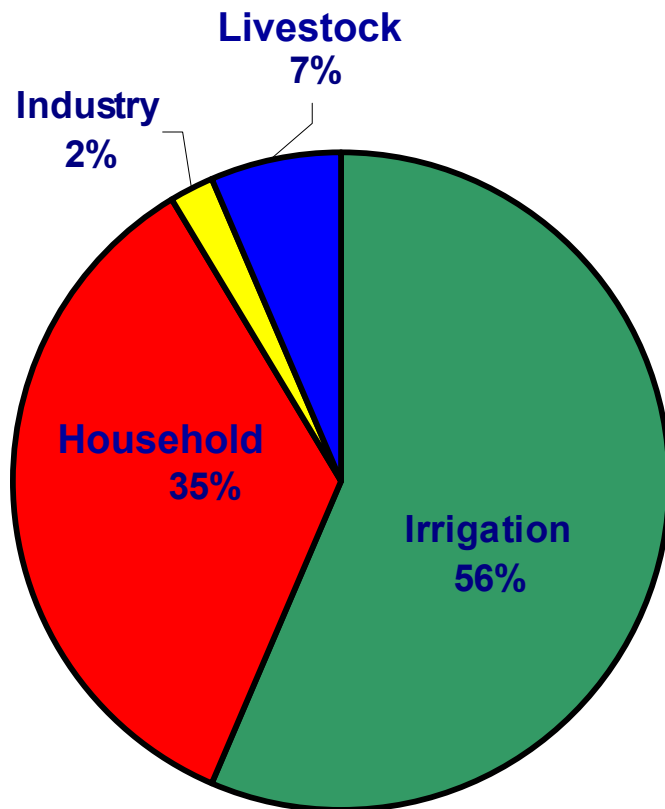
# Key Scenario Drivers

## Changes in Water Prices

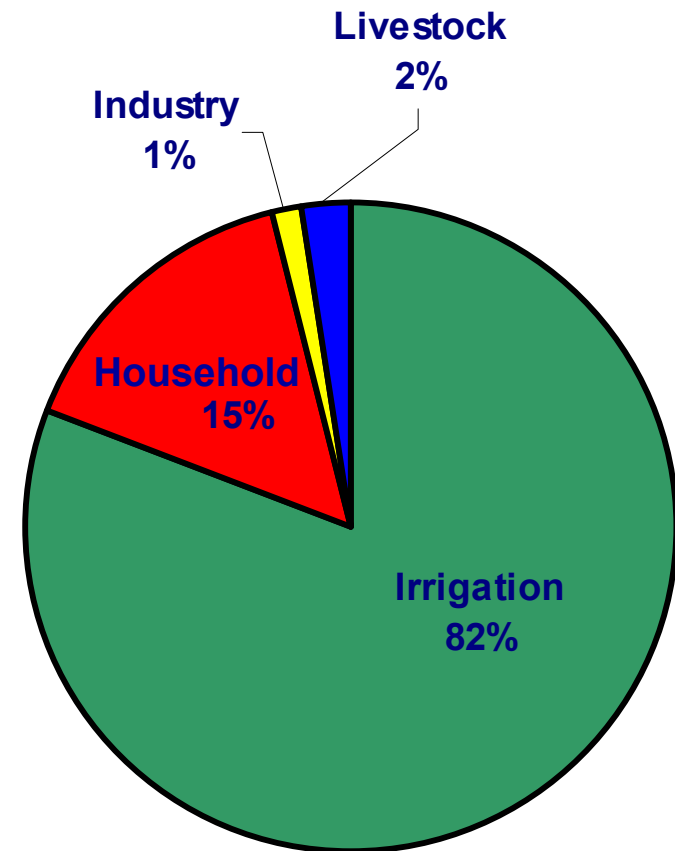
	Water Crisis	Sustainable Water Use
<i>percent change, 1995-2025</i>		
<b>Industrial</b>		
Developed Countries	<b>+25%</b>	<b>+75%</b>
Developing Countries	<b>+50%</b>	<b>+125%</b>
<b>Agricultural</b>		
Developed Countries	<b>0</b>	<b>+100%</b>
Developing Countries	<b>0</b>	<b>+200%</b>
<b>Household</b>		
Developed Countries	<b>+25%</b>	<b>+40%</b>
Developing Countries	<b>+50%</b>	<b>+80%</b>

# Water Consumption Shares by Sector, 1995

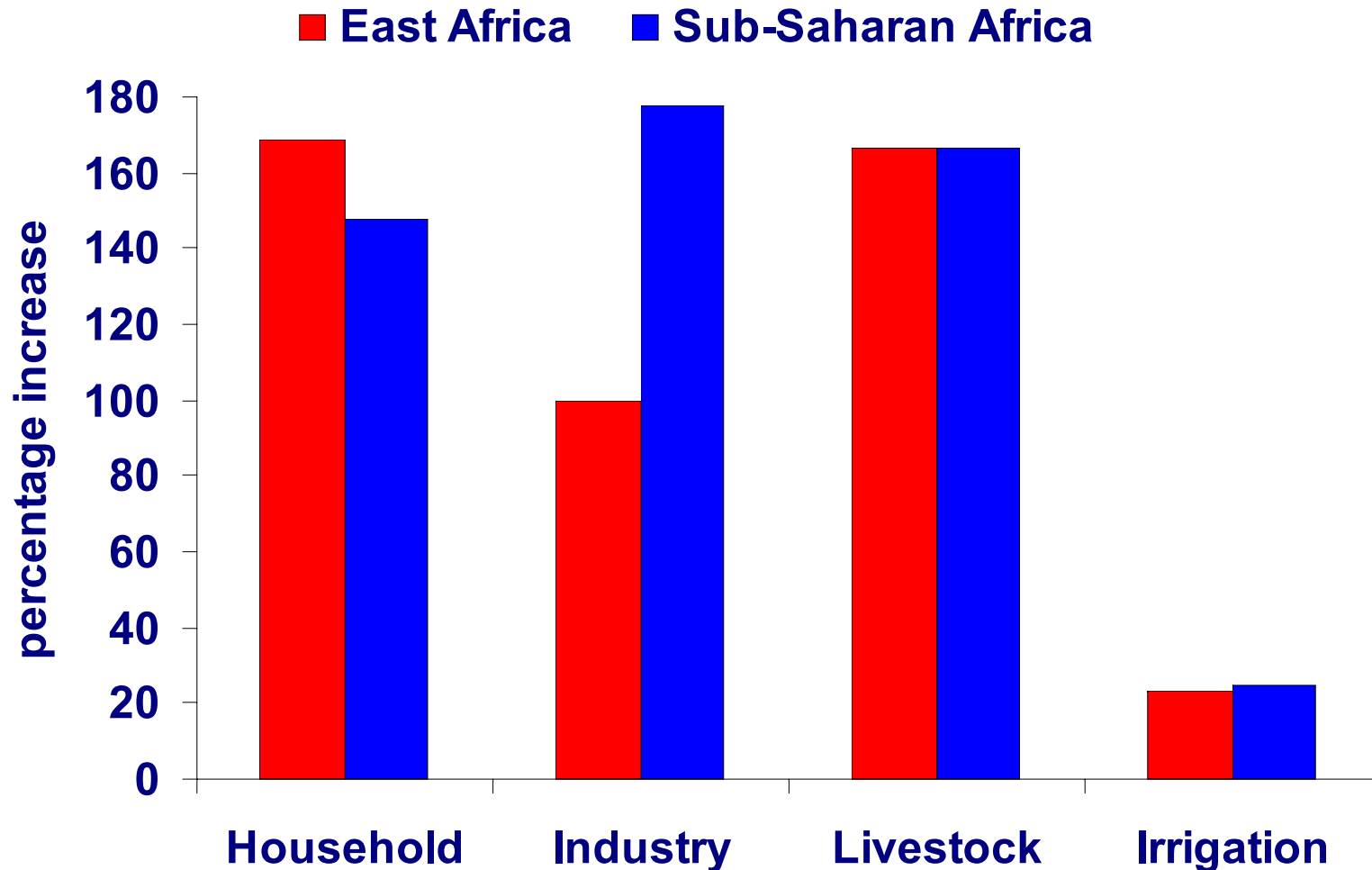
## East Africa



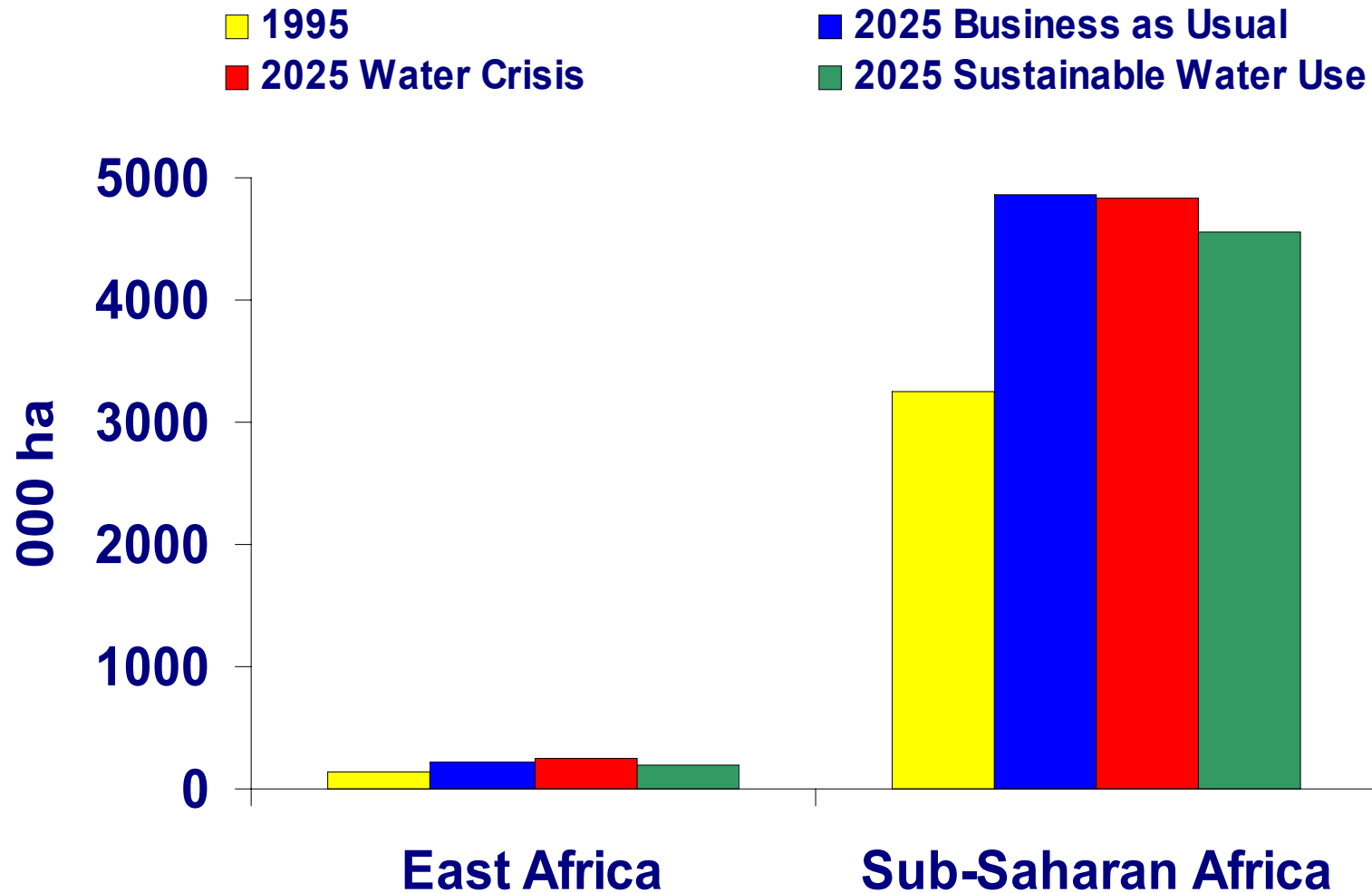
## Sub-Saharan Africa



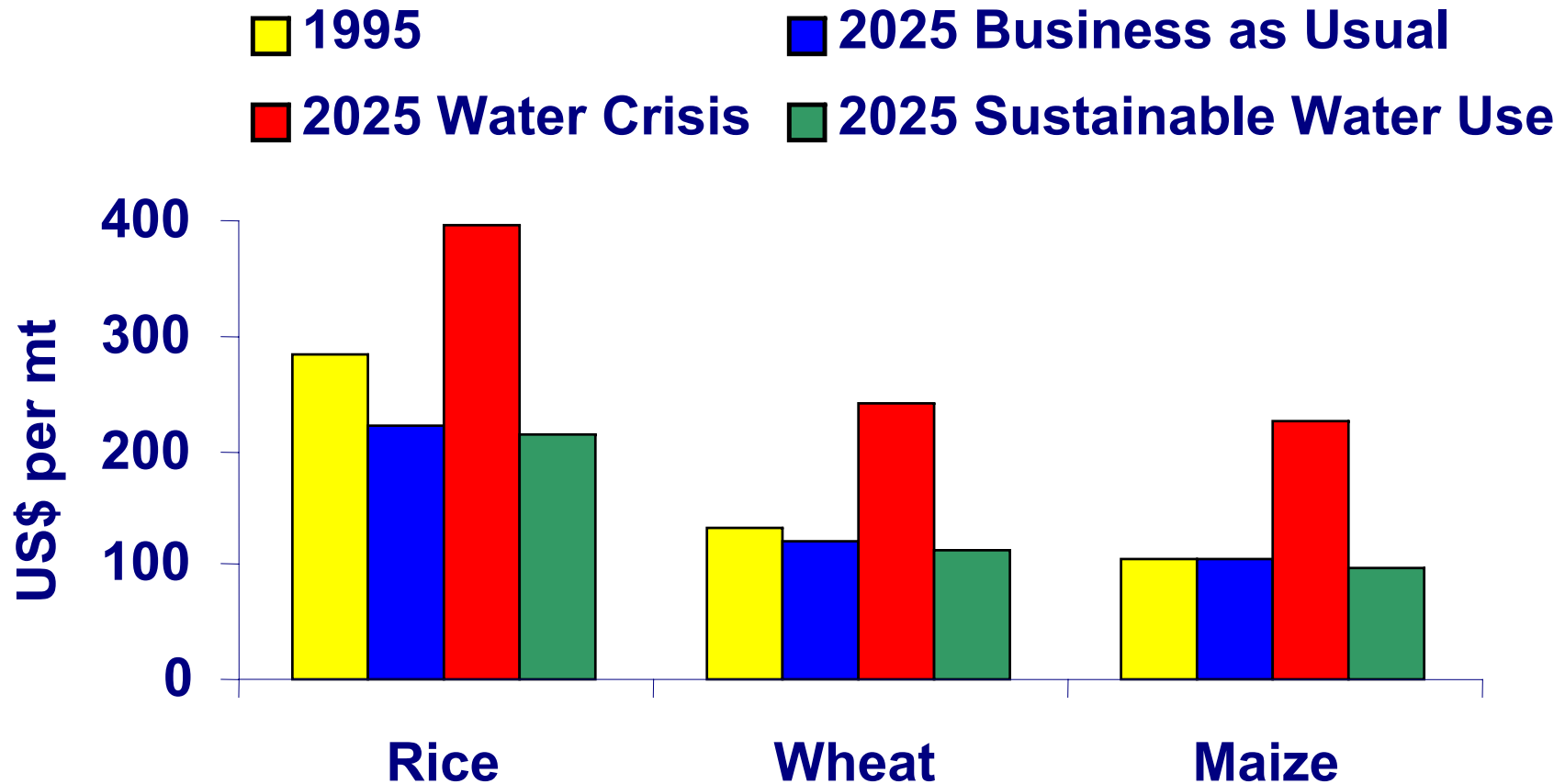
# Increase in Water Consumption between 1995 and 2025, BAU



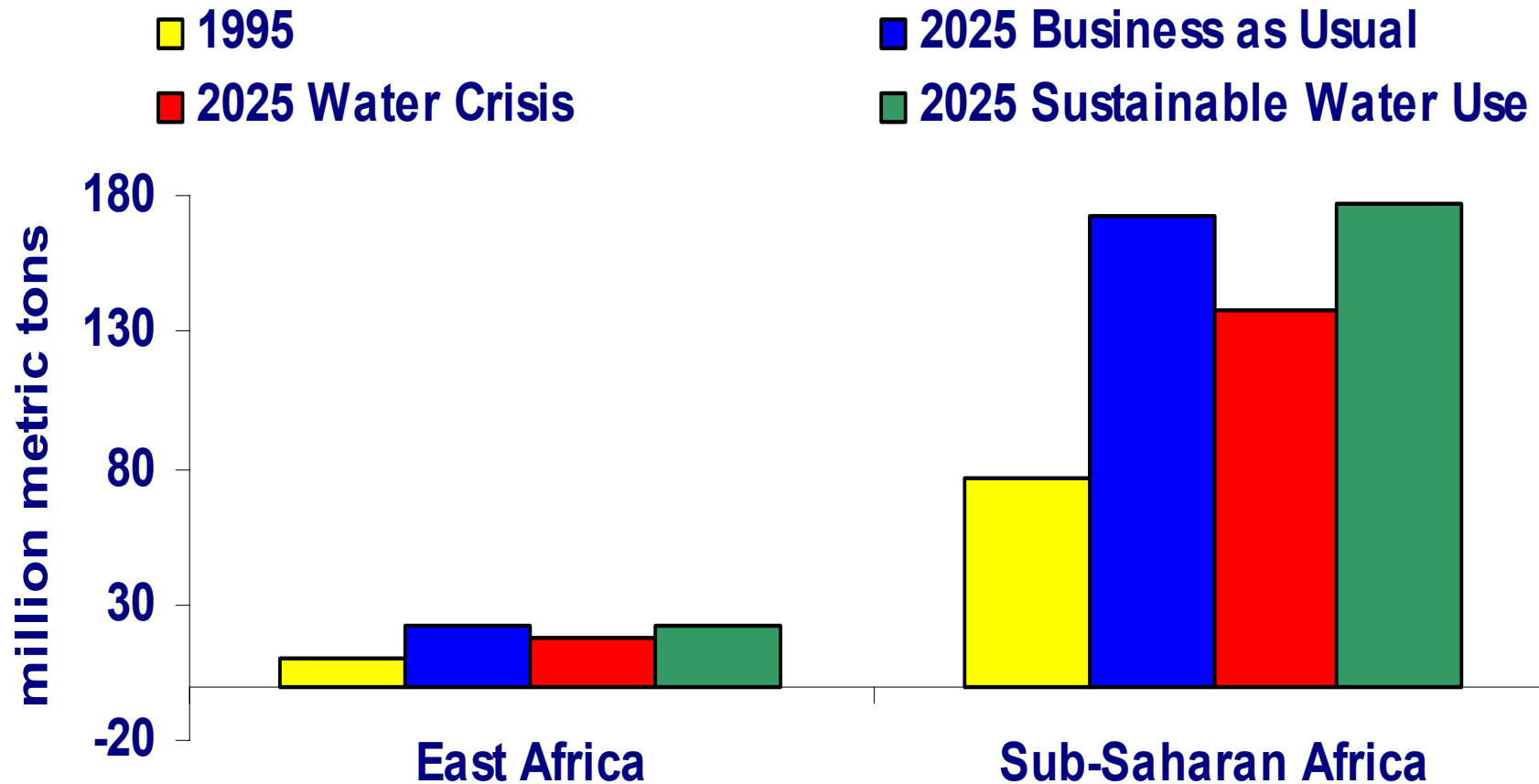
# Irrigated cereal area, 1995-2025 under alternative scenarios



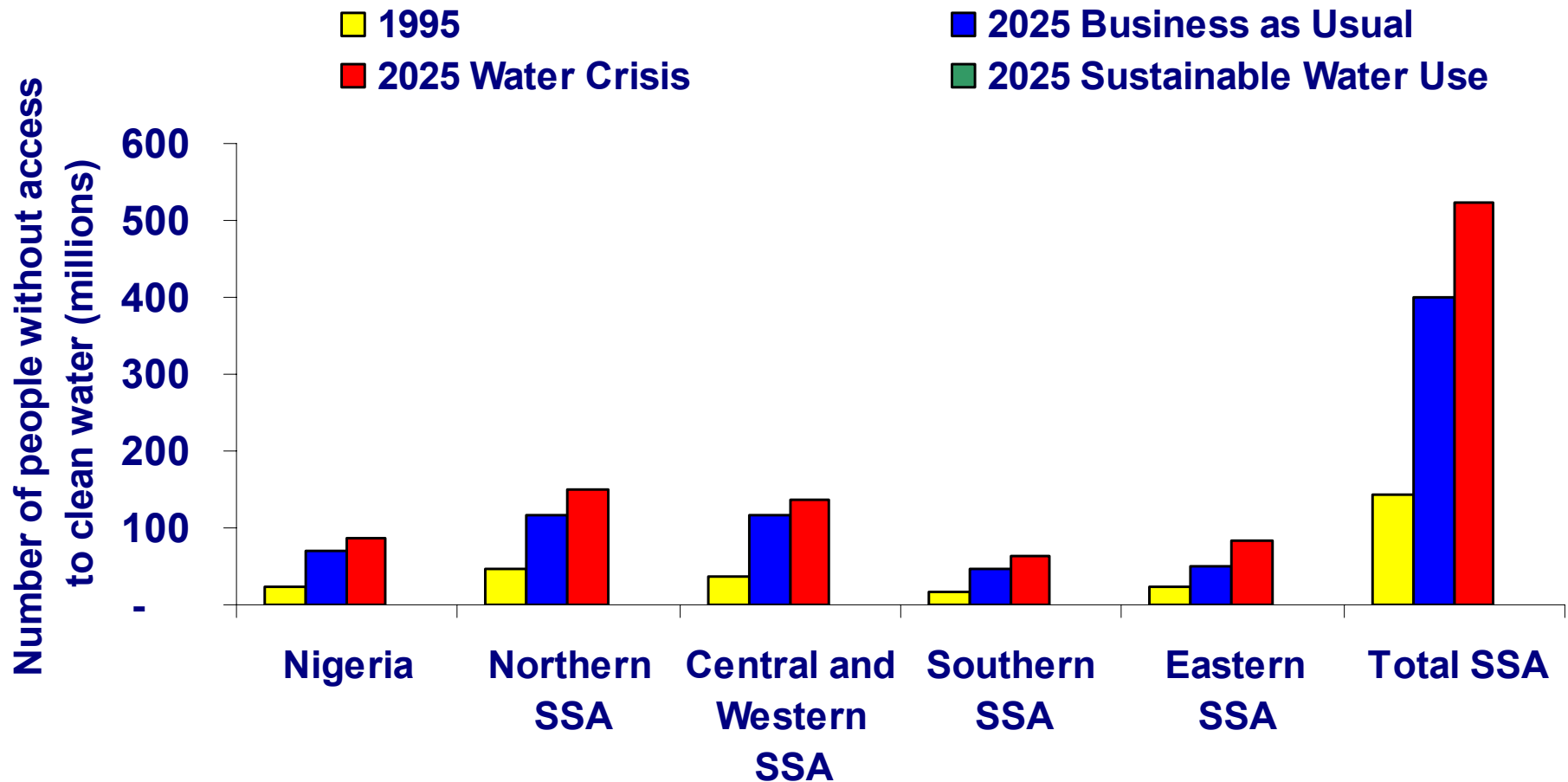
# International Grain Prices



# Total Grain Demand



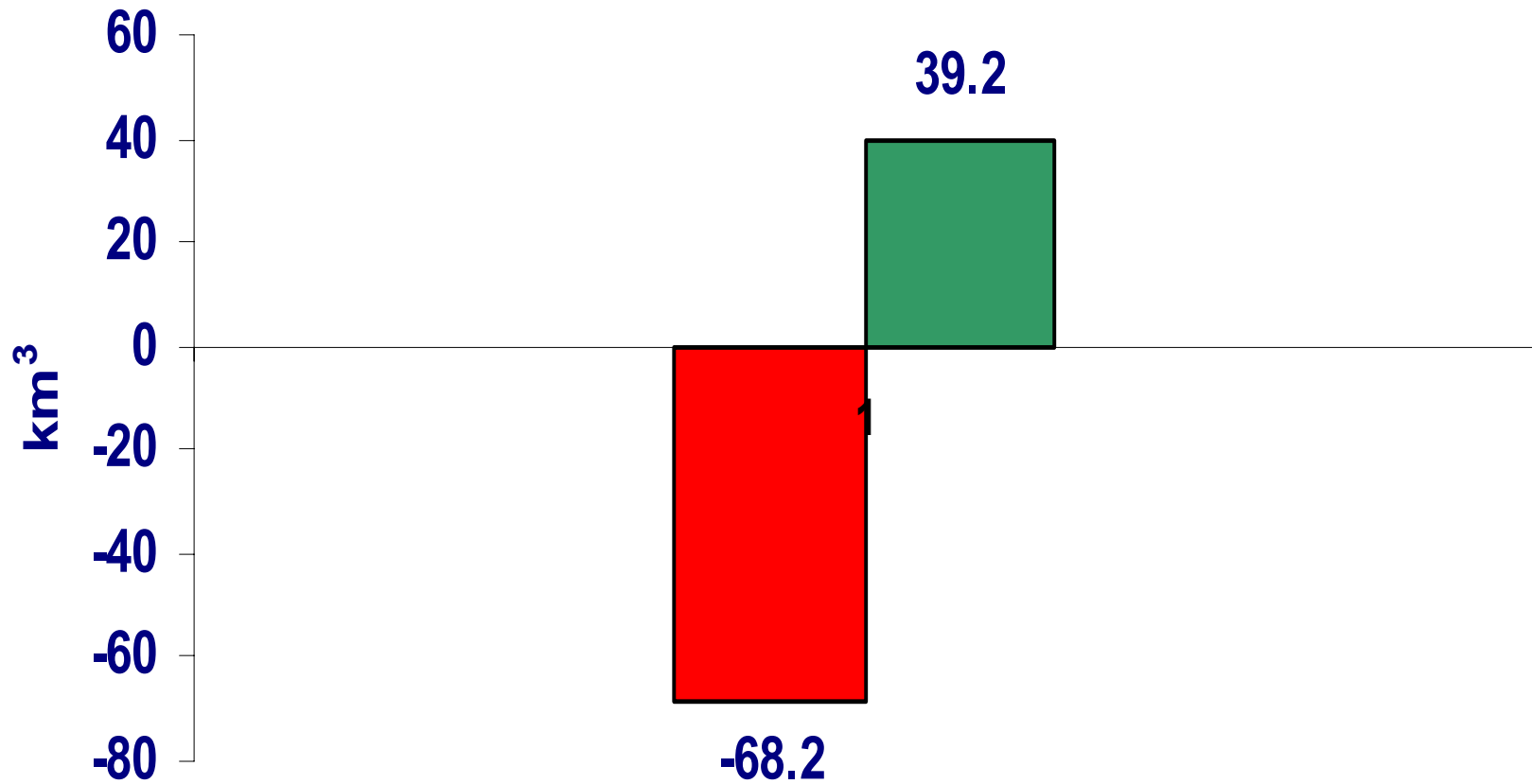
# People without Access to Safe Water, Alternative Scenarios



# Change in Environmental Flow in 2025

Compared to Business as Usual Scenario, Sub-Saharan Africa

■ Water Crisis ■ Sustainable Water Use



# Key Messages

- 1. Increasing competition for water severely limits irrigation and constrains food production**
- 2. Slow progress in extending access to safe drinking water; water quality will decline; amount of water for environmental uses will be inadequate**
- 3. Moderate worsening in current water policies and investments could lead to full-blown water crisis**
- 4. Fundamental changes in water management and policy can produce a sustainable future for water and food**

# Policy Conclusions

- **Selective investments to expand irrigation**
  - **High financial and environmental costs, but some expansion necessary**
  - **Private investment in groundwater**
- **Increased investment in household water supply**

# Policy Conclusions

- **Reform of water management, policies, and investments to improve water use efficiency**
  - **Industrial recycling**
  - **Household, municipal water conservation**
  - **Irrigation: gains from technology, management, institutional reform**
  - **Investing for efficiency**

# Policy Conclusions

- **Water price incentives and water trading**
  - **Direct price increases for households and industry**
  - **Subsidies targeted to the poor**
  - **Irrigation water price increase can be punitive**
  - **Design pricing mechanisms to pay irrigators to use less water**
  - **Establish water rights**

# Policy Conclusions

- **Increasing crop productivity: water management, agricultural research and rural investment**
  - **Emphasis on crop breeding for rainfed agriculture**
  - **Water harvesting and minimum tillage**
  - **Rural infrastructure investment to improve access to markets, credit, inputs**