CESM Societal Dimensions Working Group Meeting

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The Water-Food-Economy-Climate nexus of ALPS scenario

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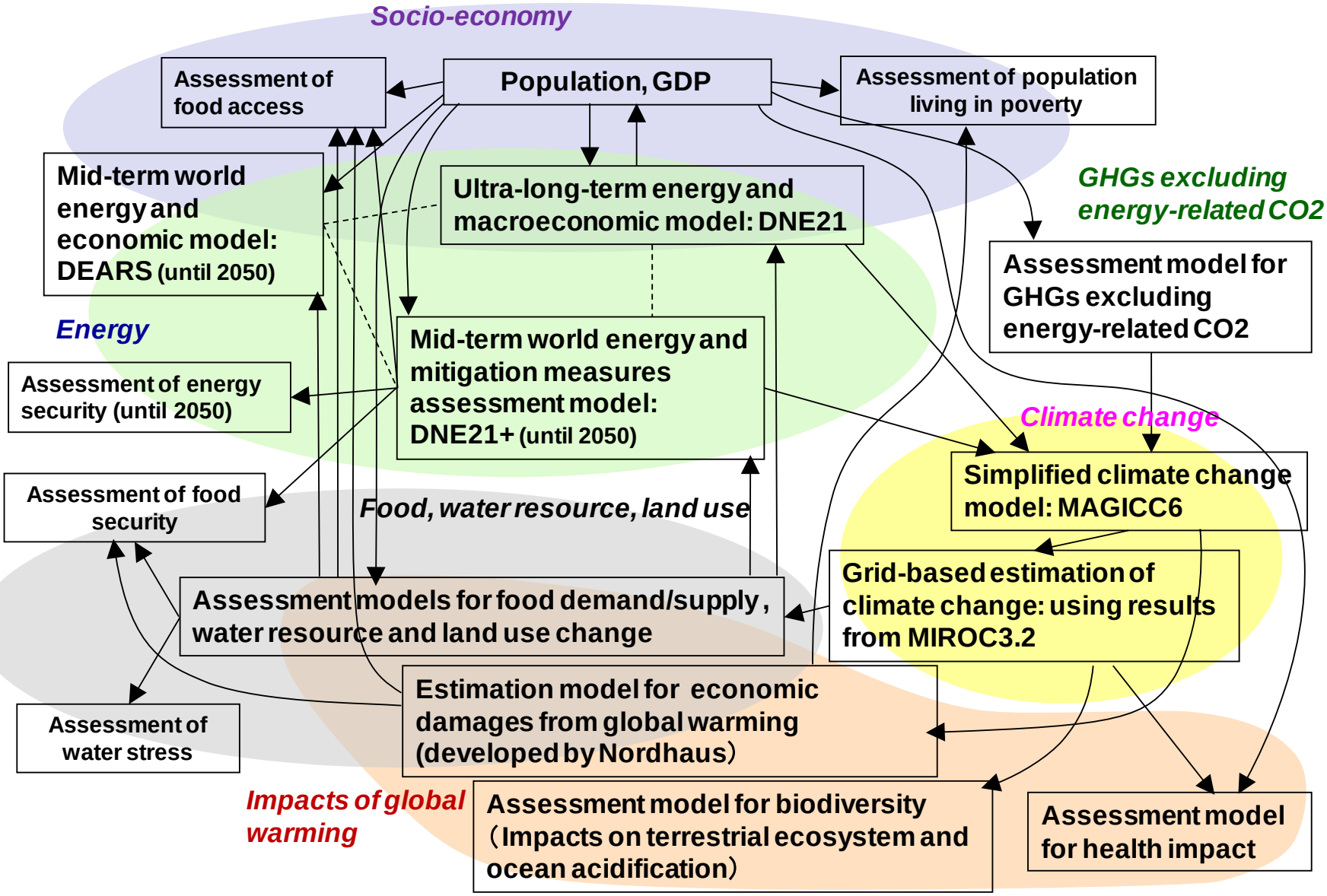
Objective

- **The ALPS (ALternative Pathways toward Sustainable development and climate stabilization) project explores policy implications for mitigation in the context of sustainable development.**
- **Climate policy is one of the sustainable development goals. Mitigation options need to be implemented not only from the climate perspective but also from the well-balanced multiple objectives for sustainable development with deep understanding of their trade-offs and synergies.**
- **The project covers the nexus of climate, water, food, land use, energy and economy.**

Research Coverage



Assessment Framework

DNE21+ Model

- Assessment model for energy-related CO2 emissions
- 54 regions in the world
- Bottom-up modeling (200-300 specific technologies are modeled)

LULUCF Model

- Assessment model for Land use (land area for food, energy crops, and afforestation)
- CO2 emission from LULUCF
- 15-minute-grid model
- Crop productivity is estimated based on the GAEZ model

Non-Energy CO2 Emissions Scenario

- Projection module for non-energy CO2 emissions
- 54 regions in the world
- Estimates of sectoral non-energy CO2 emissions to be consistent with GDP and production activities

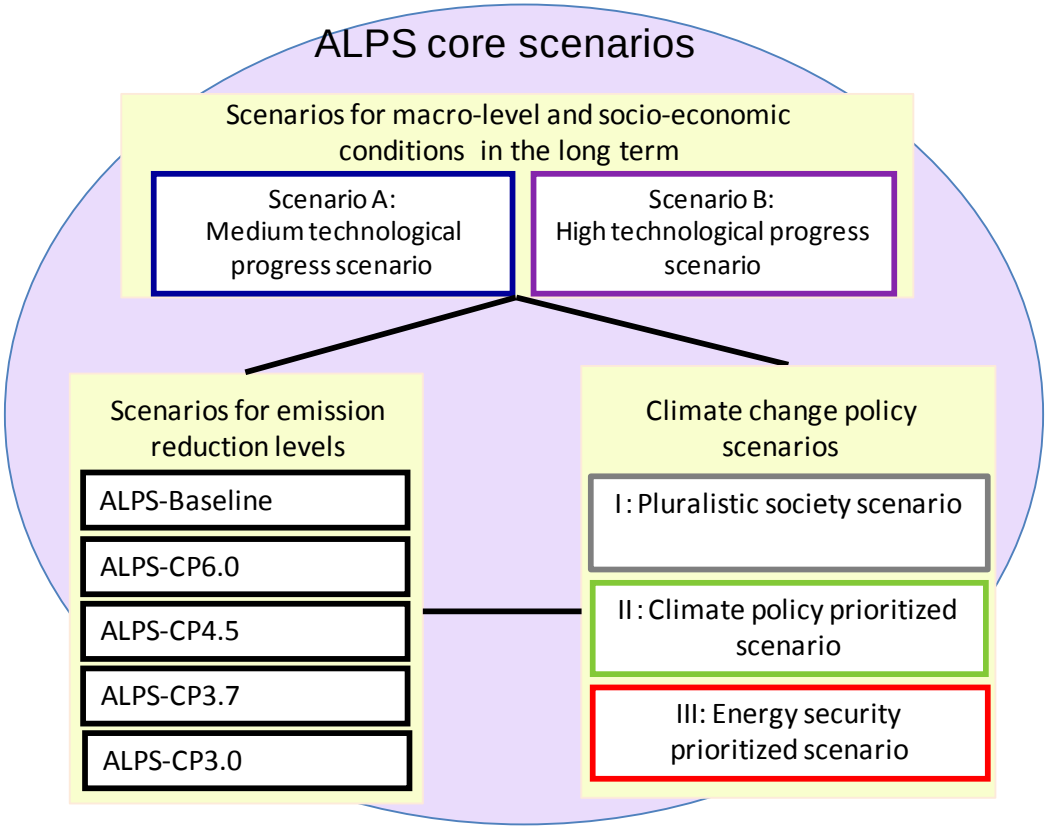
Non-CO2 GHG Assessment Model

- Assessment model for the five types of non-CO2 GHG emissios (CH4, N2O, HFCs, PFC, SF6)
- 54 regions in the world
- The methodology is similar to the USEPA assessment

Integrated Assessment Framework covers 6 GHGs emissions, emission reduction costs and potentials, and cost-effective mitigation measures/technologies

ALPS scenarios

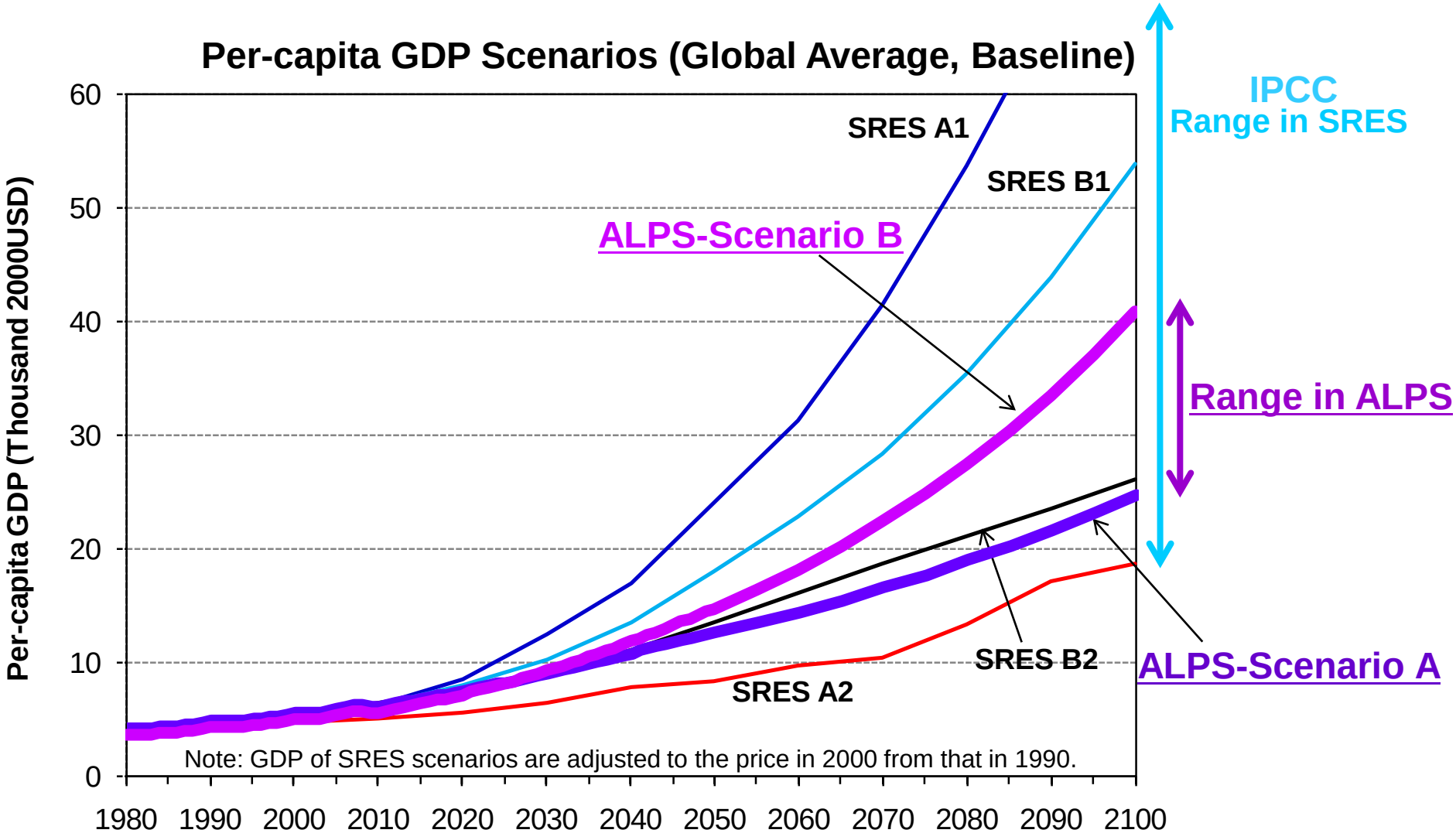
- **The ALPS scenarios consist of three different axis;**
  1. **Socio-economic scenarios**
  2. **Climate change policy scenarios**
  3. **Emissions scenarios consistent with Representative Concentration Pathways (RCPs)**



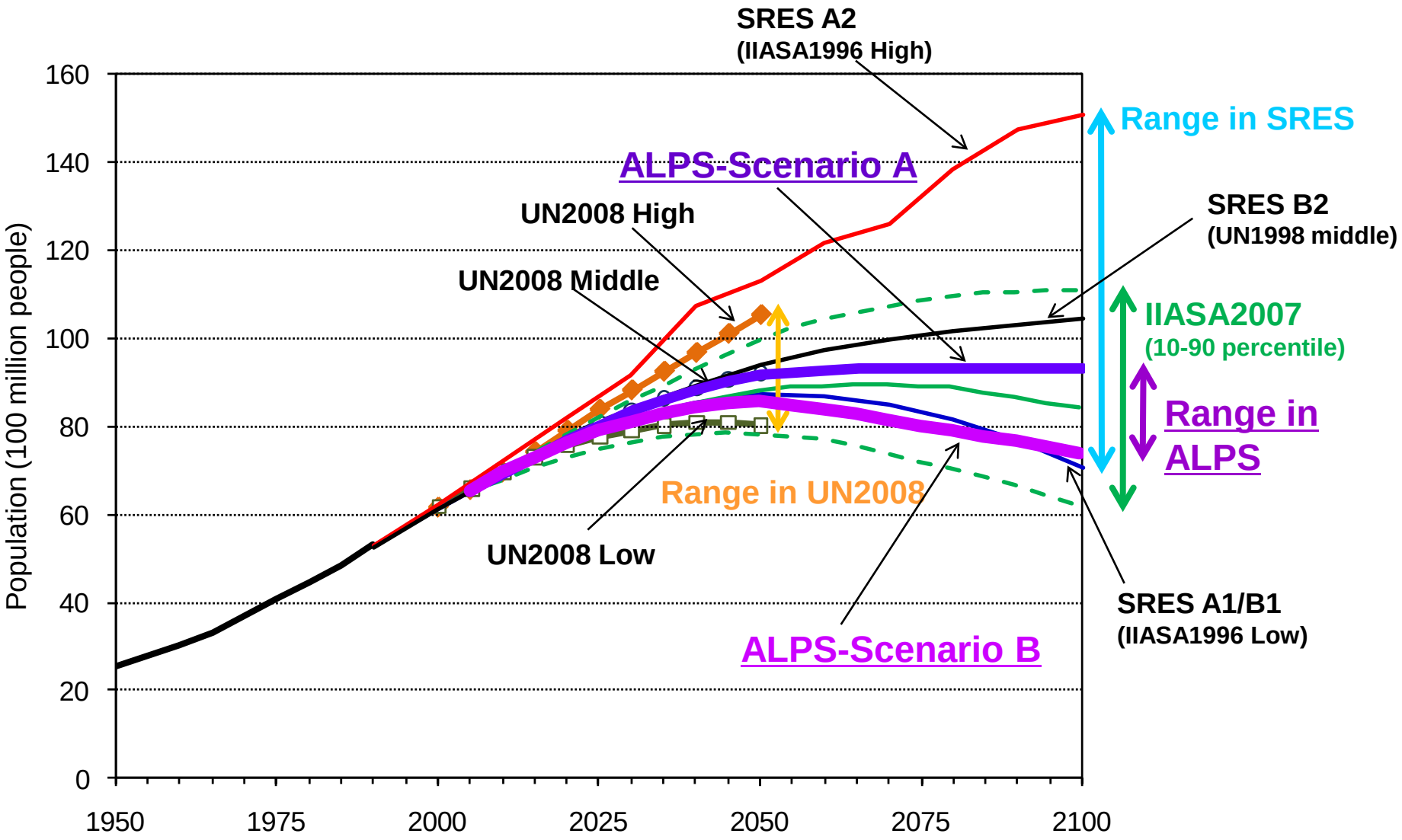
Indicators for sustainability assessment

Category	Indicator
Economic and poverty	Income (GDP per capita)
	People living in poverty (incl. impacts of climate change and mitigation efforts)
	Food access (amount of food consumption per GDP) (incl. impacts of climate change and mitigation efforts)
	Energy access (access to grid electricity; People relying on the traditional use of biomass for cooking)
Agriculture, land-use, and biodiversity	Land area for Agriculture (incl. impacts of climate change)
	Food security (amount of food imports per GDP) (incl. impacts of climate change and mitigation efforts)
Water	People living under water stress (incl. impacts of climate change)
Energy	Sustainable energy use (cumulative fossil fuel consumption)
	Energy use efficiency (primary energy consumption per capita and per GDP)
	Energy security (share of total primary energy consumption accounted for by oil and gas imports with country risks)
Climate change	Economic impact of mitigation measures (marginal abatement cost (carbon price) and GDP loss)
	Global mean temperature change
	Aggregated economic impact of climate change

Per-capita GDP

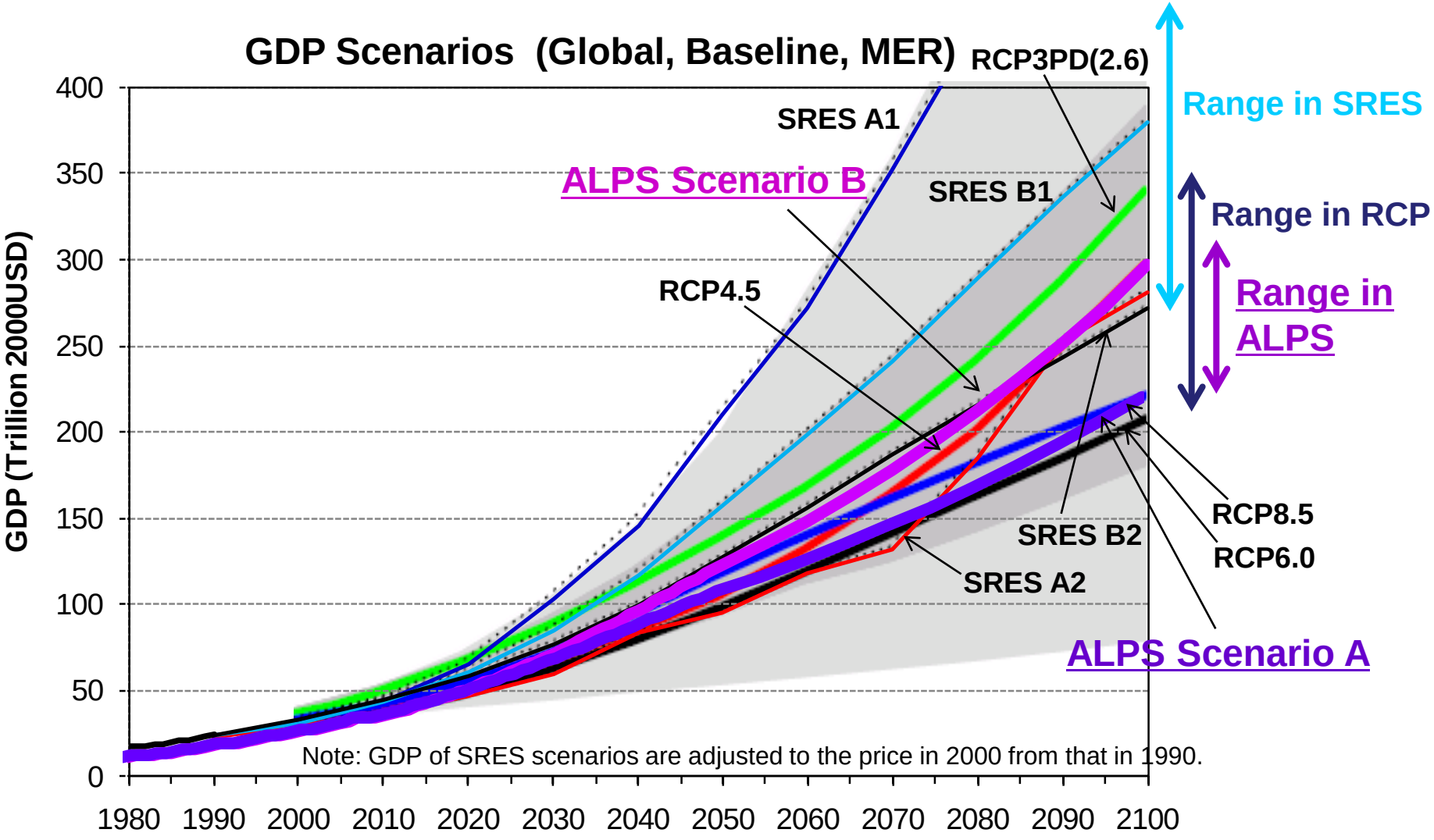


Population



Higher per-capita GDP induces lower population growth

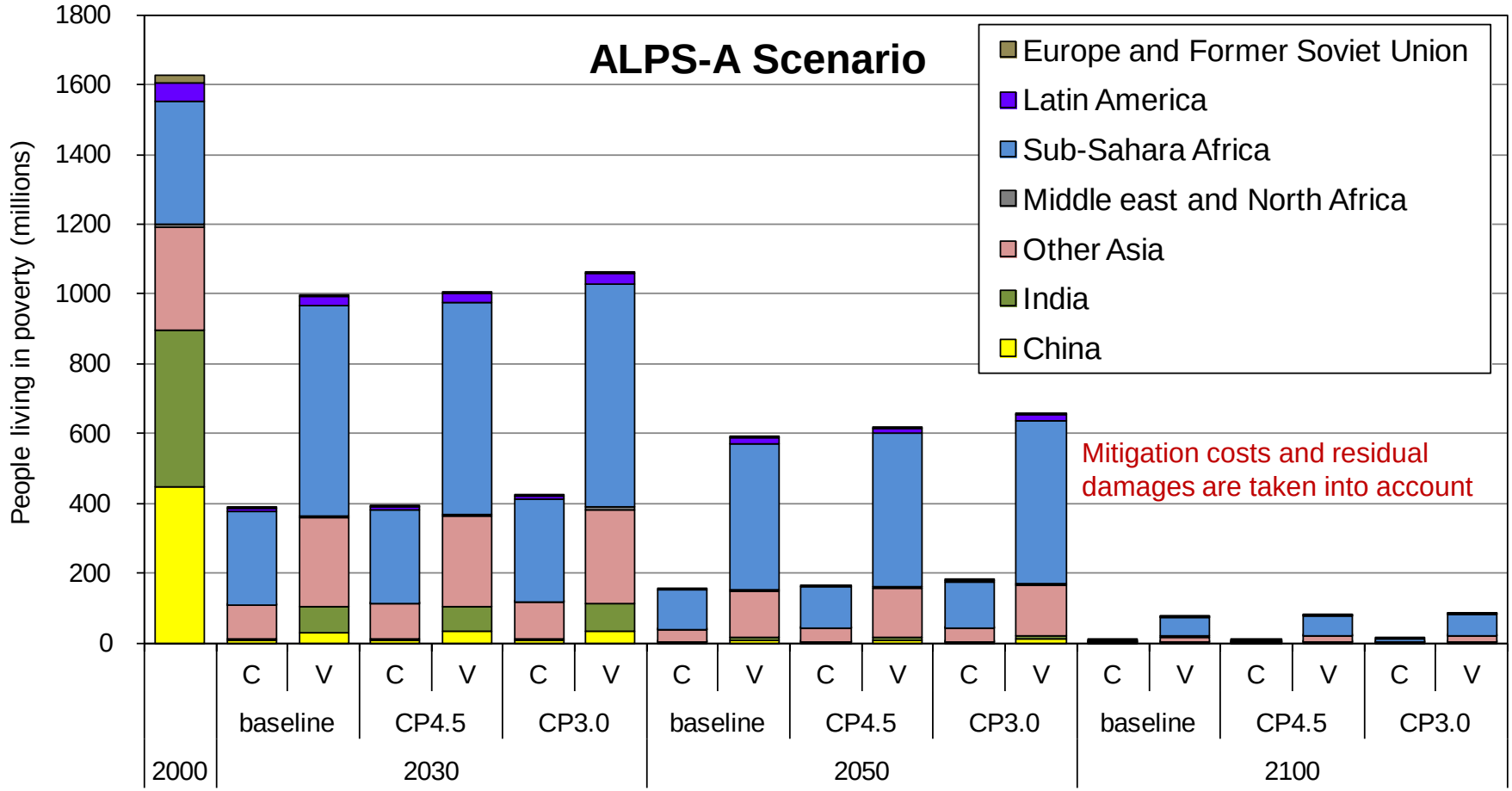
GDP



Scenario A: Lower per-capita GDP * Higher population

Scenario B: Higher per-capita GDP * Lower population

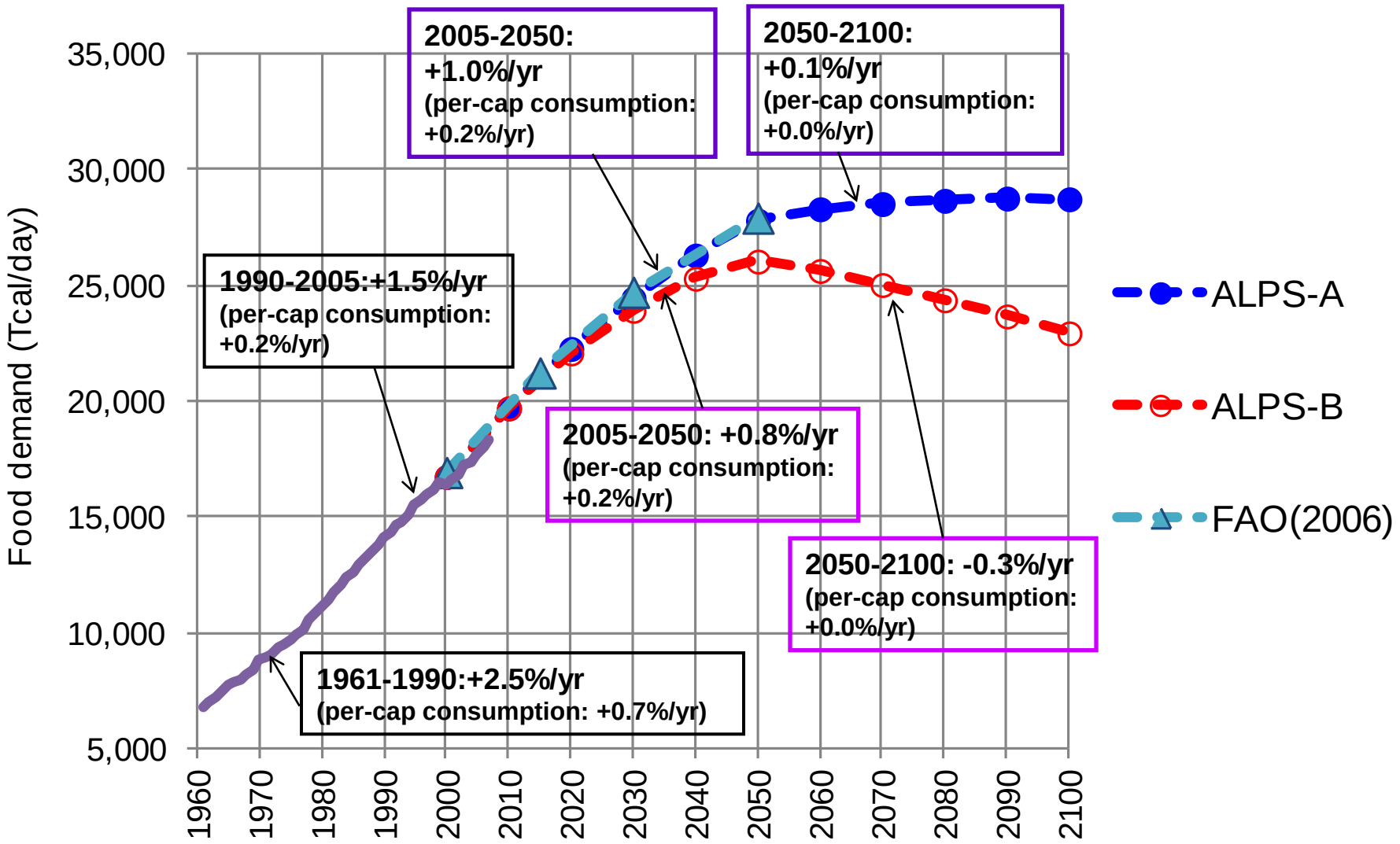
People Living in Poverty



Note: Constant and variant international poverty lines are adopted by using the poverty thresholds of income at constant 1.25$/day ('C') and at 1.25-2.83$/day affected by oil price increase ('V'), respectively.

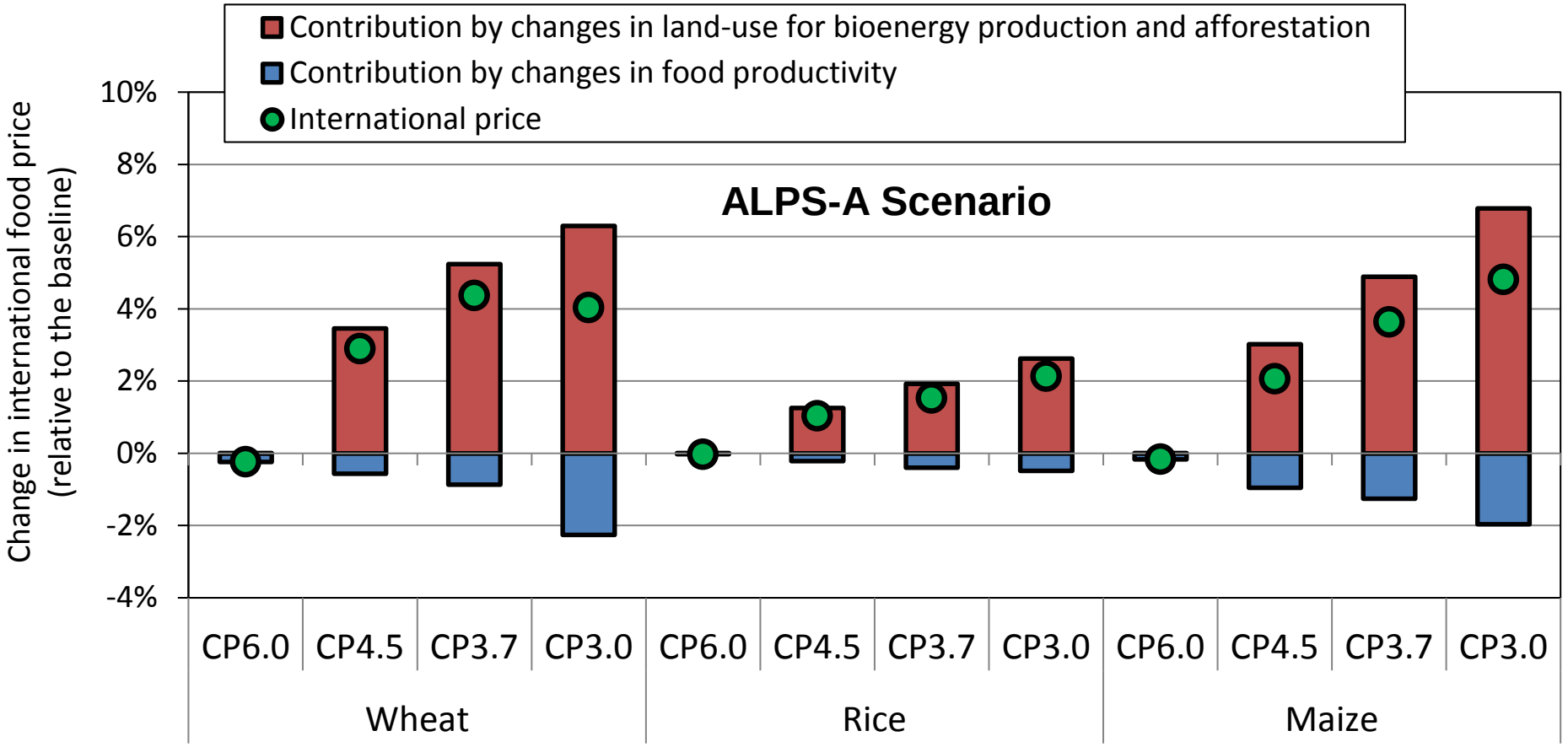
- **As global economy grows, people living in poverty will decrease in the future**
- **Population below poverty line for CP3.0 will be slightly larger than others due to over- burden of mitigation efforts**

Global Food Demand



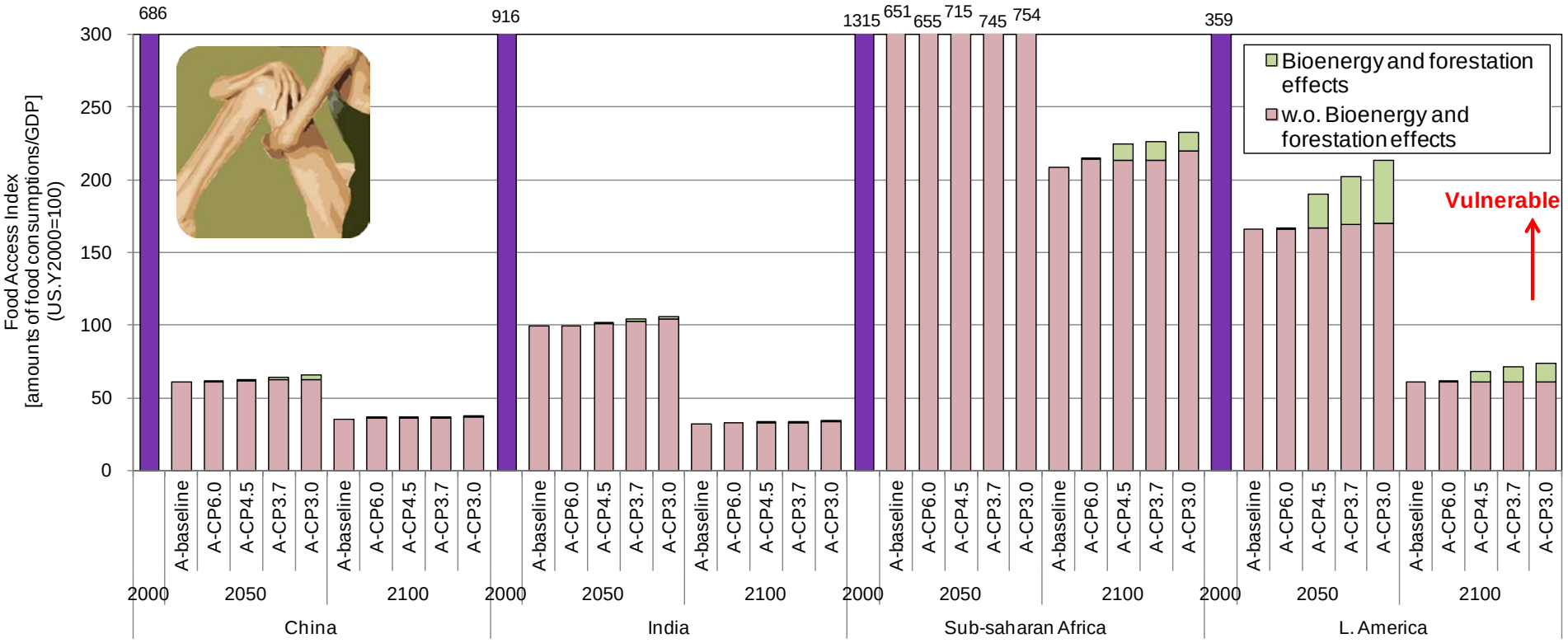
Population decrease has larger impacts on food demands than per-capita income increase.

Food Price Changes in 2050



- **Food prices are affected by food productivity change and land use change.**
- **Ambitious climate goal brings food productivity growth, but limits crop land for food production due to land-use for bioenergy production and afforestation.**

Food Access Index



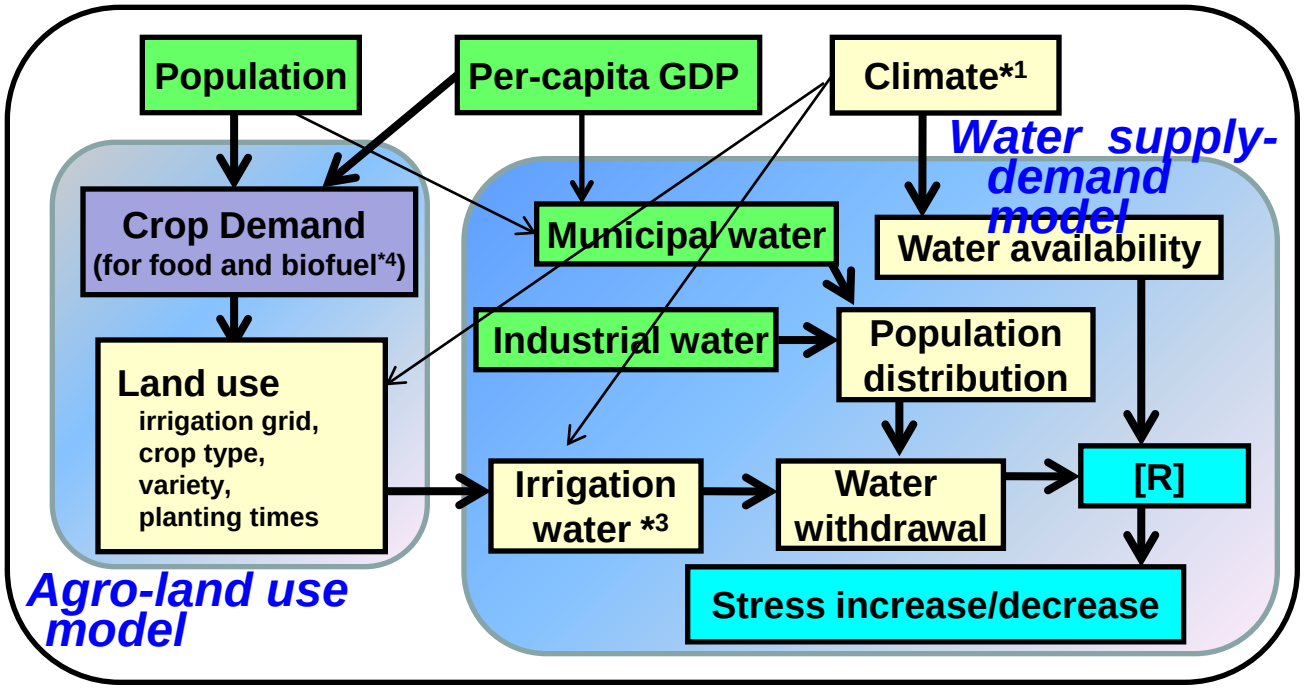
- **Food access index: Food consumption (food demand * food prices) / GDP**
- **Income growth mitigates vulnerabilities of food access. The impact of temperature increase on food productions are relatively small compared with the effects of income increase. Large scale forestation and bio-energy production for deep emissions cuts slightly increase vulnerabilities of food access.**

Water Stress

- **Water stress index**

$$[R] = \frac{\text{Annual municipal, industrial and agricultural water withdrawal}}{\text{Annual water availability}}$$

- **Water supply-demand model + Agro-land use model**



Hayashi et al (2013)

grids

river basins*2

Countries

32 or 54 regions

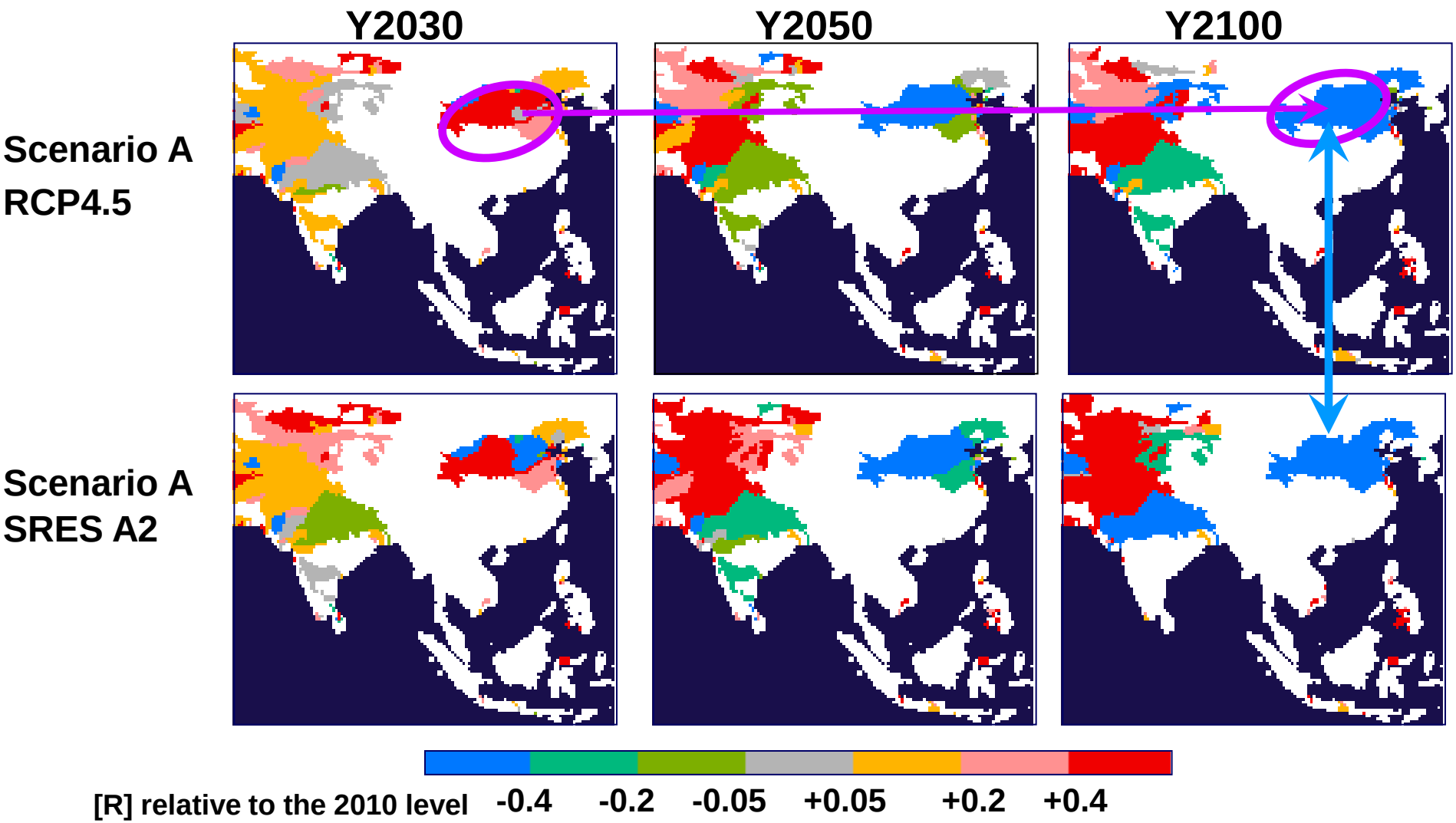
*1 Pattern scaling AOGCM's projections (MIROC3.2 (Medres))

*2 TRIP (Oki, 2001).

*3 Irrigation efficiency (Döll and Siebert, 2002)

*4 A constant demand for biofuel at the 2010 levels.

Change in the water stress in Asia



- Rather than climate scenarios difference, the long term socio economic changes has bigger impact on the water stress

Conclusion

- **Most of indicators shows that the impacts of socio-economic development on sustainability are greater than those of climate change.**
- **There are synergies between climate change and other sustainable development issues as well as trade-offs.**
- **Consistent assessment for climate change and other sustainable development challenges help well-balanced decision making.**
- **It is important to maintain balance in multiple sustainable objectives for our future well-being.**

- **Our socio-economic scenarios are in process of updates in line with SSPs. Our research agenda includes distributional issues.**