# Integrating Water, Sustainable Development and Climate Change: Applying the Sustainable Water Resources Management (SWARM) Framework

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**Keynote Paper presented at the**
**American Society of Civil Engineers International Conference on Environmental and Water Resources**
**AIT, Bangkok, 6 January 2009**

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**WHAT ?** are the challenges water, sustainable development and climate change issues are complex and closely interlinked

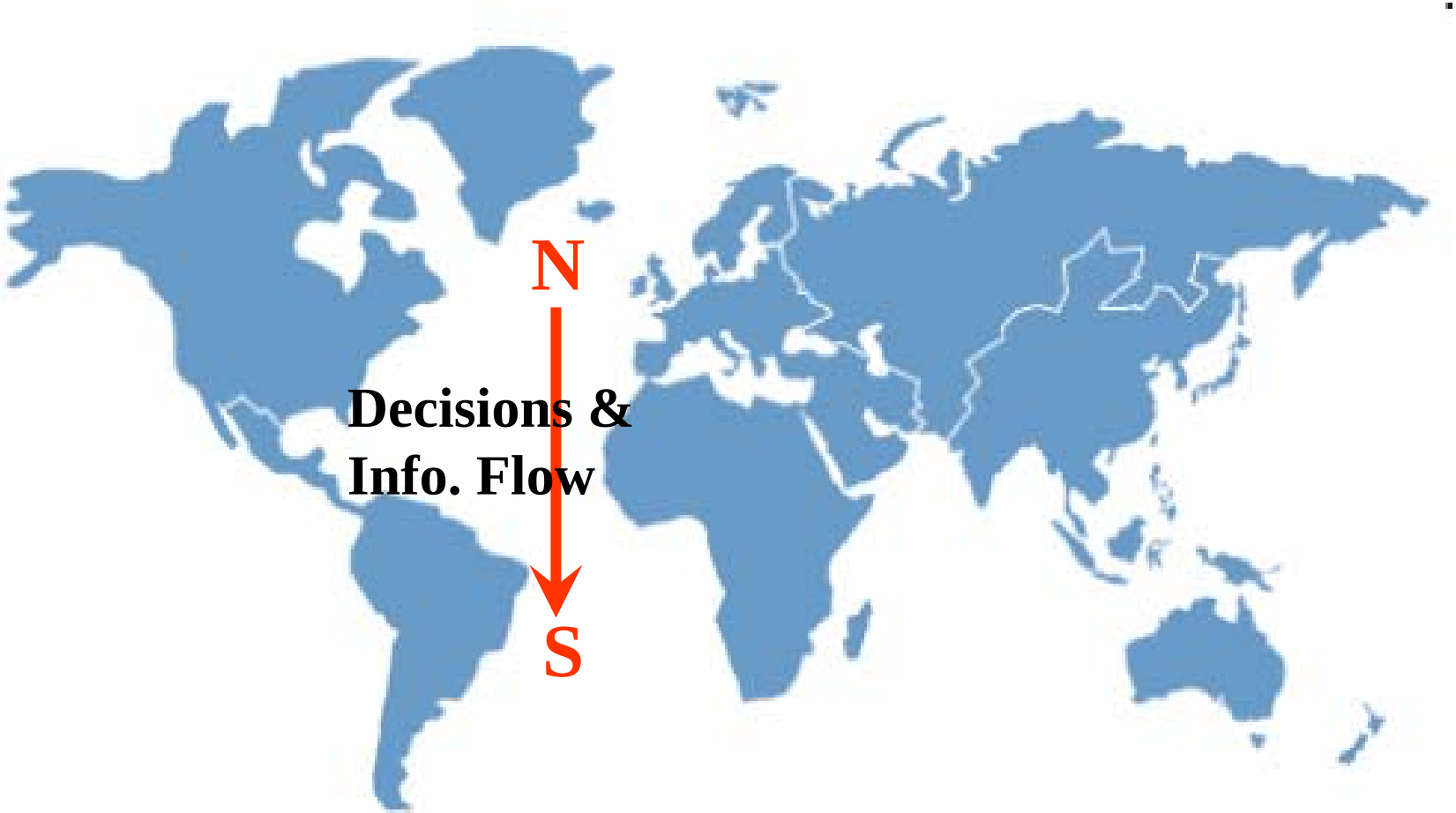
**WHAT ?** are the challenges

water, sustainable development and climate change issues are complex and closely interlinked

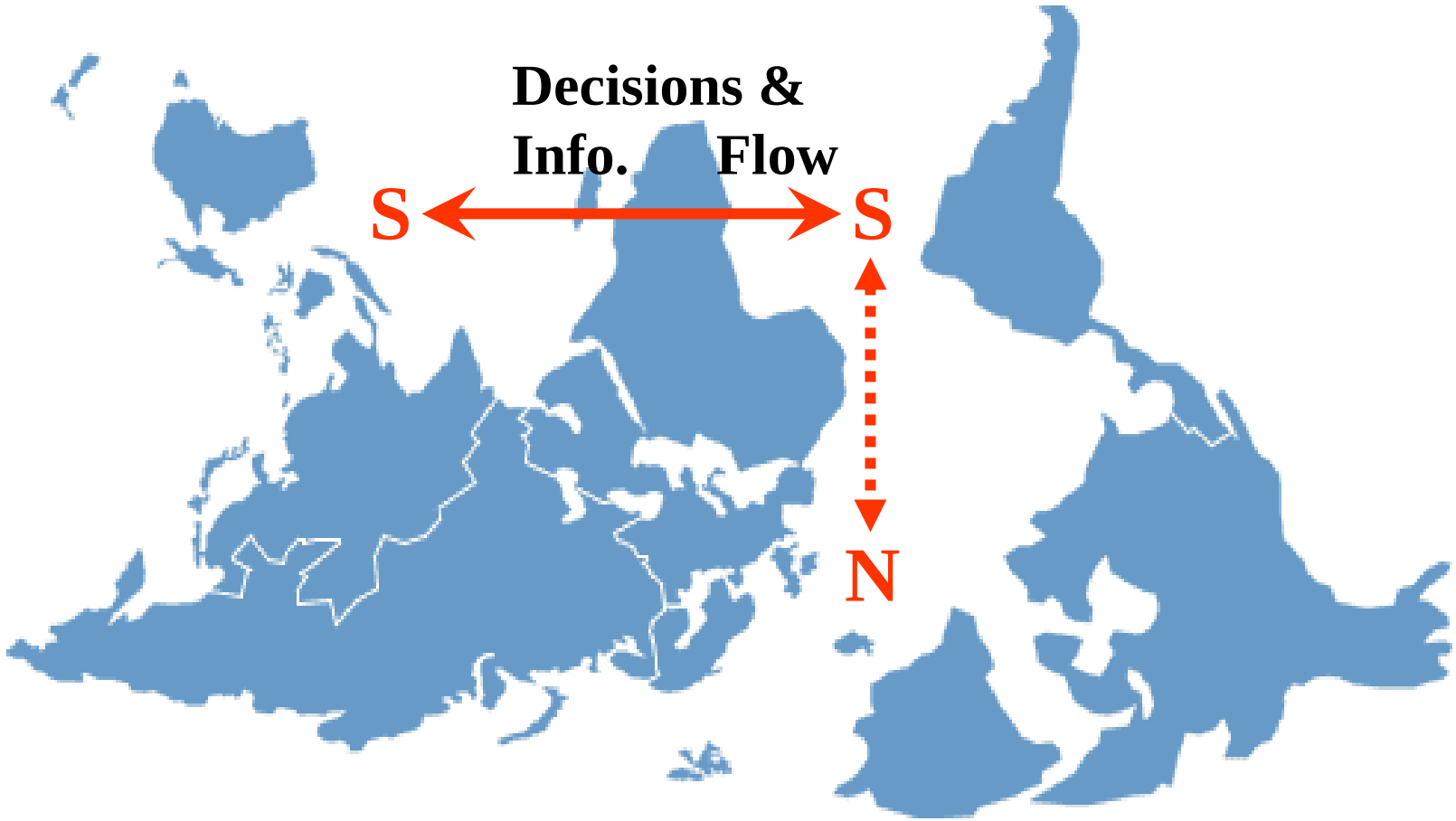
**HOW ?** can we seize the opportunities

by making development more sustainable and exploiting synergies using the sustainomics framework for sustainable water resources management (SWARM)

# Traditional North-oriented Worldview - More Technoeconomic-Financial Focus



# Emerging South-oriented Worldview - More Balanced: Poverty & SD Focus

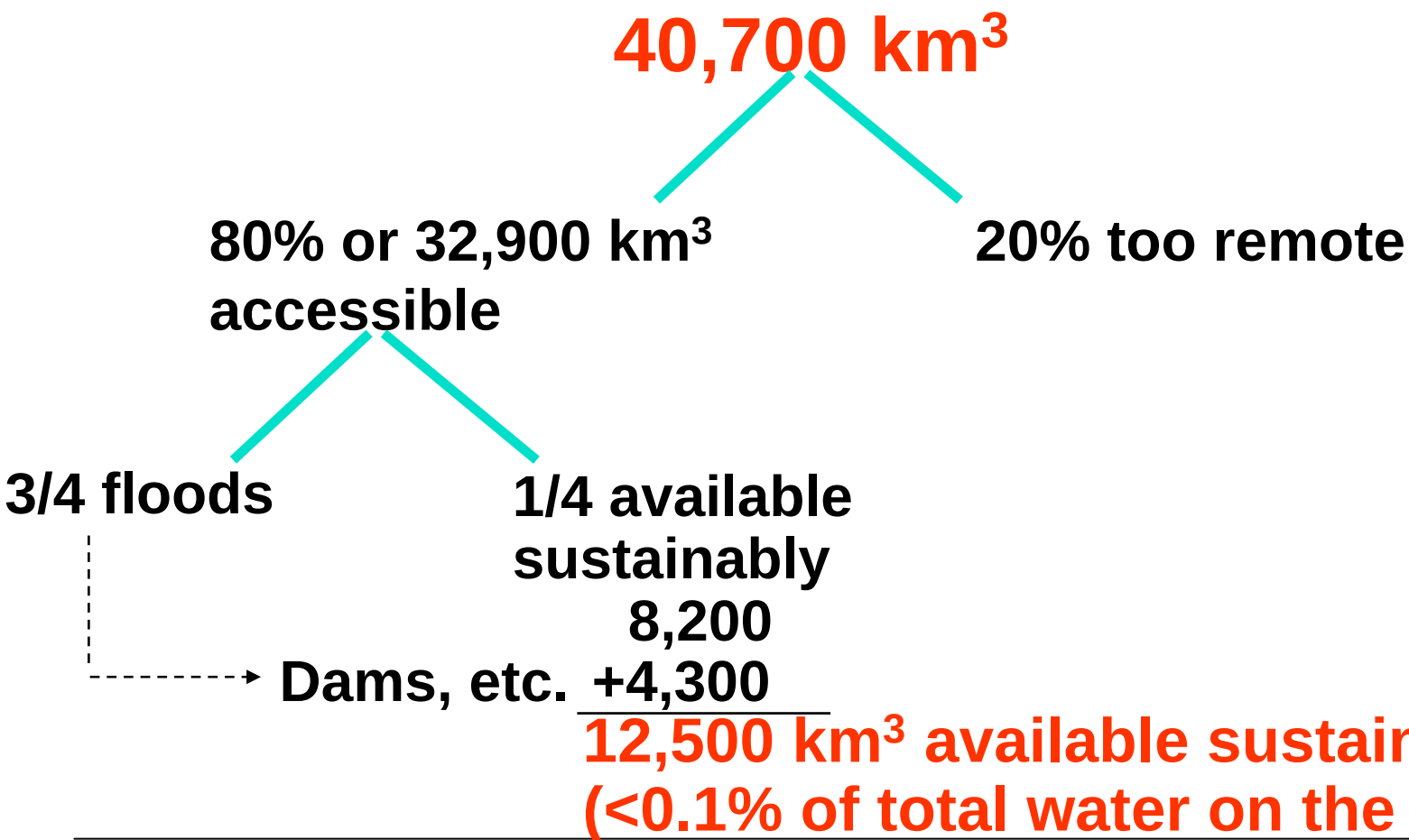


# World of Water – Distribution and Availability

**Total water on Earth (100%: ~13.5 million km$^3$)**

- 2.5% fresh water
  - 2/3 glaciers and ice caps
  - 1/3 or 110,300 km$^3$ useable
    - 2/3 lost to evapo-transpiration, etc
    - 1/3 or 40,700 km$^3$ potentially accessible to humans
- 97.5% salt water

# Total water available sustainably in 2000 (~12,500 km$^3$ < 1% of Total)



# The Emerging World of Sustainable Water Resources Management (SWARM) - Challenges and Opportunities

- **Meet growing water needs for development**
- **Maintain cost effectiveness and financial viability**
- **Ensure secure and diverse water supply**
- **Provide affordable and reliable water services**
- **Protect the environment and the planet**
- **Balance competing uses of water**
- **Address governance/privatisation issues**

# Costs of Water Supply are rising rapidly due to:

- **Water scarcity**
- **Mismanagement**
- **Increasing distance of water sources from users**

# Water resources availability (examples)

| | Total Water Resources (Cu. M per capita per year) |
|---|---|
| Sri Lanka | 2,634 |
| India | 1,913 |
| Pakistan | 1,892 |
| Saudi Arabia | 119 |
| Brazil | 32,256 |

**Water sector problems worsen sharply below 2500 cu.m/capita/yr. And water stress ensues at ~2000 cu.m/cap/yr.**

# Relative water withdrawals (2005): Competition among sectors/users

| | Water Use as share of total use (%) | | |
|---|---|---|---|
| | Domestic | Agriculture | Industry |
| Sri Lanka | 2 | 96 | 2 |
| Low Income | 4 | 91 | 5 |
| Middle Income | 13 | 69 | 18 |
| High Income | 14 | 39 | 47 |
| World | 8 | 69 | 23 |

**Example: water extraction and bottling causing increasing problems for access to water of the poor**

# Assessing Water Services (2000)

## The Glass Half Full?

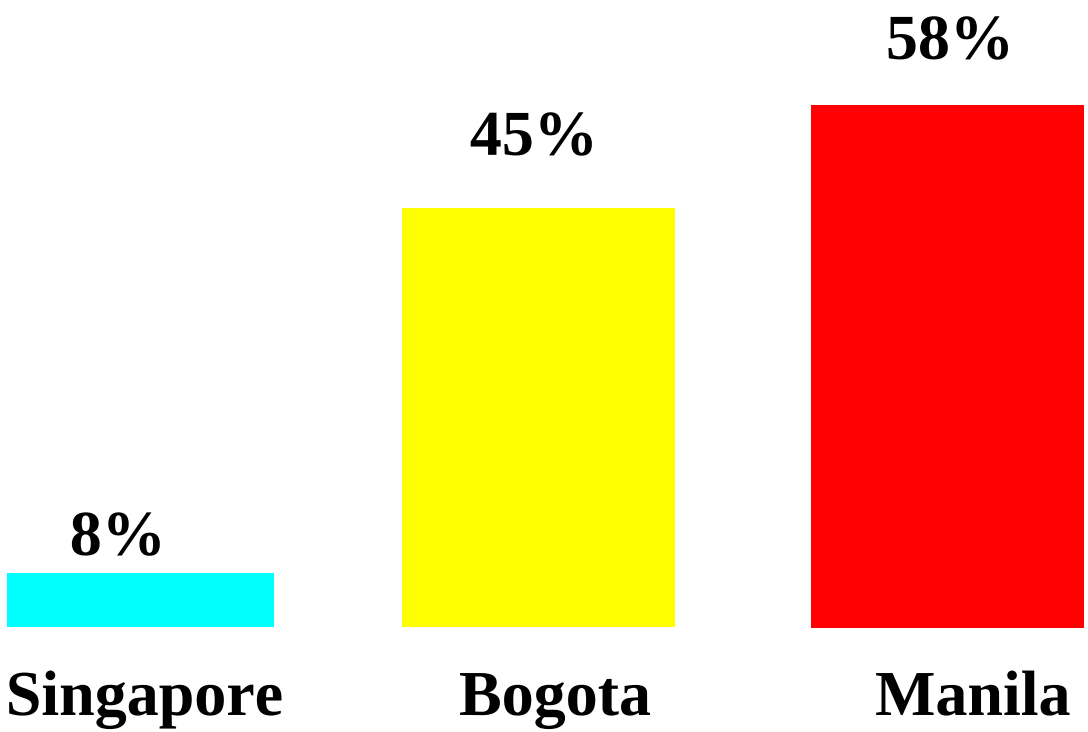
- 1.6 billion more people have access to water supply
- 1 billion more people have access to sanitation

**OR**

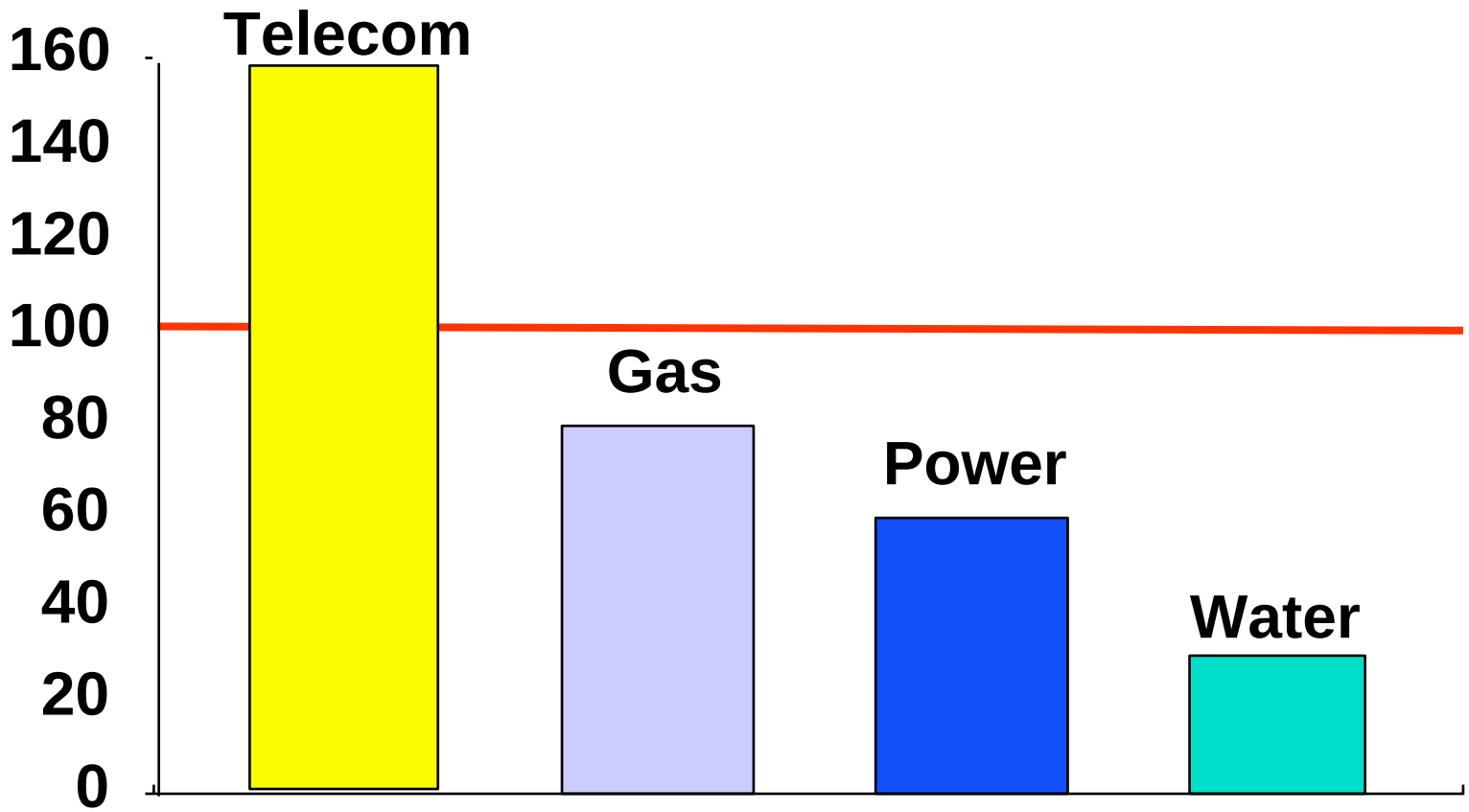
## The Glass Half Empty?

- 1 billion people have NO access to adequate water supply
- 1.7 billion people have IN-adequate sanitation facilities

# Mismanagement: Inefficient Supply Utilities and "Unaccounted-for-Water"



# Poor cost recovery in water and sanitation sector constrains investment



# Major resource savings possible if water services were made more

- **Accountable**
- **Efficient**
- **Responsive**

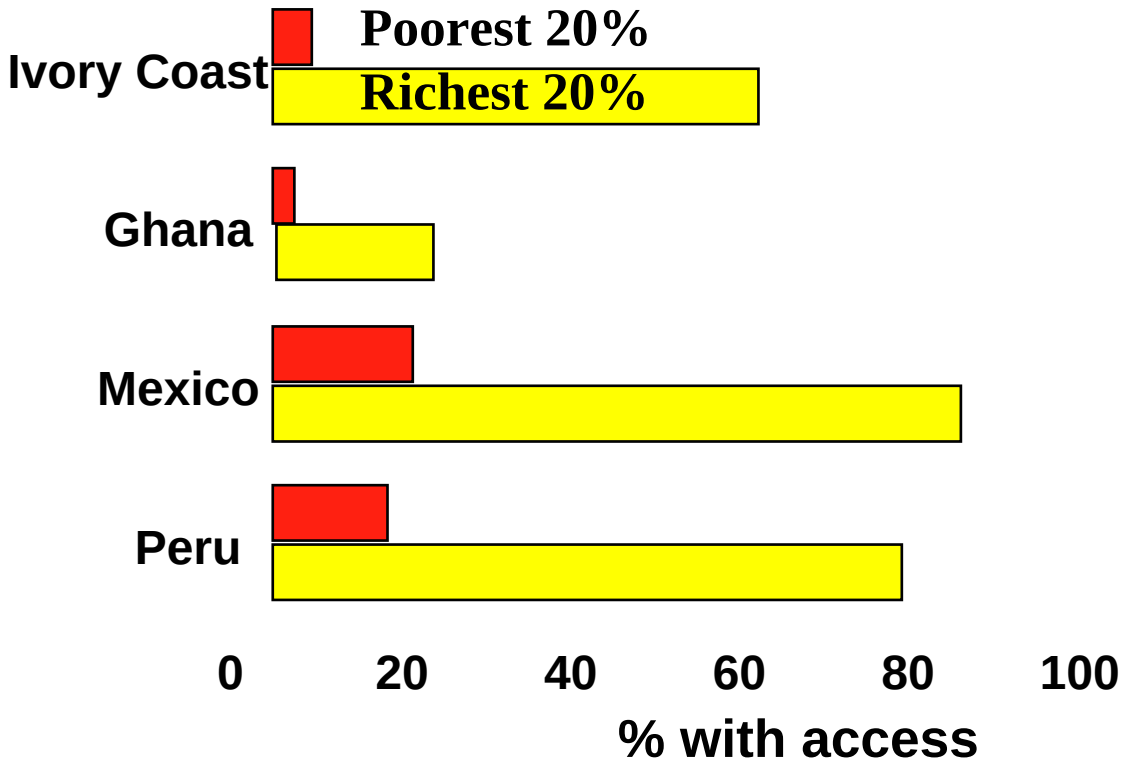
# Innovative approaches to cost recovery - Grameen Bank

- Rural water supply promoted in Bangladesh
- Making non-subsidized credit available to poor women
- > $15 million a year for tubewells
- 98% repayment

# Innovative approaches to cost recovery - Chile's 'Water Stamps'

- Importance of financially viable utilities
- Cross-subsidies reduces utilities' incentives to serve poor
- Government-financed 'water stamps' for locally-identified poor
- Separation of welfare and commercial roles

# Equity: when services are rationed, the poor get rationed out

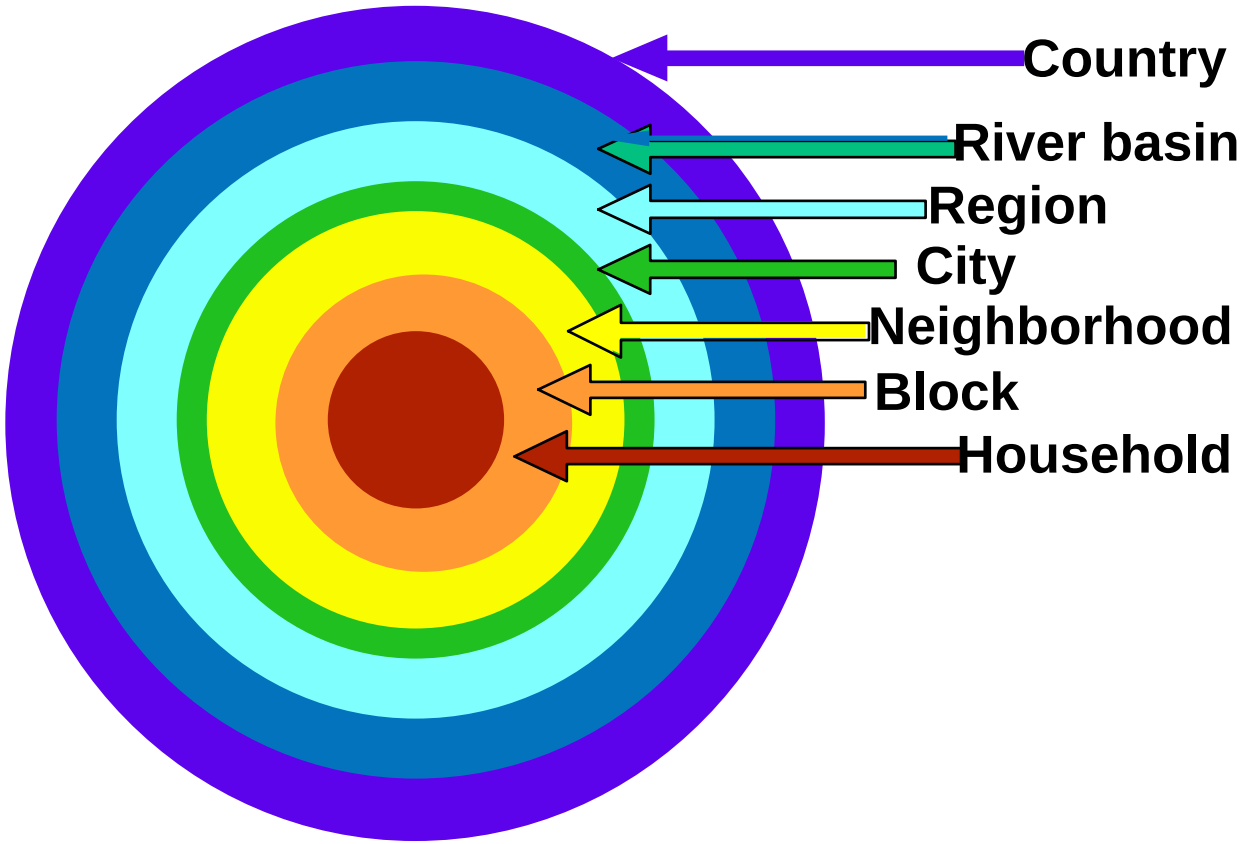


# High Private Water Price Paid by Poor with no Access to Public Water Sources (Ratio)

| Location | Price ratio (private to public) |
|---|---|
| Cairo | 40:1 |
| Tunis | 10:1 |
| Abidjan | 5:1 |
| Nairobi | 11:1 |
| Lagos | 11:1 |
| Nouakchot | 100:1 |
| Dacca | 25:1 |
| Karachi | 83:1 |
| Jakarta | 60:1 |
| Cali | 10:1 |
| Guayaquil | 20:1 |
| Lima | 17:1 |
| Port-au-Prince | 100:1 |

Source: Webb and Iskandarani (1998)

# Equity: Who should pay for services at different levels?



# Applying Public Finance Principles Example: Sewerage Services

- Households pay cost for on-lot services
- Blocks (group of households) pay for tertiary sewers
- Neighborhoods (groups of blocks) pay for secondary sewers
- City (groups of neighborhoods) pays for trunk sewers

# Water,

# Sustainable Development

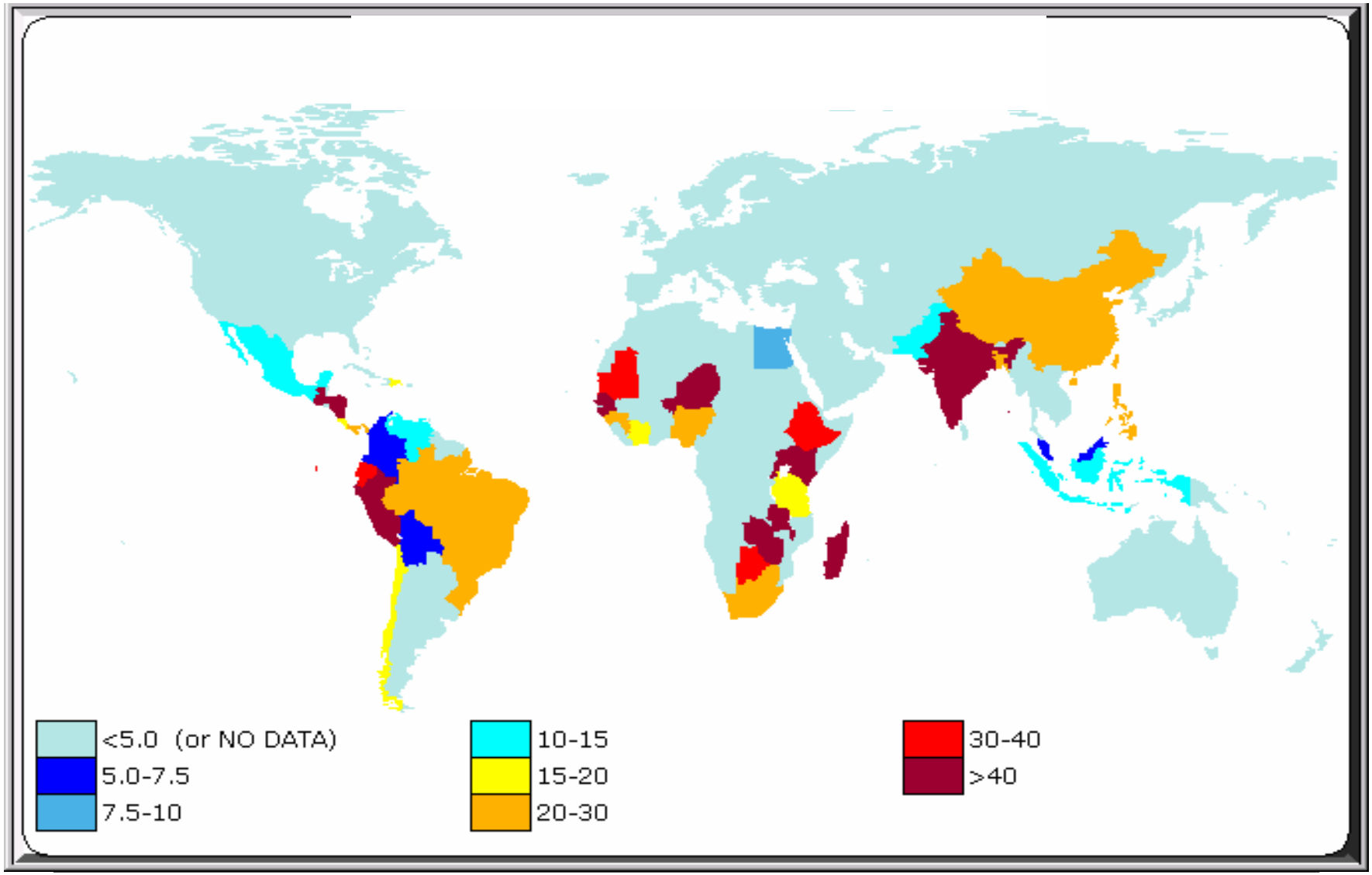
# and Climate Change

# Water is essential for Sustainable Development, especially in Developing Countries

**Sustainable Development Challenges include:**

- **alleviate poverty** for the 1.3 billion people who live on less than $1 per day and the 3 billion people who live on less than $2 per day
- provide adequate **food**, especially for the 800 million people who are malnourished today—this will require food production to double in the next 35 years without further environmental degradation, e.g., deforestation
- provide **clean water** for the 1.3 billion people who live without clean water and provide sanitation for the 2 billion people who live without sanitation
- provide **energy** for the 2 billion people who live without electricity
- provide a **healthy environment** for the 1.4 billion people who are exposed to dangerous levels of *outdoor pollution* and the even larger number exposed to dangerous levels of *indoor air pollution and vector-borne diseases*
- provide **safe shelter** for those that live in areas susceptible to civil strife due to environmental degradation and those vulnerable to natural disasters

# Poor living on < $1 per day - in Developing Countries

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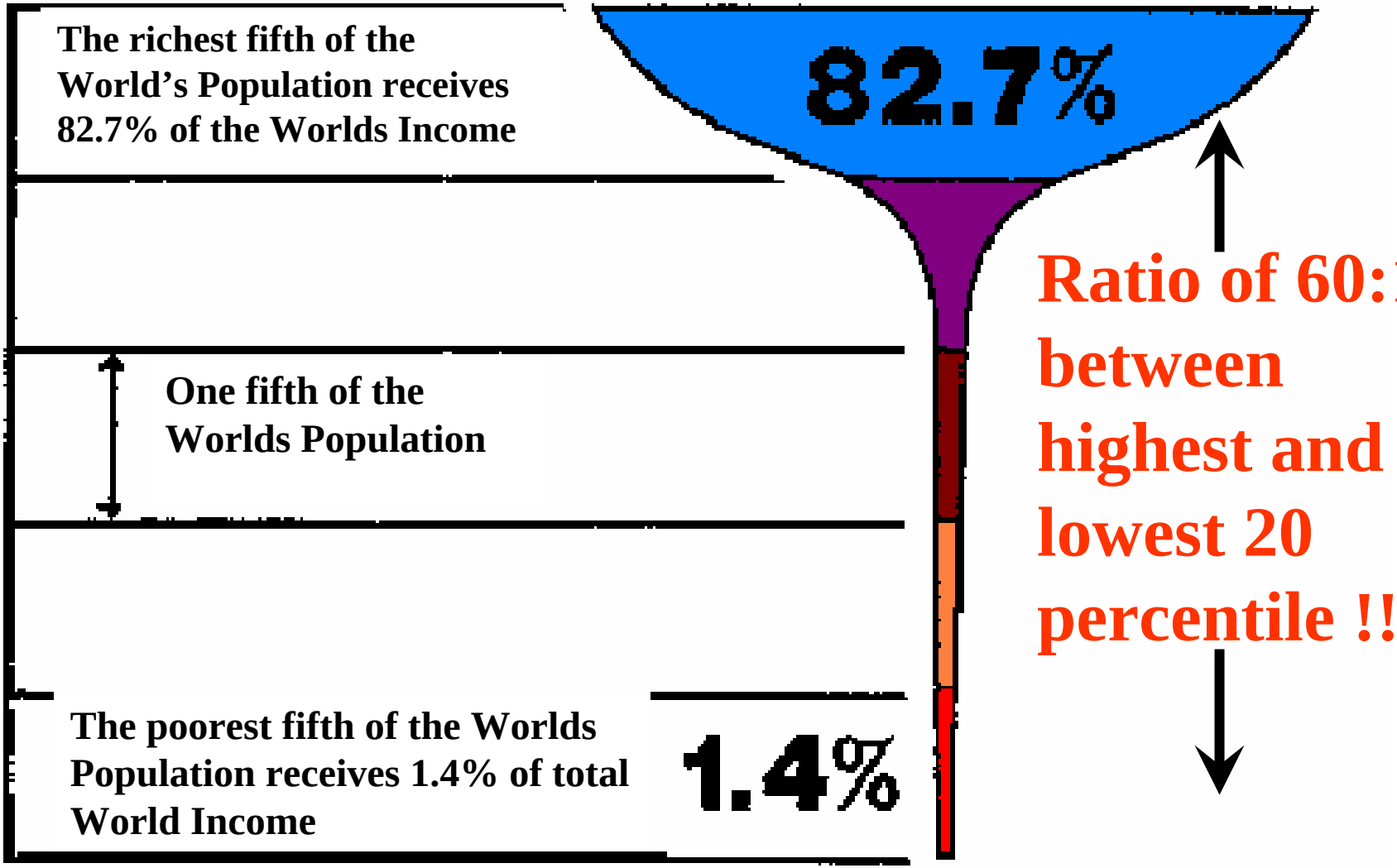
# World Income Distribution 2000: Champagne Glass



# Major agreements on SD - Poverty Focus

## 1. UNCED 1992: Rio Earth Summit

- Rio Declaration of Principles
- Agenda 21
- UNFCCC

## 2. Millennium Development Goals 2000: UN

## 3. WSSD Goals 2002: Johannesburg Summit

## 4. Millennium Development Summit 2006: UN

# Millennium Development Goals (MDG)

*United Nations Millennium Declaration, 2000*

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empowerment
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development

**Water is an implicit goal**

**Commendable targets, but will they be met?**

# Global Environment - Climate Change

## Brief Overview of IPCC AR4:

## Risk to Sustainable Development

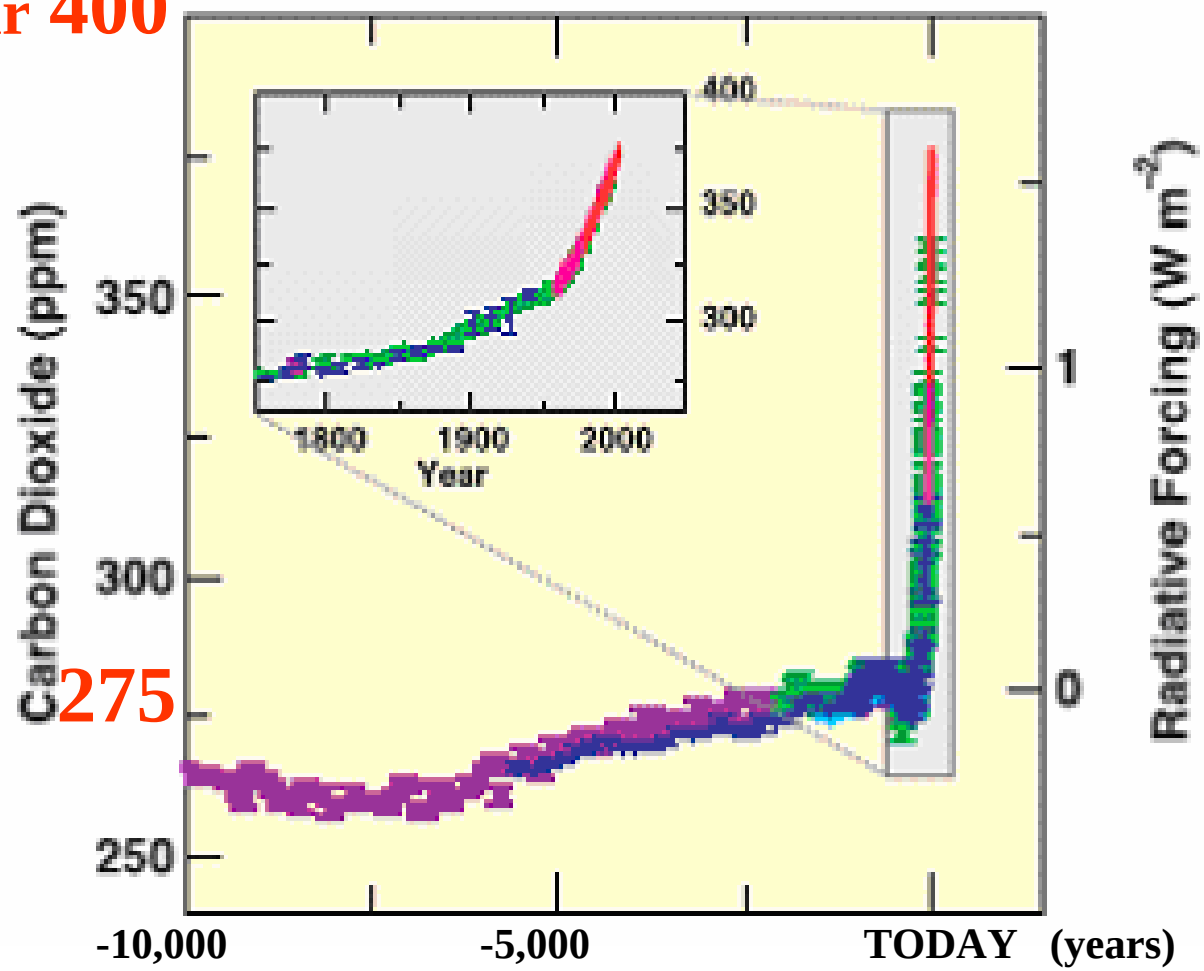
# IPCC AR4 – Summary of Main Findings

- **Global warming in unequivocal. Total radiative forcing of the climate now is unprecedented in several thousand years, due to rising concentrations of GHG (CO2, CH4 & NO2).**
- **Humans activities since the 18th century are very likely to have caused net warming of Earth's climate, dominating over the last 50 years. More temp. and sea level rise is inevitable, even with existing GHG concentrations.**
- **Long term unmitigated climate change would likely exceed the capacity to adapt, of natural managed and human systems.**
- **Poor countries and poorest groups will be most vulnerable to warming, sea level rise, precipitation changes and extreme events. Most socio-economic sectors, ecological systems and human health will suffer.**
- **Adaptation measures are available, but must be systematically developed**
- **Mitigation technologies are also available, but better policies and measures (PAM) are needed to realize their potential.**
- **Making development more sustainable (MDMS) by integrating climate change policy into sustainable development strategy is the most effective solution.**

# MAIN DRIVER

# Changes in CO2 from ice core and modern data

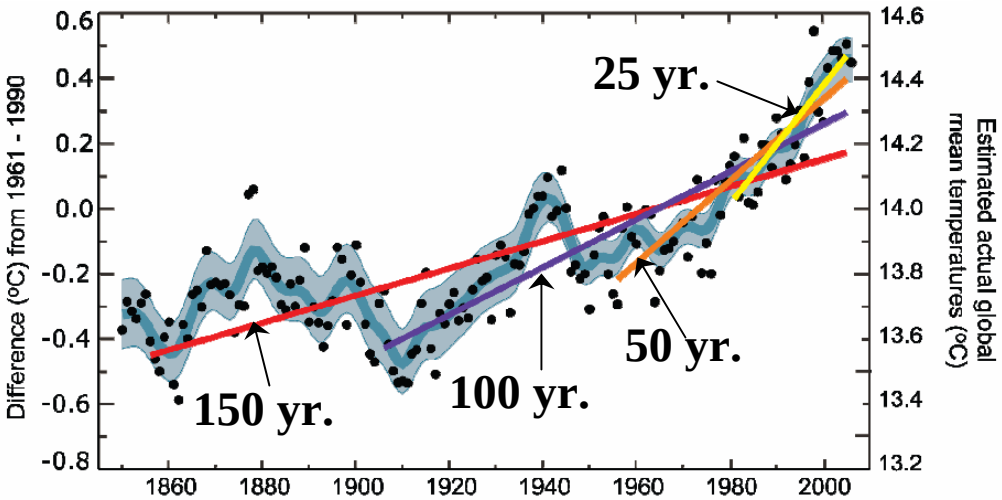
**Now: near 400**



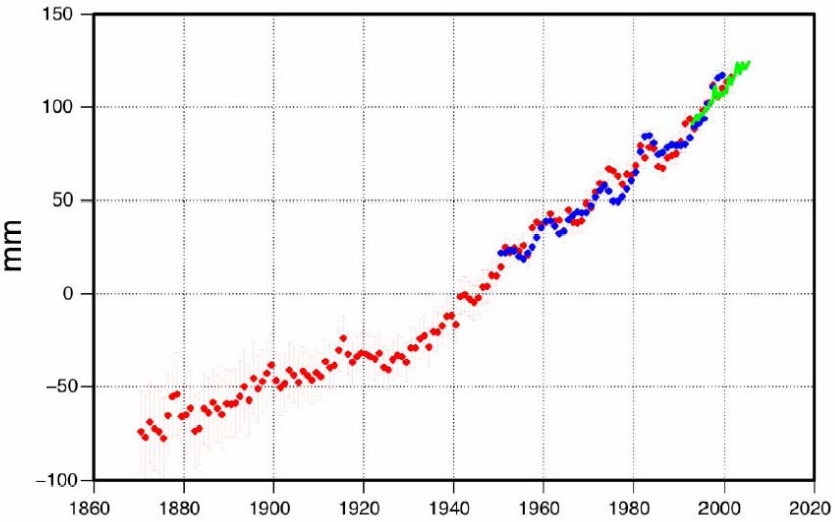

**Pre-ind: 275**

# RESULT: Mean temp, sea level and arctic ice cover

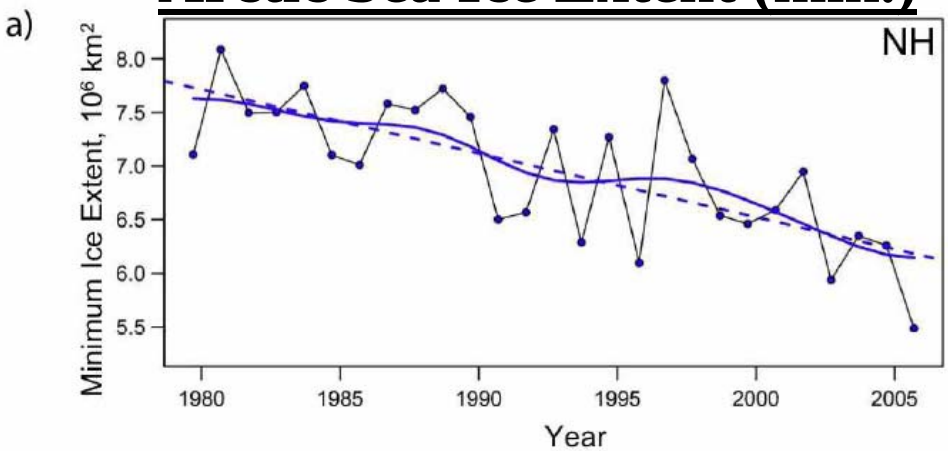
## Mean Temperature



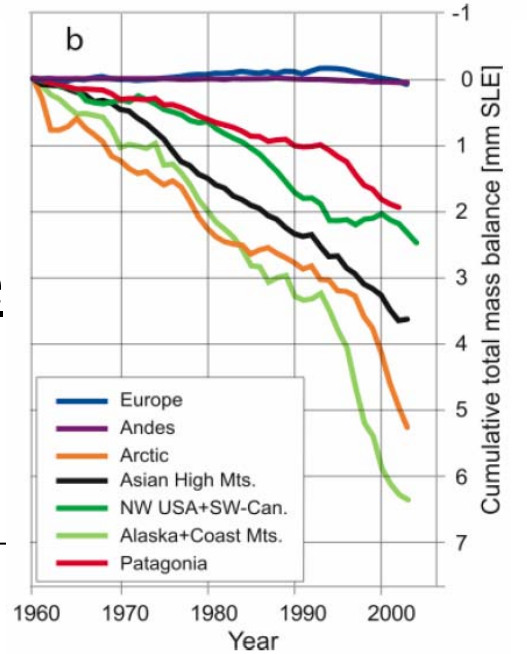

## Mean Sea Level




## Arctic Sea Ice Extent (min.)




## Glacier Mass Balance

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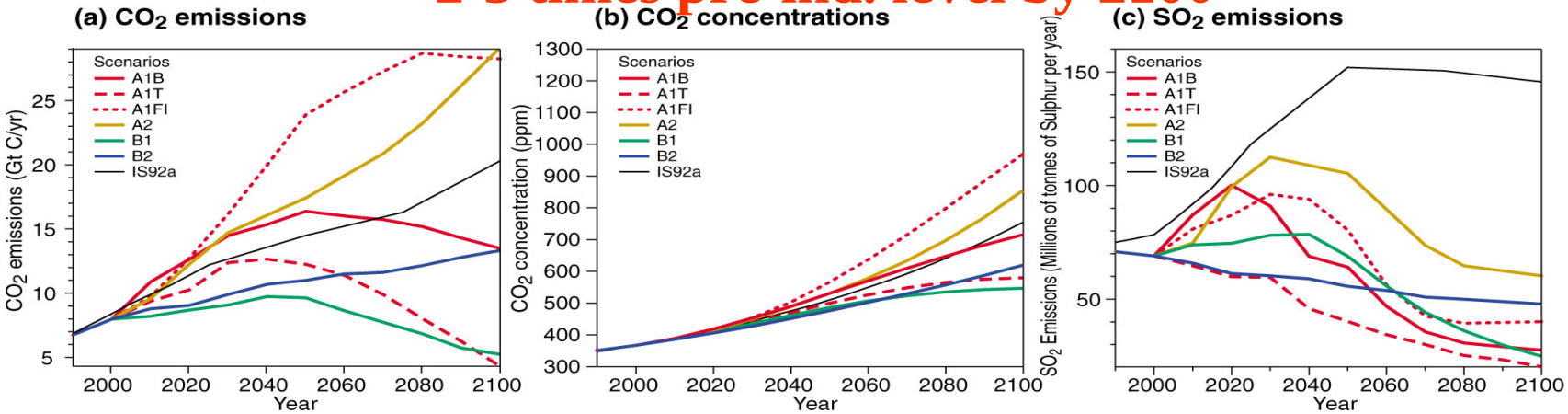
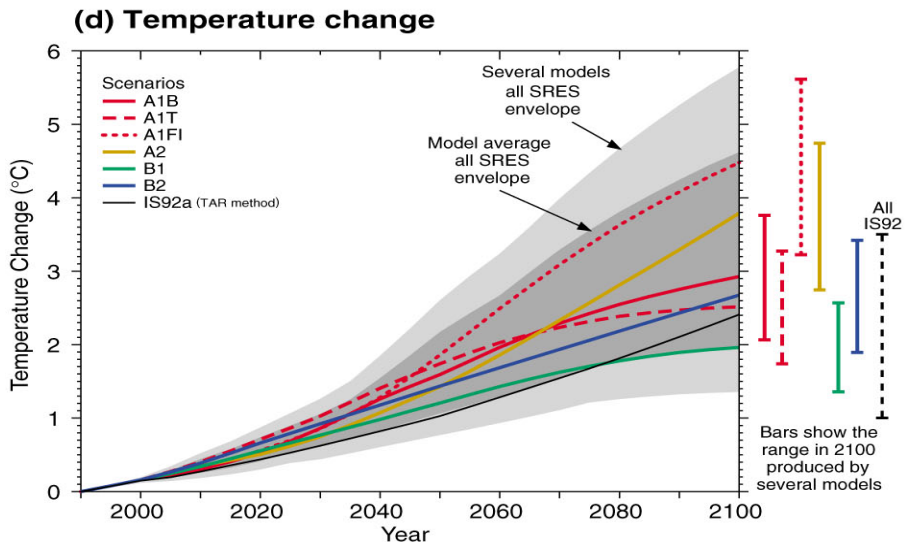
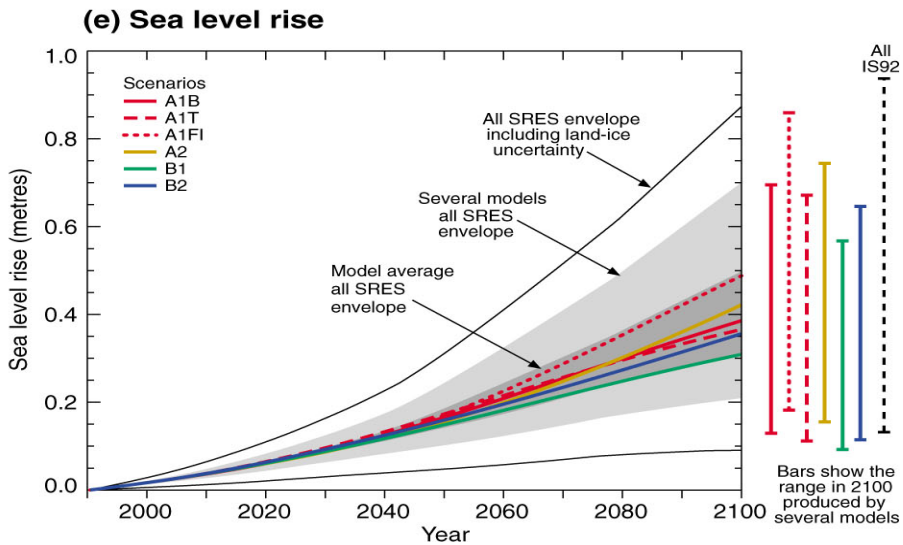
# The Global Climate of the 21st Century

## 2-3 times pre-ind. level by 2100




**Temp. rise ~3C (1.8 to 4) by 2100**

**Sea level rise ~0.4m (0.2 to 0.6) by 2100**

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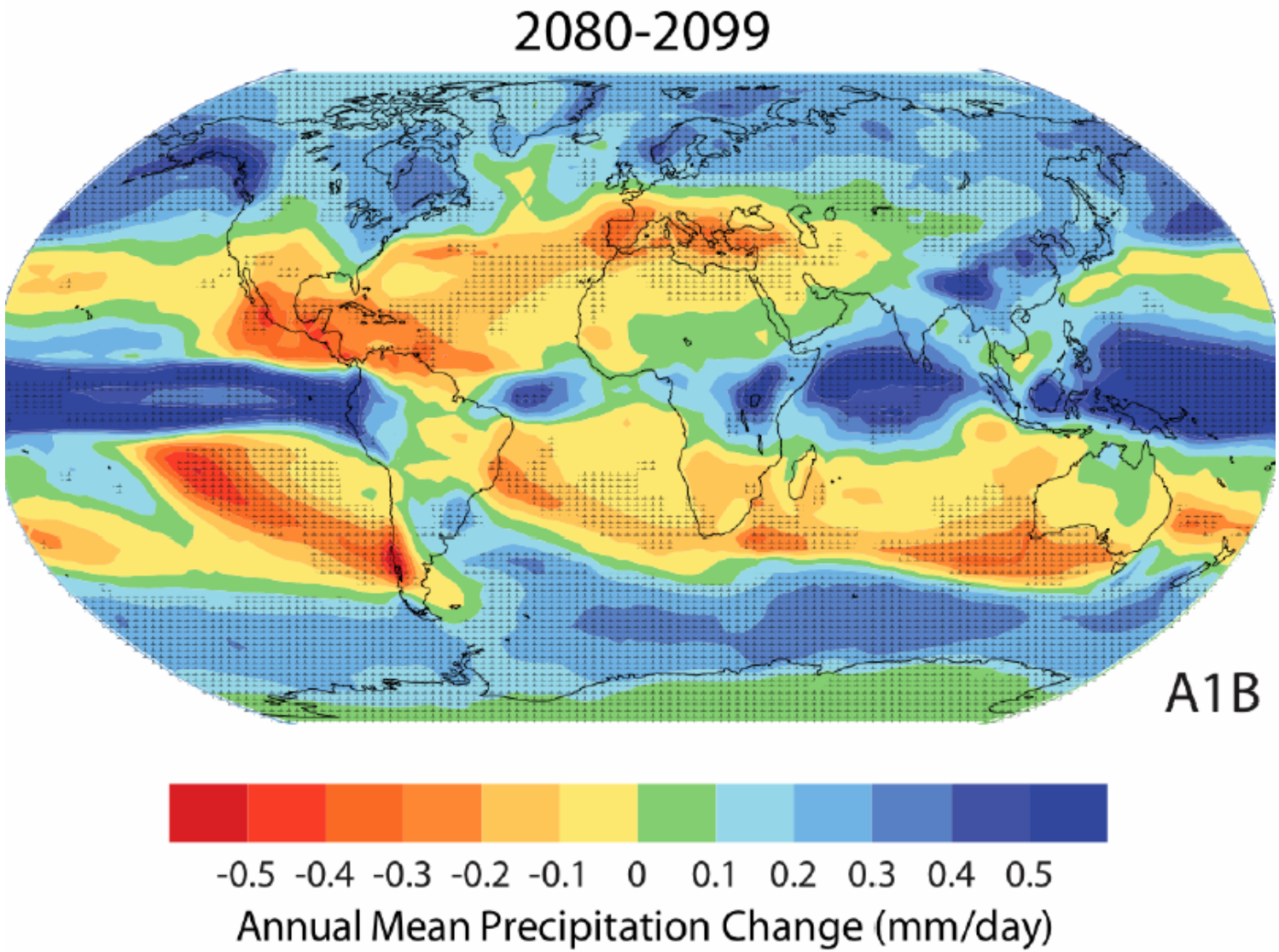
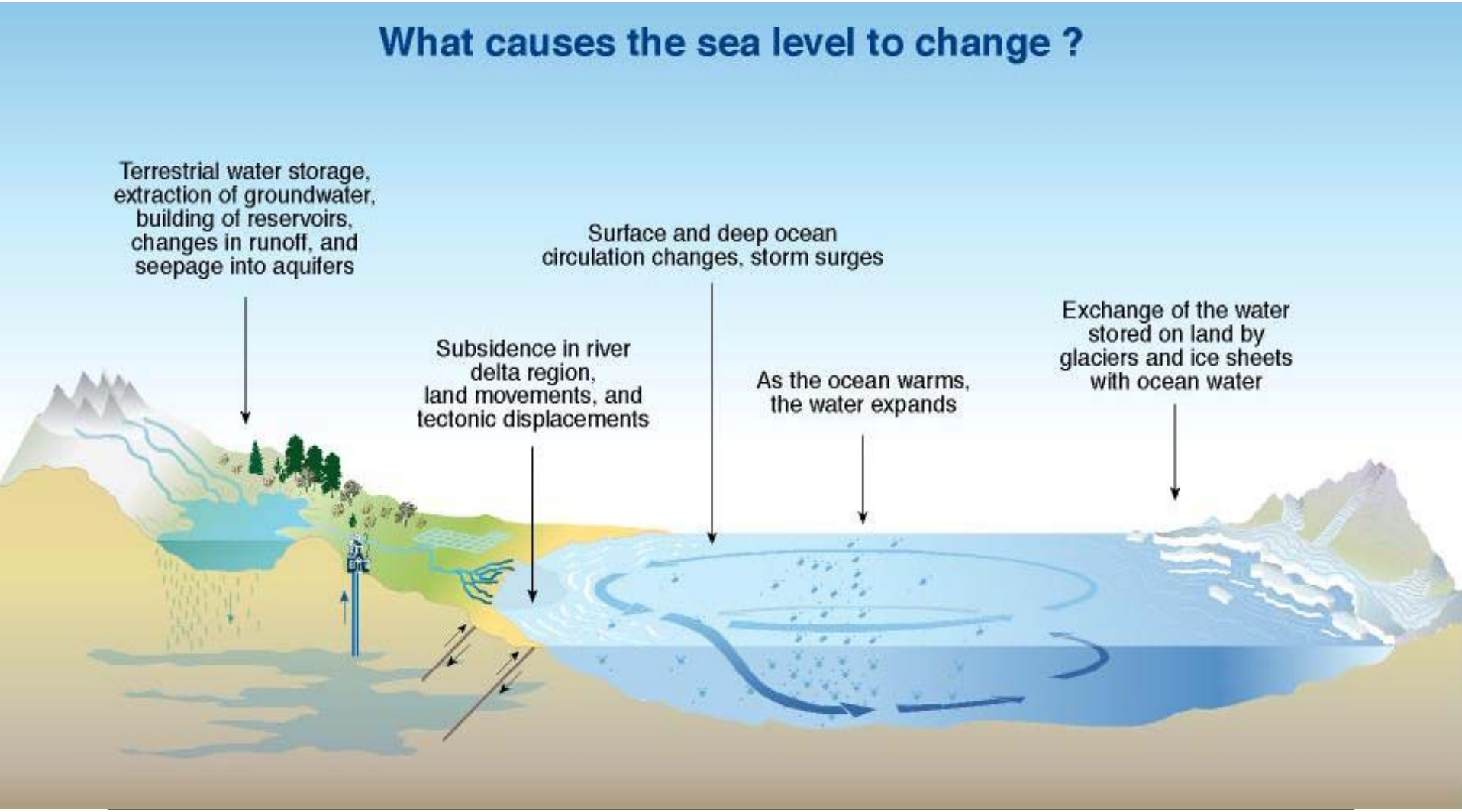
# Dry areas will get dryer & wet areas will get wetter



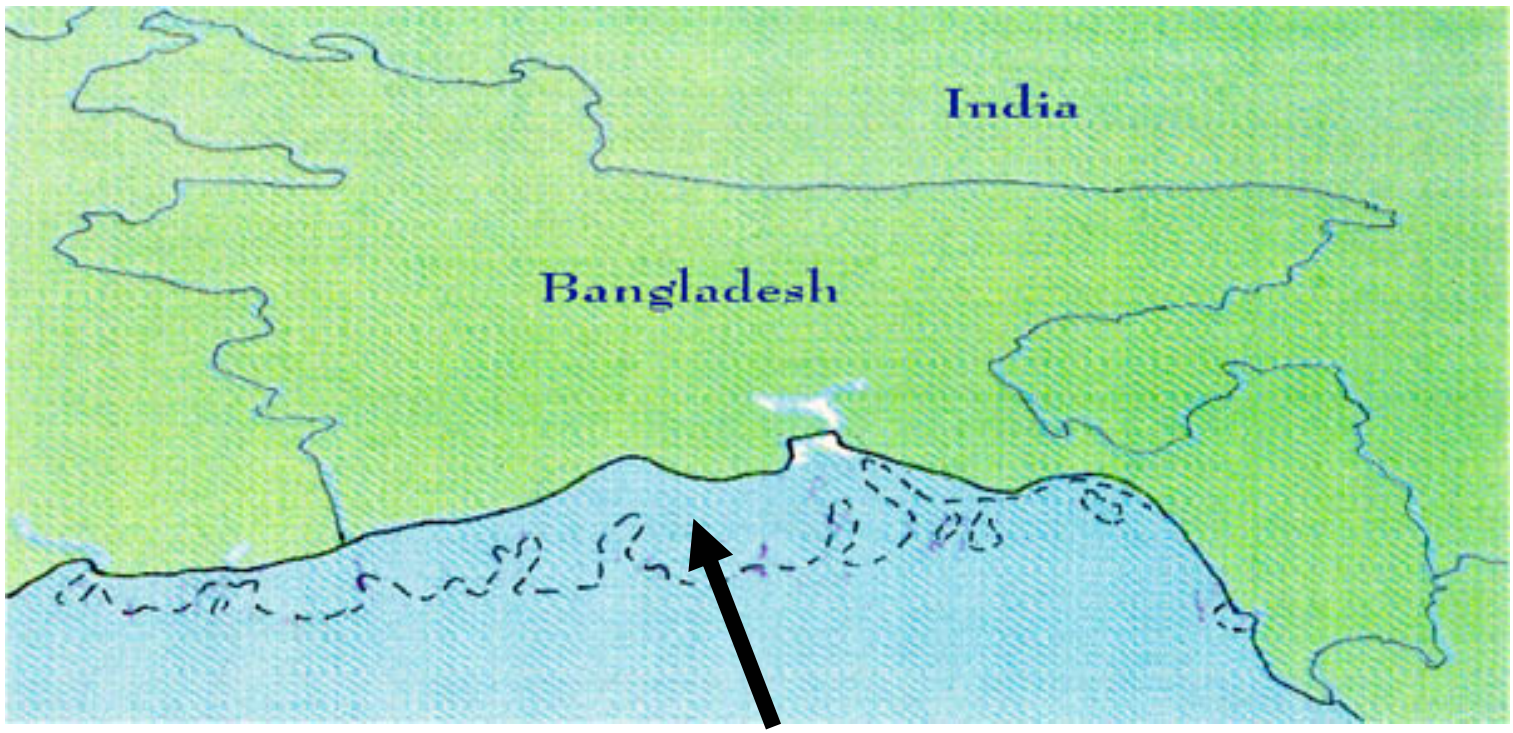
# SEA LEVEL RISE will be caused by thermal expansion of the oceans and melting of land ice and ice sheets



**MEAN SEA LEVEL RISE of 0.4 m (range: 0.2 to 0.6) is projected by 2100 but with significant regional variations**

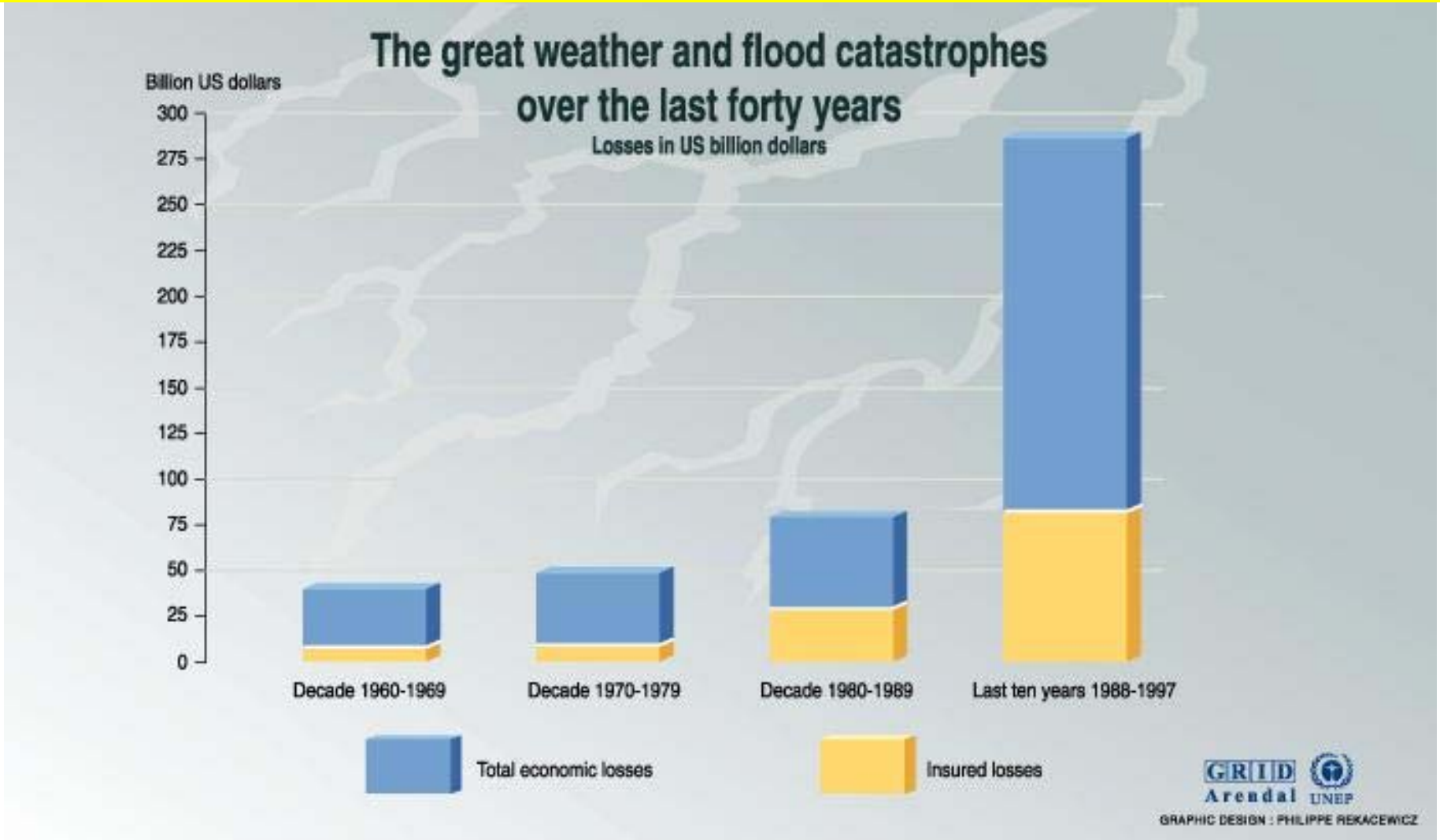
Increased risk of floods, potentially displacing tens of millions of people, due to sea level rise and heavy rainfall events, especially in Small Island States and low-lying deltaic areas.

**Bangladesh is projected to lose about 17% of its land area with a sea level rise of one meter** - very difficult to adapt due to lack of adaptive capacity

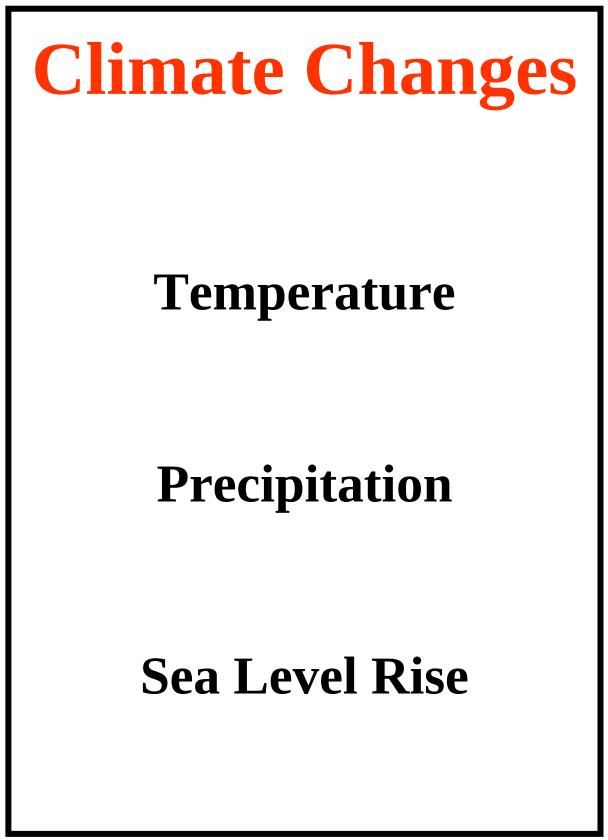



Flooded area

# Extreme Weather Events - Worsening Trend
# Economic Damage Increasing



# OVERALL: More adverse than beneficial impacts on biological and socioeconomic systems




**Health Impacts**
Weather-related Mortality
Infectious Diseases
Air Quality- Respiratory Illnesses

**Agriculture Impacts**
Crop Yields
Irrigation Demands

**Forest Impacts**
Forest Composition
Geographic Range of forests
Forest health and productivity

**Water Resources Impacts**
Water supply
Water quality
Competition for water

**Impacts on Coastal Areas**
Erosion of beaches
Inundation of coastal lands
Additional costs to protect coastal communities

**Species and Natural Areas**
Loss of habitat and species

# Key IPCC Findings – A Few Beneficial Impacts

increased agricultural productivity in some mid-latitude regions ( only for warming of up to a few degrees C)

increased water availability in some water-scarce regions

reduced winter mortality in mid- and high-latitudes

increase in timber supply (with well managed forests)

# Potential Large Scale Impacts - Uncertain

**Greenhouse gas emissions in the 21st century might set in motion large-scale, high-impact, non-linear, and potentially irreversible changes in physical and biological systems over the coming decades to millennia**

- **Melting of ice sheets** (sustained warming of a few $^{o}$C over millennia is projected to lead to an increase in sea level of several meters due to loss of Greenland and Antarctic Ice)
- **Thermohaline circulation**
- **Species extinction and biodiversity loss**
- **Catastrophic climate-development interactions**

# UN Framework Convention on Climate Change 1992

## Article 2

**Stabilize atmospheric GHG concentrations** to prevent 'dangerous' anthropogenic inteference in the climate system:

- enable **economic development** to proceed in a sustainable manner
- ensure **food production** is not threatened
- allow **ecosystems** to adapt naturally

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UNFCCC also speaks of **"common but differentiated responsibilities"**

# Adaptation Burden & Equity: CC → SD

## Adaptation is first priority of developing countries that are most vulnerable to climate change

- **Climate change is likely to impact disproportionately upon the poorest countries and the poorest persons within all countries,** exacerbating inequities in health status and access to adequate food, clean water and other resources.
- **Net economic effects will be negative in most developing countries**
- **Impacts will be worse** - many areas are already flood and drought prone, and economic sectors are climate sensitive
- **Lower capacity to adapt** because of a lack of financial, institutional and technological capacity, and access to knowledge

# Most Vulnerable People

Children

Elderly

Poor

# Most Vulnerable Regions

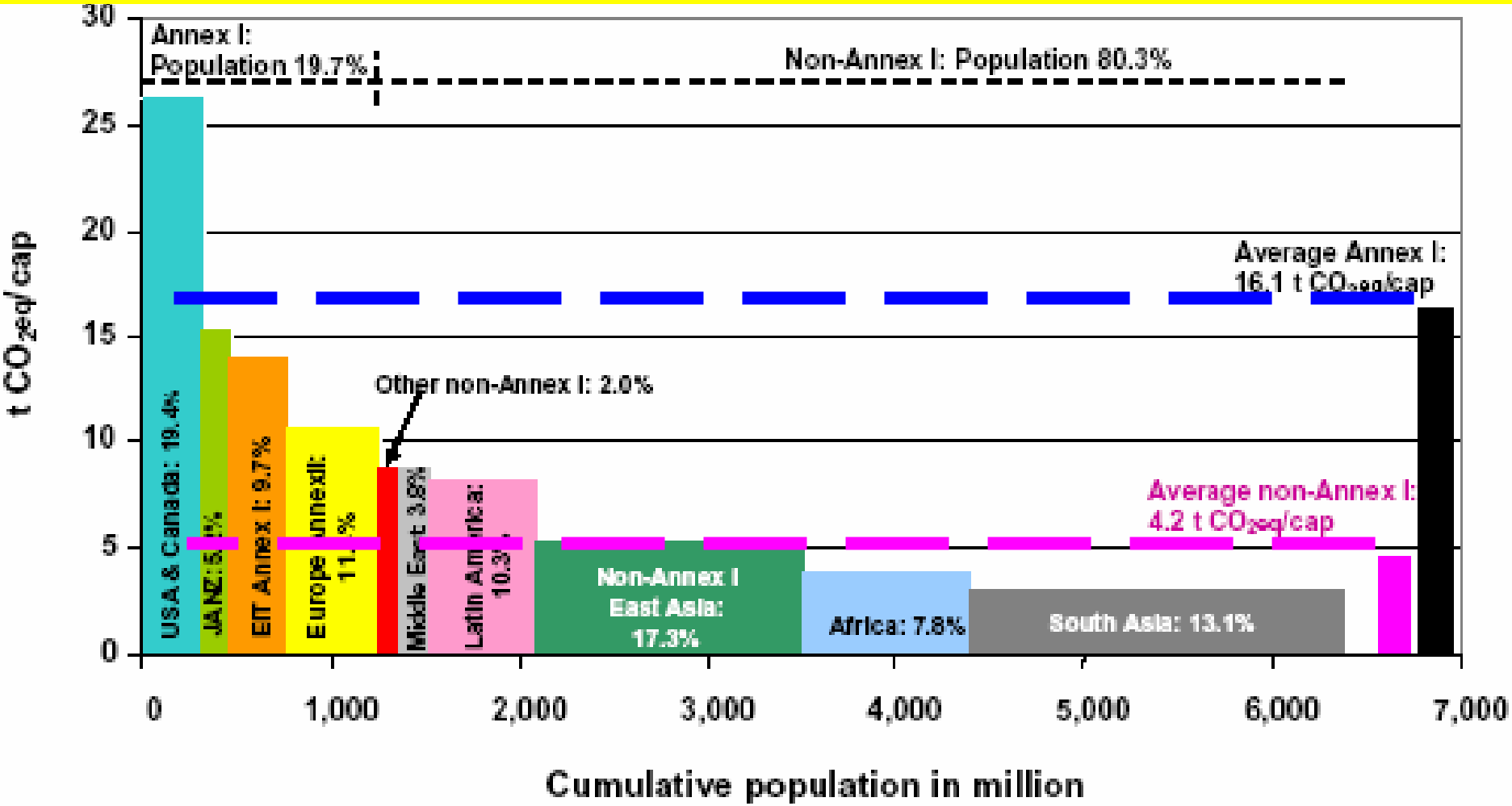



# Most Vulnerable Systems and Sectors

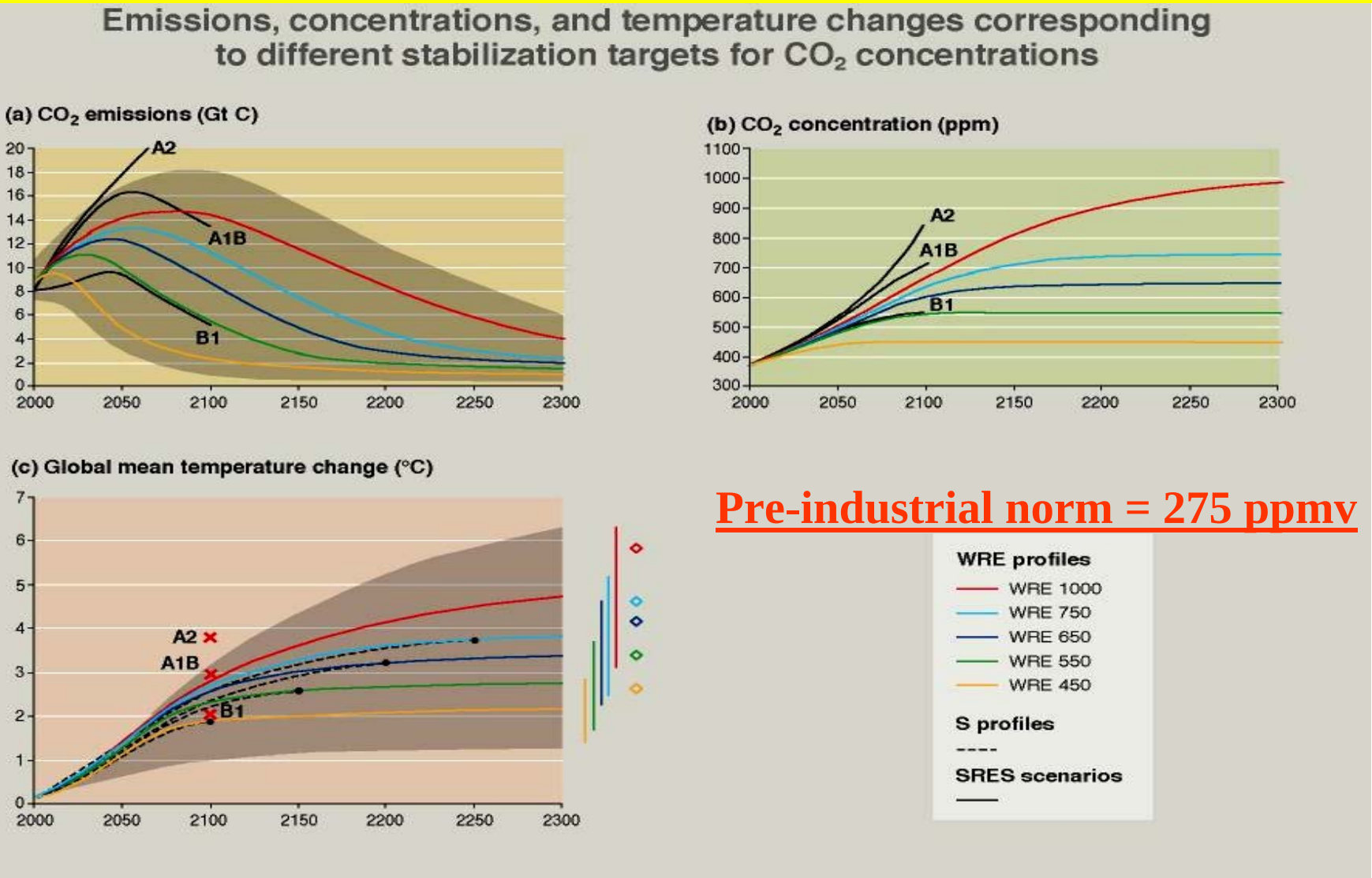
- Some ecosystems:
  - Coral reefs; sea-ice regions
  - Tundra, boreal forests, mountain and Mediterranean regions
- Low-lying coasts, mangroves & salt marshes
- Water resources in mid-latitudes & dry Tropics
- Low-latitude agriculture
- Human health where adaptive capacity is low

# Mitigation Responsibility & Equity: SD → CC

## Mitigation is main responsibility of industrial countries with high per capita GHG emissions



# Stabilization of the atmospheric concentration of carbon dioxide will require significant emissions reductions



# The Challenge of Mitigation

The near-term Challenge is to achieve the Kyoto targets.

Process continues with meeting of parties (MOP) – separate from conference of parties (COP)

The longer-term challenge is to meet the objectives of Article 2 of the UNFCCC, i.e., stabilization of atmospheric concentrations of GHG concentrations at a level that does not harm the climate system (food security, ecological systems and sustainable economic development).

Process starts with post-Kyoto (beyond 2012) - second round of commitments, discussions began in 2008.

Copenhagen 2009 is a historic opportunity.

# Mitigation: Kyoto Protocol (1997) in force in 2005 (without US)

1. **Annex 1 Countries undertake mitigation -- GHG emission reductions (2008-2112) relative to 1990:**

| | |
|---|---|
| EU | - 8 % |
| USA | - 7 % |
| Japan | - 6 % |
| Australia | + 8 % |
| Russian Federation | 0 % |
| **all developed countries** | **- 5 %** |

2. **No obligations for developing countries and economies in transition**

3. **Kyoto Mechanisms: CDM, JI, emissions trading**

# Disturbing Near Term Trends in GHG Emissions: 1970-2030

## During 1970-2004 (Actual)

GHG emissions covered by the Kyoto Protocol have increased by about 70%.

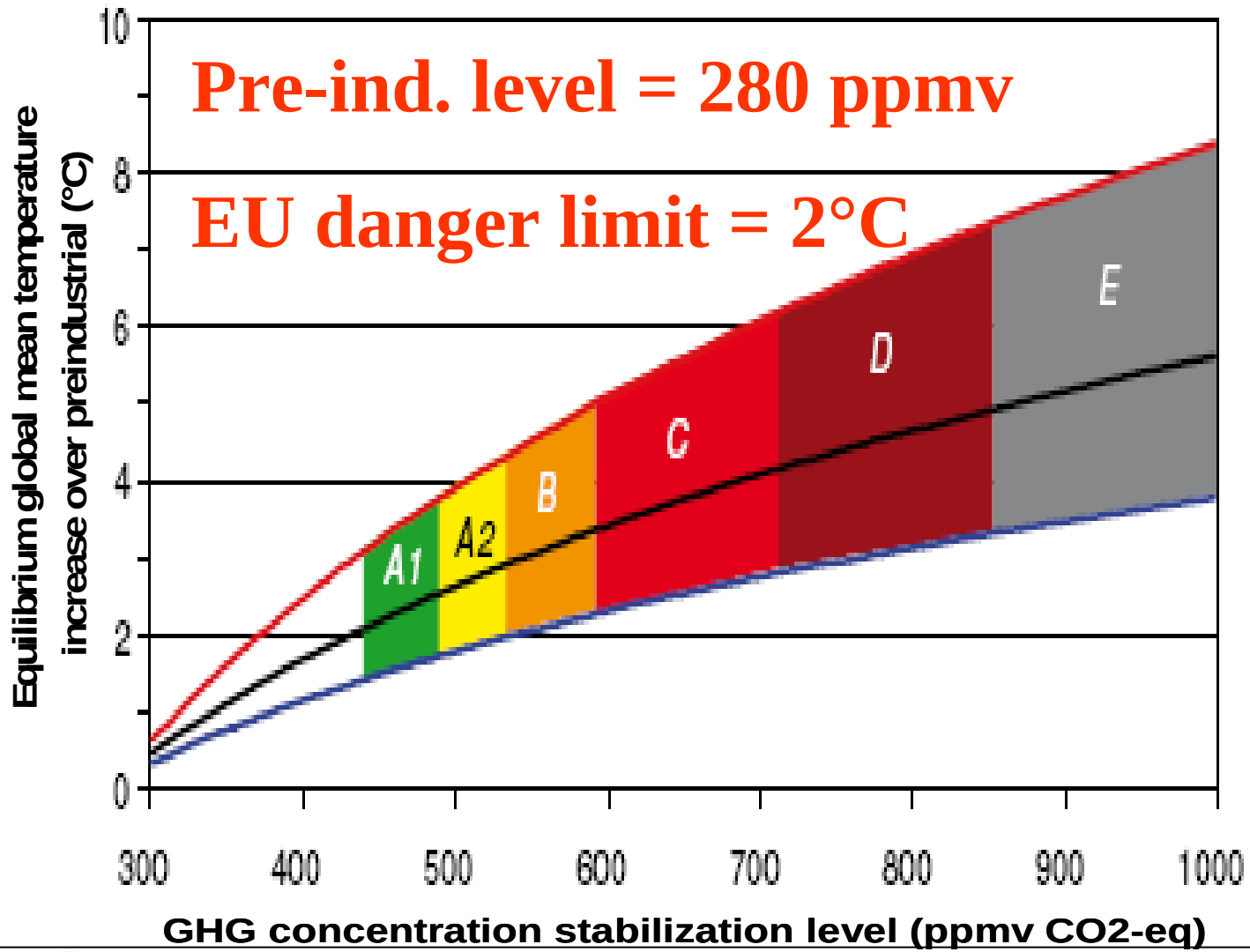
CO2 (77% of GHG), has grown by about 80%.

Even after Kyoto 1997, emissions have continued to increase

## During 2000-2030 (projected)

GHG emission will rise 45-110% with current policies. Two thirds of this growth will be in developing countries, but per capita emissions in developed countries will remain 3-4 times higher.

# Stabilisation levels and equilibrium global mean temperatures



# Concentrations, mean temp. rise & peak year emissions

The lower the stabilization level, the more quickly emissions would need to peak and to decline thereafter. EU danger limit = 2°C

Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels.

| $CO_2$ stabili-zation | CO2-Equivalent Stabili-zation level | Year CO2 needs to peak | GDP reduction in 2030 | Reduction in 2050 relative to 2000 | Global Mean temp. incr. at equilib. | Global average sea level rise from thermal expansion |
|---|---|---|---|---|---|---|
| ppm | ppm | Year | % | Percent | °C | metres |
| 350 – 400 | 445 – 490 | 2000 – 2015 | < 3 | -85 to -50 | 2.0 – 2.4 | 0.4 – 1.4 |
| 400 – 440 | 490 – 535 | 2000 – 2020 | < 2 | -60 to -30 | 2.4 – 2.8 | 0.5 – 1.7 |
| 440 – 485 | 535 – 590 | 2010 – 2030 | 0.6 | -30 to +5 | 2.8 – 3.2 | 0.6 – 1.9 |
| 485 – 570 | 590 – 710 | 2020 – 2060 | 0.2 | +10 to +60 | 3.2 – 4.0 | 0.6 – 2.4 |
| 570 – 660 | 710 – 855 | 2050 – 2080 | | +25 to +85 | 4.0 – 4.9 | 0.8 – 2.9 |
| 660 – 790 | 855 – 1130 | 2060 – 2090 | | +90 to +140 | 4.9 – 6.1 | 1.0 – 3.7 |

# GHG Mitigation Costs: 2030 and 2050

## 1. GDP reduction costs

| Stabilisation levels (ppm $CO_2$-eq) | Median GDP reduction [a] (%) | | Range of GDP reduction [b] (%) | | Reduction of average annual GDP growth rates (percentage points) [c], [e] | |
|---|---|---|---|---|---|---|
| | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| 445 – 535 [d] | Not available | | < 3 | < 5.5 | < 0.12 | < 0.12 |
| 535 – 590 | 0.6 | 1.3 | 0.2 to 2.5 | slightly negative to 4 | < 0.1 | < 0.1 |
| 590 – 710 | 0.2 | 0.5 | -0.6 to 1.2 | -1 to 2 | < 0.06 | < 0.05 |

## 2. Costs per tonne of $CO_2$equivalent mitigated

**To achieve a 2100 target of 550 ppmv, the costs in 2030 will be US$ 20-80 per tonne mitigated. These costs could fall further to US$ 5-65 with induced technological advanced.**

# Global Long Term Perspectives

- **Lessons of History**
- **Future Scenarios**

# Sustainability & Resource Use: Historical view

## DURABLE USE OF RESOURCES

- Nile Basin (Egypt)

  Pharaonic system lasted over 4000 years, with sustainable resource use and reasonable quality of life

- Yellow River Basin (China)

  Imperial system was stable for many millenia, and supported flourishing society

- Saraswati River (India)

  Hosted a flourishing civilisation for 4000 years. River eventually dried up due to tectonic activity, climate change and desertification, and water piracy.

## OVEREXPLOITATION OF RESOURCES

- Sahara Desert

  Once green with many animals and hunters. Over-exploitation led to a drier habitat which could no longer sustain these populations

# Major Current Global Issues (handled piecemeal)

## Poverty, inequity and human well-being

**billions living on <1 per day without basic needs, unequal income distribution**

## Scarce resources, conflict and competition

**energy, water, land, food, etc.**

## Environmental damage

**degradation of air, land and water, climate change, etc.**

## Globalisation

**high risks (e.g., financial crises), but benefits if well-managed**

## Governance

**mis-management, corruption, govt. business and civil society partnership crucial**

## Private-public balance

**Excessive government control and unrestrained markets are both risky extremes**

# Uncoordinated responses complicate matters

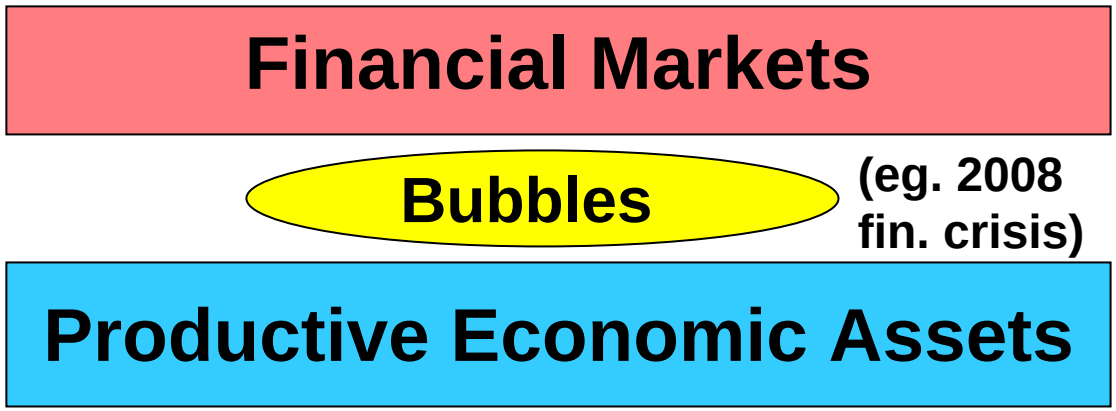
## Example: 2007-2008 food scarcity

**Human actions**

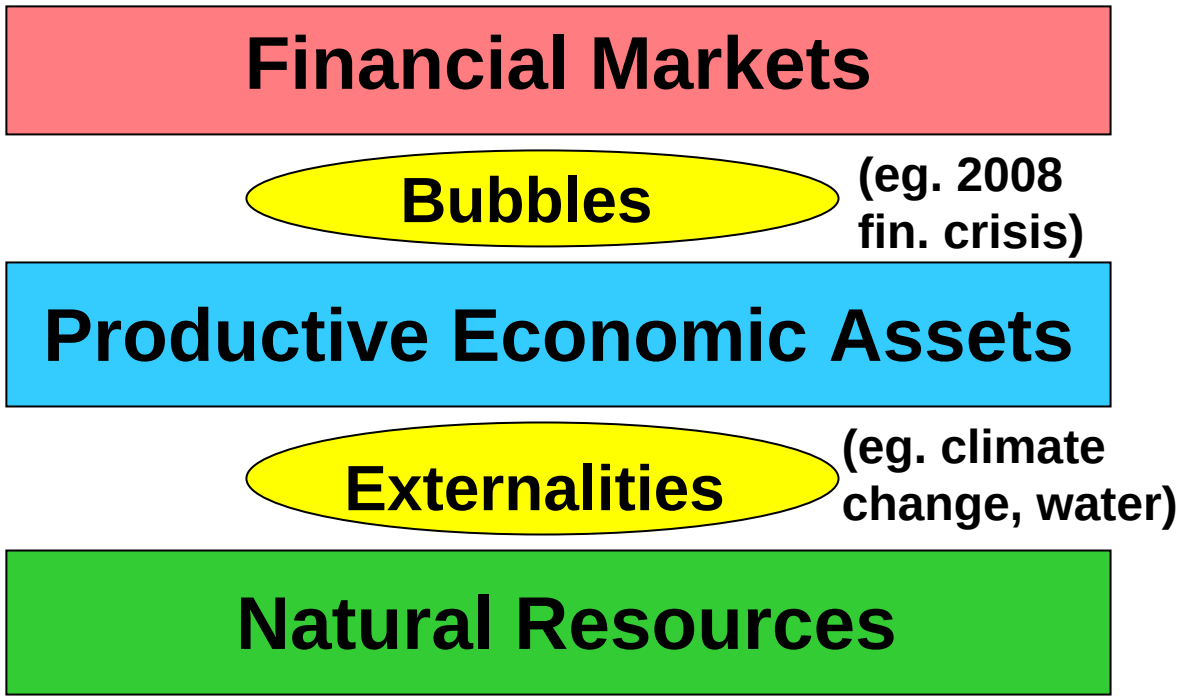
- **Oil crisis → Corn ethanol**
- **Drought → Grain shortage**

**Nature**

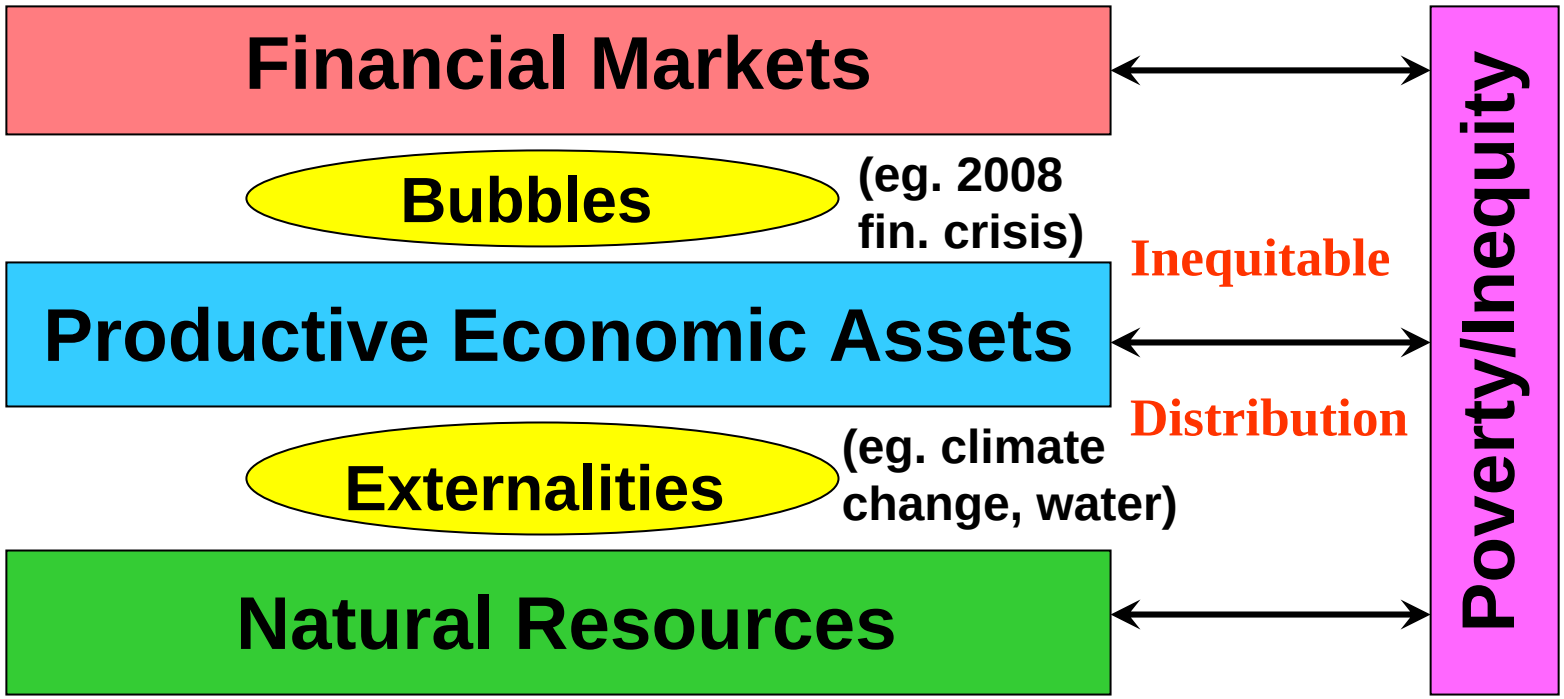
} **Food Scarcity**



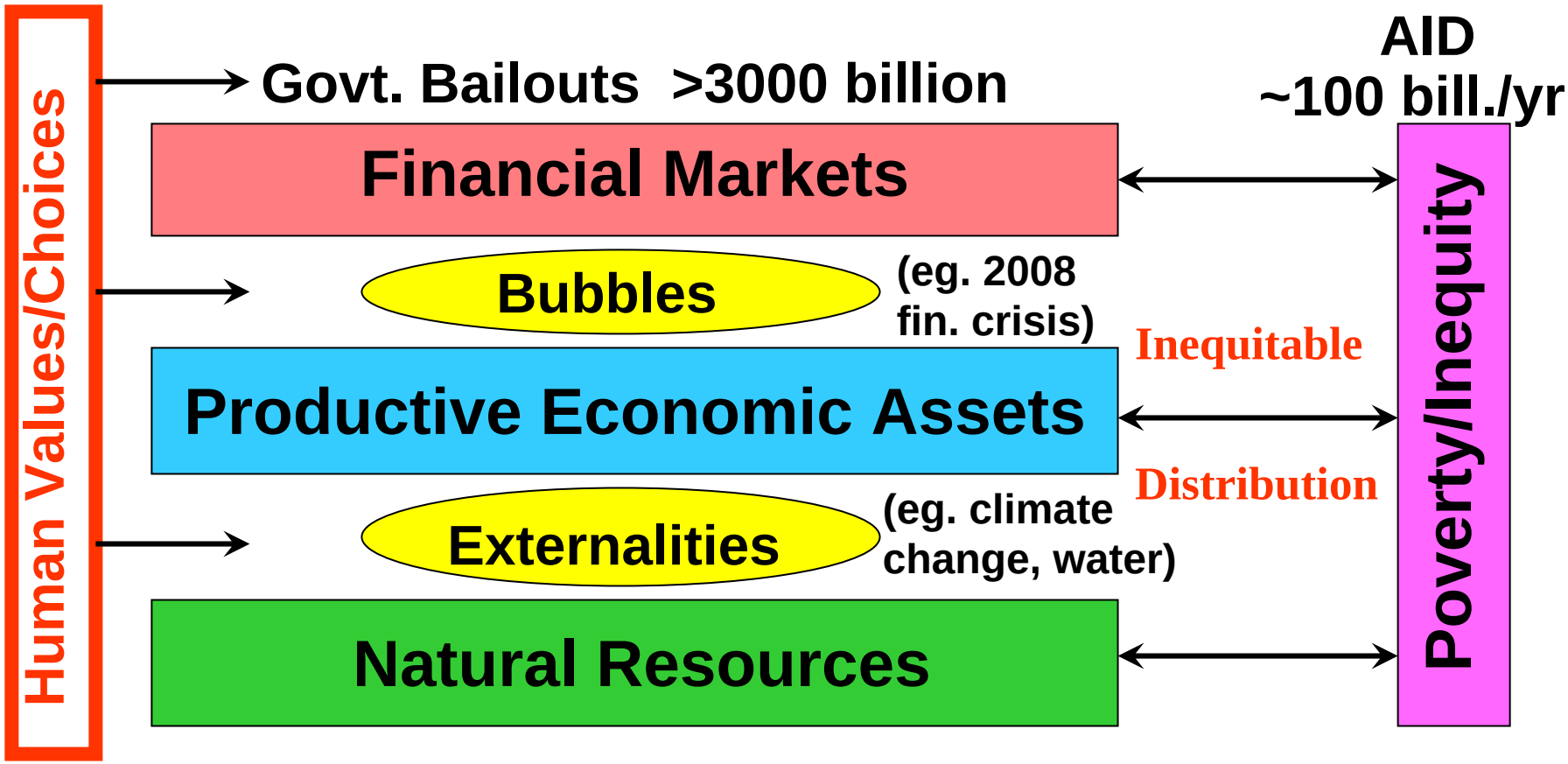

# Risks due to divergences between Illusions and Realities: 1




# Risks due to divergences between Illusions and Realities: 2




# Risks due to divergences between Illusions and Realities: 3




# Risks due to divergences between Illusions and Realities: 4

# Some Long Term Global Scenarios

| MAIN SCENARIOS | VARIANTS |
|---|---|
| 1. Barbarization | Breakdown<br>Fortress World |
| 2. Conventional | Market Driven<br>Policy Reform |
| 3. Transition | New Sustainability<br>Eco-Communalism |
| Likely Actual Future (BAU) | Mix of above scenarios |

**Source:** Adapted from Global Scenario Group (2000)

# Barbarization

Unrestrained market forces increase risk of conflict (erosion of ethical & moral underpinnings of civilization)

Poverty, Inequity
Resource scarcity (water, energy, etc.)
Social polarization, Conflict, Terrorism
Environmental harm, Climate change

**Chaos, Break-down**
Conflict, rivalry and competition for resources overwhelm all efforts to impose order

**Fortress World**

Local, regional and international groups respond selfishly to protect their interests

# A Long Term Vision of Sustainable Development: 1

| Levels | Indicators | Time | Human Interventions |
|---|---|---|---|
| Main Issues | Poverty, Inequity, Exclusion, Resource Conflicts, Harm to Environment (including CC) | Now ⟸ | High risk from unrestrained, myopic market forces ("Washington consensus", globalisation etc.) – Reactive: piecemeal - mainly govt. |



Source: Munasinghe (2007), IPCC, MA, GTI

# A Long Term Vision of Sustainable Development: 2

| Levels | Indicators | Time | Human Interventions |
|---|---|---|---|
| Main Issues | Poverty, Inequity, Exclusion, Resource Conflicts, Harm to Environment (including CC) | Now ⇐ | High risk from unrestrained, myopic market forces ("Washington consensus", globalisation etc.) – Reactive: piecemeal - mainly govt. |
| Immediate Drivers | Consumption Patterns, Population, Technology, Governance | Transition ⇐ | Making development more sustainable (MDMS) with systematic policy reform to manage market forces (Sustainomics) – Proactive: integrated, harmonious approach - govt., business, civil soc. |



Source: Munasinghe (2007), IPCC, MA, GTI

# A Long Term Vision of Sustainable Development: 3

| Levels | Indicators | Time | Human Interventions |
|---|---|---|---|
| Main Issues | Poverty, Inequity, Exclusion, Resource Conflicts, Harm to Environment (including CC) | Now ← | High risk from unrestrained, myopic market forces ("Washington consensus", globalisation etc.) – Reactive: piecemeal - mainly govt. |
| Immediate Drivers | Consumption Patterns, Population, Technology, Governance | Transition ← | Making development more sustainable (MDMS) with systematic policy reform to manage market forces (Sustainomics) – Proactive: integrated, harmonious approach - govt., business, civil soc. |
| Underlying Pressures | Basic Needs, Social Power Structure, Values, Perceptions, Choices, Knowledge Base | Long Term ← | Fundamental global sustainable dev. transition catalysed through grass roots citizens movements, driven by social justice and equity, innovative leadership, policies, info. flows, tech. (new SD paradigm) – Proactive: civil soc., business, govt. |



Source: Munasinghe (2007), IPCC, MA, GTI

**HOW ?**

can we seize the opportunities
by making development more sustainable and exploiting synergies using the sustainomics framework for sustainable water resources management (SWARM)

# Sustainable Water Resources Management (SWARM)

## Integrating Water (and Environmental) Policies within Overall Sustainable Development Strategy using the Sustainomics Framework

# SUSTAINOMICS
# Core Concepts

## Basis for Integrating Water (and Environmental) Policies into Sustainable Development Strategy

# Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

# Understanding Sustainable Development – some (ideal) generic definitions

**"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"**

**Source: Bruntland et al. (1987)**

**"process for improving the range of opportunities that will enable individual human beings and communities to achieve their aspirations and full potential over a sustained period of time, while maintaining the resilience of economic, social and environmental systems"**

**Source: Munasinghe (1992, Rio Earth Summit)**

# Rationale for practical approach based on Making Development More Sustainable (MDMS)

**The precise definition of sustainable development remains an elusive (perhaps unreachable) goal.**

**Parallel track strategy:**

**1. Long term - aim for goal of sustainable development.**

**2. Short to medium term – make development more sustainable.**

**Making development more sustainable (MDMS) is a less ambitious strategy that is more practical to implement because many unsustainable activities are easier to recognize and eliminate. Method is incremental (or gradient-based).**

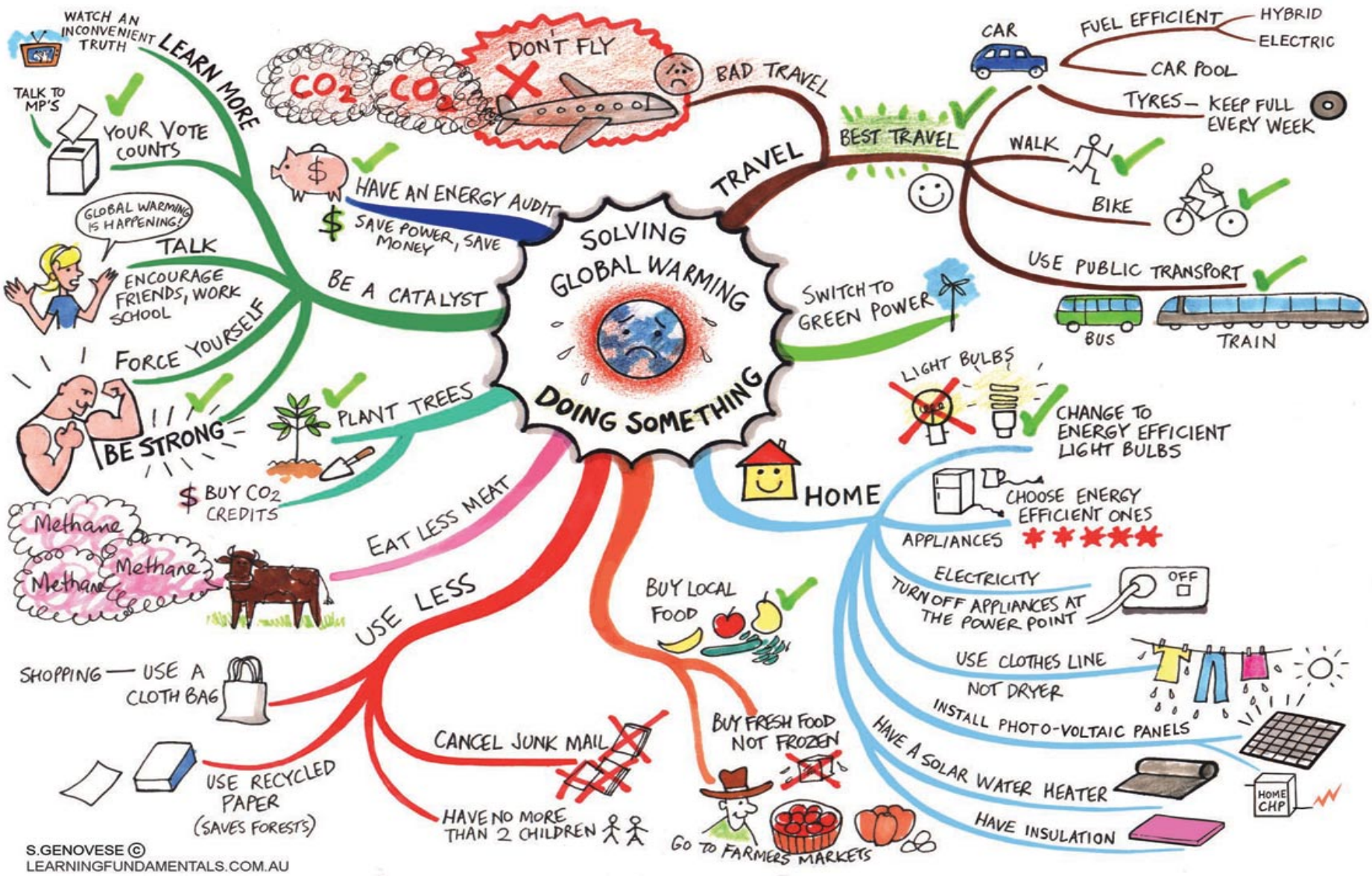
**Furthermore, water decisionmakers cannot be expected to address all the problems of sustainable development.**

**PRACTICAL TEST TO EMBED WATER OPTIONS IN SD:**

**Does it make development more (or less) sustainable?**


**Many obviously unsustainable practices exist today. MDMS encourages us to eliminate them NOW! Examples include water pollution, wastage and deforestation.**

# Making Development More Sustainable: Personal Lifestyle Changes

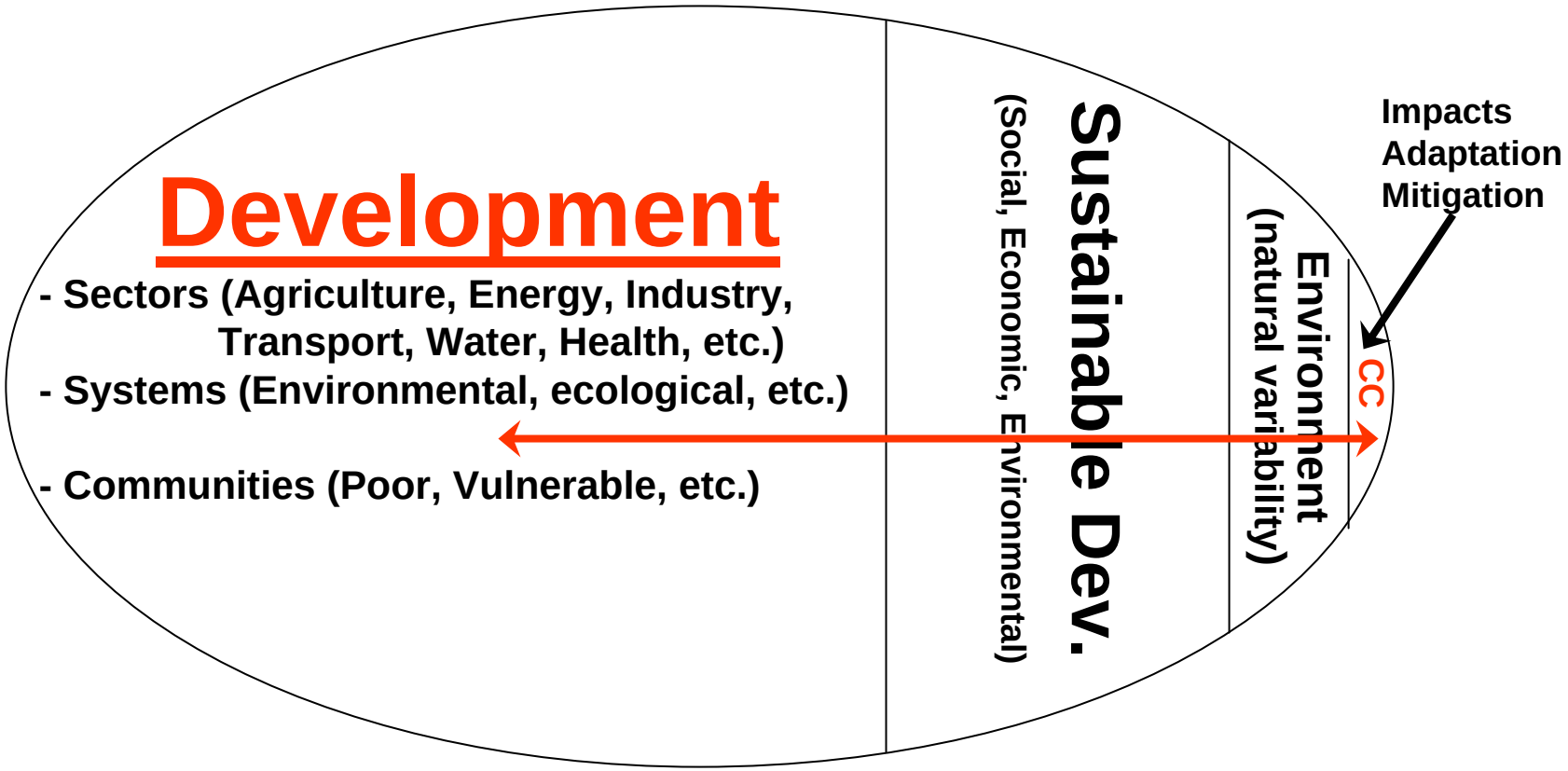


# MDMS: Corporate Social Responsibility

- Corporate Social Responsibility (CSR) is a concept whereby organizations consider the interests of society by taking responsibility for the impact of their activities on customers, suppliers, employees, shareholders, communities and the environment in all aspects of their operations.
- This obligation is seen to extend beyond the statutory and conventional obligation to comply with legislation and seek profits. It sees organizations voluntarily taking further steps to improve the quality of life for employees and their families as well as for the local community and society at large.

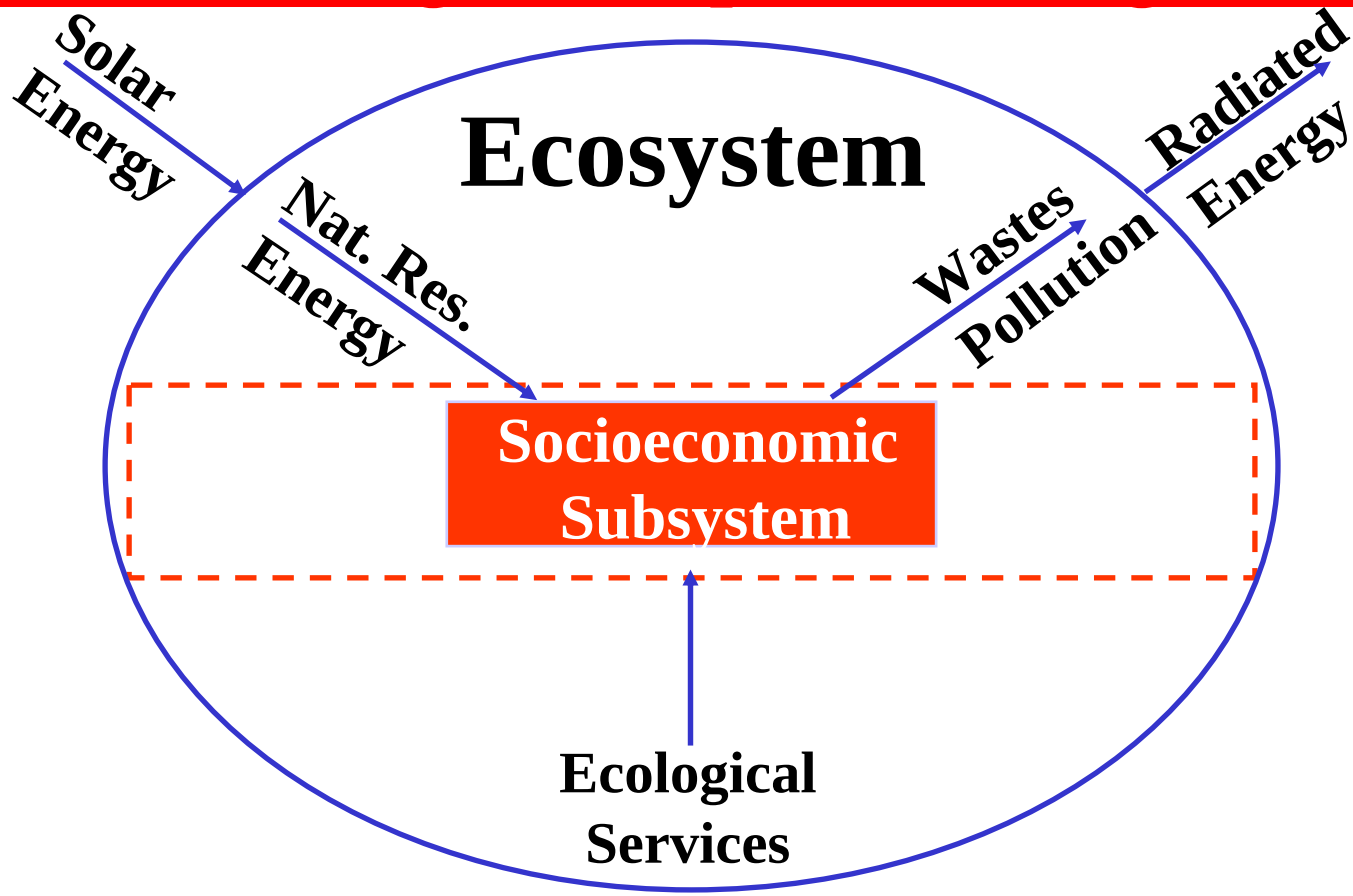
# MDMS: National Level CC-SD Integration

## Make decision makers see sustainability as a key element of the national development strategy



# MDMS Global Level

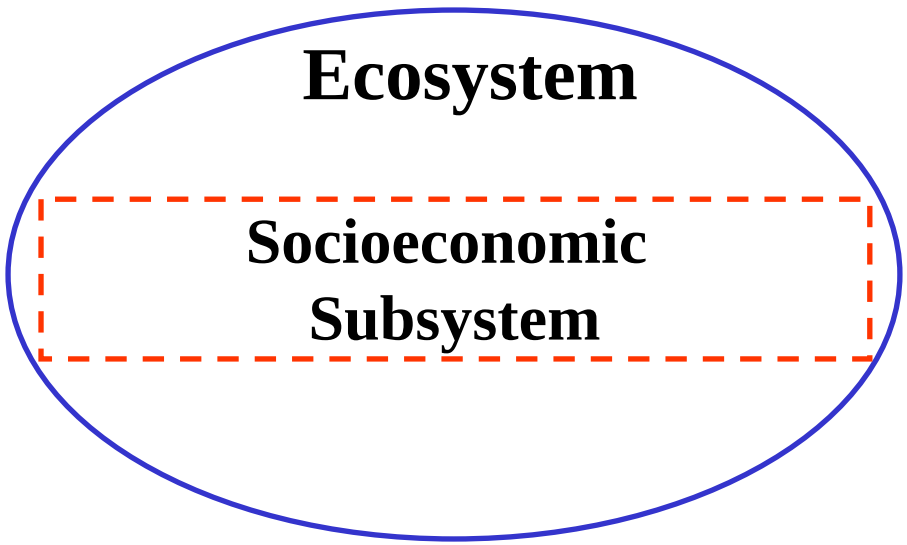
## Restructuring development and growth I



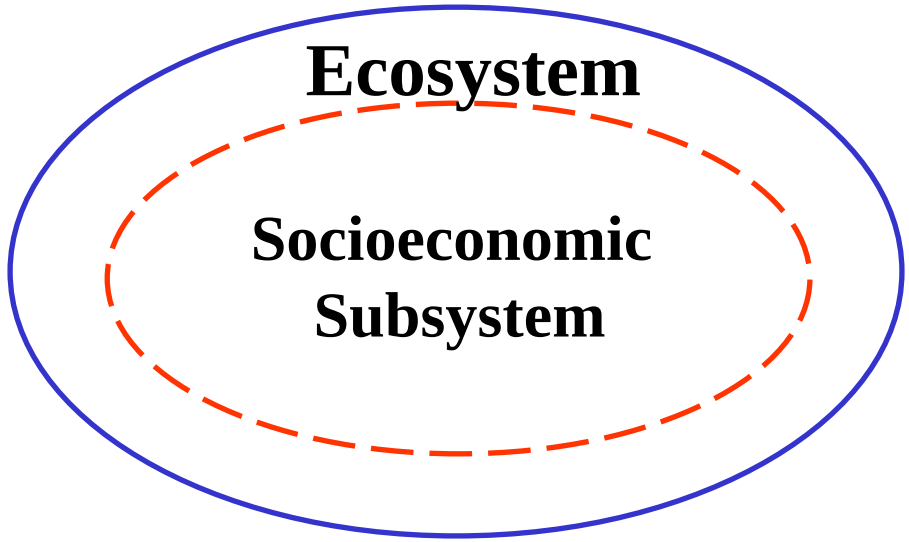

**The capacity of the ecosystem may become overloaded by the growing socio-economic subsystem (broken lines).**

# MDMS Global Level

## Restructuring development and growth II (rounding the rectangle)




Unsustainable

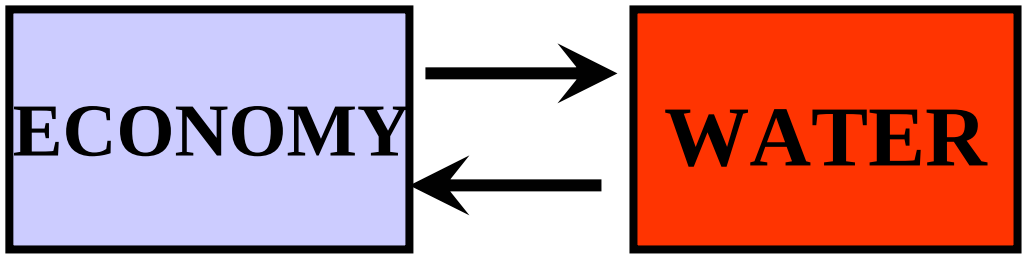



Sustainable

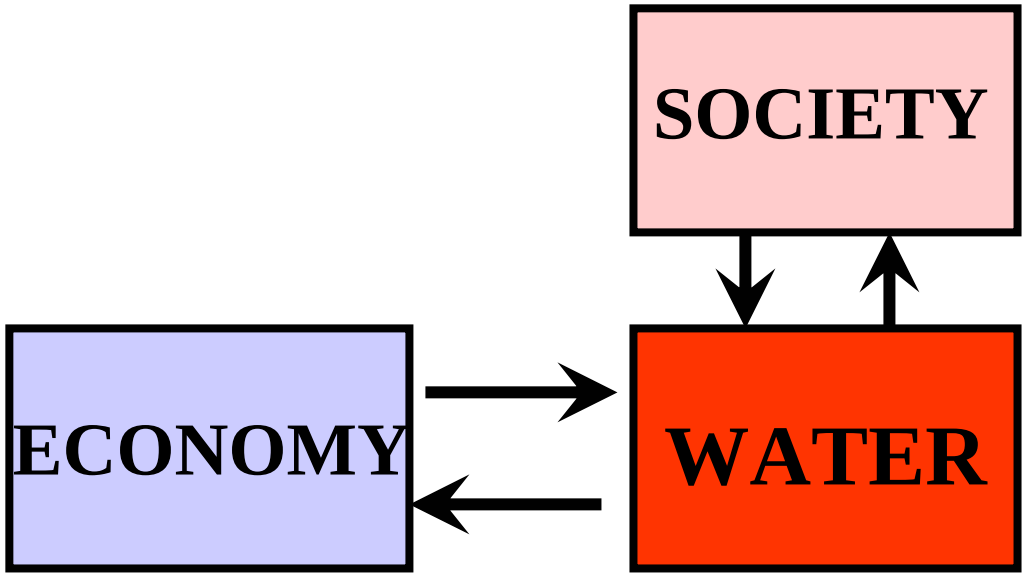
# Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

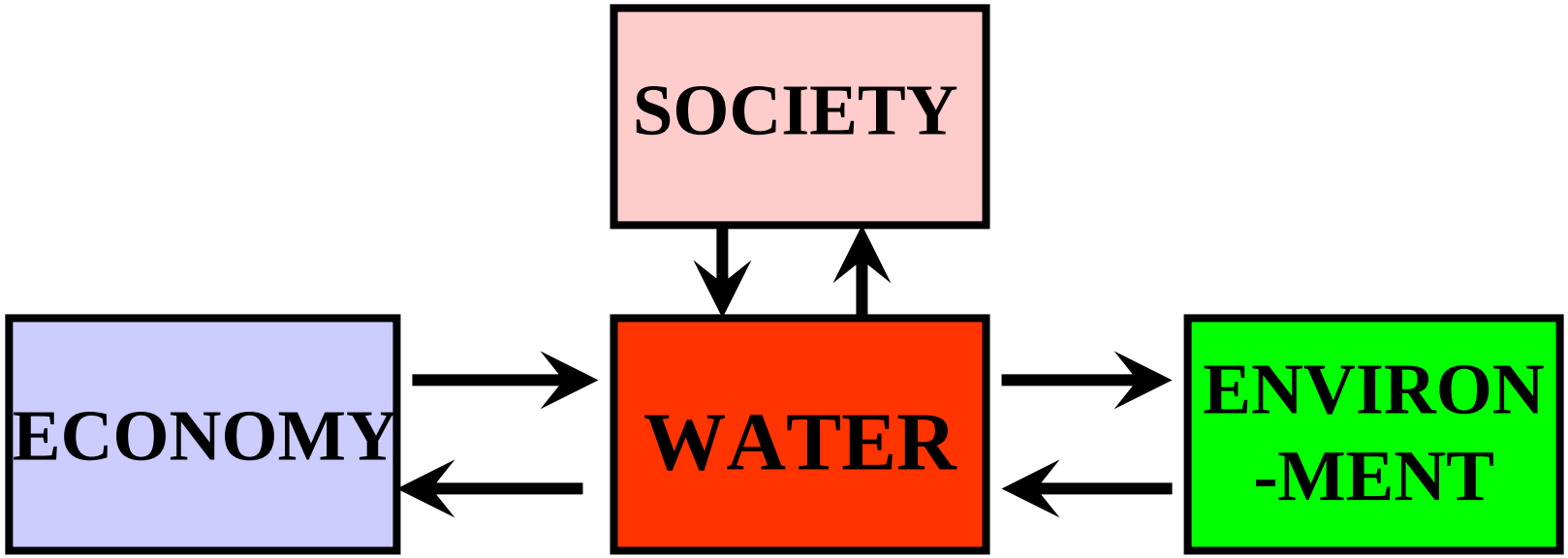

**Supply technology-oriented, hydrology, hydro-dynamics, technical efficiency, etc.**




**Supply-demand balance, price and income elasticity of demand, cost-benefit analysis, least cost investment planning, demand management, long run marginal cost pricing, etc.**

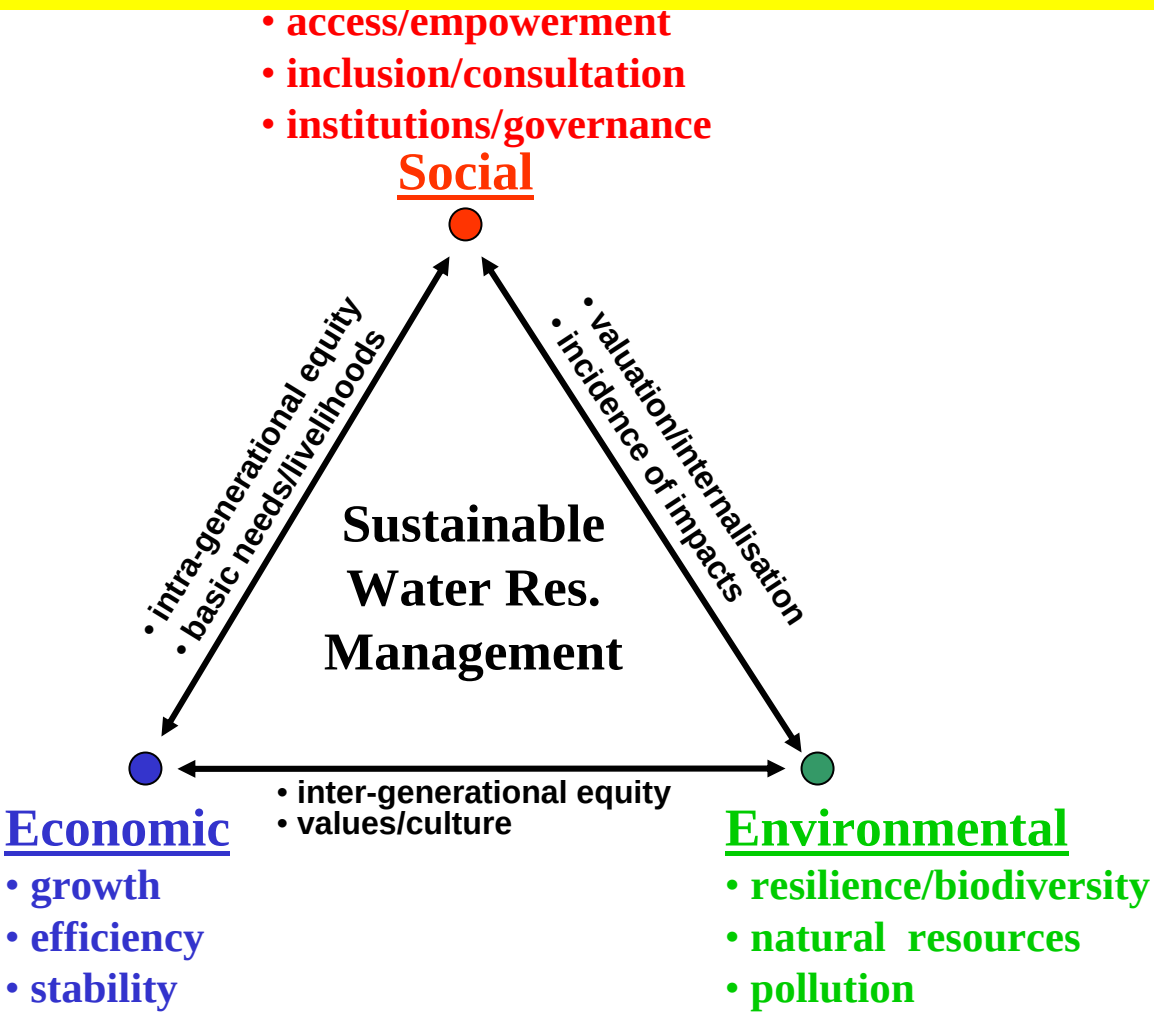



**Poverty, equity, basic water needs, affordability, social assessment, etc.**



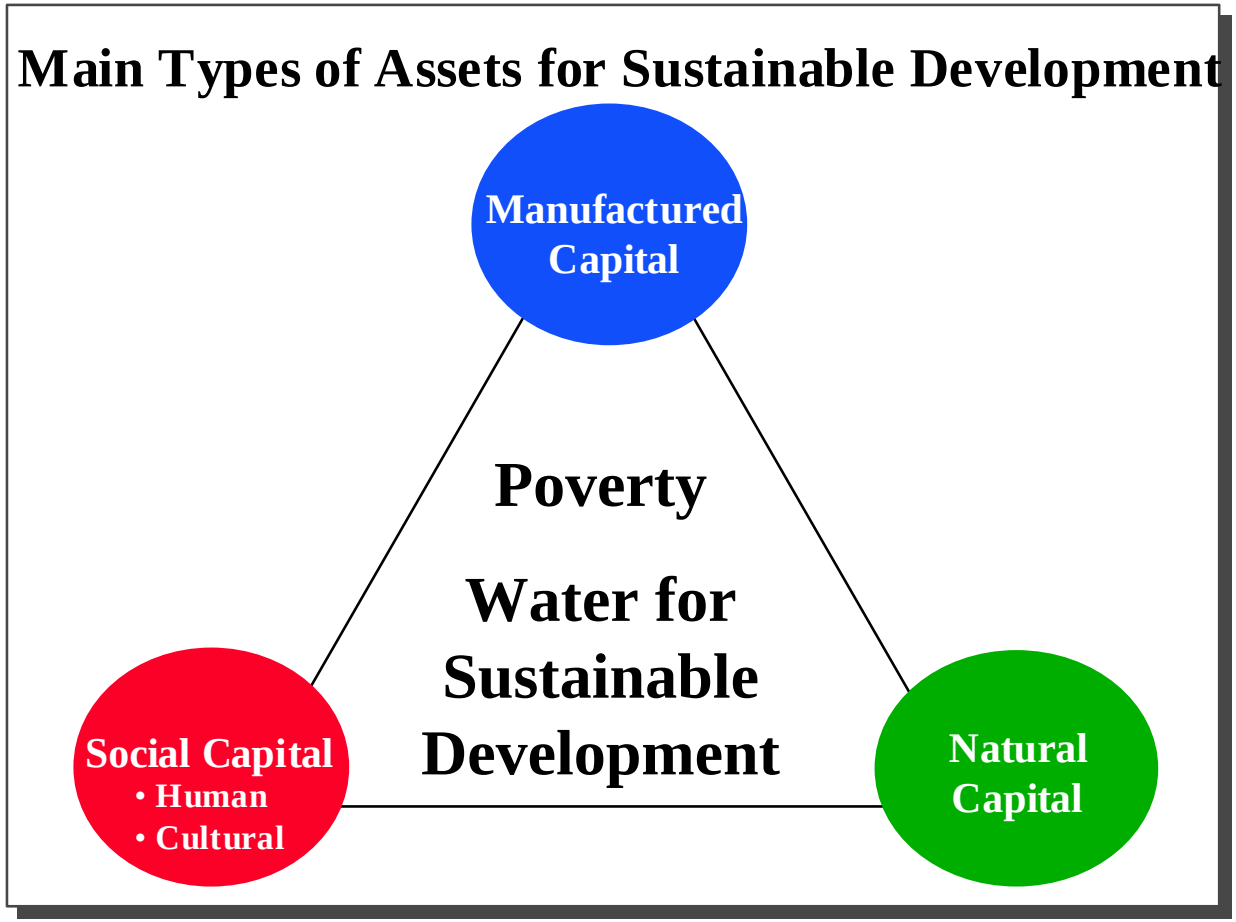

**Environmental assessment and valuation, extended CBA, multi-criteria analysis, integrated national water planning and pricing, multi-sector macro-models, etc.**

# SWARM framework: economy, environ., society




**Sustainable Development Triangle - key elements and interconnections (corners, sides and centre)**

**Source: Munasinghe [1992], Rio Earth Summit**




**Source:** Munasinghe (1992), Rio Earth Summit

# Social Capital: Ignored, Undervalued, Invisible

- **At individual level:** is built on personal networks that help us enormously in our private and professional lives.
- **At community and national levels:** is the invisible glue that binds society together.

# Social Capital – Civil Society is Main Source

## Examples of Civil Society Response: 2004 Tsunami - Sri Lanka versus 2005 Hurricane Katrina - New Orleans, USA

| Event | Deaths | GNP/capita |
|---|---|---|
| 2004 Tsunami – Sri Lanka | ~35,000 (1 in every 570 people) | ~ USD 1,000 |
| 2005 Hurricane Katrina - USA | ~1850 (1 in every 200,000 people) | ~ USD 35,000 |

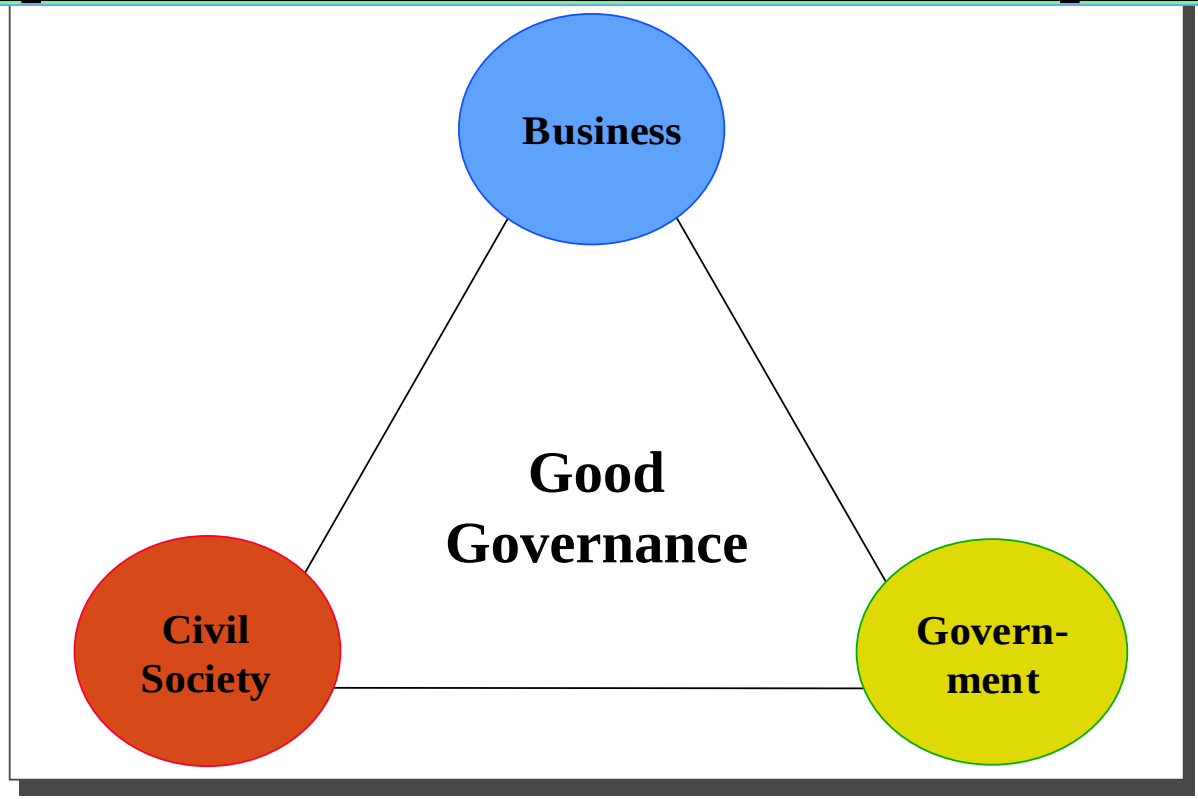
# Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

# Transcending Boundaries for Sustainable Development

- **Disciplinary**
- **Space**
- **Time**
- **Stakeholder**
- **Operational**

# Transcending Stakeholder Boundaries to Ensure Cooperation for Sustainable Development

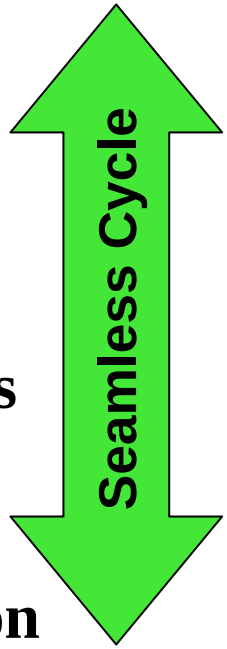



**Not only government, but also business and civil society have a vital and balanced role to play in strengthening local, national and global citizenship**

**Source:** Munasinghe (1992), Rio Earth Summit

# Transcending Operational Boundaries

| ACTION | ACTOR |
| --- | --- |
| Observations and Data | Observers |
| Concepts and Ideas | Thinkers & Philosophers |
| Models & Analyses | Scientists & Analysts |
| Interpretation of Results | Translators & Communicators |
| Plans & Policies | Decision Makers |
| Practical Implementation | Implementing Agents |




**Each stage of activity from observation to implementation should flow smoothly and not become compartmentalised**

Source: Munasinghe (2002), Int. J. of Sust. Dev.

# Core concepts and elements

1. Making development more sustainable (MDMS)
2. Sustainable development triangle
3. Transcending boundaries
4. Full cycle application of integrative tools – from data gathering to practical policy implementation

# Integrative analytical tools and practical applications (linking across global, national and local levels)

## Integrative Analytical Tools

1. Restructuring Growth to Make Development More Sustainable (MDMS)
2. Optimisation and Durability
3. SD Analysis (Macro Level)
4. Action Impact Matrix (AIM)
5. Green Accounting (SEEA-SNA)
6. Integrated Models (IAM, CGE, etc.)
7. SD Analysis (Micro Level)
8. Multi-Criteria Analysis (MCA), Cost-Benefit Analysis (CBA) and Economic Valuation
9. SD Indicators

## Application Levels

A. Global-transnational

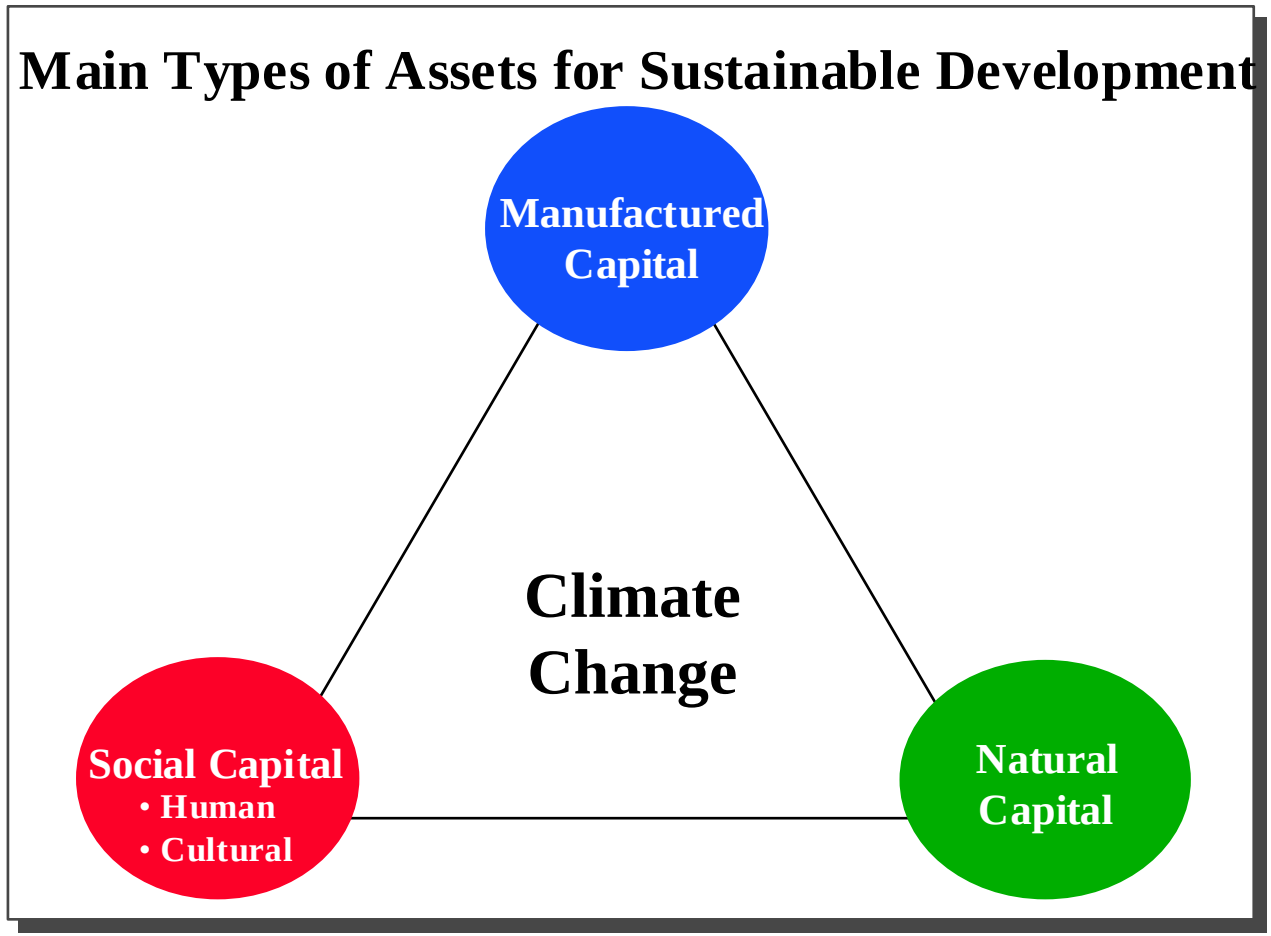
B. National-macroeconomic

C. Subnational-sectoral

D. Local-project

Linkages Across Levels

# Integrating across the three dimensions of SD




**Economic approach focuses on optimality - maximise growth**
**Environmental & social approaches use durability – overall system health**

# Integration via Sustainable Development Assessment (SDA)

(partial equilibrium analysis at sector/project level )

1. **Economic/Financial Assessment (CBA)**
2. **Environmental Assessment (EA)**
3. **Social Assessment (SA)**
4. **Poverty Assessment (PA)**
5. **Technical Assessment (TA)**

**Choice of appropriate SD indicators is vital for SD Assessment**

# SD Indicators

- Social
- Environmental
- Economic
- Institutional

**many indicators are available; thus choice is critical for specific task at hand**

# Growing Potential for Water conflicts

## ISSUES

- Freshwater is becoming scarcer in the 21st century
- Tension at national and local levels is an emerging trend
- Increasing concern over potential for conflicts
- Need more cooperation and wise resource management

## OPTIONS

- Move from competition & conflict to cooperation & sharing
- Reduce emphasis on arbitration of individual disputes
- Establish frameworks for sustainable water resources management

# SWARM Approach

**Water is a valuable resource that has economic, social and ecological value Holistic integration is needed of these three dimensions within the SD triangle**

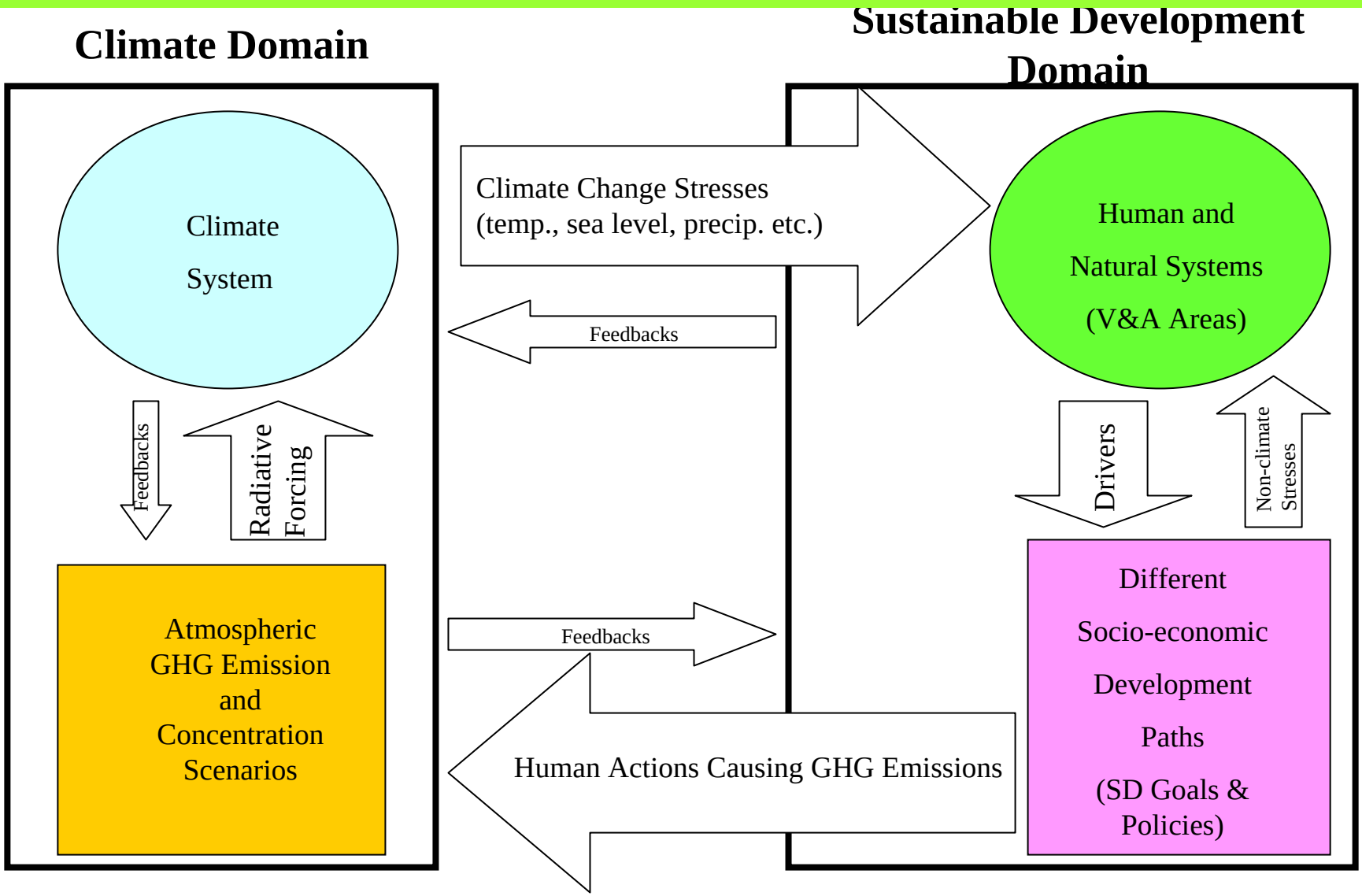
**Water institutions need to manage and develop water resources based on inclusive and participatory methods**

# Need for Better Cooperation and Partnerships

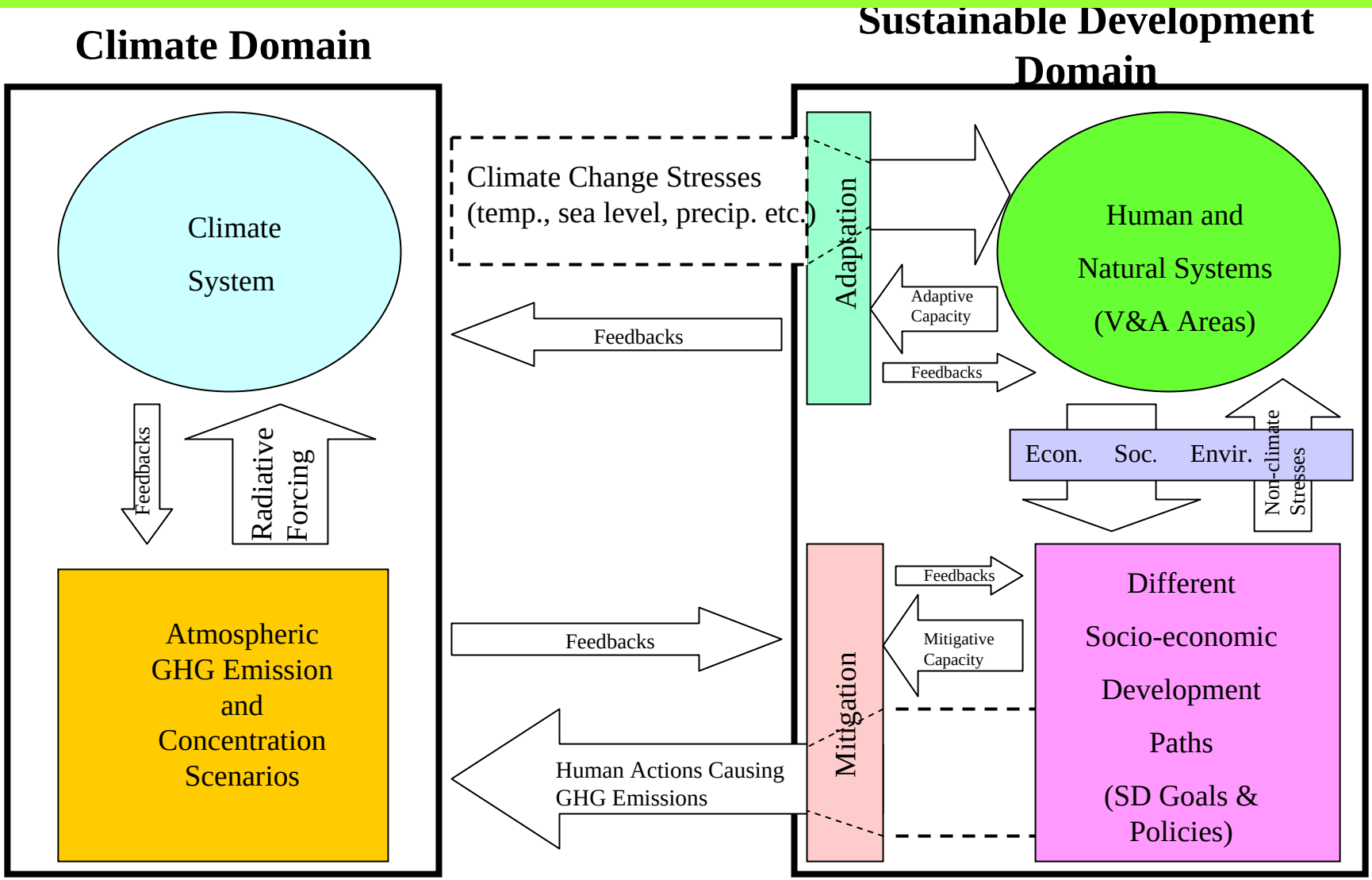
- International
- Regional
- National
- Local
- Community

# Tracing the Links Between Water, Climate Change and Sustainable Development

# Global Level CC-SD Links 1



# Global Level CC-SD Links 2



# MOST DESIRABLE:

## CC Policies that Harmonise Both Adaptation and Mitigation (Win-Win) and also Make Development More Sustainable (MDMS)

**Examples: growing forests, saving water**

## Many trade-offs also arise and need to be reconciled

**There are many practical analytical tools and policy options to integrate water, SD and CC responses (from global to local levels)**

**There are many available case studies and best practice examples involving sustainomics applications**

# Practical Applications of Sustainomics Framework to Identify Sustainable Water Options

## Global, National and Project Level Examples

# Sustainomics
# Global Level Application

# Making Development More Sustainable via "Tunneling": A Potential Post-Kyoto Framework for Jointly Managing Climate Risk & Right to Develop

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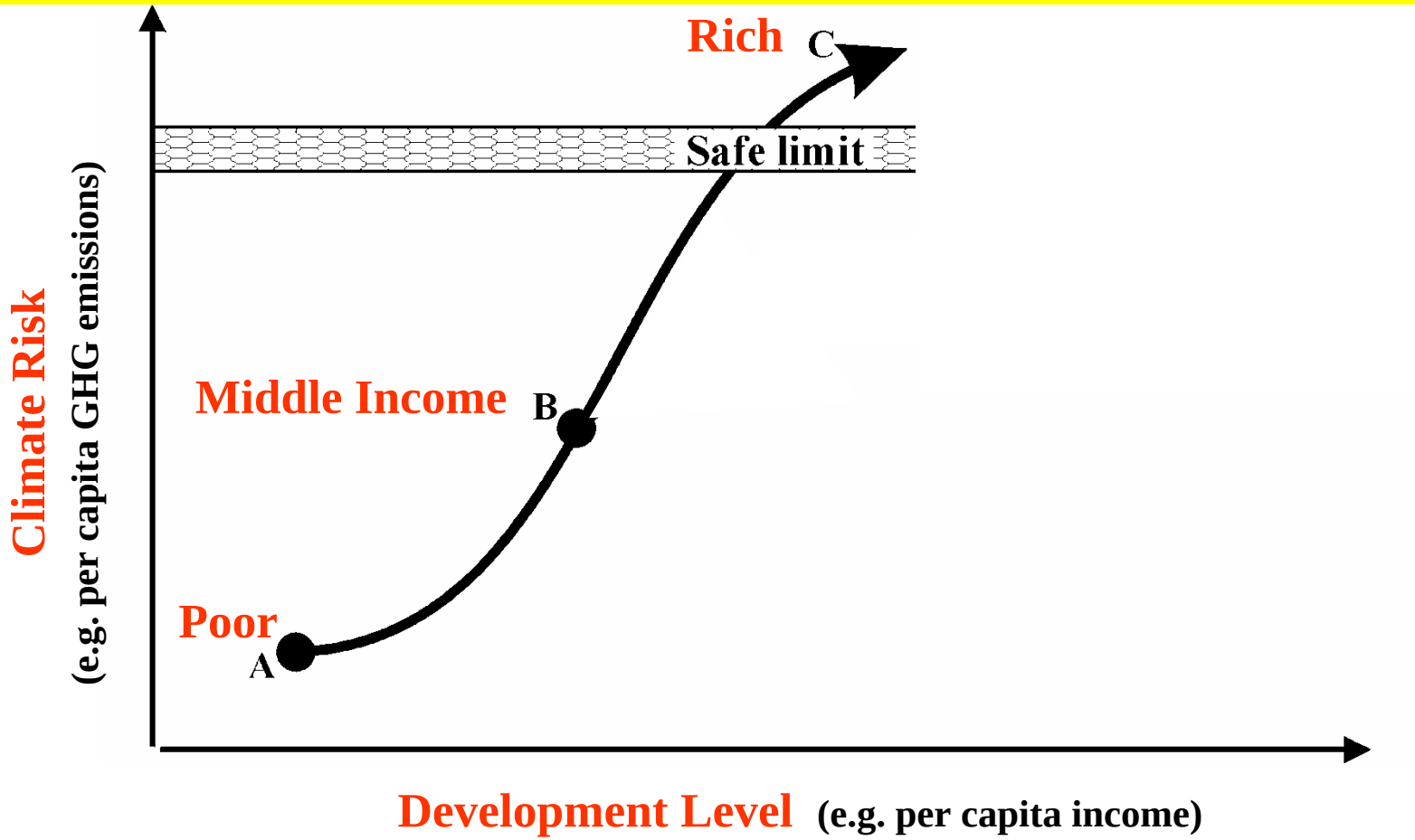
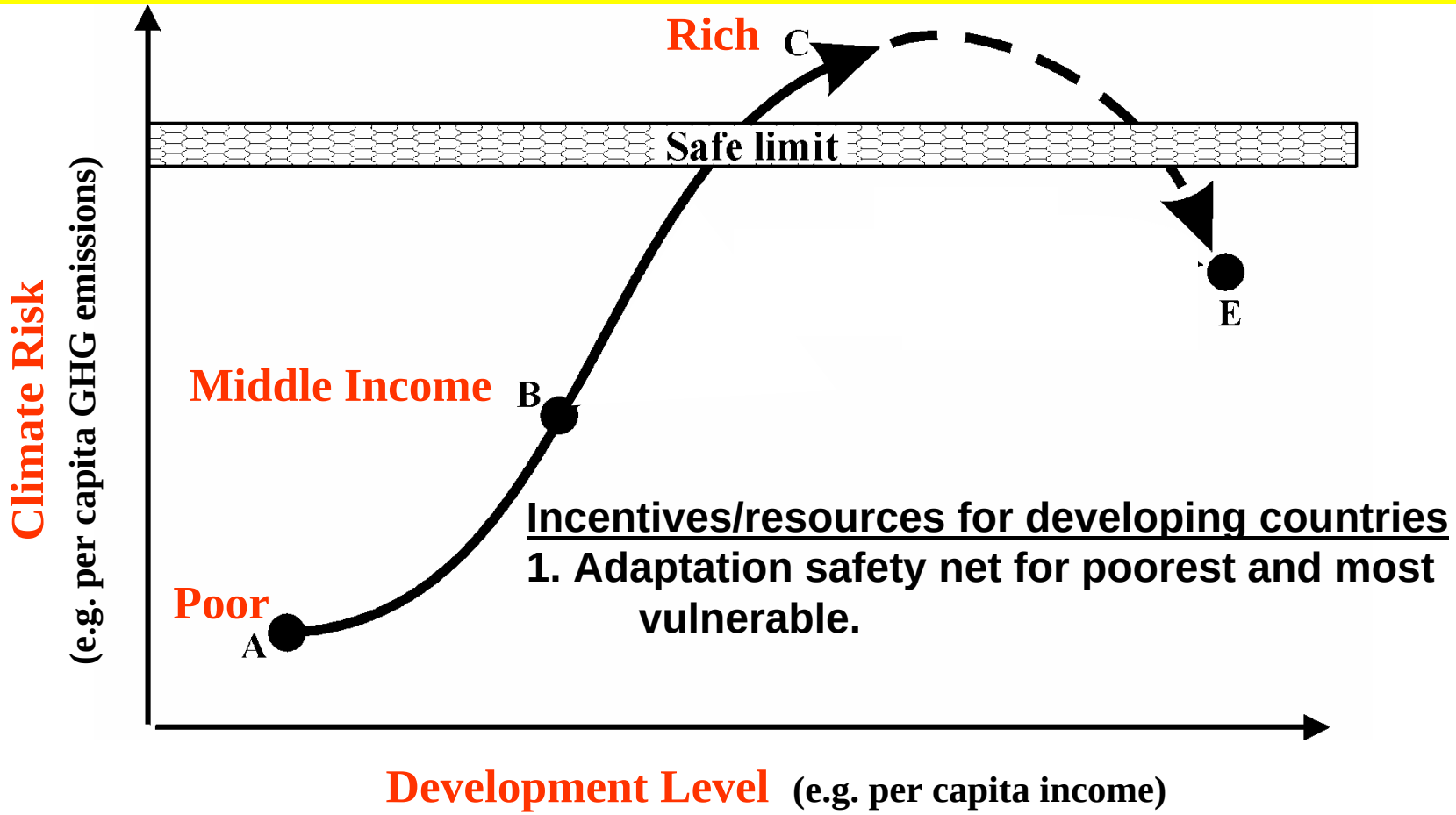
# MDMS via "Tunneling": global cooperation to manage Climate Risk & Right to Develop - Step 1



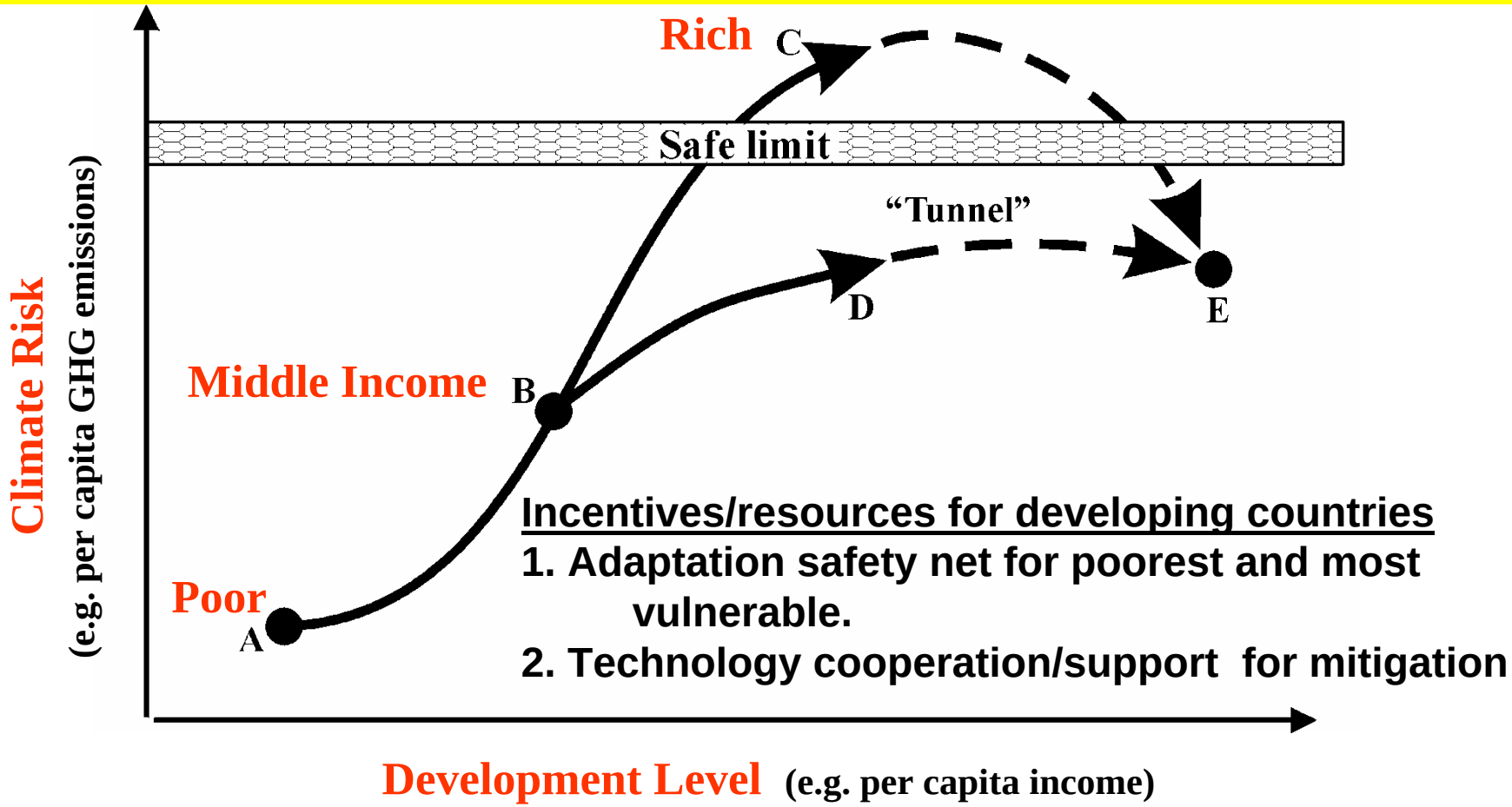

*Source*: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*, 15:121-4.

# MDMS via "Tunneling": global cooperation to manage Climate Risk & Right to Develop - Step 2




*Source*: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*, 15:121-4.

# MDMS via "Tunneling": global cooperation to manage Climate Risk & Right to Develop - Step 3



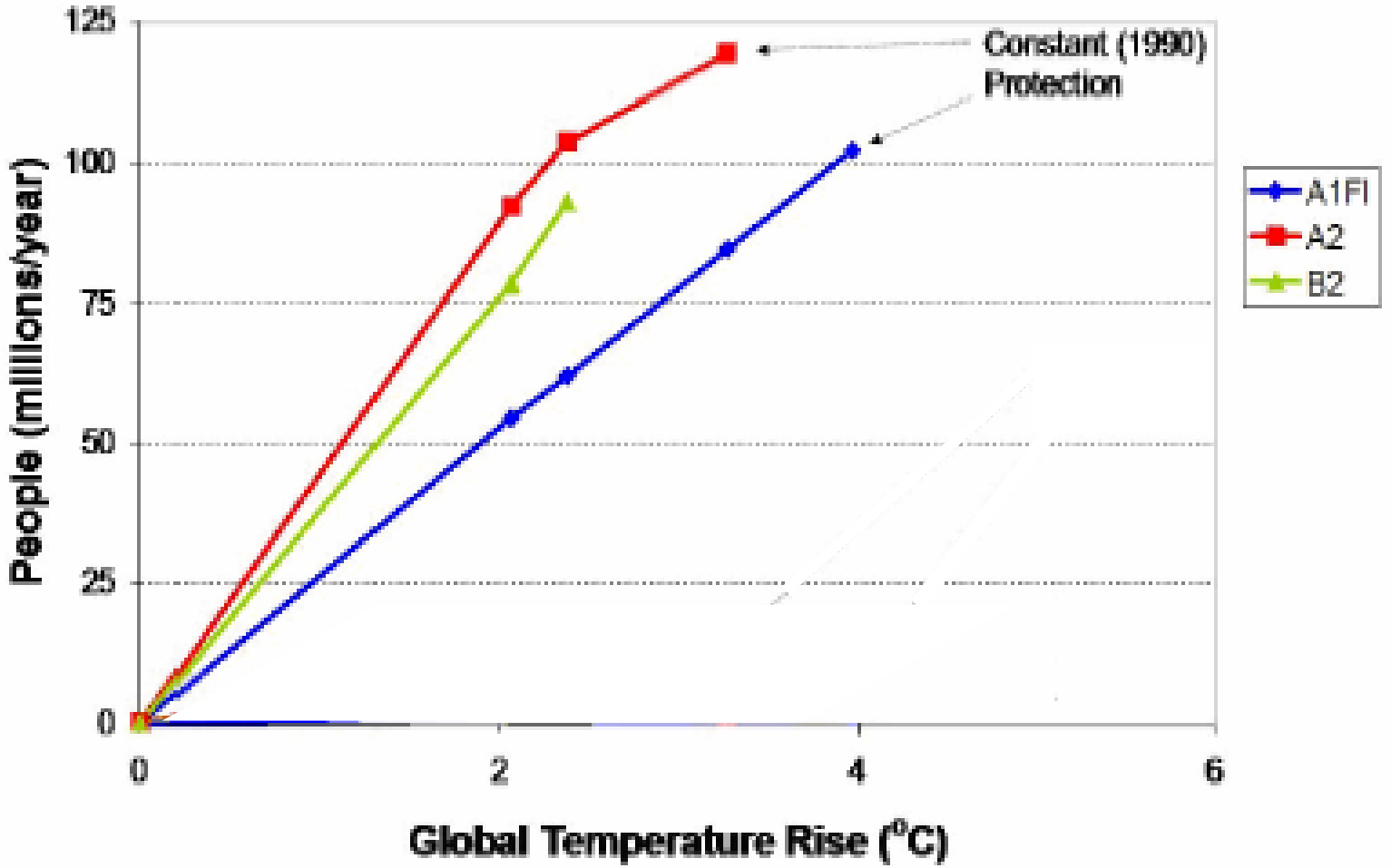

*Source*: M. Munasinghe (1995) "Making Growth More Sustainable," *Ecological Economics*, 15:121-4.

# Adaptation and Vulnerability Reduction

## Advantages of Early Action

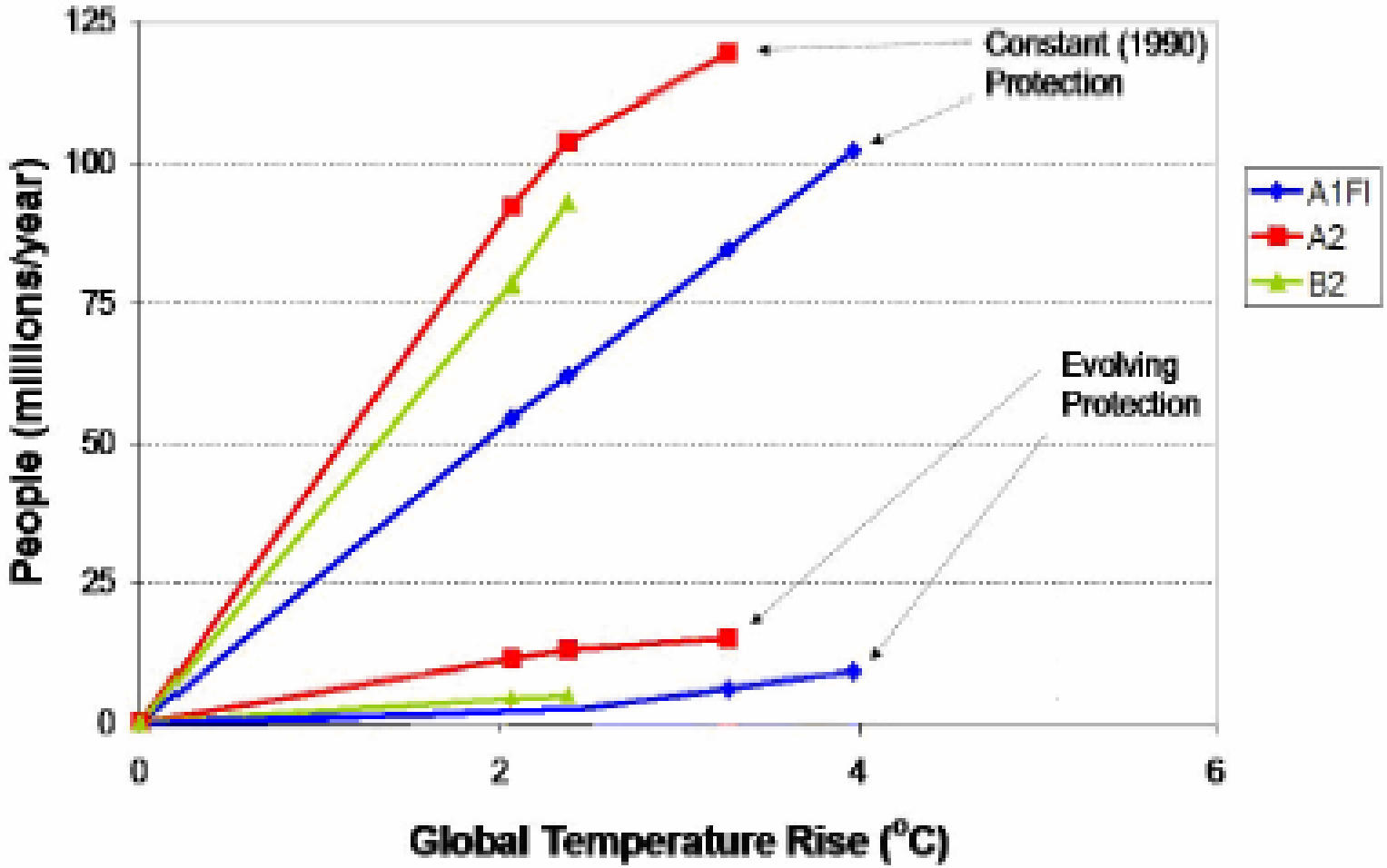
# Adaptation Example: People flooded in coastal areas 2080

**Constant protection = spending maintained at 1990 levels.**



# Adaptation Example: People flooded in coastal areas 2080

**Constant protection = spending maintained at 1990 levels.**
**Evolving protection = spending increases at same rate as GDP.**

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# National Level Application

# Integrating CC Policies into National Water Sector and SD Strategy

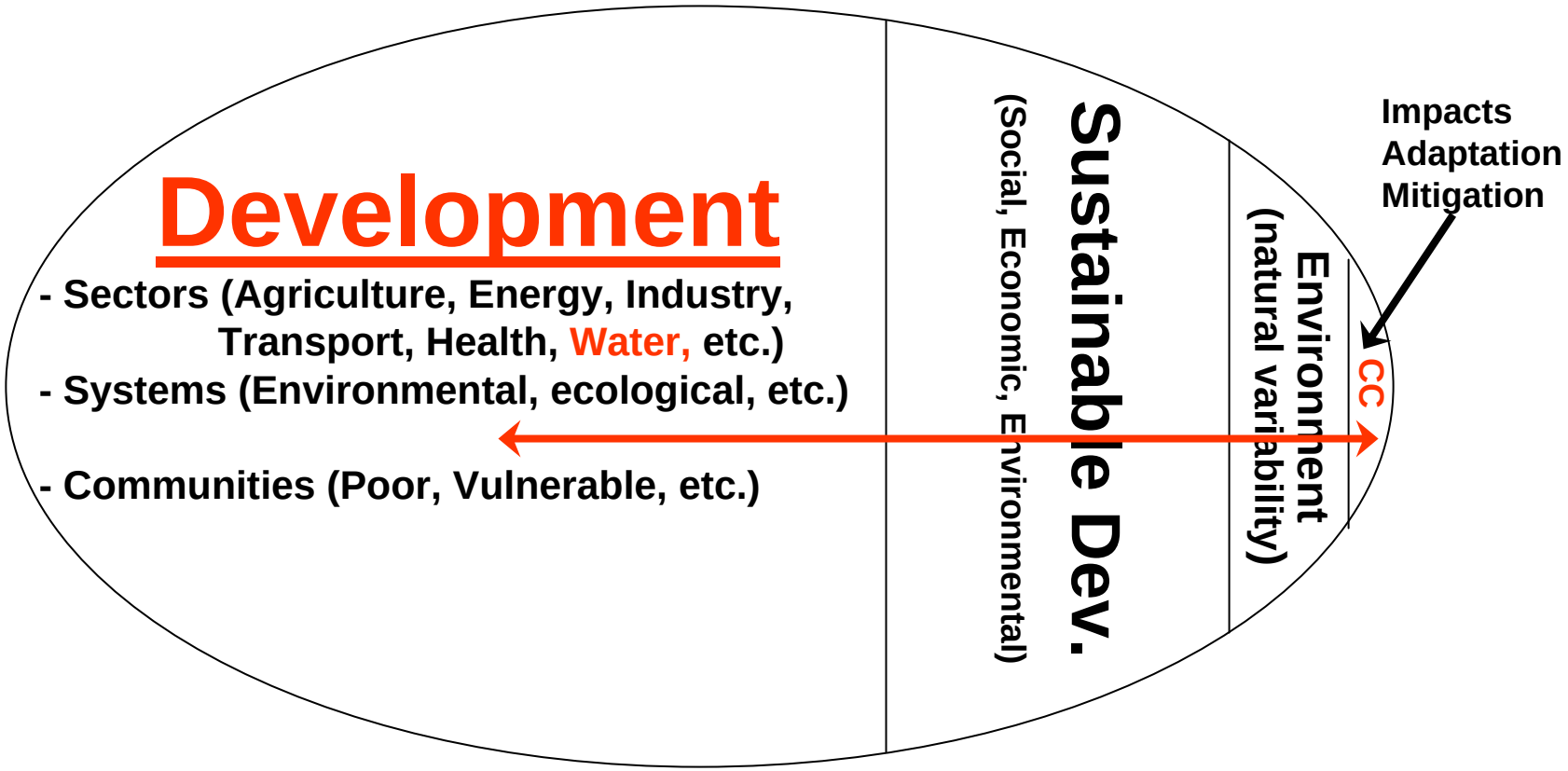
# Developing Country Example:

# Typical Response Options for a National Climate Change Strategy

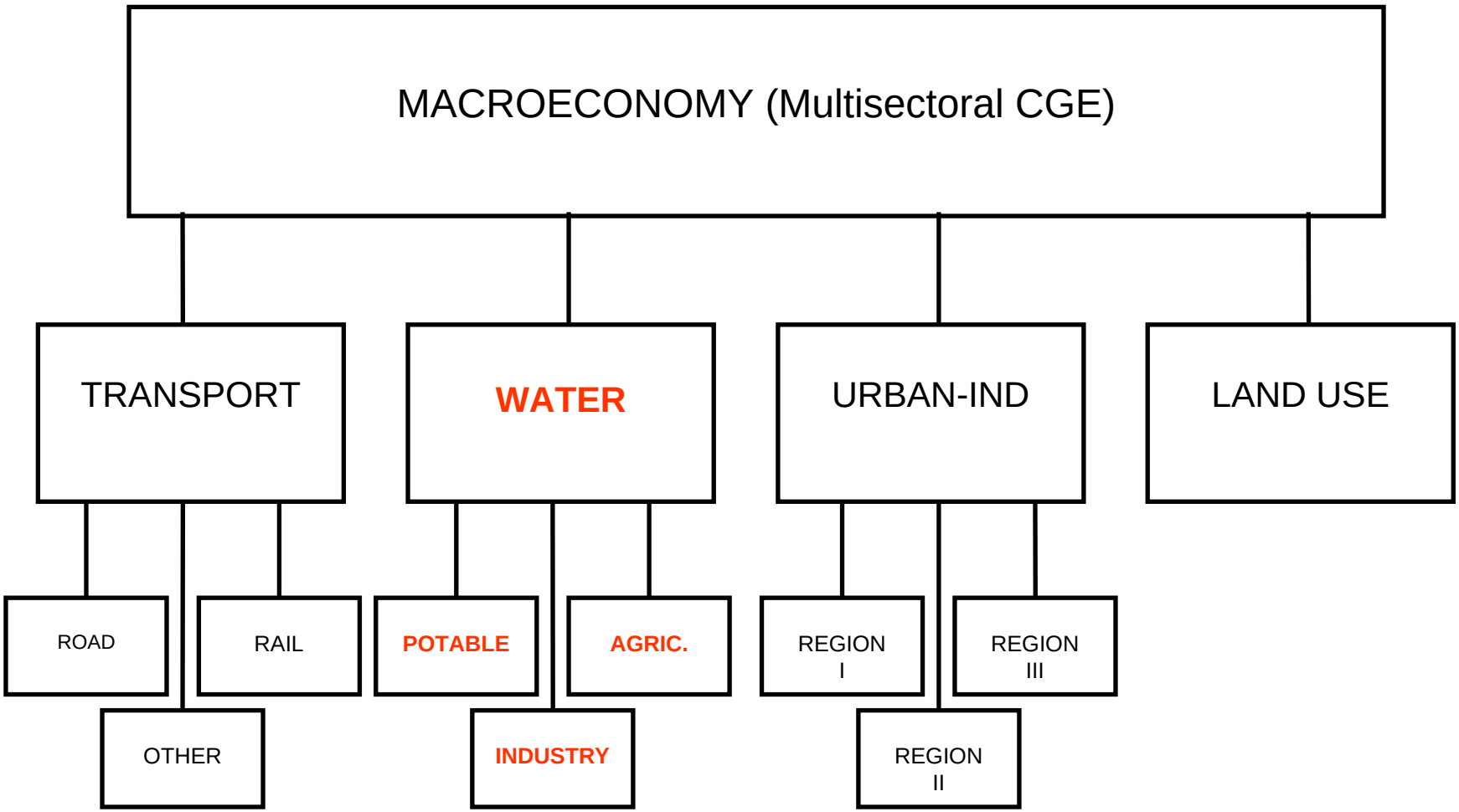
1. Grow Fast (reduce vulnerability to CC)
2. Improve adaptive capacity (reduce impacts)
3. Mitigate (compensation needed to offset costs)
4. Integrate CC-SD strategy by combining 1,2 & 3

# Integrating CC Policies into National SED Strategy

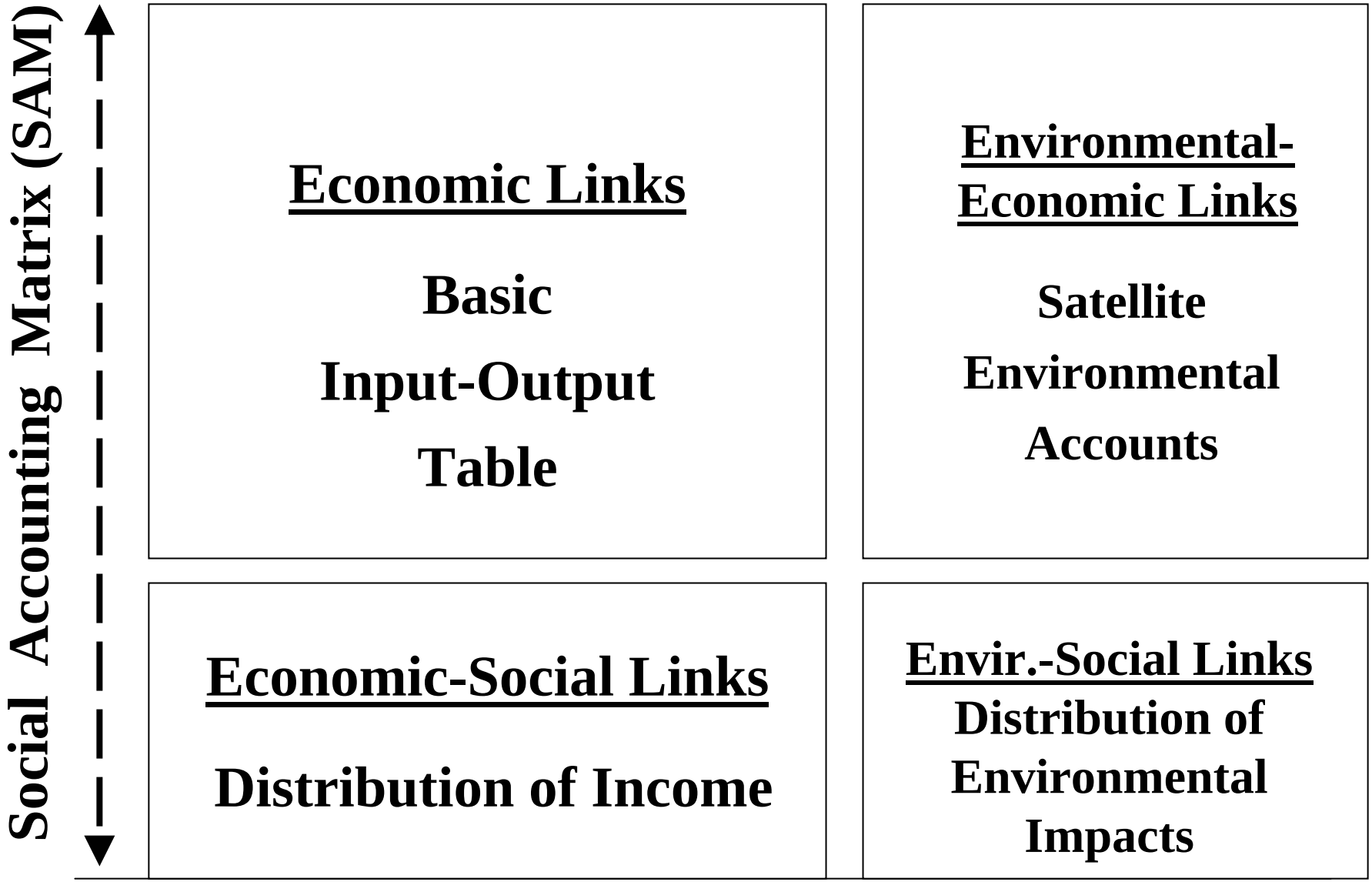
## Make decision makers see climate change as a key element of the national sustainable development strategy



# Sri Lanka Integrated SWARM Model Structure



# Expanded National Income Accounts for SD




**Source:** Munasinghe (2001), Macroeconomics and Environment

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# Water Pricing Incorporating Economic, Social and Environmental Concerns

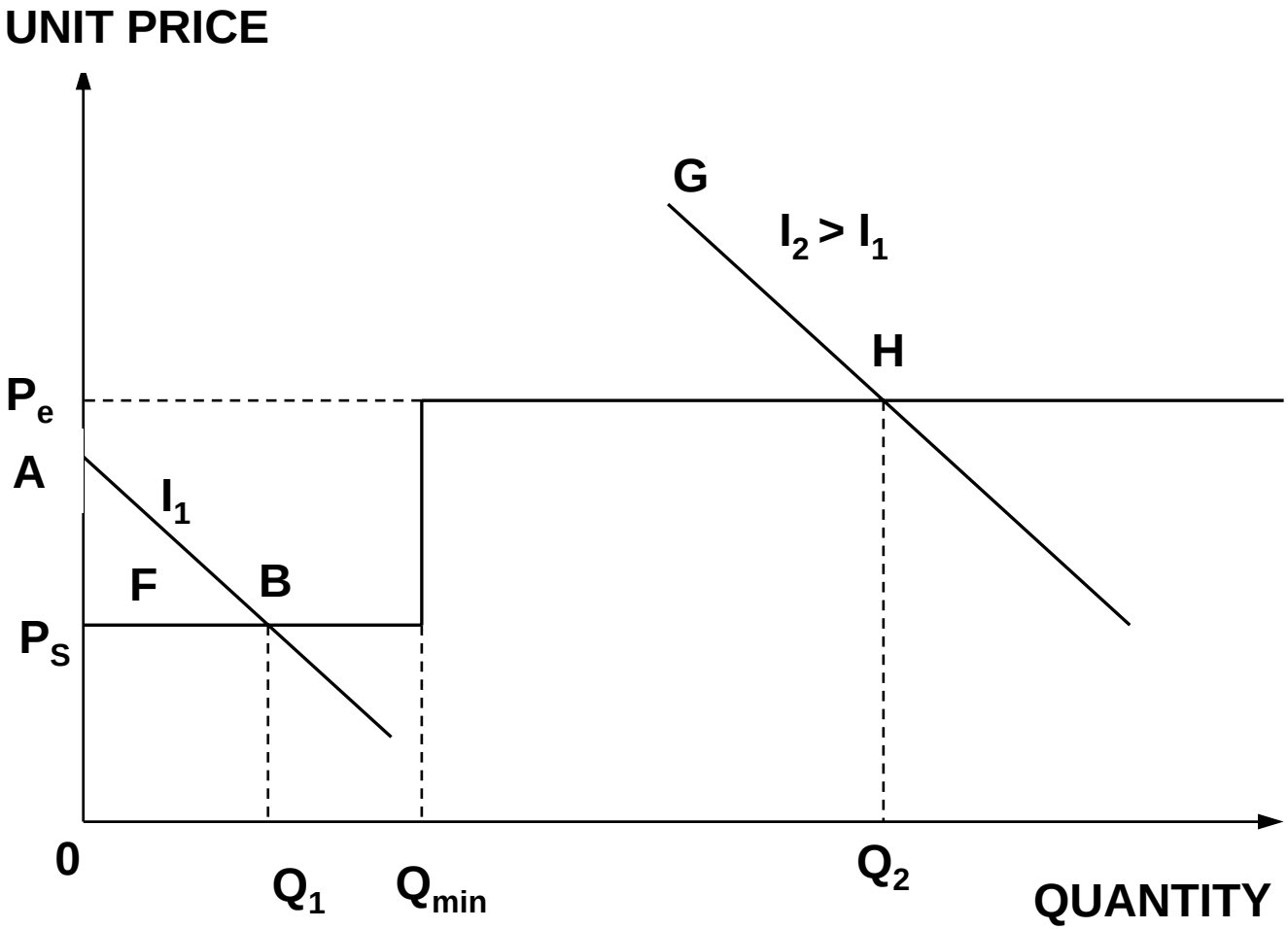
# Sustainable Water Pricing: incorporates Economic, Environmental and Social Goals

1. **Economic efficiency: prices based on long-run marginal cost to reflect scarcity**
   **e.g., rising water supply, high opportunity costs etc.**

2. **Environmental protection: prices incorporate (internalise) externalities**
   **e.g., add pollution taxes, wastewater disposal costs etc.**

3. **Social equity: subsidised prices to meet basic water needs of the poor**
   **e.g., reduced or lifeline prices for minimum use by poor**

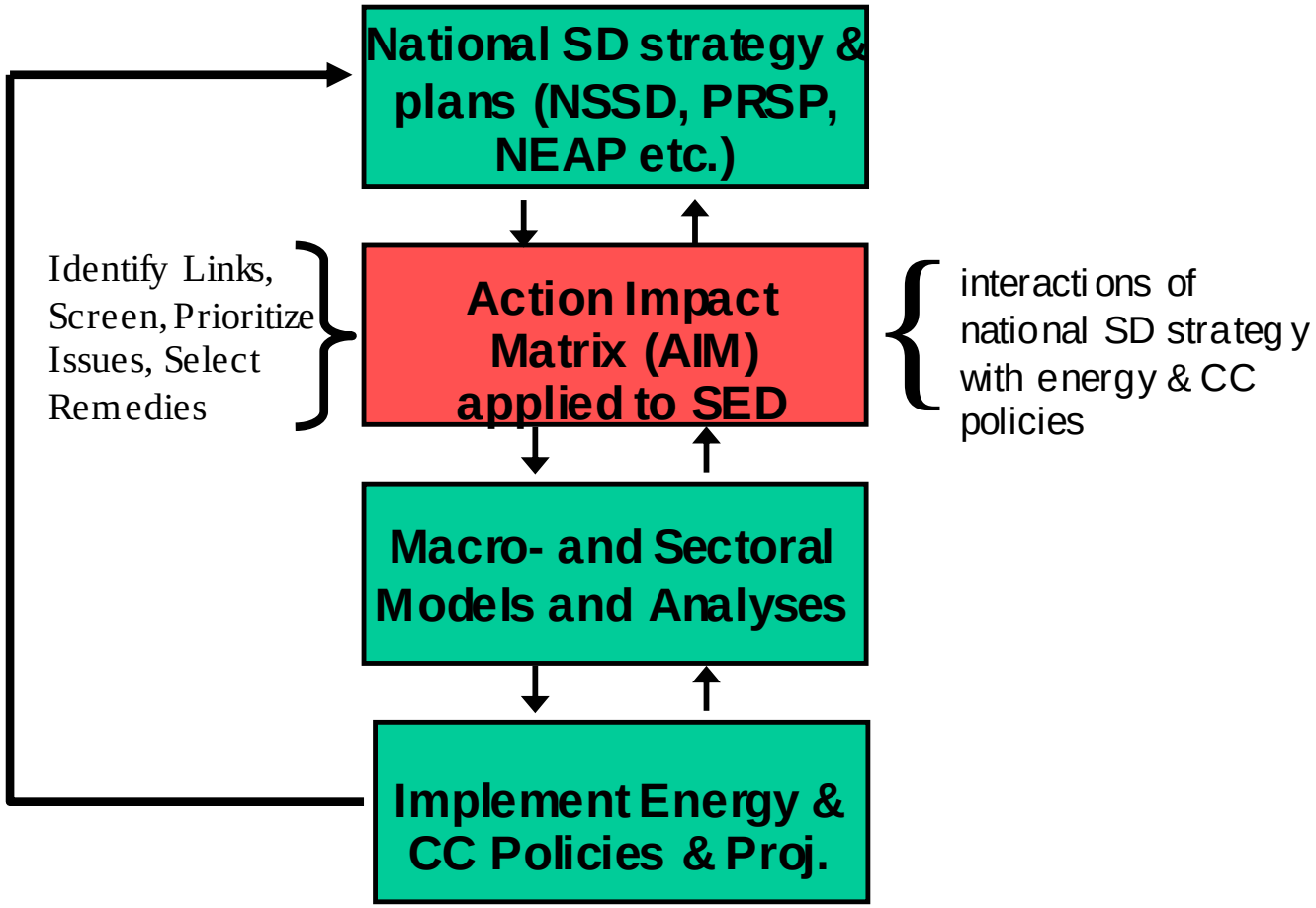
# Introducing Social Concerns – Pricing Water to Meet Basic Needs



# Application of Action Impact Matrix (AIM) Methodology to Analyse SD-CC Links in Sri Lanka

## Brief Introduction

# Analysing SD-CC Links using the Action Impact Matrix (AIM)



# Action Impact Matrix (AIM) Methodology

**The AIM methodology may be used to better understand interactions among three key elements, at the country-specific level:**

**(a) national development policies and goals;**

**(b) key SD issues and indicators; and**

**(c) climate change adaptation (and mitigation).**

**First, the two-way linkages between elements (a) and (b) are explored, in the context of natural climate variability. Then, we impose the additional impacts of element (c) on the interactions between elements (a) and (b).**

**The AIM approach analyses key economic-environmental-social interactions to identify potential barriers to making development more sustainable (MDMS) - including climate change. It also helps to determine the priority macro policies and strategies in economic, environmental and social spheres, that facilitate implementation of climate change adaptation and mitigation to overcome the effects of climate change.**

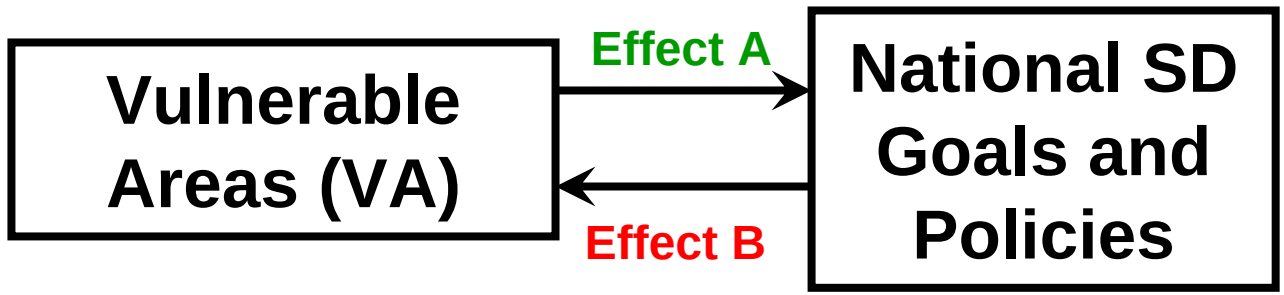
**Thus, the AIM helps to integrate CC within SD. It has been used since the early 1990s to link macroeconomic policies and environment.**

# AIM Process

**The AIM methodology relies on a fully participative stakeholder exercise to generate the AIM itself. Up to 50 experts are drawn from government, academia, civil society and the private sector, who represent various disciplines and sectors relevant to both sustainable development and climate change. In the initial exercise, they usually interact intensively over a period of about two days, to build a preliminary AIM. This participative process is as important as the product (i.e., the AIM), since important synergies and cooperative team-building activities emerge. The collaboration helps participants to better understand opposing viewpoints, resolves conflicts, and ultimately facilitates implementation of agreed policy remedies. On subsequent occasions, the updating or fine-tuning of the initial AIM can be done within a few hours by the same group, since they are already conversant with the methodology.**

# Integrating Adaptation into SD Strategy using the AIM

# Action Impact Matrix (AIM) for Analyzing SD-CC Adaptation Links: 1



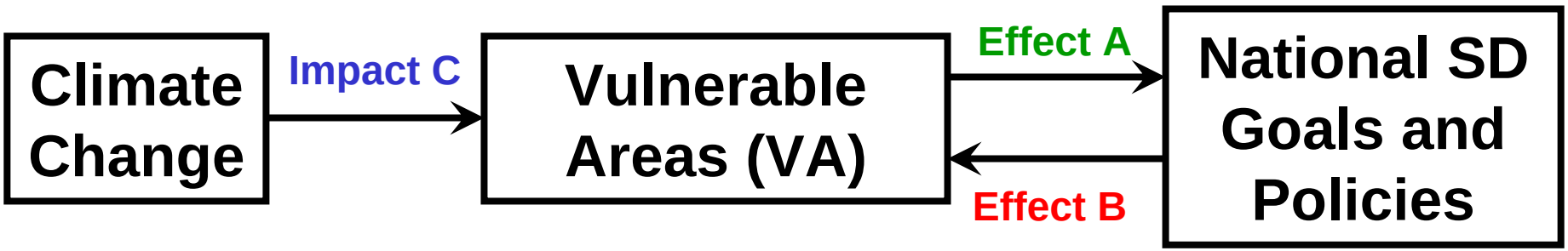

**Step 1: DEV-AIM = Effect B**

**(Development Effects on VA)**

**Step 1: VED-AIM = Effect A**

**(VA Effects on Development)**

# Action Impact Matrix (AIM) for Analyzing SD-CC Adaptation Links: 2




**Step 2: DEV-AIM = Effect B + Impact C**

**(Development Effects on VA)**

**Step 2: VED-AIM = Effect A + Impact C**

**(VA Effects on Development)**

# Building the AIM – Step 1: Identify Rows and Columns

**Row Headings:** key national macro-economic goals and policies.

**Column Headings:** key vulnerable areas (VA), and associated economic, environmental and social indicators.

| | | Vulnerable Areas (VA) | | | |
|---|---|---|---|---|---|
| | | Economic | | Environmental | Social |
| | | (1) Agricultural output | (2) Industrial Activity | (3) Water Resources | (4) Health |
| Dev. Goals/Policies | | | | | |
| (A) | Growth | | | | |
| (B) | Poverty alleviation | | | | |
| (C) | Food Security | | | | |
| (D) | Employment | | | | |

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# Adaptation Effects on Development (VED-AIM) in Sri Lanka – CC Impacts and Effects of VA on Development Goals/Policies

## Key Vulnerabilities, Impacts and Adaptation (VIA)

**Notation**
+ Beneficial
- Harmful
3 High
2 Moderate
1 Low

| | | (1) Agric. Output | (2) Hydro Power | (3) Defore station | (4) Bio-div. (flora & fauna) | (5) Wet-lands & coastl ecosy stems | (6) Water resour ces | (7) Poor comm unities | (8) Human health | (9) Infra-struct. | (10) Indust ries & Tour-ism |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (S0) | Status (Nat. Variability) | -1 | 0 | -2 | -1 | -1 | -2 | -1 | 0 | 2 | 2 |
| (S1) | Status (+CC Impacts =>) | -2 | -1 | -2 | -2 | -2 | -3 | -2 | -1 | -1 | -1 |
| **Dev. Goals/Policies (+CC Impacts)** | | | | | | | | | | | |
| (A) | Growth | -1 | -1 | -1 | -1 | -1 | -2 | -2 | -1 | -1 | -1 |
| (B) | Poverty alleviation | -2 | 0 | -1 | -1 | -1 | -2 | -2 | -2 | -1 | -1 |
| (C) | Food Security | **-3** | 0 | -1 | -1 | -1 | **-3** | -1 | -1 | 0 | 0 |
| (D) | Employment | -1 | 0 | -1 | 0 | -1 | -2 | -1 | -2 | -1 | -2 |
| (E) | Trade & Globalisation | -2 | -1 | 0 | 0 | 0 | -1 | -1 | 0 | -2 | -1 |
| (F) | Budget Deficit Reduction | -1 | -1 | 0 | 0 | 0 | 0 | 0 | -2 | 0 | -1 |
| (G) | Privatisation | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | -1 | -1 |

# VED-AIM Example: Priorities for Policy Analysis

## The -3 values in cells C1 & C6: Agriculture, Water Resources –> Food Security

**Priority area for further detailed research and modeling. For example, a specific model may be used to study the effects of climate change induced rainfall variations (as well as temperature rise and possible carbon fertilisation) on the most important types of crops (for a study using Ricardian agricultural modelling, see Seo, Mendelsohn and Munasinghe, 2005). Specific policy options could be simulated – e.g., measures to protect against floods and droughts, more efficient use of water in agriculture, use of drought resistant crops, etc.**

# Detailed description of impacts of climate change on food security via agriculture and water resources

## Background

**Global warming will lead to temperature increases and alterations in the hydrological cycle through increases in surface temperature and rates of evaporation, and in some regions, increases in precipitation. Changes in the total amount of precipitation and its frequency and intensity directly affect the magnitude and timing of run-off and the intensity of floods and droughts. Such changes will have significant impacts on agriculture and water resources.**

## Rainfall

**Dharmasena (2004), Bandara and Wickramagamage (2004)**

## Temperature

**Zubair et al. (2004), Bandara & Wickramagamage, 2004.**

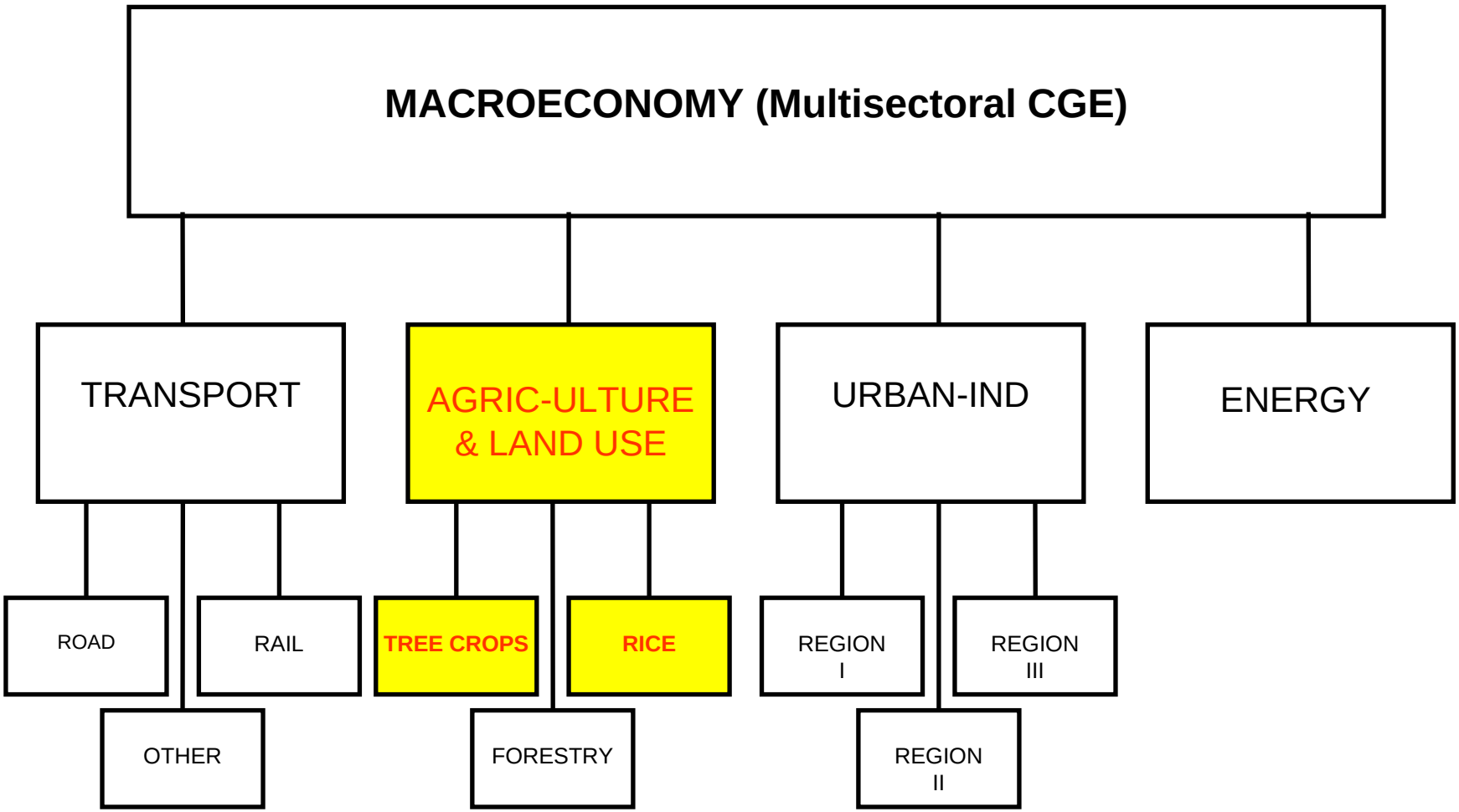
## Asian Brown Cloud (ABC)

**Swain and Herath (2004), Herath et al, (2004), Pathirana and Herath (2004)**

# Integration via SD Analysis at the Macroeconomic/Sectoral Level (general equilibrium analysis)

1. Macroeconomic/Sectoral Modeling
2. Environmental and Macroeconomic Analysis
3. Poverty/Income Distributional Analysis

# Multi-sector Computable General Equilibrium Model



# AIM Detailed Follow-up Study: Sector Example

# Analysing Water and Climate Change Impacts on Agriculture in Sri Lanka

**Source: M. Munasinghe and S. Perera (2006)**

# Downscaled GCM Results: Range of Climate Change Predictions for Sri Lanka in 2050

| Global Scenario | Period | Rainfall | Temperature |
|---|---|---|---|
| B1 | NEM | Increase by 50 mm over the baseline | Max. temperature: increase by $0.8^0$ C<br>Min. temperature : increase by $1.0^0$ C |
| B1 | SWM | Increase by 350 mm over the baseline, especially over the Western slopes of the central hills | Max. temperature: increase by $0.8^0$ C<br>Min. temperature : increase by $0.8^0$ C |
| A1F1 | NEM | Increase by 70 mm over the baseline, especially over the Eastern slopes of the central hills | Max. temperature: increase by $1.1^0$ C<br>Min. temperature : increase by $1.4^0$ C |
| A1F1 | SWM | Increase by 520 mm over the baseline, especially over the Western slopes of the central hills | Max. temperature: increase by $1.1^0$ C<br>Min. temperature : increase by $1.2^0$ C |

# Sri Lanka - National level impact on Agric. Revenue in 2050 – temp/rain & equity

## (A1F1 scenario based projection)

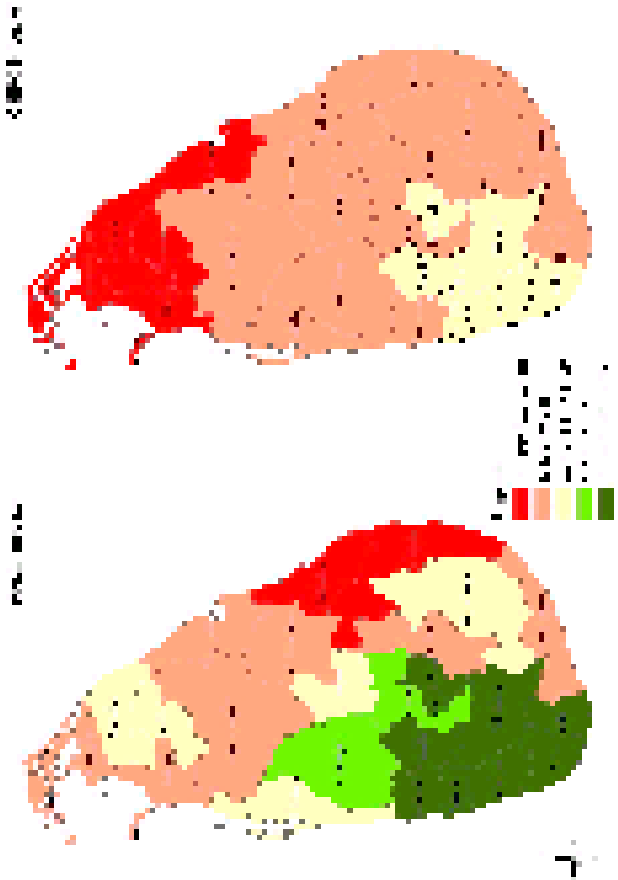
| Crop | Temperature Effect | Rainfall Effect | Temp. Plus Rainfall Effect |
|---|---|---|---|
| Paddy (Rice) (dry zone – poorer) | -3.5% | -7.8% | -11.4% |
| Plantation Crops (wet zone – richer) | +1.5% | +2.0% | +3.5% |

# Impact on Sri Lanka national economy in 2050* - GDP effect small BUT equity effect larger

| Crop | Change of Total GDP in 2050 (%) | Change Agriculture GDP in 2050 (%) |
|---|---|---|
| Rice (dry zone – poorer) | -0.36 | -2.46 |
| Plantation Crops (wet zone – richer) | +0.10 | +0.70 |
| Rice + Plantation Crops | **-0.26** | - 1.76 |

*Note: Assuming the same economic structure in 2050

# Sri Lanka Impacts: HAD3 and CSIRO models



# Some Key Policy Implications

1. Moderate overall impact on agricultural output and national economy, but some effects will emerge within next two decades
2. Significant potential risk to food security (rice)
3. High poverty impact on small farmers
4. Equity impact (small rice farms versus large tree crop plantations)
5. Demographic impact (potential migration from dry to wet zone)

# River Basin Management

# Example from Europe

# Matching environmental quality and financial resources

- Germany's Ruhr basin (80 years)
- French river basin financing agencies (30 years)
- Now being adapted in other countries (Brazil, Poland, and Spain)

# Key features of Ruhr-French institutional systems

- Participation (water parliamentarians decide balance between costs & benefits)
- Subsidiarity (never do at a higher level what can be done effectively at lower level)
- Technical efficiency (technical agency advised parliamentarians how best to spend resources)

# Key features of Ruhr-French typical instruments and use of revenues

- Instruments (maximum use of market based instruments, “user pays, polluter pays” principle)

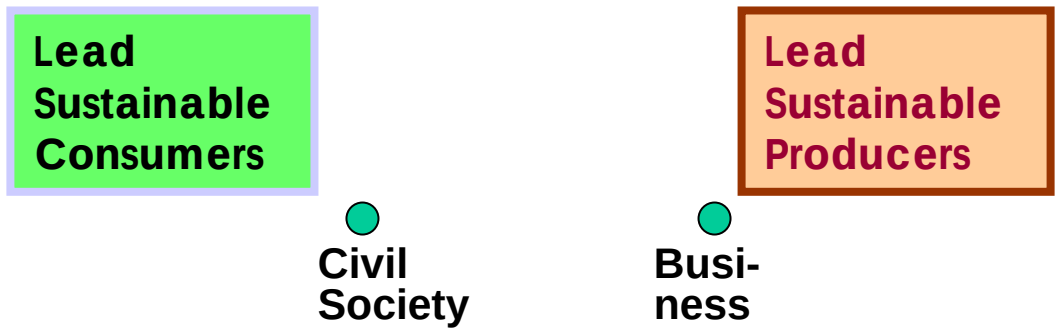
- Revenues (used to finance municipal wastewater treatment facilities among other things)

# Community Level Application

# Making Development More Sustainable: Linking Sustainable Water Service Producers and Consumers

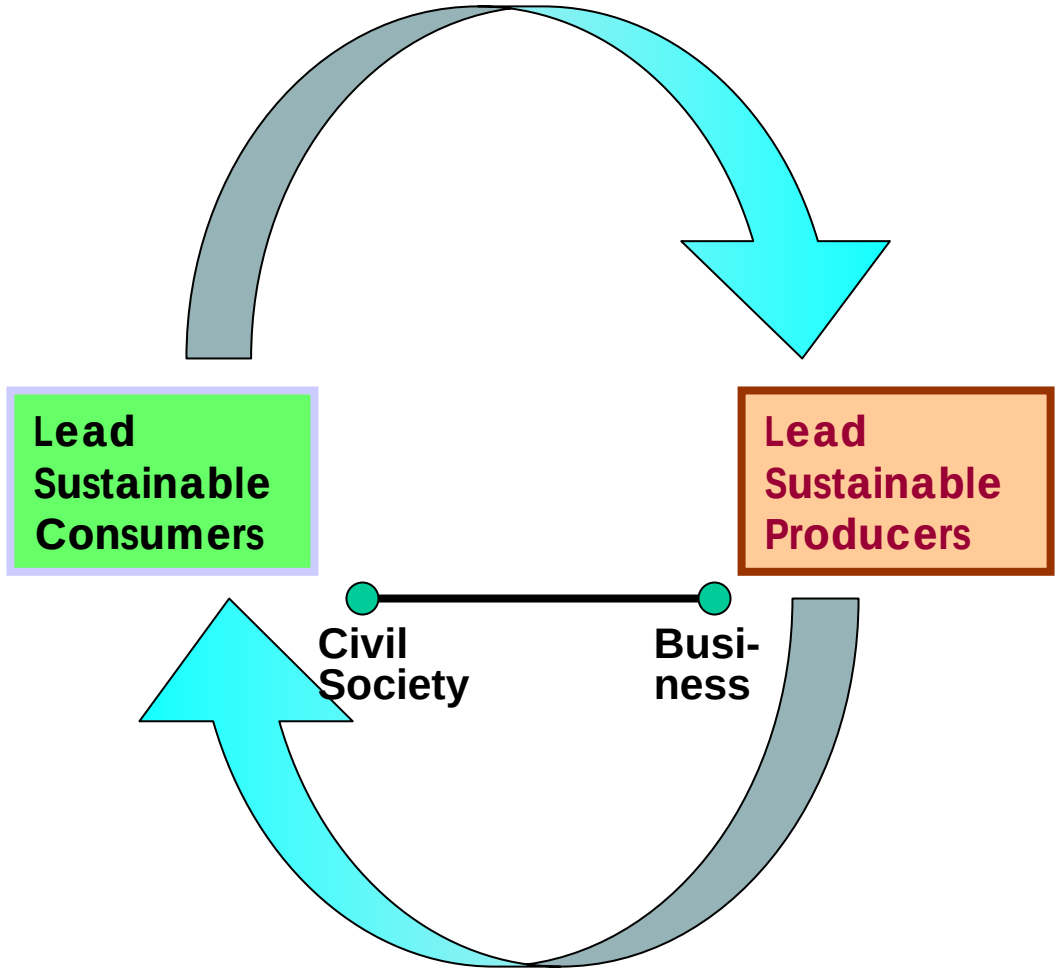
# Water Services: Sustainable Consumption & Production 1

## Virtuous Cycle for Making Development More Sustainable (MDMS)



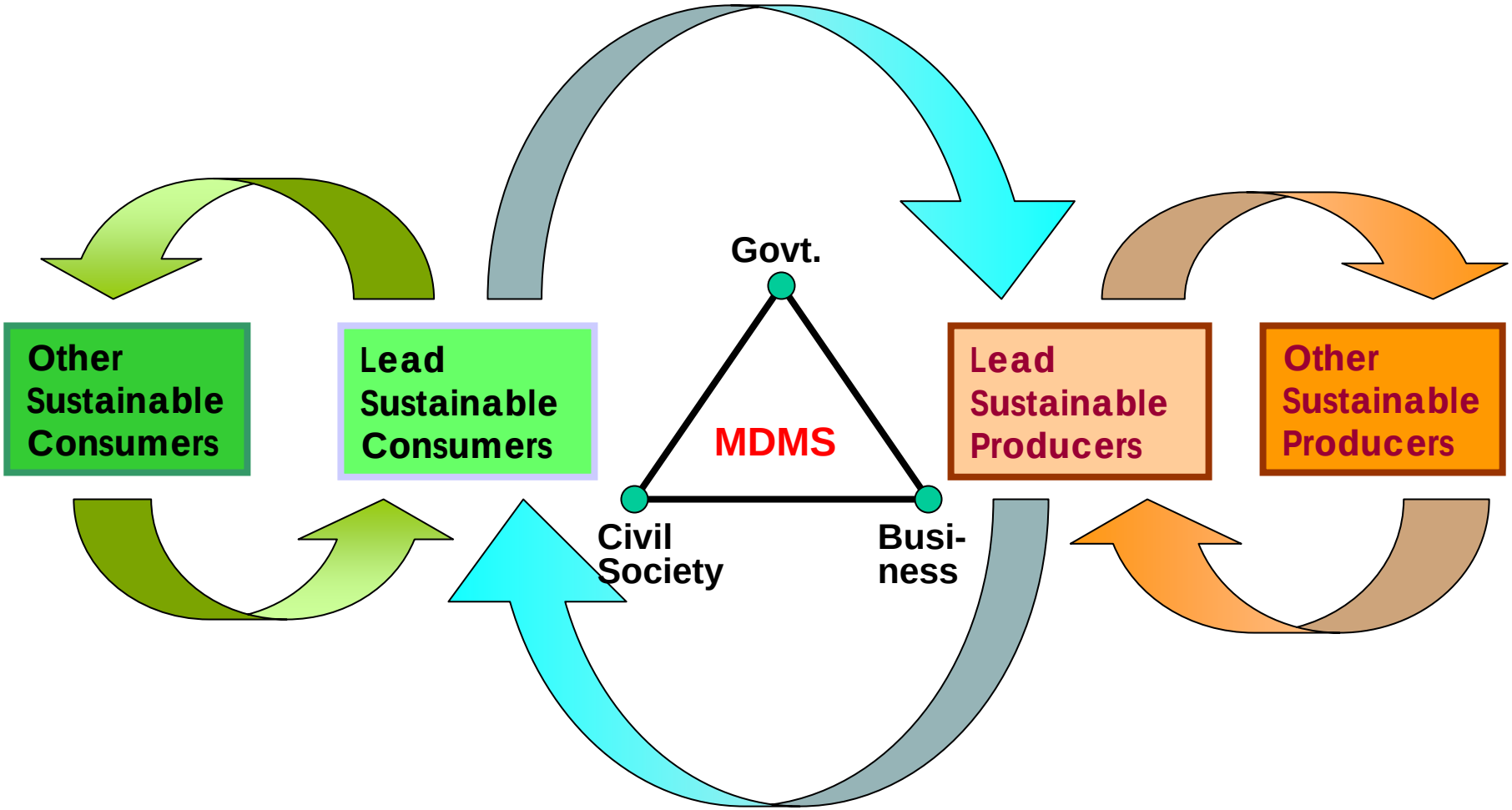
# Water Services: Sustainable Consumption & Production 2

## Virtuous Cycle for Making Development More Sustainable (MDMS)



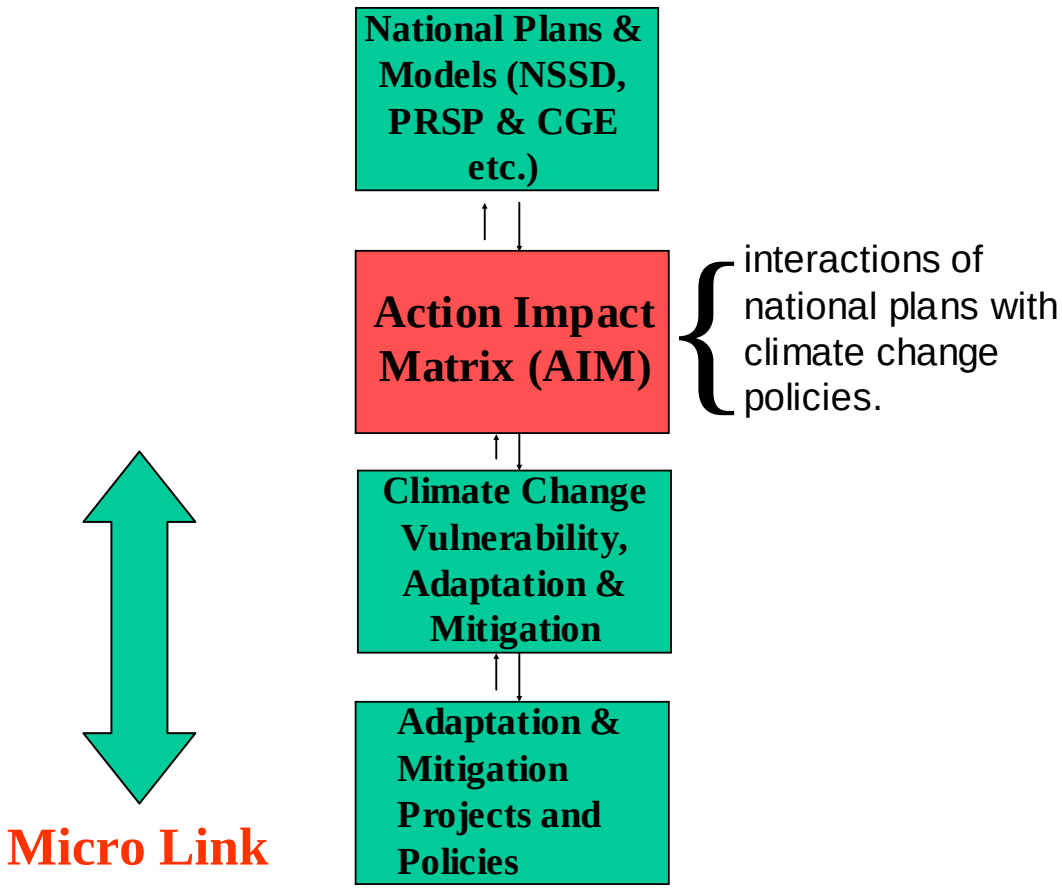
# Water Services: Sustainable Consumption & Production 3

## Virtuous Cycle for Making Development More Sustainable (MDMS)



# Project and Micro Level Analysis

# Assessing links between development plans and adaptation and mitigation – Micro and Project Linkage



# Project Level Example

## Assessing economic, social and ecological indicators for small hydro in Sri Lanka

**Primary Source:** **Morimoto R., and Munasinghe M. (2005) "Small hydropower projects and sustainable energy development in Sri Lanka", *Int. Journal of Global Environmental Issues*, Vol.4.**

**Summary:** **Munasinghe, M. (2002) "The sustainomics trans-disciplinary meta-framework for making development more sustainable: applications to energy issues", *Int. J. of Sustainable Dev.*,Vol.4, No.2, pp.6-54.**

# Overview of study

- Hydro affects all three dimensions of sustainable development.
- Reviews linkages between potential impacts of energy production and consumption on sustainable development,.
- Multi-criteria analysis used to assess the role of small hydro-power projects in sustainable water and energy development.
- 3 key variables (measured per unit of GHG avoided per year):

  ***Economic*** - electricity supply costs,

  ***Social*** - numbers of people displaced (resettled),

  ***Environmental*** - biodiversity loss
- Analysis helps policy-makers compare and rank project alternatives more easily and effectively.
- The multi-criteria analysis, which includes environmental and social variables, supplements and balances cost benefit analysis which is based on economic values alone.

# Economic indicator used

Average generation costs per unit of avoided CO2 emissions per year **[Ci/Qi]**

where
Ci = total economic cost of project i
Qi = quantity of avoided CO2 emissions due to project i

Each unit of hydro-electricity produced is assumed to reduce a unit of thermal generation and thereby avoid associated CO2 emissions.

This measure is equivalent to using net benefits per unit of avoided GHG emissions: NBi/Qi
where
NBi = (Bi – Ci) = net benefit from project i ;
Bi = total benefit from project i ;
and we assume that the total benefit per unit generated is the same for all projects compared: Bi/Qi

# Environmental Indicator used

Average biodiversity index value per unit of avoided CO2 emissions per year:

**Gi = Ei / [Avoided CO2 emissions per year due to hydro-generation at site i]**

where Ei is the biodiversity index

$$Ei = \sum_j wj.\ Aij$$

where Aij is the area (hectares) of ecosystem of type j at site i,

wj is relative biodiversity value of ecosystem type j

Another useful indicator is average biodiversity index value per hectare of affected land

**$Fi = Ei / [\sum_j Aij] = Ei /$[Total land area affected at site i]**

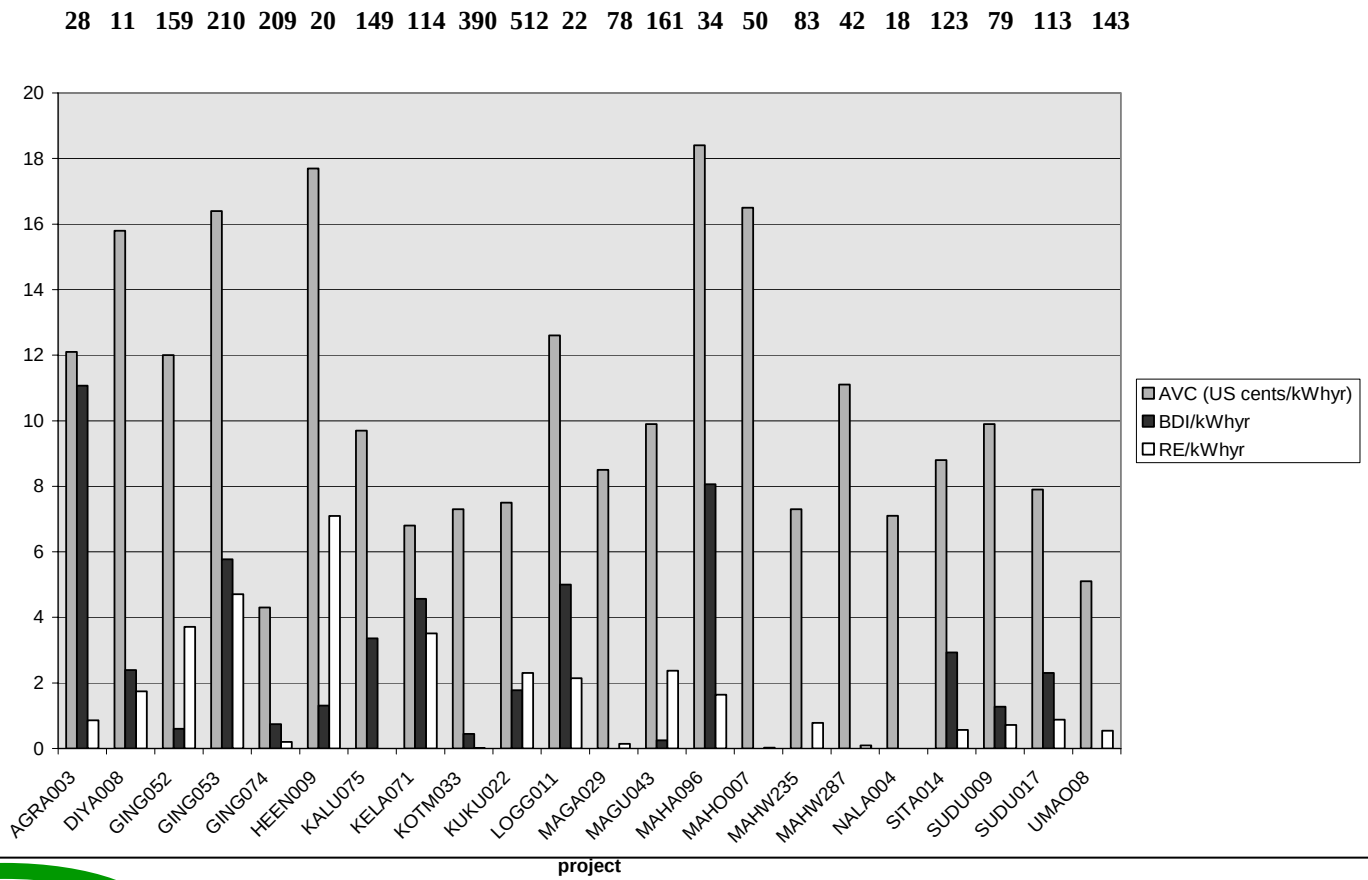
# Social Indicator used

Resettlement = Number of people resettled per unit of avoided CO2 emissions per year

Minimising the number of people resettled due to dam construction is an important social objective.

# Project Level:
# Economic, social and ecological indicators for small hydro in Sri Lanka

**Average generation costs (AVC), biodiversity index (BDI), and number of resettled people (RE) by hydroelectric project. All indices are per tonne CO2 avoided per year. Numbers of people resettled and the biodiversity index are scaled for convenience (by multipliers $10^{-5}$ and $10^{-9}$ respectively). The values at the top of the graph indicate the annual energy generation in gigawatt hours (GWh).**

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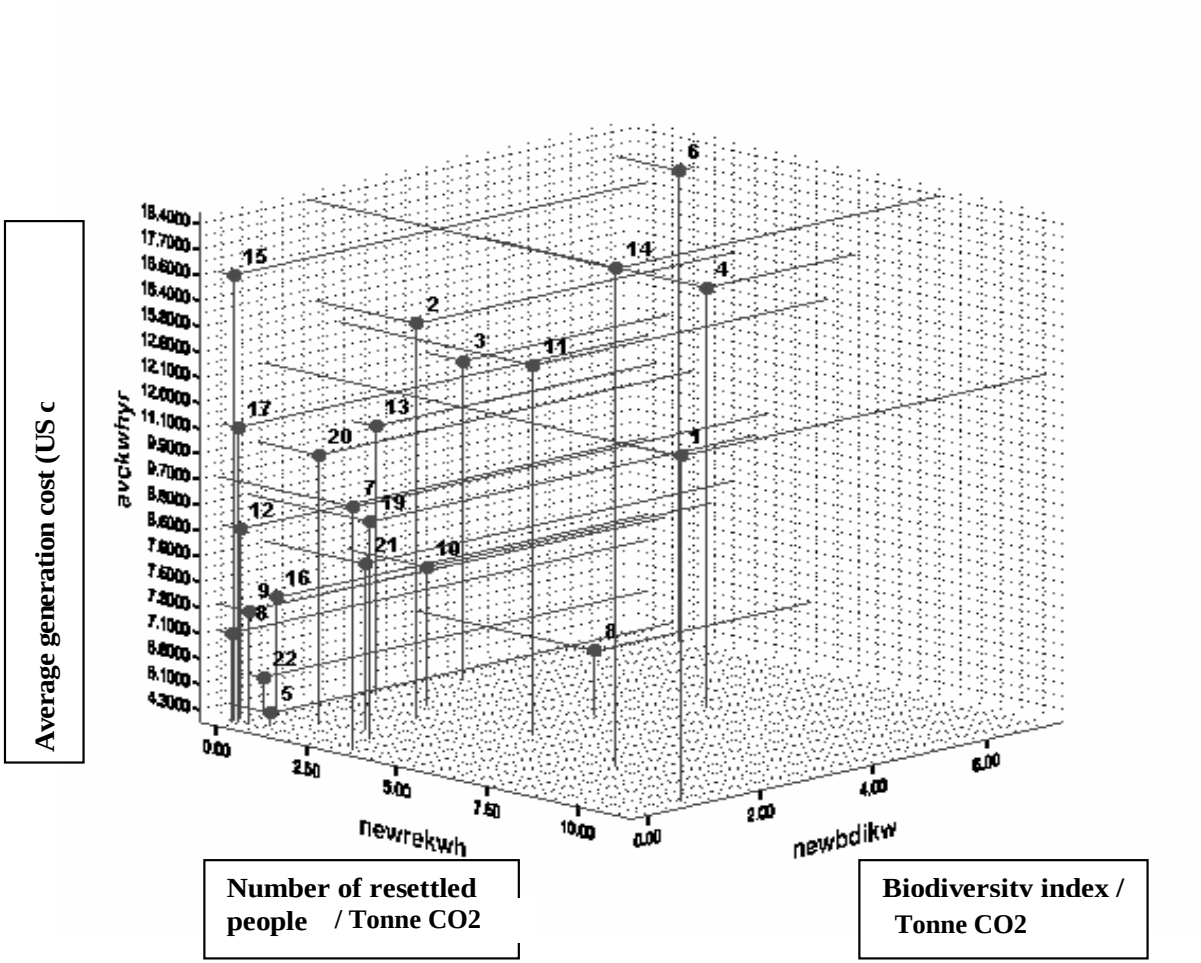
# Three dimensional MCA of SD indicators of small hydro

**Figure 5. Three dimensional MCA of sustainable development indicators for various hydropower options.**
**Source: Morimoto, Munasinghe and Meier [2000]**



# Conclusions of Study

- MCA helps policy-makers compare project alternatives more easily and effectively by narrowing down the range of choices
- Looks at all aspects of project (social, environmental and economic) unlike CBA which emphasises economic aspects.

**WHAT ?** are the challenges

water, sustainable development and climate change issues are complex and closely interlinked

**HOW ?** can we seize the opportunities

by making development more sustainable and exploiting synergies using the sustainomics framework for sustainable water resources management (SWARM)

# Optimistic final message for S. Asia and the World

**Sustainable development, water & climate are interlinked problems that pose a serious challenge to us all – water is a key element.**

**Although the issues are complex and serious, these problems can be solved together, provided we begin now.**

**We know enough already to take the first steps towards making development more sustainable, that will transform the risky "business-as-usual" scenario into a safer and more secure future.**

**Water resources need to be combined with balanced use of key types of capital – social, economic & natural.**

**Governance systems must be transformed to deal with multiple crises in an integrated way.**

**Industry and civil society can be re-organised and re-energised, to work with government in mobilising resources, framing issues, identifying options and implementing them.**

**WATER IS A KEY ELEMENT OF THE SOLUTION & NOT THE PROBLEM – KEY ROLE FOR WATER EXPERTS !**

# Ancient Pali Blessing – from Sri Lanka

***DEVO VASSATU KALENA***
***SASSA SAMPATTI HETU CA***
***PHITO BHAVATU LOKO CA***
***RAJA BHAVATU DHAMMIKO***

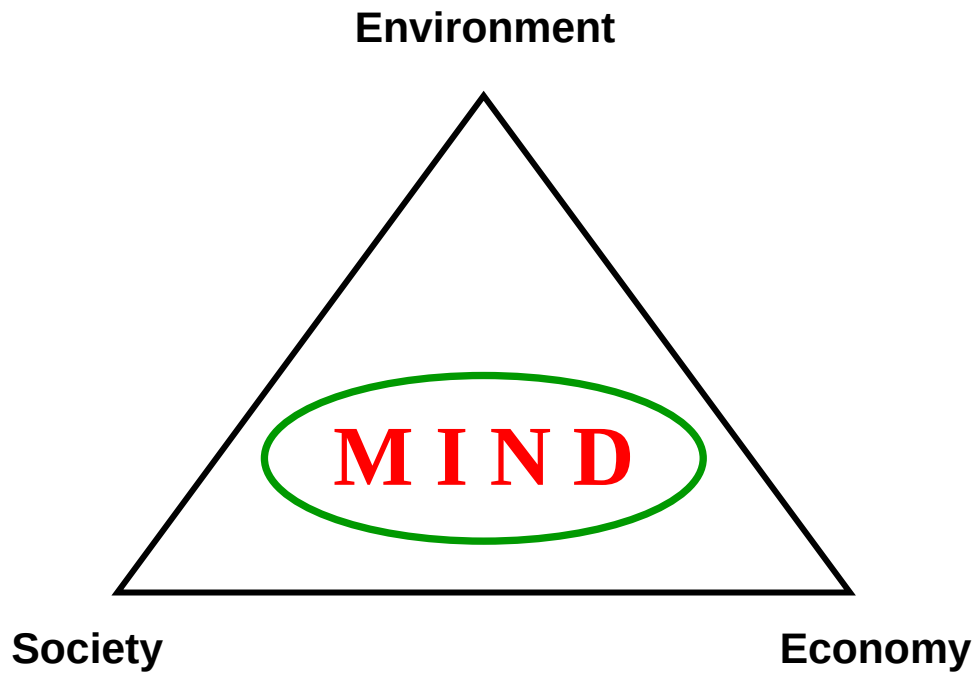
**May the rains come in time *(environment)***
**May the harvests be bountiful *(economy)***
**May the people be happy and contended**
**May the king be righteous *(society)***

**Even in ancient times, a favourable environment, economic prosperity, social stability, and good governance, were well known as the key factors to make development more sustainable.**

# Suggestions for Further Information

1. **Munasinghe, M. (2007)** ***Making Development More Sustainable: Sustainomics Framework and Practical Applications*****, MIND Press, Munasinghe Institute for Development, Colombo.**
2. **Munasinghe, M., and Swart, R. (2005)** ***Primer on Climate Change and Sustainable Development*****, Cambridge University Press, UK. –translated into Chinese**
3. **MIND (2005)** ***Action Impact Matrix (AIM) Application to Climate Change - Users Guide*****, Munasinghe Institute for Development, Colombo.**
4. **Website URL: <www.mindlanka.org>**

# An Introduction




# Munasinghe Institute for Development

**"making development more sustainable - MDMS“**

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# PROGRAMMES

- **Awards**

  Research fellowships, Scholarships, Sustainable Support Service (MS3), Book donations

- **Research & Training**

  Training workshops/expert meetings

  Applied research studies and evaluations

  UN “Centre of Excellence” for Asia in the Climate Change Capacity Development (C3D) network of the United Nations Institute for Training and Research (UNITAR).


# MIND CC-SD Training Course, CMA, Beijing, July-Aug, 2006
# 270 Senior Chinese Officials

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# MIND SD Course, Delhi, Feb. 2007
# 25 Senior Indian Civil Service Officers

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**MIND-ERC CC-SD Training Course, University of Cape Town, October 2007, for 30 Senior Decision Makers from Government, Business and Civil Society**

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The University of Manchester

# Sustainable Consumption Institute (SCI)

## Leading research into sustainable consumption

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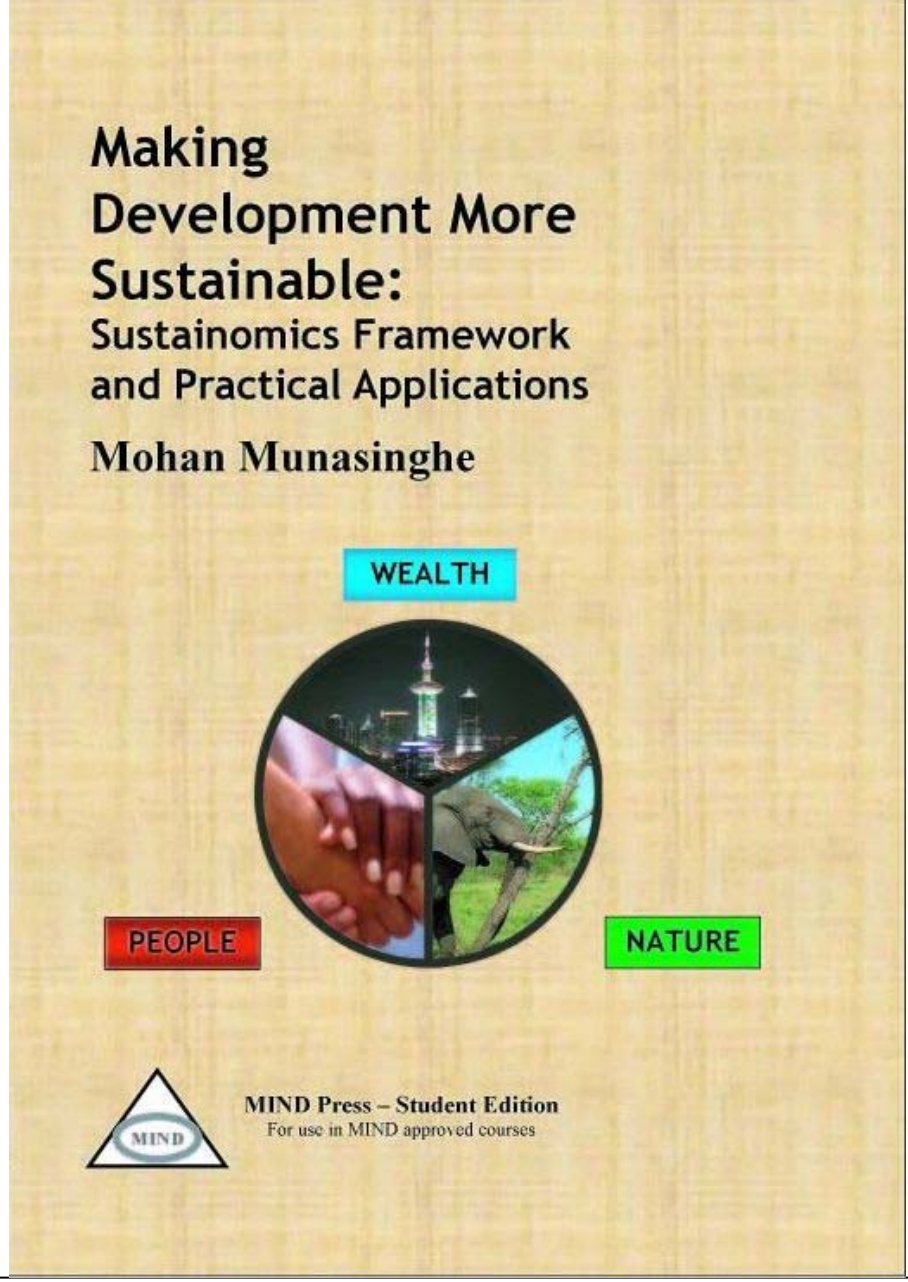
# Summary Paper (5 pages)


## Mohan Munasinghe

**Finance and Development, March 2008, pp.37-41**

**Extensive Book**

**650 pages**



# Thank You Very Much