World Water and Food to 2025
Dealing with Scarcity

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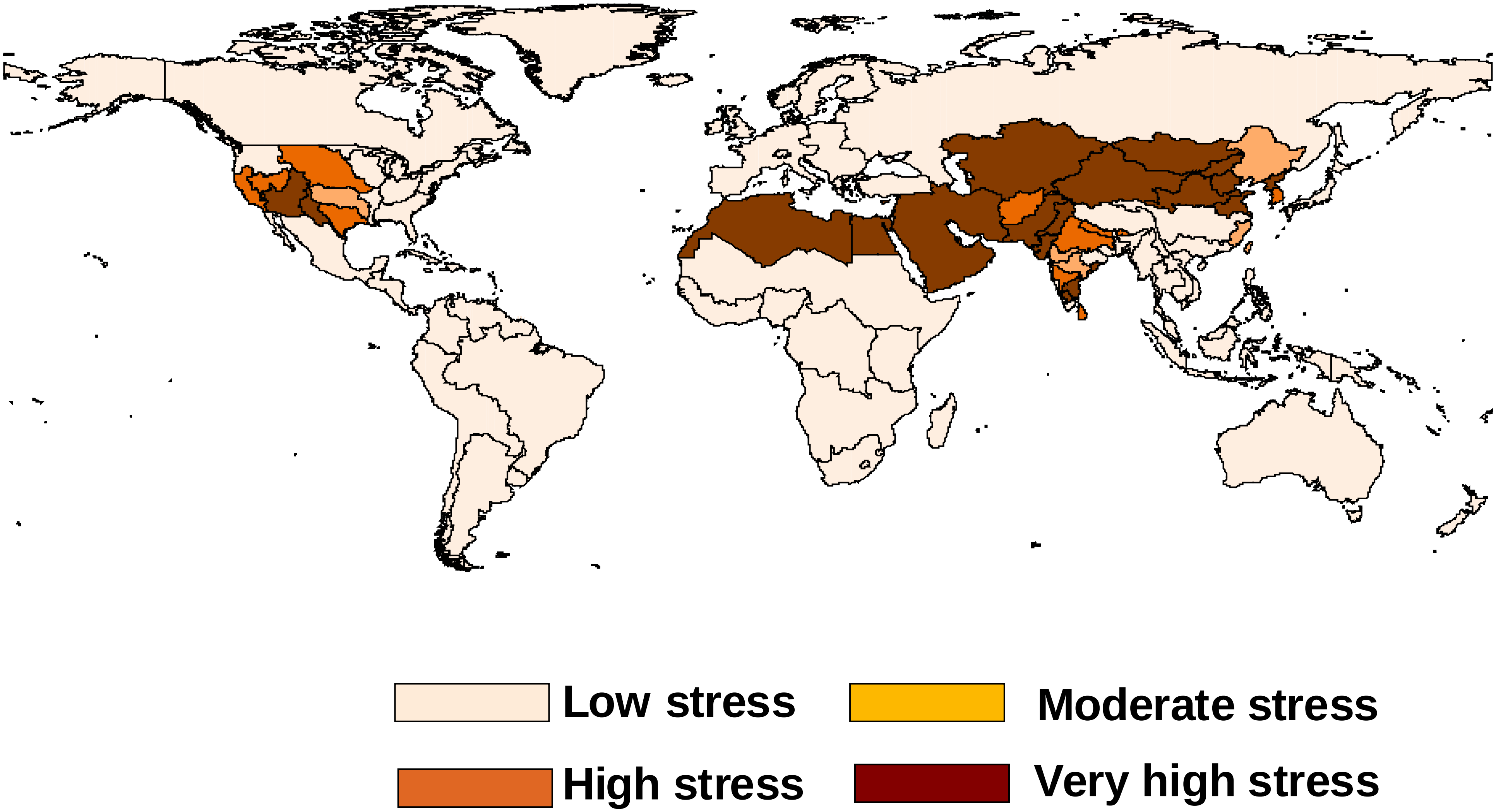
Overview of the Presentation

- Key Messages
- Model Overview
- Scenario Description
- Scenario Results
- Policy Conclusions

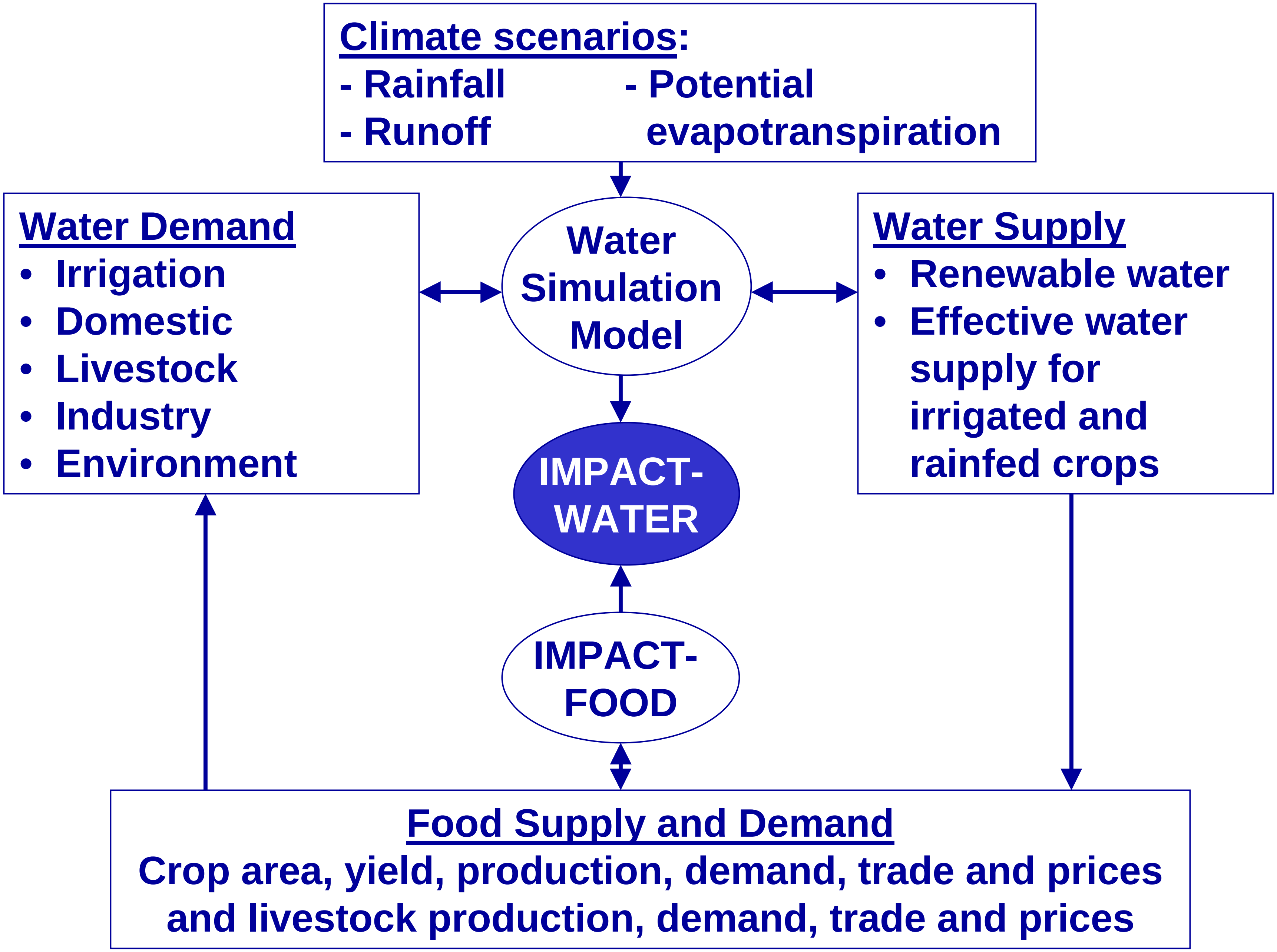
Key Messages

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

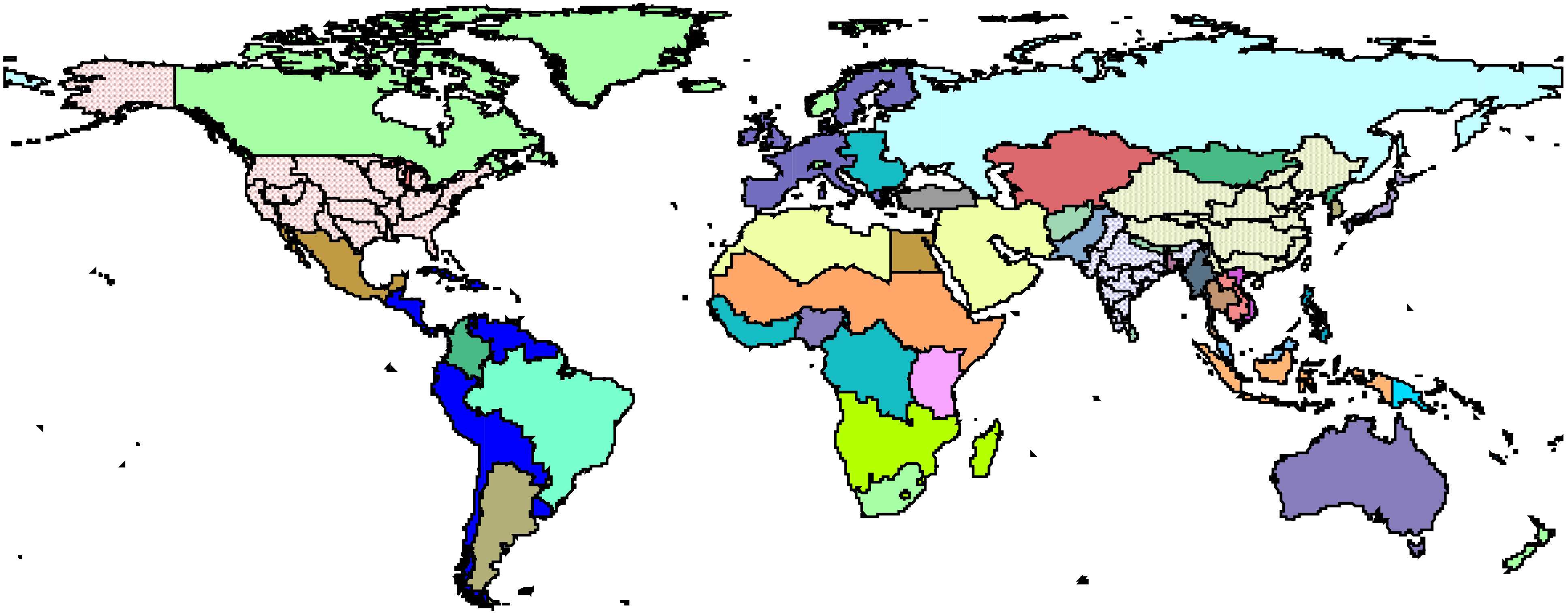
Water Scarcity Map, 1995



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(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**

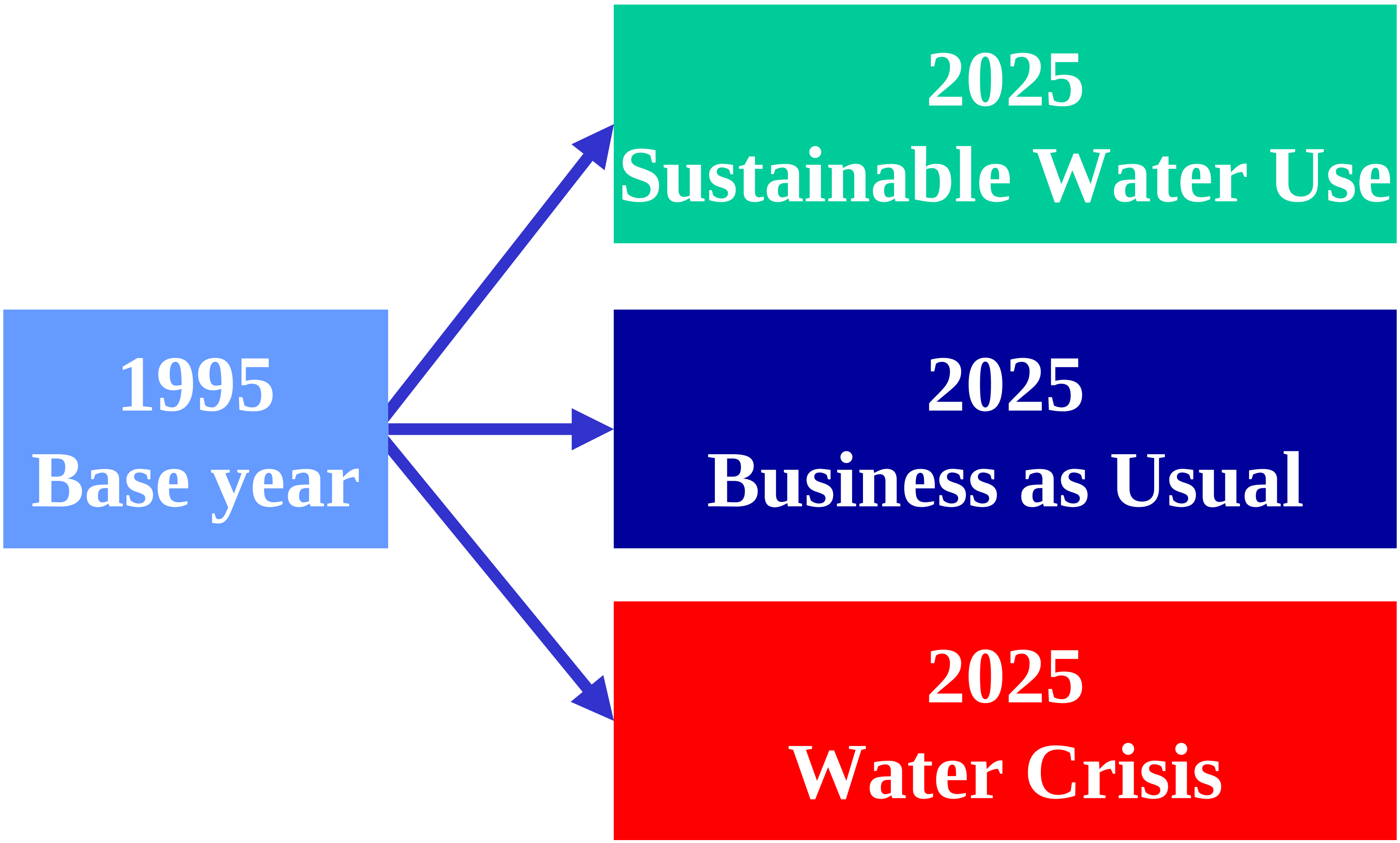
Production, Area, and Yield Equations

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



Business As Usual Scenario

- Assumes continuation of existing trends:
  - Continued decline in crop research investments
  - Declining investment in irrigation expansion and reservoir storage
  - Limited institutional and management reform
  - Water use efficiency increases slowly
  - Slow growth in harvested area
  - Production increase mainly through yield growth
  - Low priority of rainfed agriculture
  - Expansion of groundwater pumping
  - No increase in environmental flows

Water Crisis Scenario

- Assumes worsening of existing policies and trends:
  - Sharp reduction in investment in water storage, O&M
  - Degradation of irrigation infrastructure and management
  - Reduced water use efficiency
  - Lower investment in rainfed crop breeding and slower growth in rainfed crop yields
  - Increased erosion and sedimentation
  - Decline in net water storage due to reduced investment and sedimentation
  - Reduction in environmental flows
  - Low investment in water supply systems, decline in access to household water services

Sustainable Water Use Scenario

- **Assumes improvement of existing policies and trends and focus on environment:**
  - **Increase in investment in rainfed crop research and higher growth in rainfed yields**
  - **Medium growth in water storage; reduced sedimentation balances lower investment**
  - **Higher water use efficiency due to water management reform and higher agricultural water prices**
  - **More effective use of rainfall**
  - **Increased water prices and higher investment in water supply systems**
  - **Sharp increase in reserved environmental flows**
  - **Elimination of groundwater overdraft**

Key Scenario Drivers

Changes in Key Water Sector Drivers

	Business as Usual	Water Crisis	Sustainable Water Use
	percent change, 1995-2025		
▪ Basin Efficiency:	+8%	-20%	+25%
▪ Maximum Allowed Water Withdrawal	+24%	+43%	+20%
▪ Reservoir Storage	+18%	- 1%	+ 9%
▪ Potential Irrigated Area	+16%	+16%	+16%

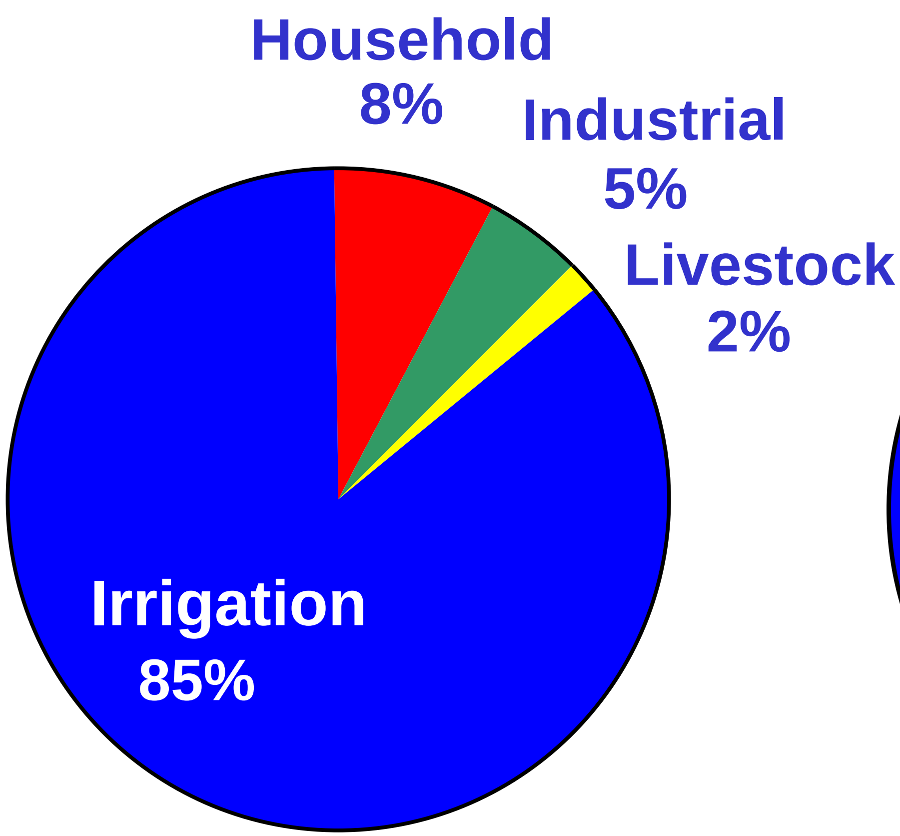
Key Scenario Drivers

Changes in Water Prices

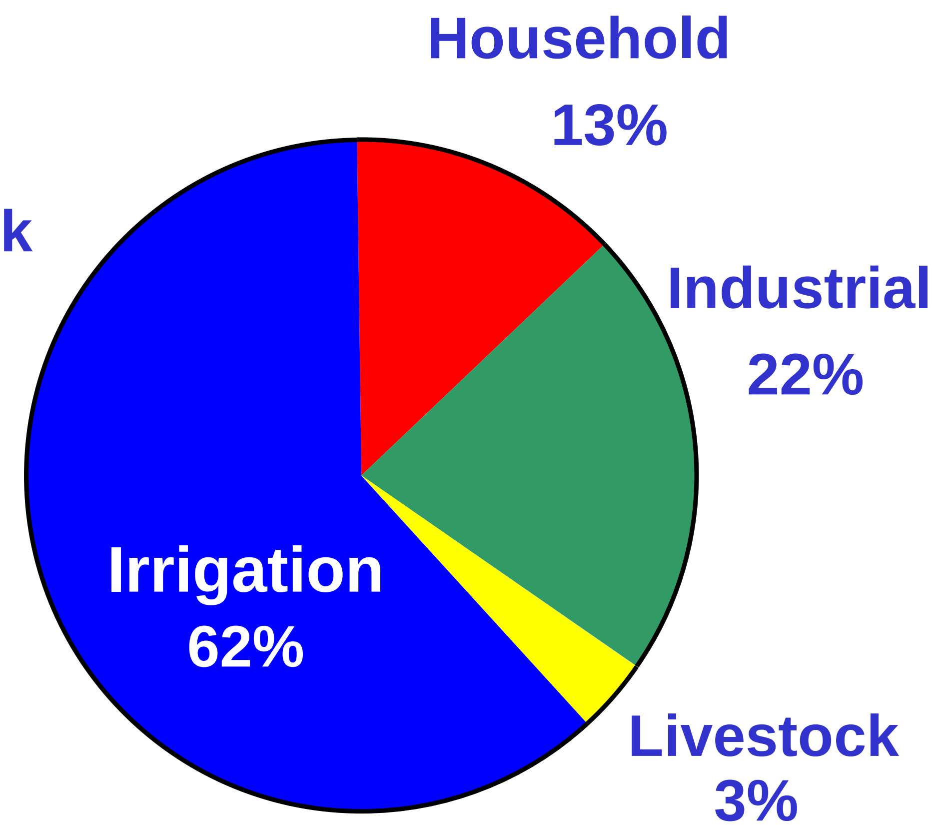
	Water Crisis	Sustainable Water Use
	percent change, 1995-2025	
Industrial		
Developed Countries	+25%	+75%
Developing Countries	+50%	+125%
Agricultural		
Developed Countries	0	+100%
Developing Countries	0	+200%
Household		
Developed Countries	+25%	+40%
Developing Countries	+50%	+80%

Water Consumption Shares by Sector, 1995

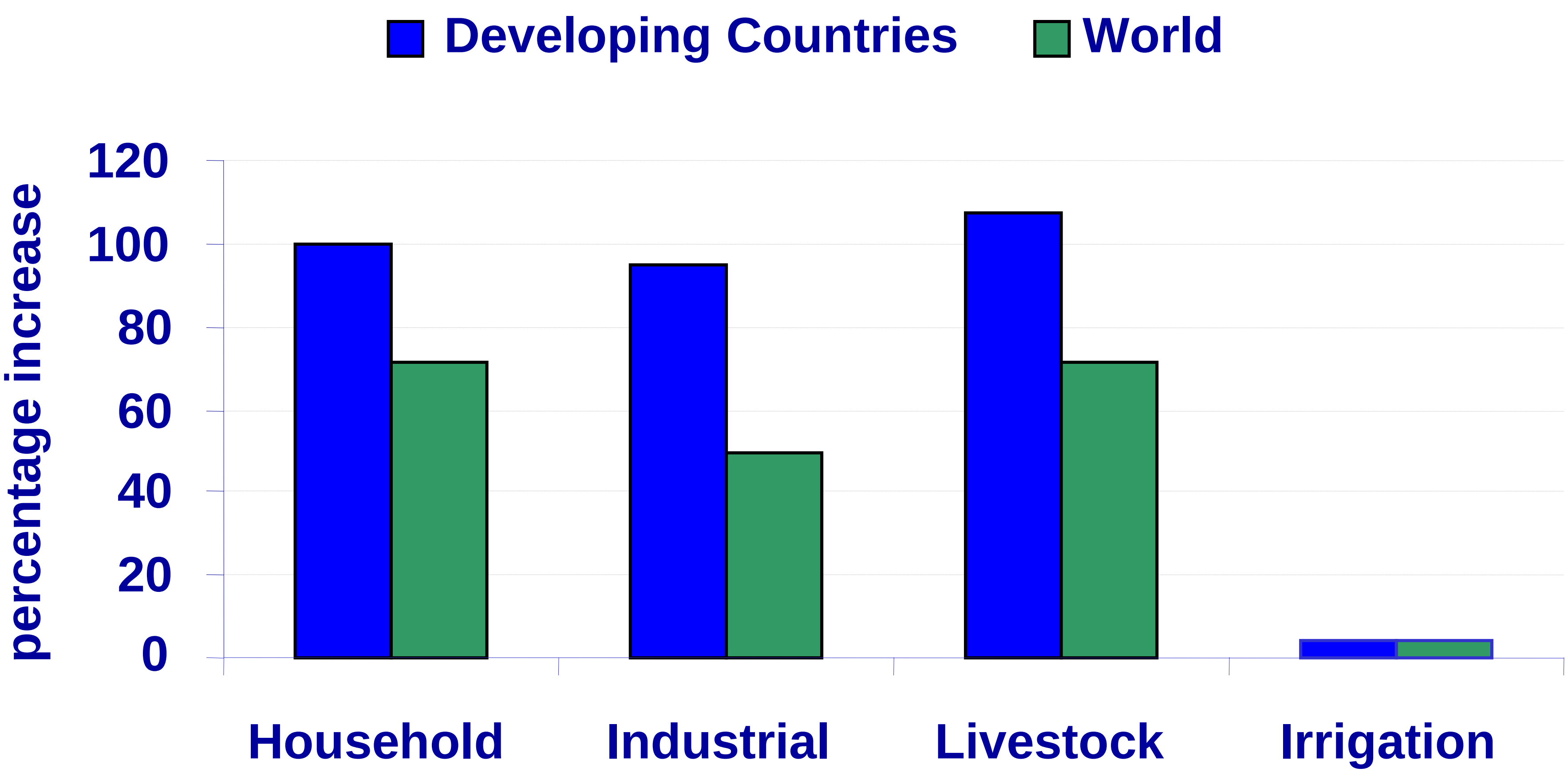
Developing Countries



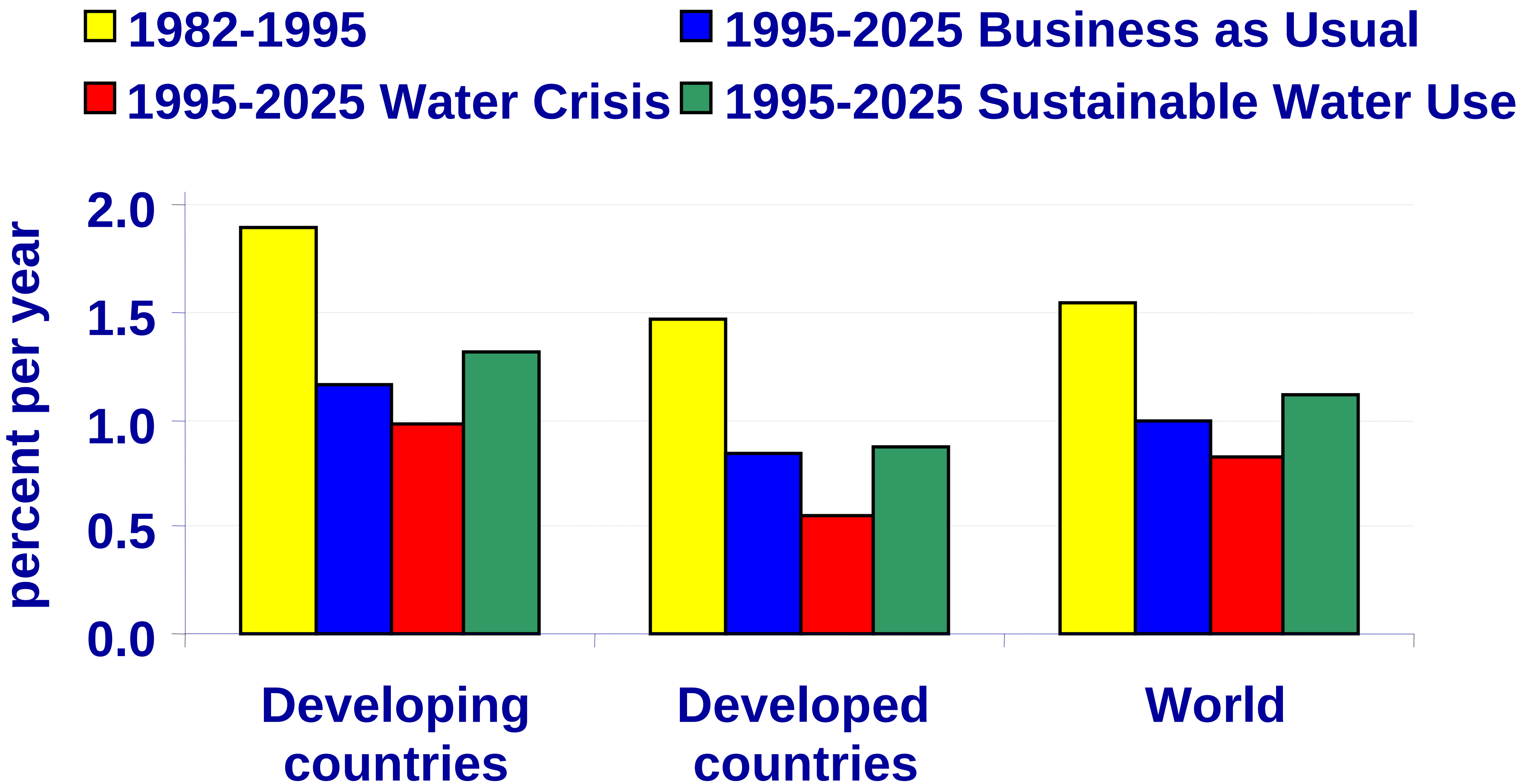
Developed Countries



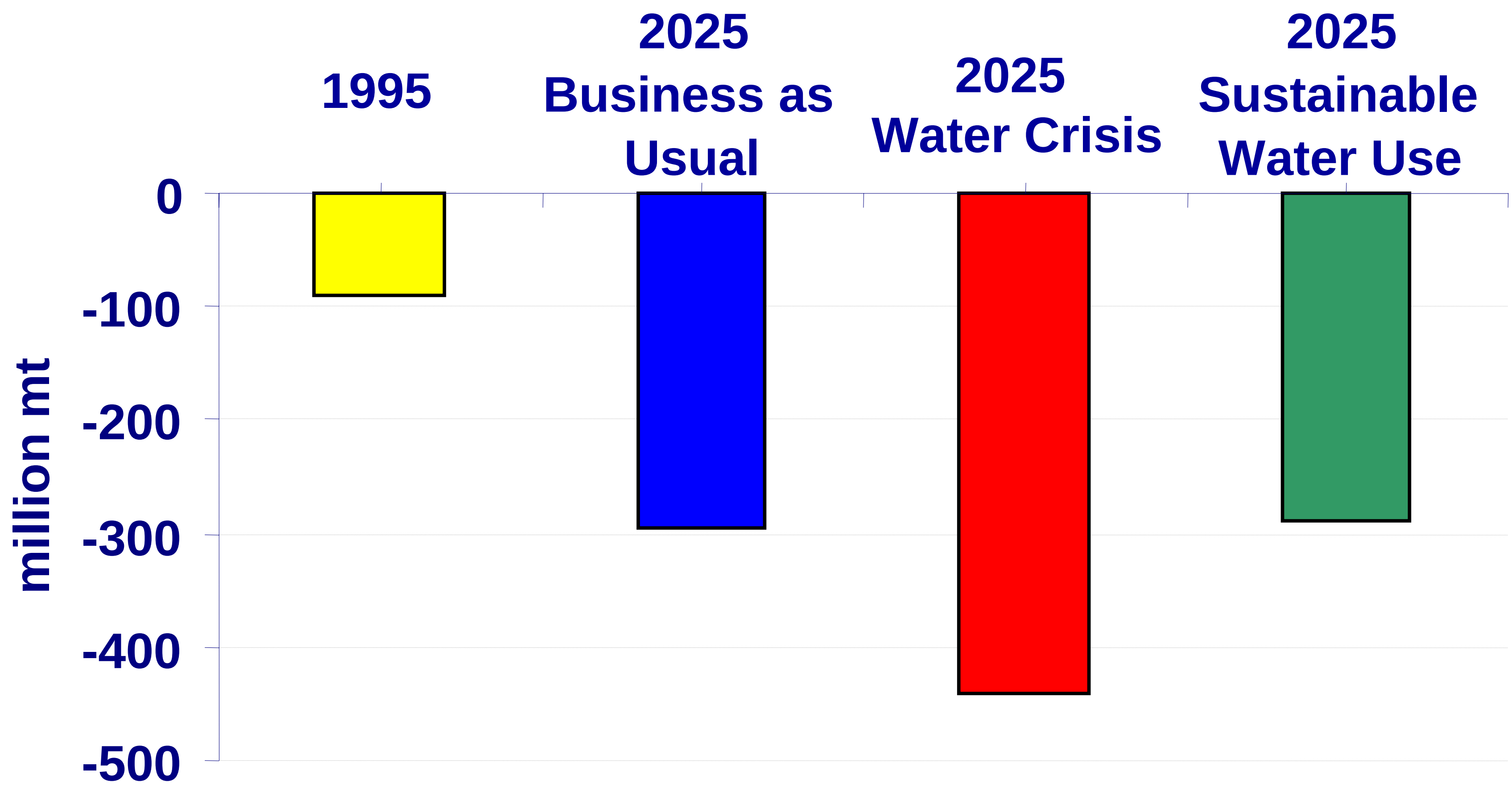
Increase in Water Consumption between 1995 and 2025, BAU



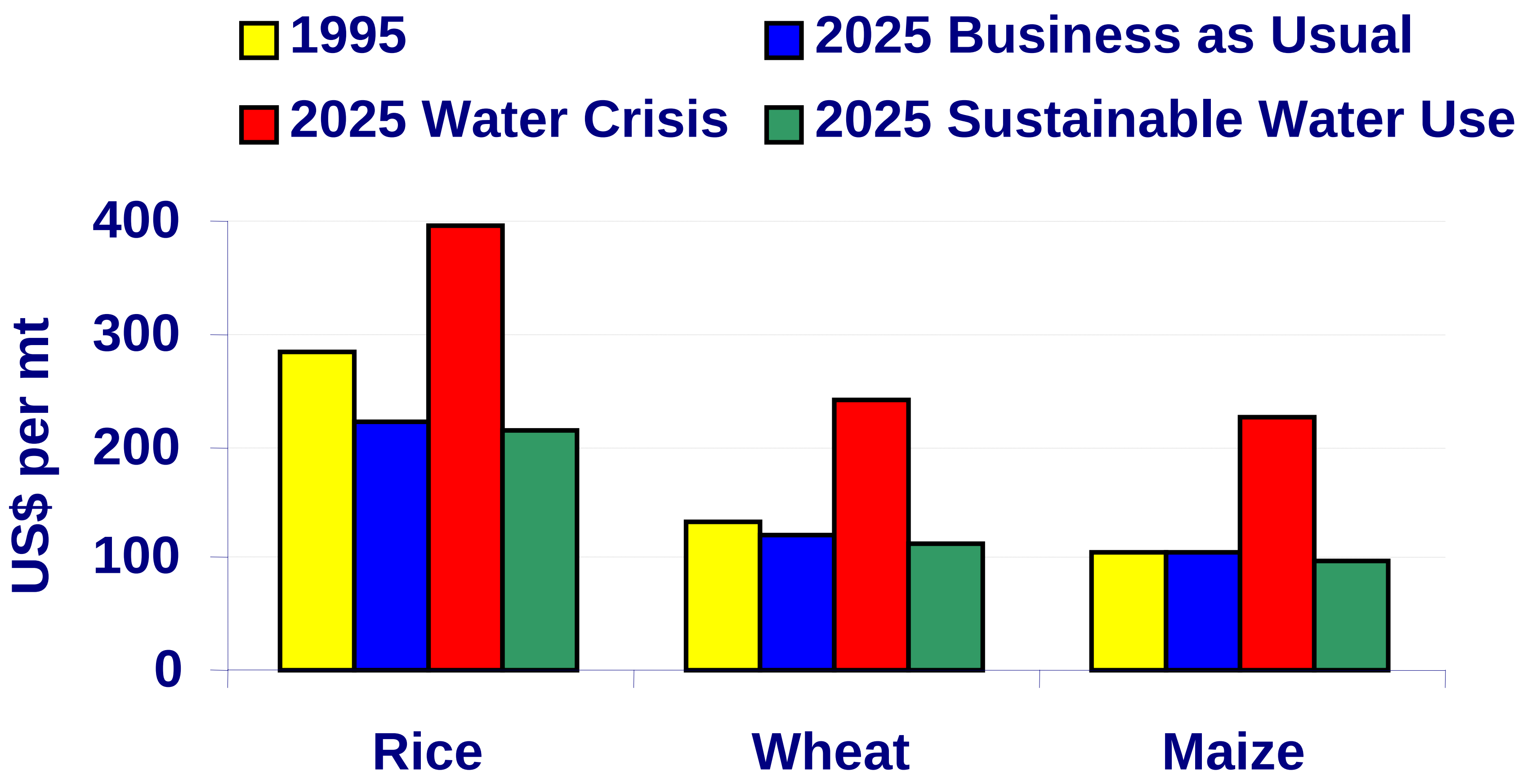
Annual cereal yield growth rate, 1982-1995 and 1995-2025



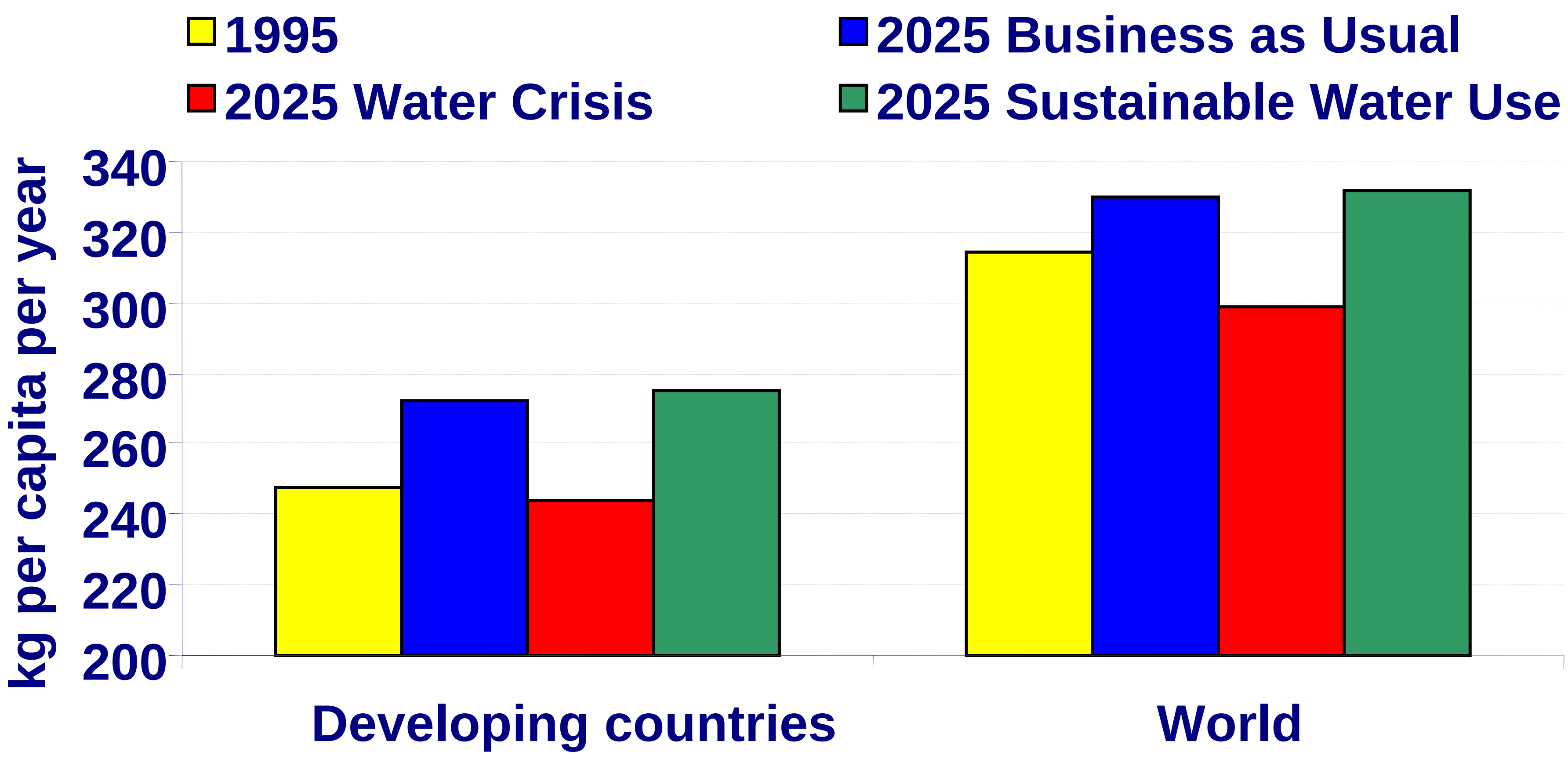
Loss of Grain Production Due to Water Scarcity, Developing Countries



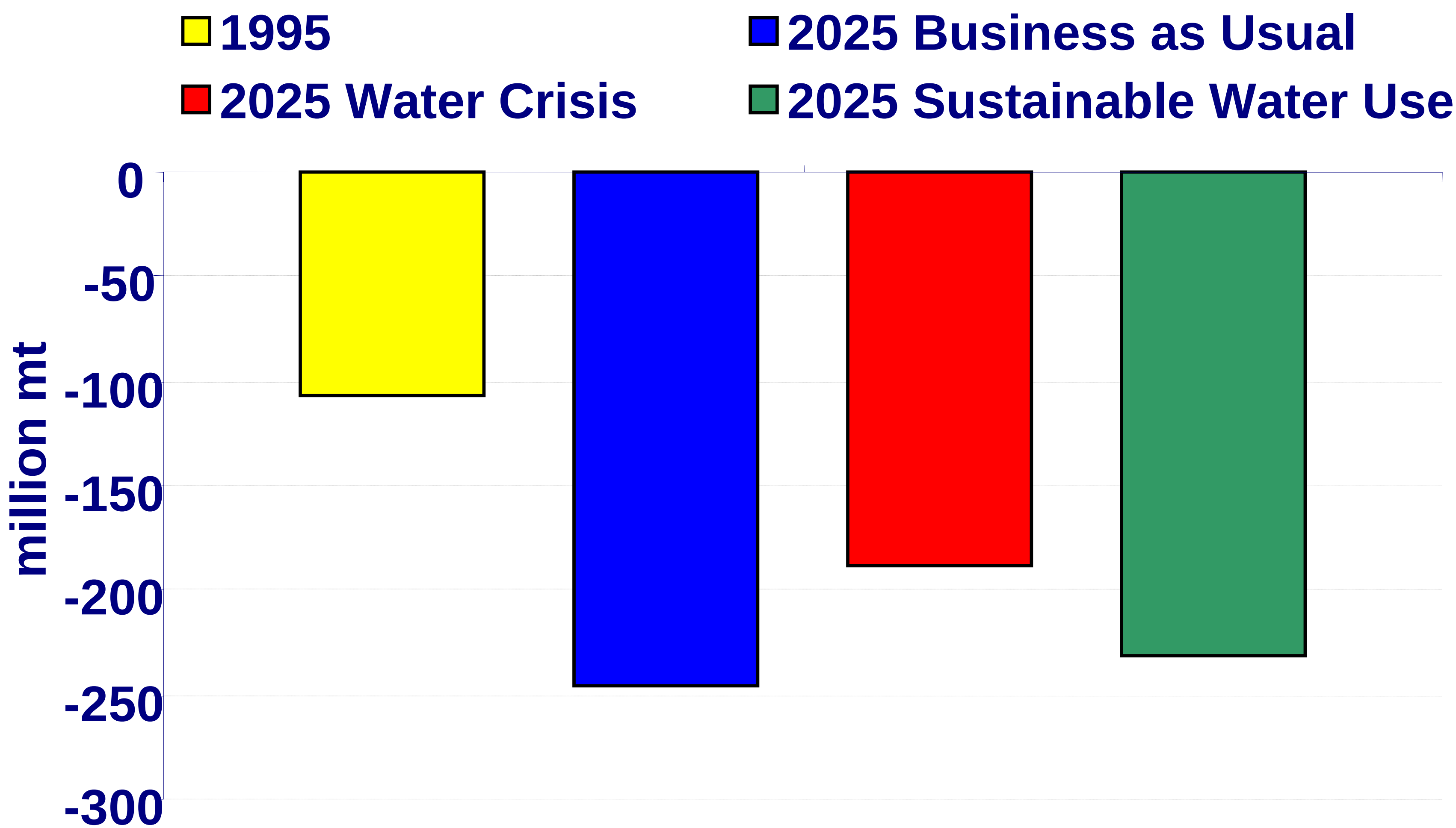
International Grain Prices



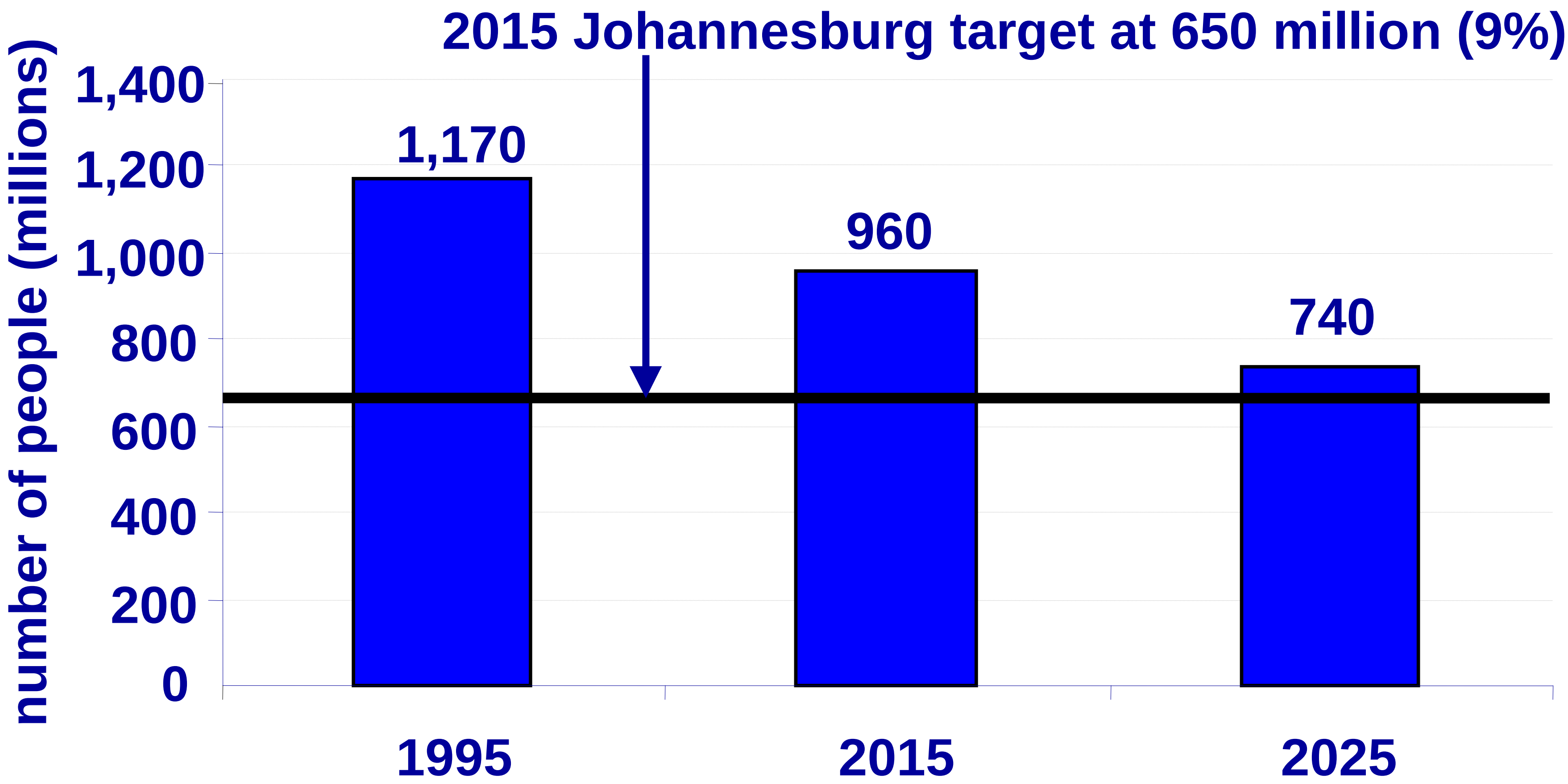
Per Capita Grain Demand



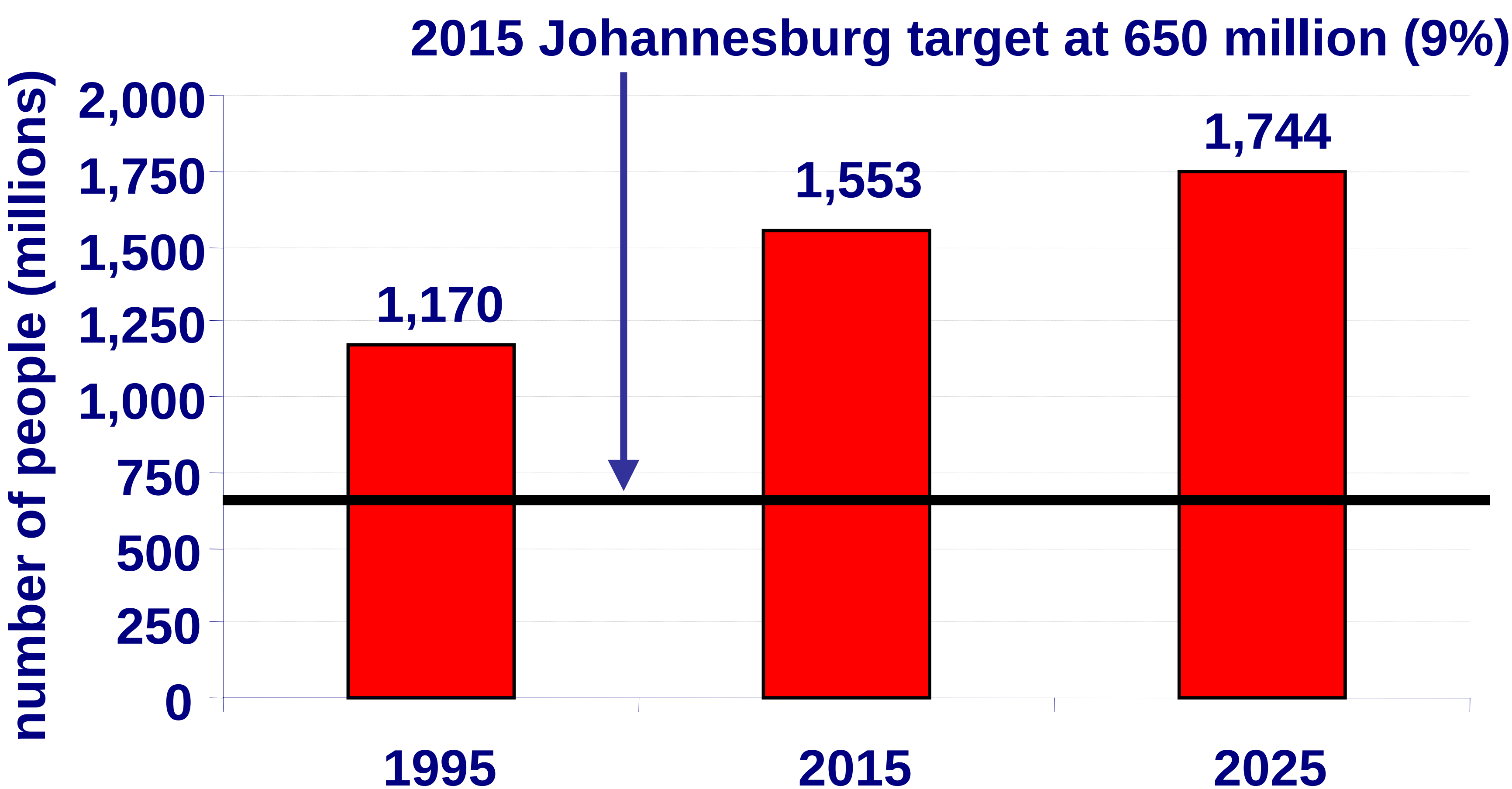
Net Grain Trade in Developing Countries



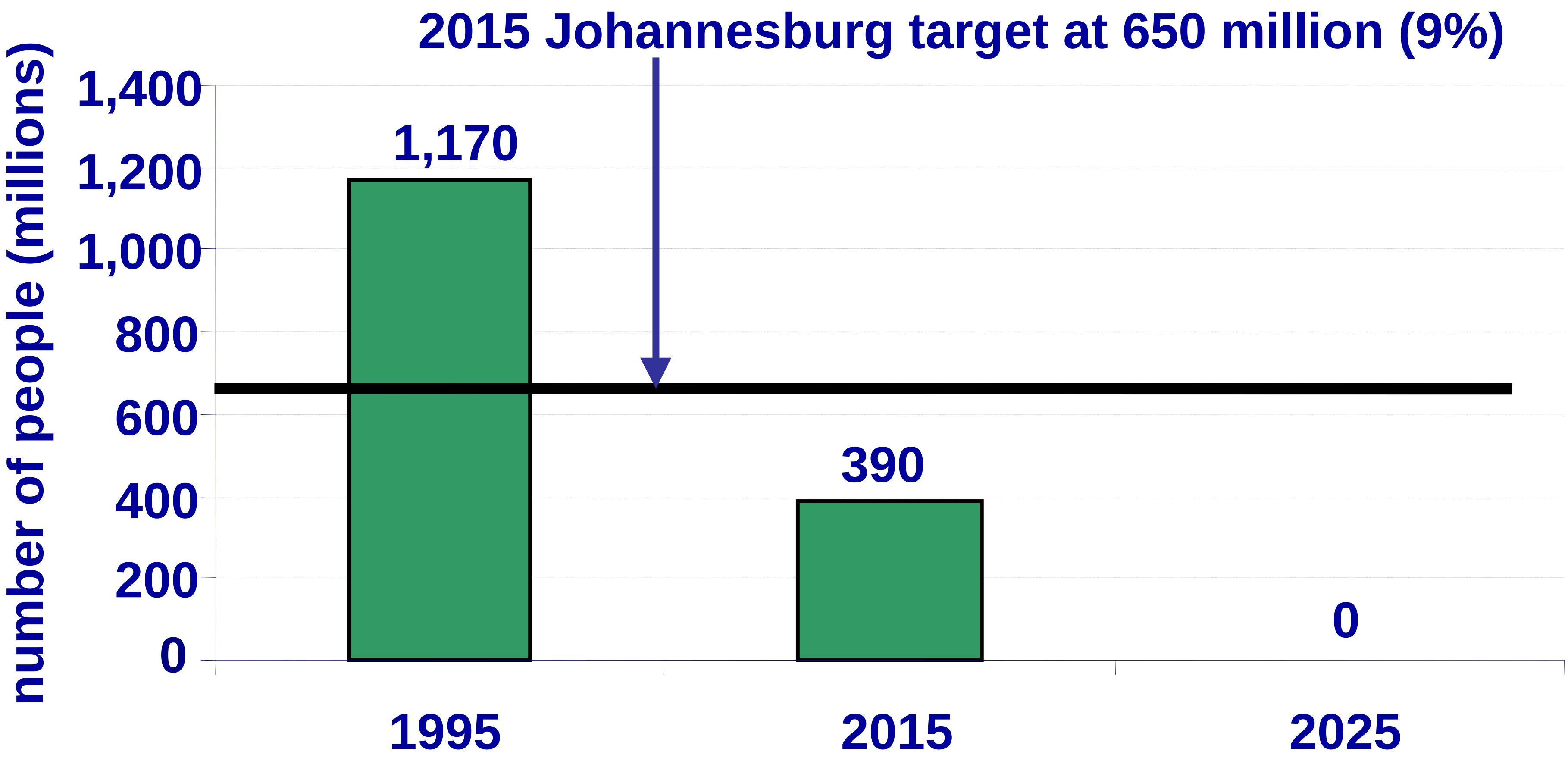
People without Access to Safe Water, Business as Usual Scenario



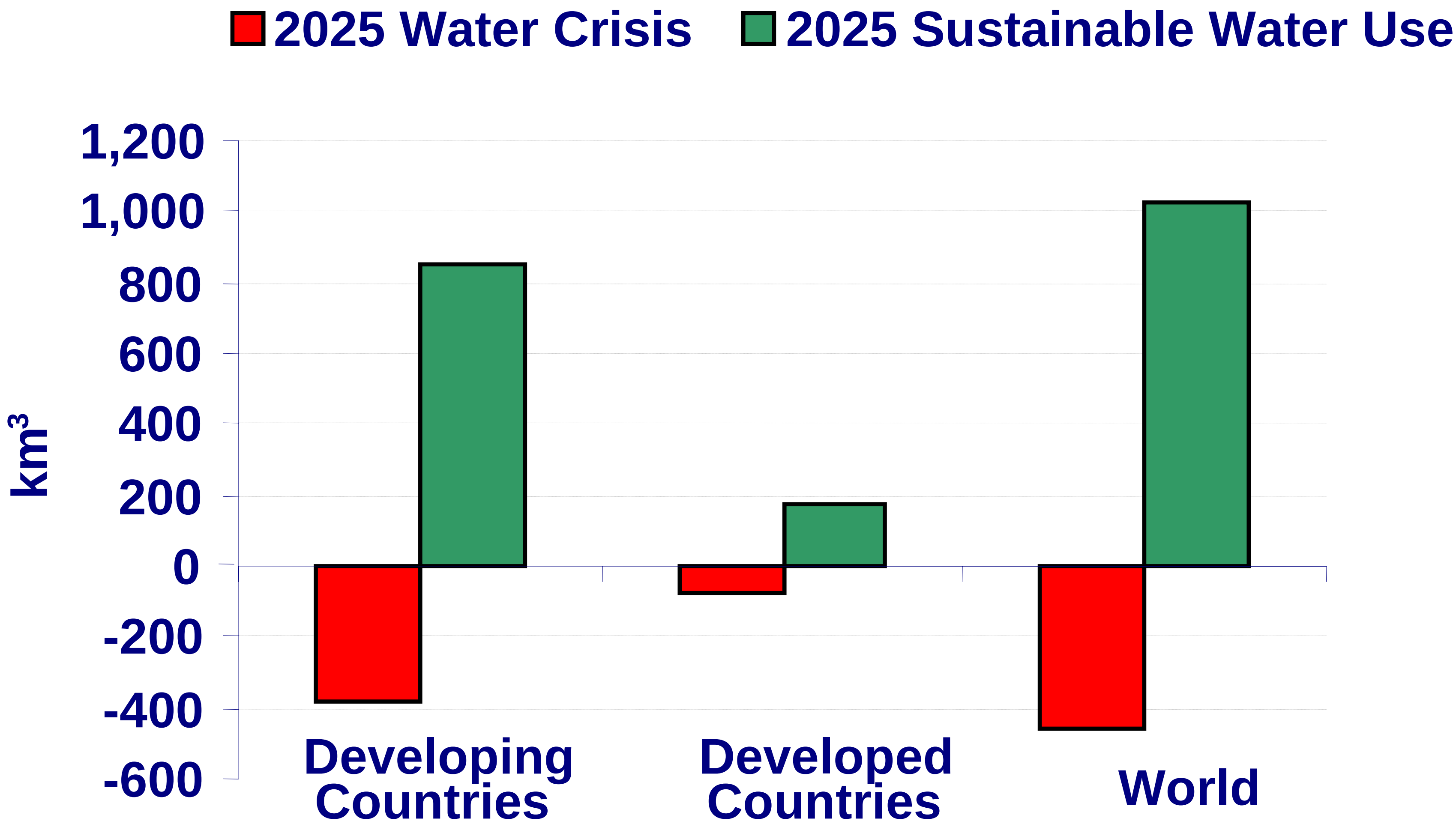
People without Access to Safe Water, Water Crisis Scenario



People without Access to Safe Water, Sustainable Water Use Scenario



Change in Environmental Flow in 2025 Compared to Business as Usual Scenario



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

Summing Up

- Under current water policies and investments, food production slows, targets for safe water access are not met, and water quality declines
- Increasing complacency leads to dramatic worsening of these trends
- Improved policies and investments can produce a far more sustainable water world
- These reforms imply fundamental changes in the way we manage water, and will take time to implement
- The time to act is now