Contribution to Millennium Ecosystem Assessment

Overview and simulation results

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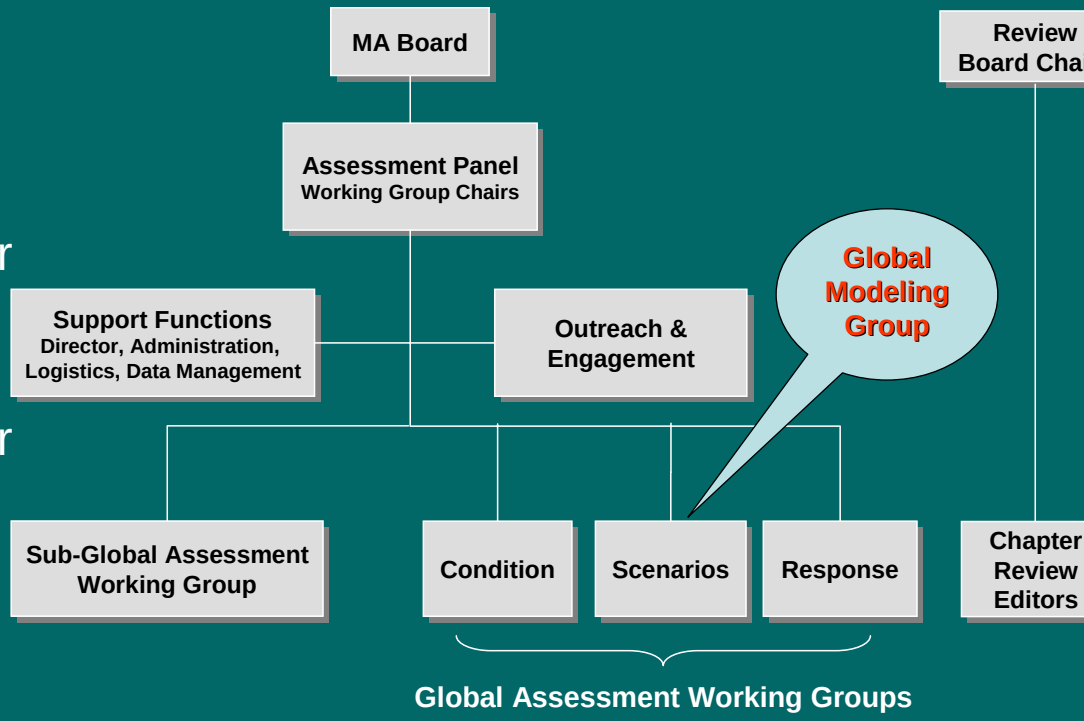
Millennium Ecosystem Assessment

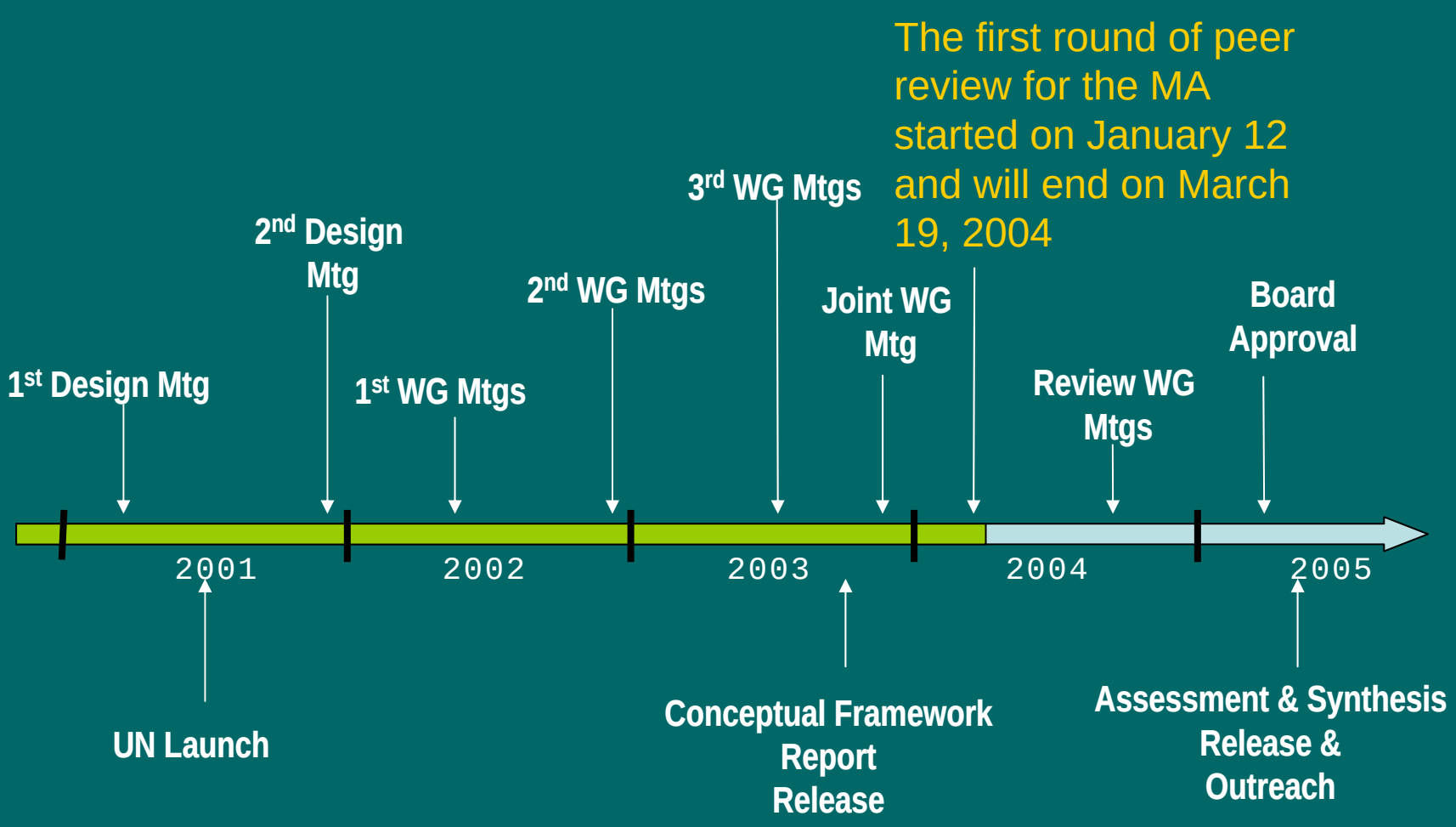
（http://www.millenniumassessment.org/en/index.htm）

- The Millennium Ecosystem Assessment (MA) is an international work program designed to meet the needs of decision makers and the public for scientific information concerning the consequences of ecosystem change for human well-being and options for responding to those changes.

- The MA focuses on:
  - ✓ Ecosystem services
  - ✓ The consequences of changes in ecosystems for human well being
  - ✓ The consequences of changes in ecosystems for other life on earth



MA Time line of Activities



Contribution to MA

- Contribution to **Chap. 9 of Scenario Assessment**
- Quantification of global long-term scenarios of natural and social environment
  - **Harmonization**
    - ✓ Driving forces, Climate sensitivity
  - **AIM models utilized for MA**
    - ✓ AIM/Water
      - Country-wise water-use (withdrawal and consumption), Country-wise renewable water resource, Spatial distribution of water-use and renewable water resources, Basin-wise water stress index
    - ✓ AIM/Agriculture
      - Potential crop productivity of Rice, Wheat and Maize
    - ✓ AIM/Ecosystem
      - SOx, NOx, Land use change, Biomass energy
  - **Uncertainty Analysis**

Scenarios of MA

MA Scenarios	Related SRES
• Global Orchestration (GO)	A1
• Techno Garden (TG)	B1+550
• Order from Strength (OS)	A2
• Adapting Mosaic (AM)	A2 ➜ B2

Direct / Indirect Drivers and Ecosystem Services of MA Scenarios

- Indirect drivers: population, technology, income, ...
- Direct drivers: Energy, Emissions, Climate change, Land use, Urbanization, ...
- Ecosystem services: Food, Fuel, Freshwater, Water supply, Air quality, ...

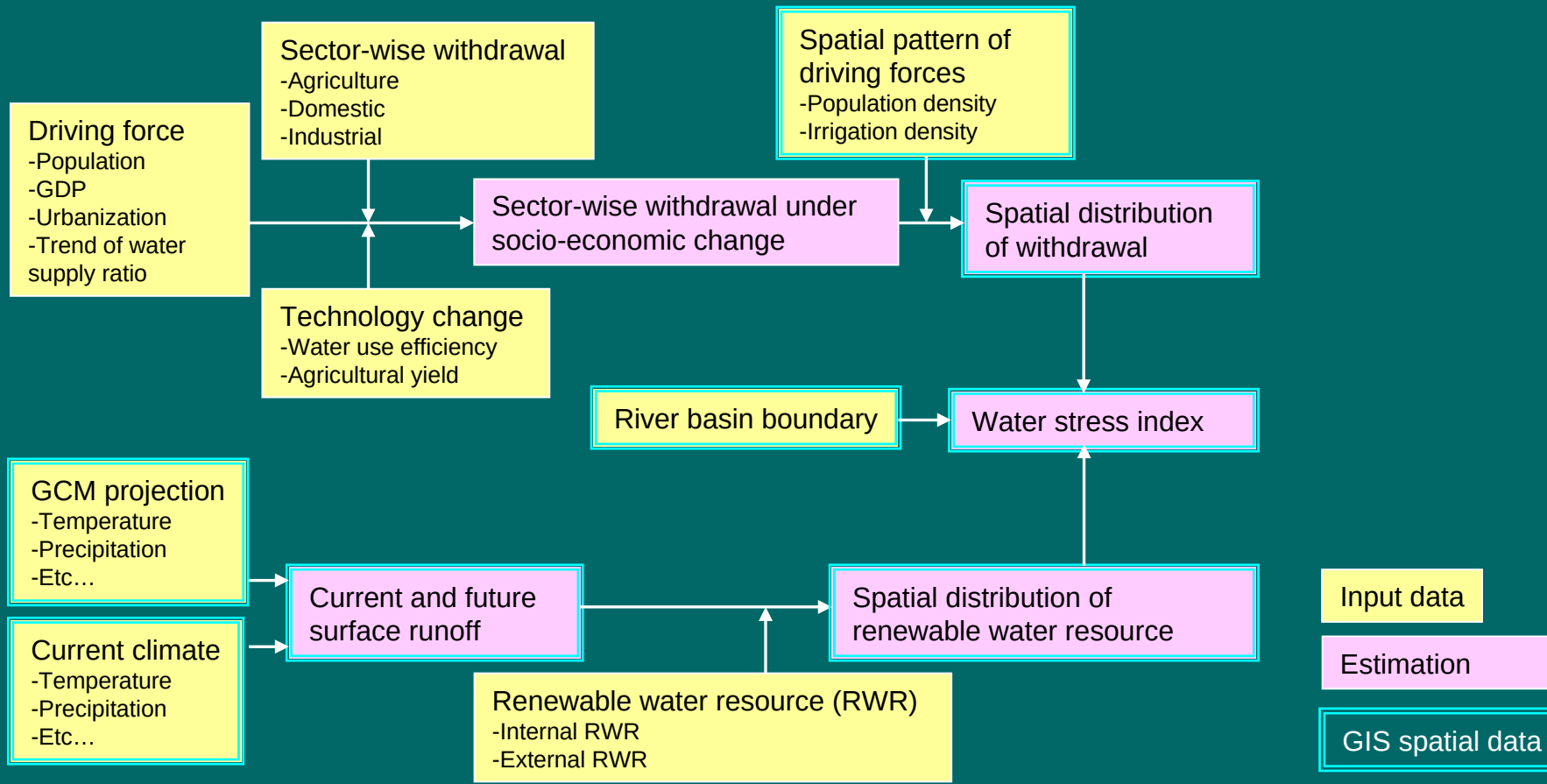
- Inputs from AIM team: rice, wheat, maize productivity change / freshwater availability, withdrawal, consumption / water stress index / urban population rate / NOx and SOx emissions / biofuel

Regional Classification of MA

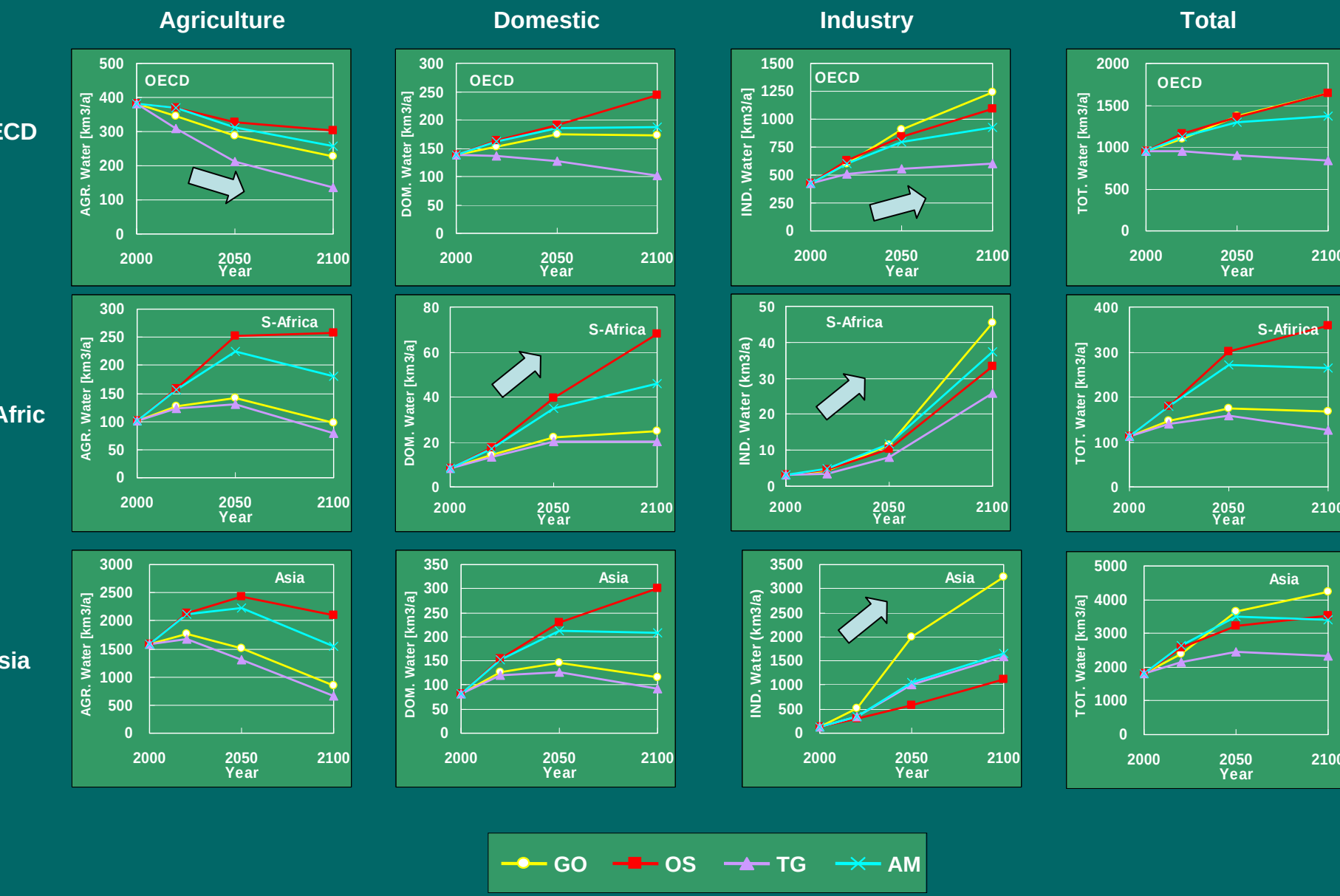
MA region	AIM/Ecosystem region
OECD-Regions	Canada / United States / Japan / Oceania / OECD Europe / Eastern Europe
Canada / United States / Japan / Oceania / OECD Europe / Eastern Europe + Baltic Countries	
FSU not including Eastern Europe	Former Soviet Union
Belaruss _Ukraine_Moldava / Rest of FSU	
MENA	Northern Africa / Middle East
Northern Africa / Middle East	
Subsaharian Africa	Subsaharian Africa
Eastern Africa / Southern Africa / Western Africa	
Latin America	Latin America
Central America / South America	
Asia (without Middle East)	East Asia / South Asia / South East Asia
East Asia / South Asia / South East Asia	
	Rest of the world

AIM/Water model

- Country-wise water-use (withdrawal and consumption)
- Country-wise renewable water resource
- Spatial distribution of water-use and water resource
- Water stress index in each river basin



Sector-wise water withdrawal



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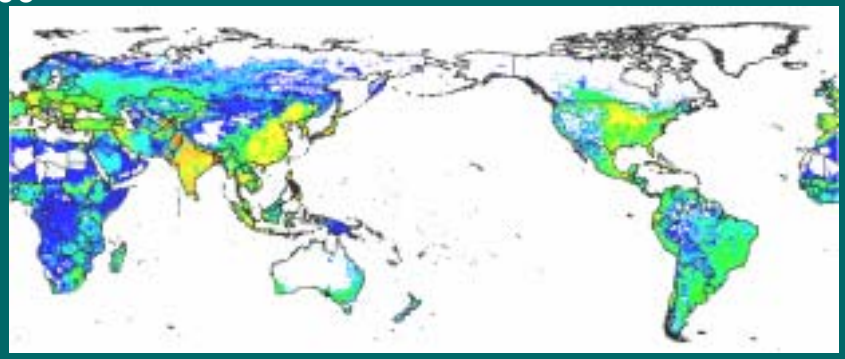

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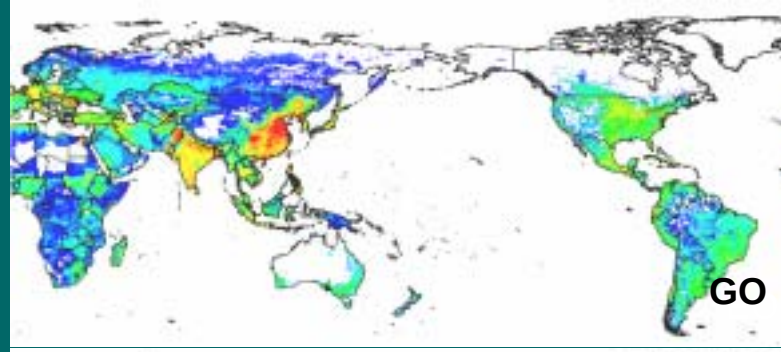
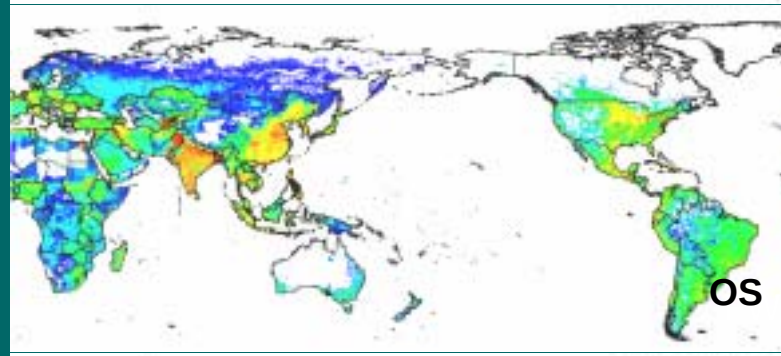
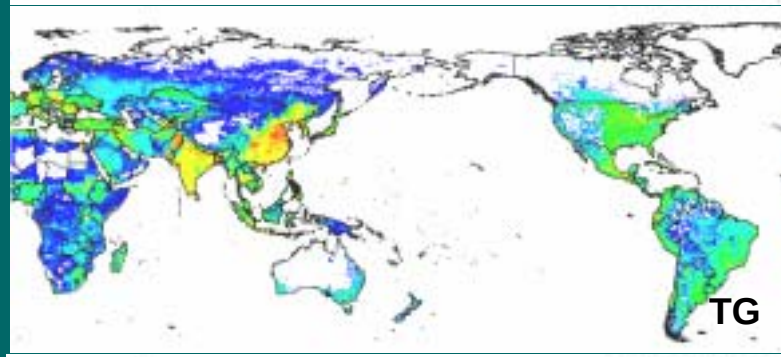
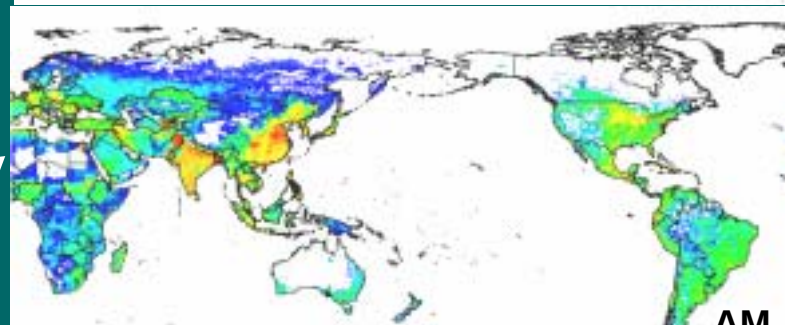






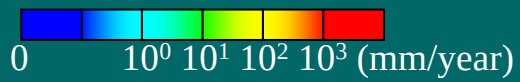


Water withdrawal per unit area in 2000 and 2100

-Developing countries: Water demand density will increase especially under GO and OS.

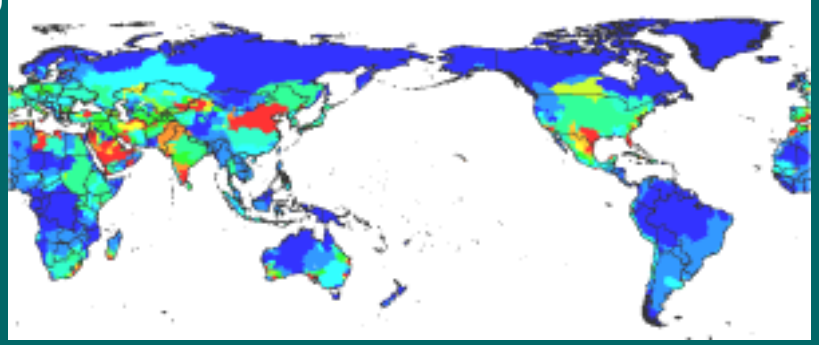
-China & East Europe: Water demand increase under GO because of quite high economic growth rate.

-Africa, Middle East & South Asia: Water demand increase under OS because of quite high population growth rate.



Water Withdrawal (total)

2000



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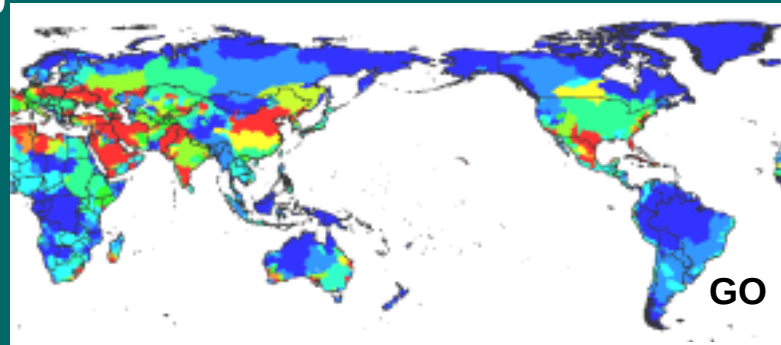
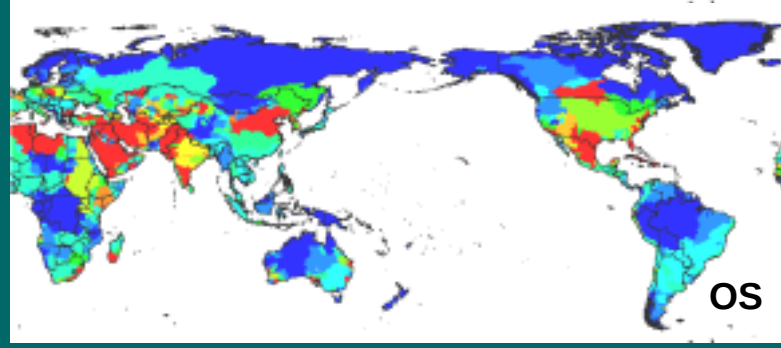
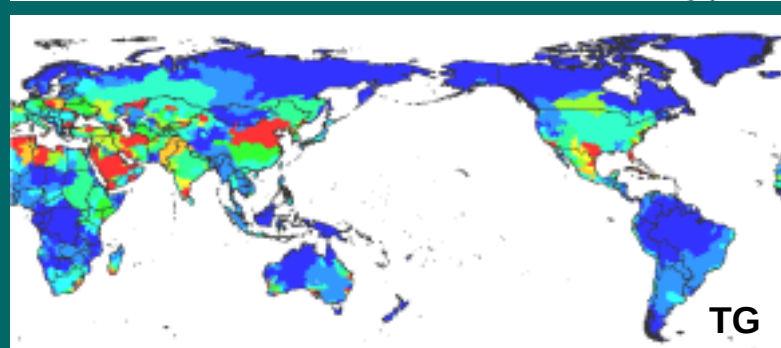
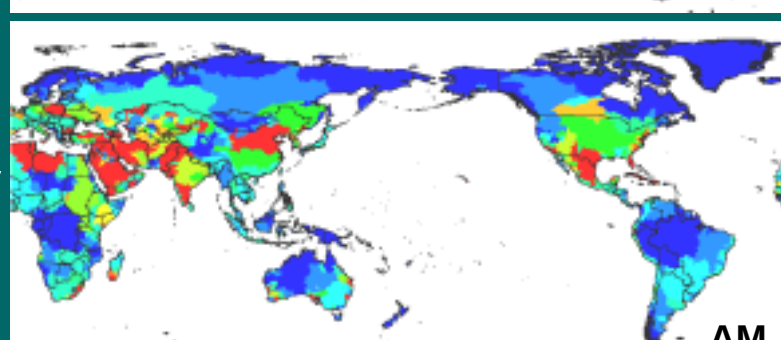




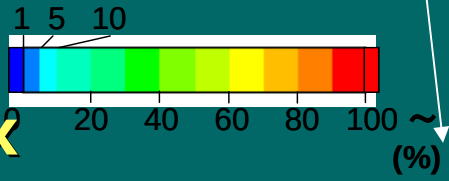




-In general, the order of stress is OS > AM > GO > TG
  Withdrawal: driven by socio-economic factors
  Water resource: driven by climate factors
  General trend of stress index change can be explained by demand side.

-ME and N. Africa
  High drought risk ← water demand increase derived from population increase and economic development.
  Mitigated in TG ← high efficiency of water use.

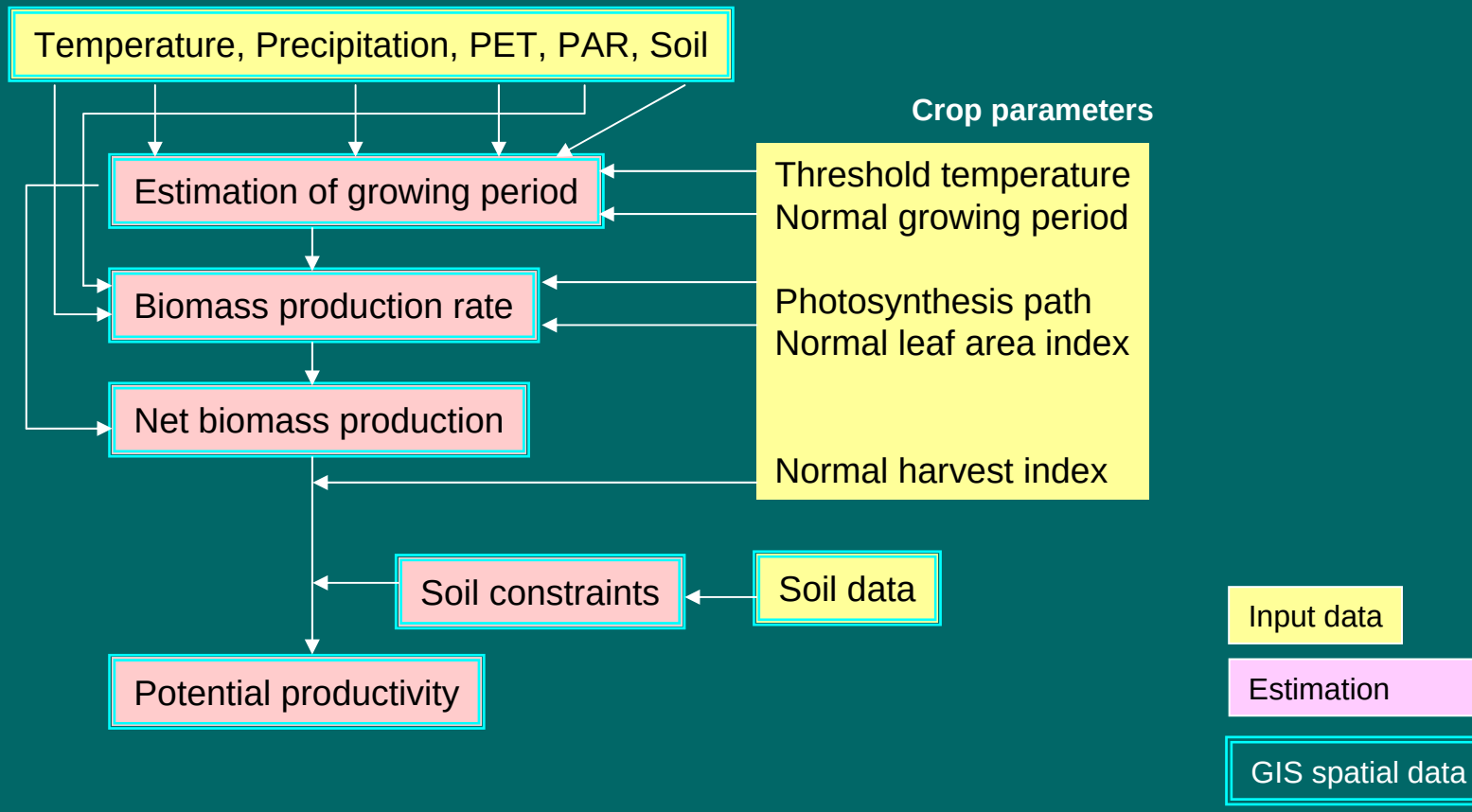
-East Europe
  High draught risk in GO ←high rate increase of industrial water withdrawal which cannot be compensated with the water use efficiency improvement.



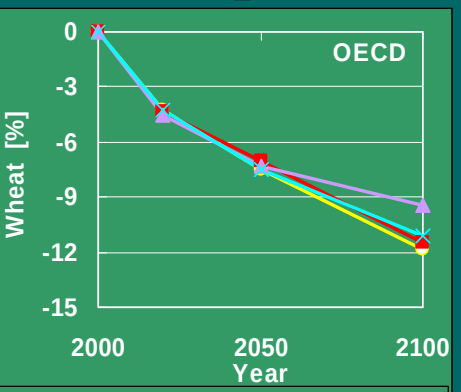
Water Stress Index
ratio between total withdrawal
nd renewable water resource)

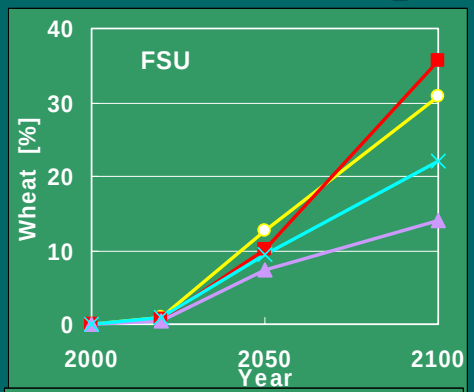
AIM/Agriculture model

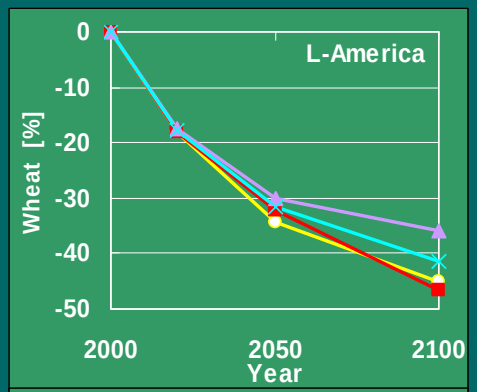
- **Spatial estimation of potential crop productivity**
  - 0.5^{o} x 0.5^{o} spatial resolution
  - Rice, Wheat, Maize, and other 9 crops



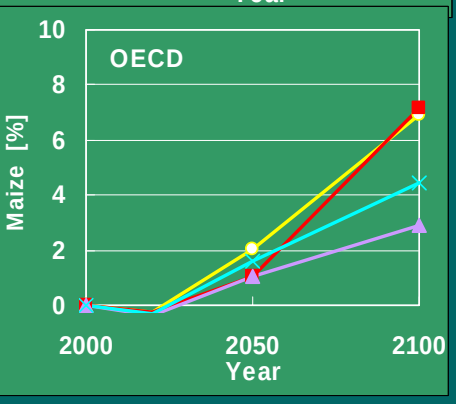
Simulation Results (Potential crop productivity)

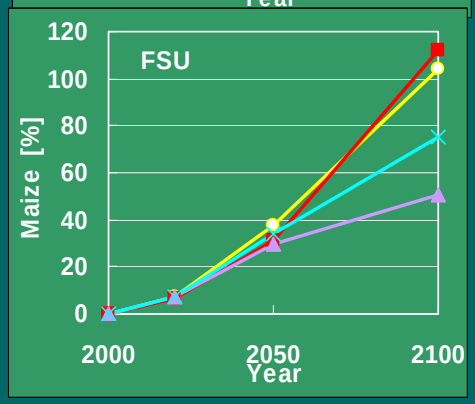


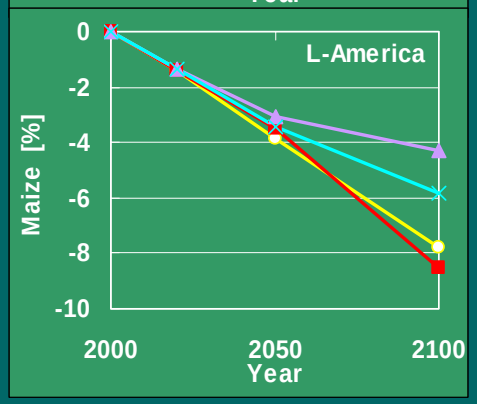




Wheat







Maize

-Generally, the degree of potential productivity change coincides with the speed of temperature increase; OS > GO > AM >TG. Potential productivity will increase in high-latitude regions, and decrease in low-latitude regions. In mid-latitude regions, effect of climate change depends on the variety of crops.

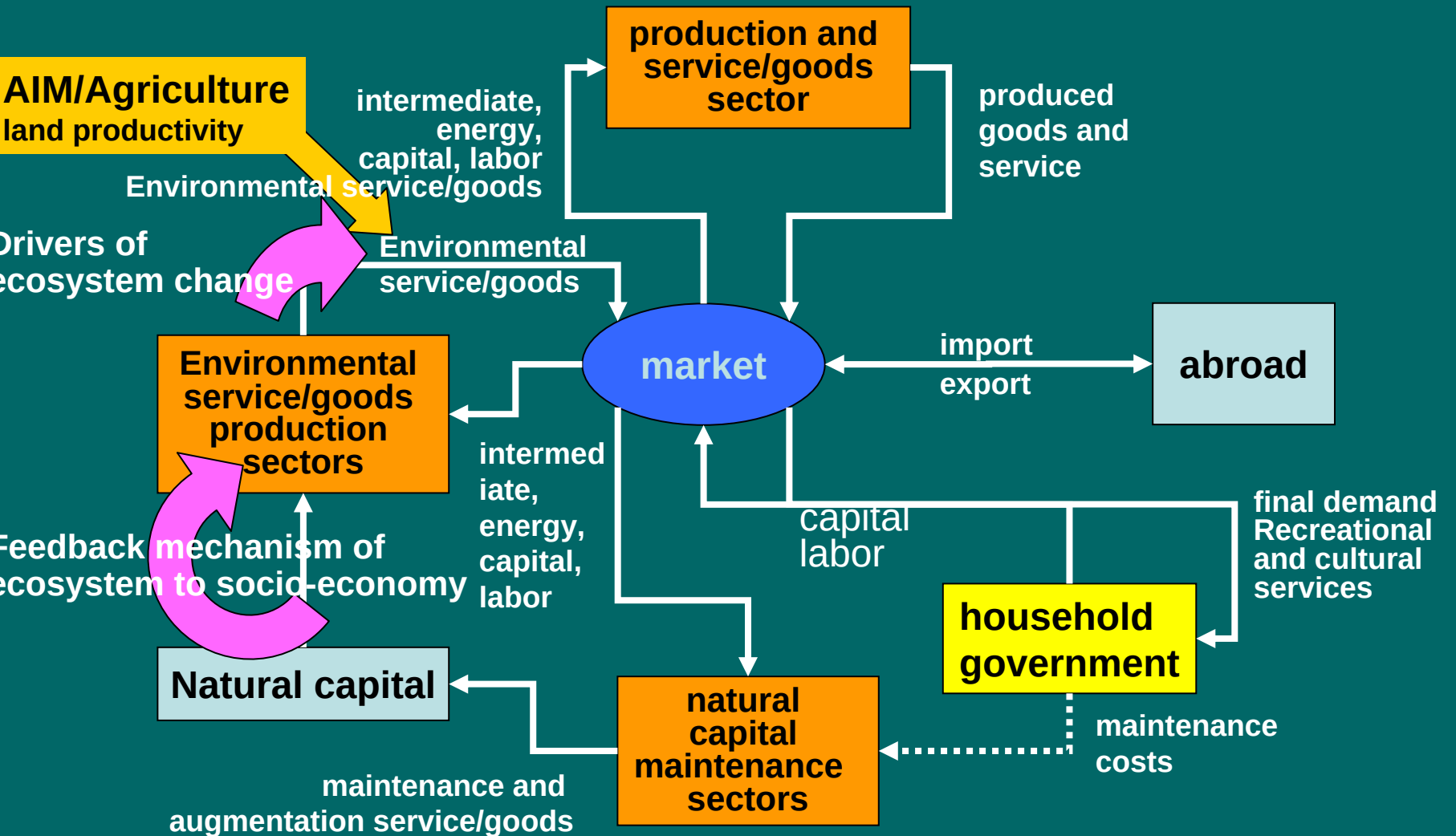
-FSU: productivities of wheat and maize increase very rapidly by global warming under any scenarios.

-Latin America: As global warming progresses, the potential productivity will decrease.

-OECD: the potential productivity of wheat will decrease, while that of maize will increase because of global warming. Generally, the most suitable temperature for maize growth is higher than that for

Structure of AIM/Ecosystem

Based on CGE model supported by other AIM models



Simulation Results (SOx)

SOx Emission = Potential SOx generation – SOx Reduction

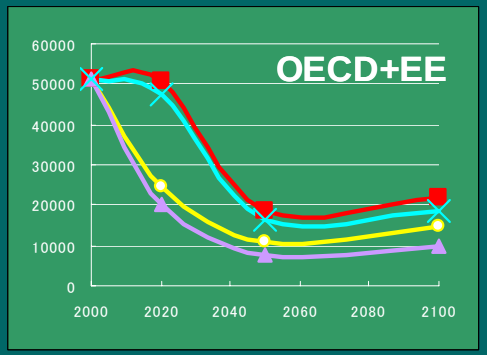
Energy use
Land use & LU change

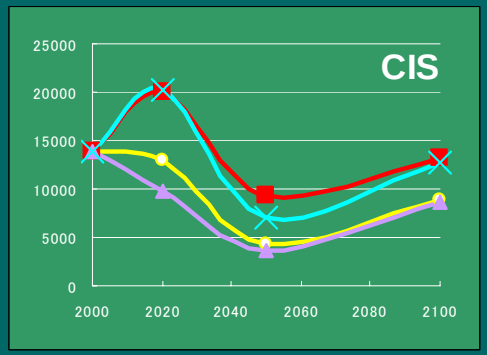
Economic growth
Population

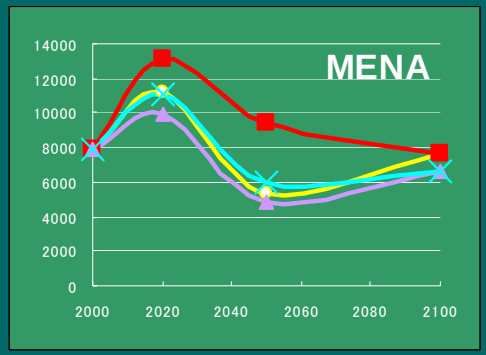
Investment of SOx red. equipment
SOx reduction efficiency

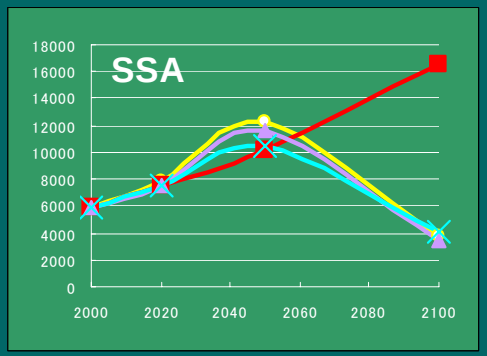
Results from AIM/Ecosystem

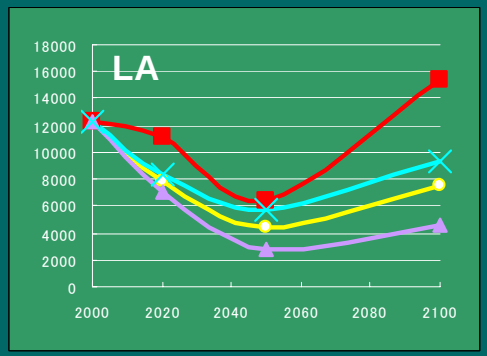
Scenarios

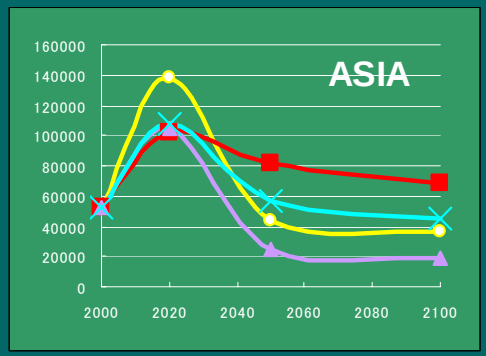












Regional SOx emissions results (MtSO2)

Simulation Results (NOx)

NOx Emission = Potential NOx generation – NOx Reduction

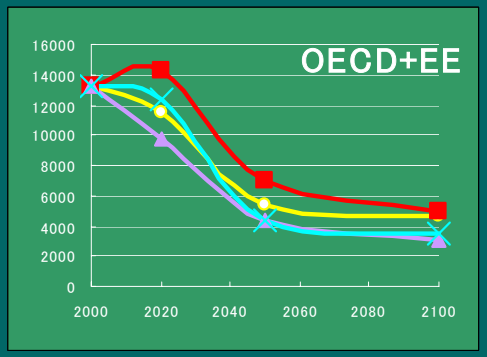
Energy use
Land use & LU change

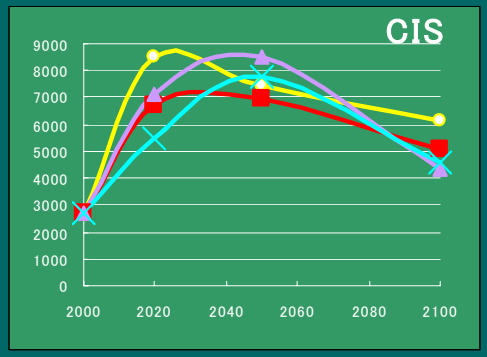
Economic growth
Population

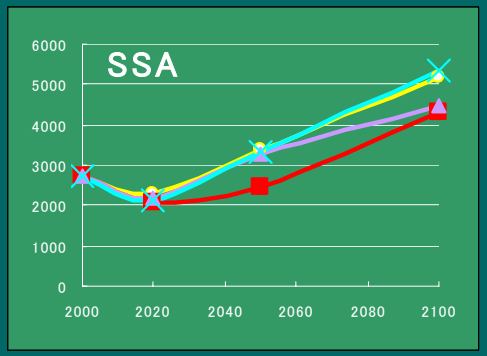
Investment of NOx red. equipment
NOx reduction efficiency

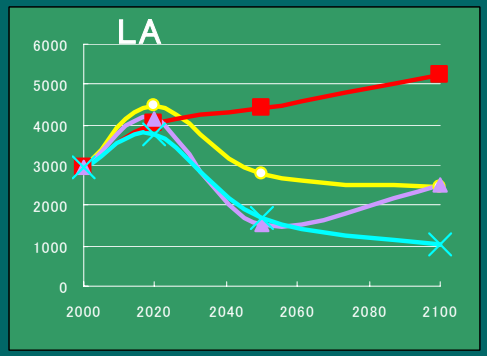
Results from AIM/Ecosystem

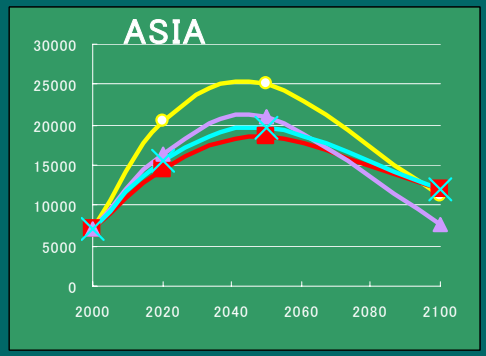
Scenarios







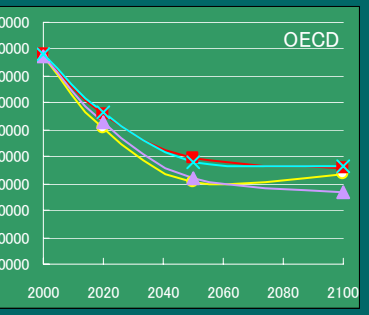


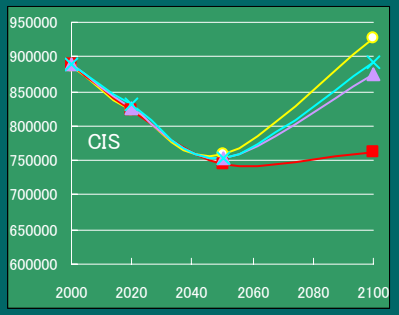


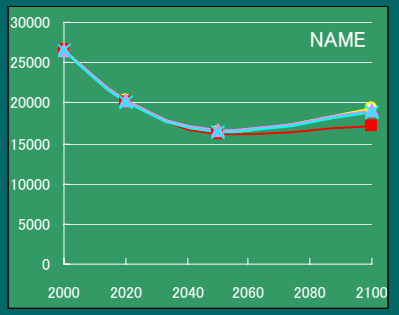
Regional NOx emissions results (MtN)

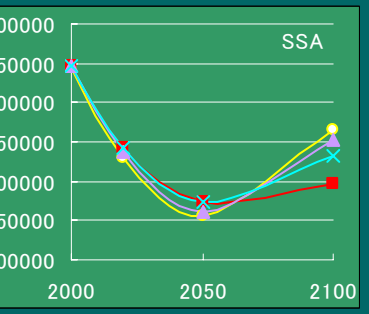
GO OS TG AM

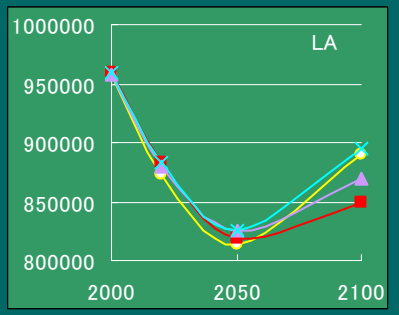
Simulation Results (Forest area)

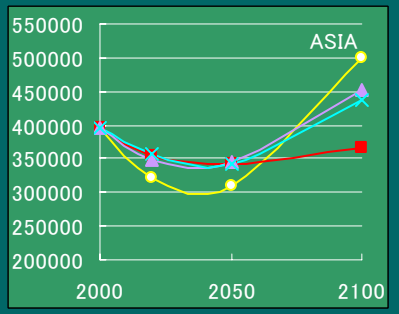


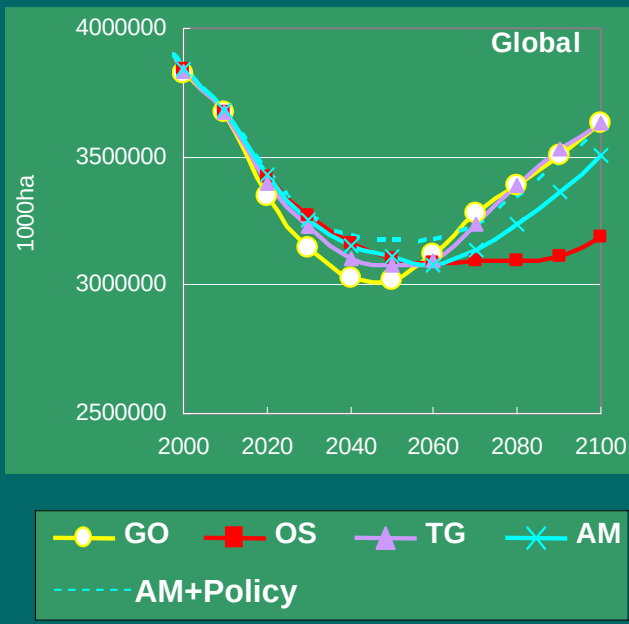












In any scenario, forest area decrease at the beginning of 21st century.
- Pressure from other land use; agriculture, pasture & biomass plantation
  - GO: Pressure from meat demand & plantation biomass
  - OS & AM: Pressure from general food demand
- Pressure from globalization; GO & TG

In 2nd half of 21st century, forest area is recovered.
- Effects of technologies: TG & GO
- Pressure from population: OS

Forest protection policy in AM will recover the forest area at the same level of those in TG and GO.

Messages from simulations

1. Till the middle of 21st century, the pressure on the ecosystem would continue
2. Globalization (rapid economic growth) scenarios will damage ecosystem
3. Population growth would prevent ecosystem from recovering
4. Technology improvement will help recovery of ecosystem
5. Specific policies would be necessary to maintain ecosystem