Avoid climate change impacts on human health through undernourishment in the context of the Paris Agreement

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Potsdam, Germany | October 11th-13th, 2017

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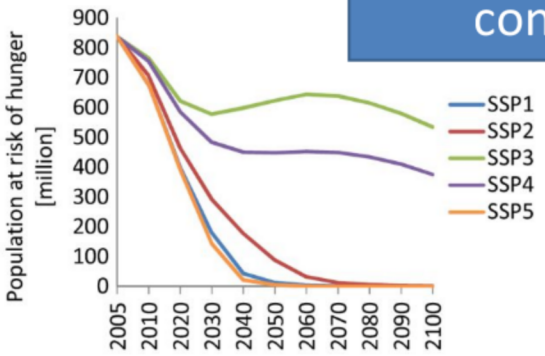
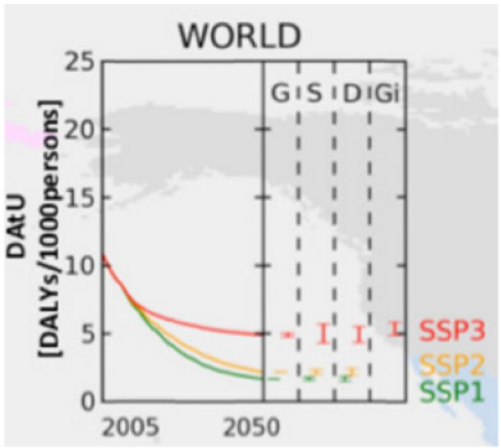
Climate-induced undernutrition



Hasegawa et al., 2015,ERL



Ishida et al., 2014

Socio-economic conditions

Climate change

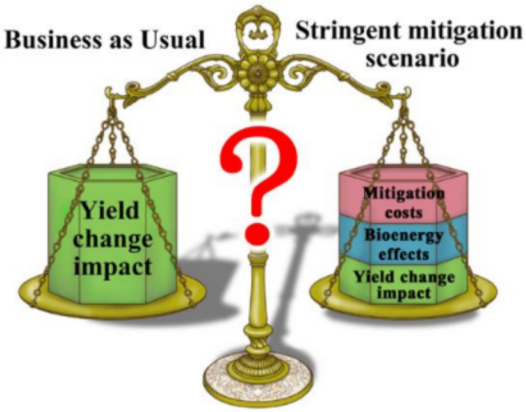
Adaptation

Hasegawa et al., 2014

Mitigation

Hasegawa et al., 2015, EST

Undernourishment/ Risk of hunger



Health impacts

Economic implications

Hasegawa et al., 2016

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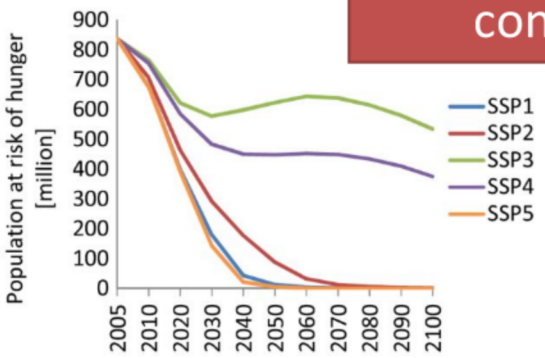

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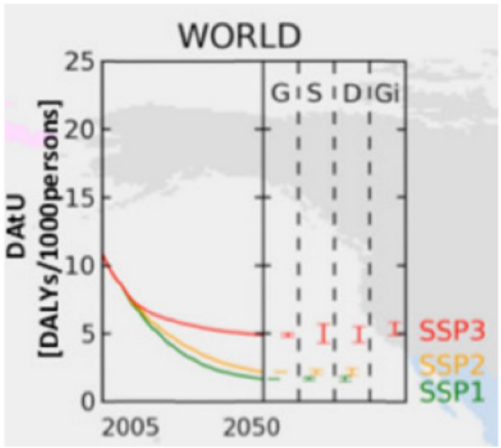

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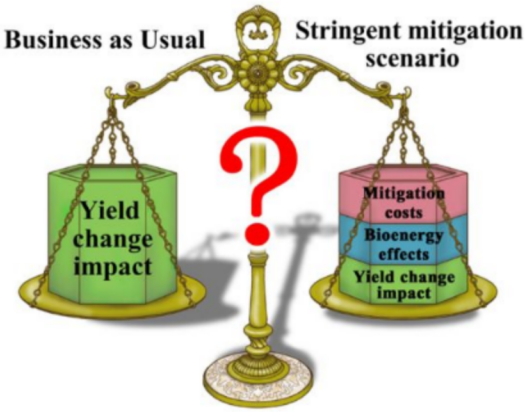

Health impacts

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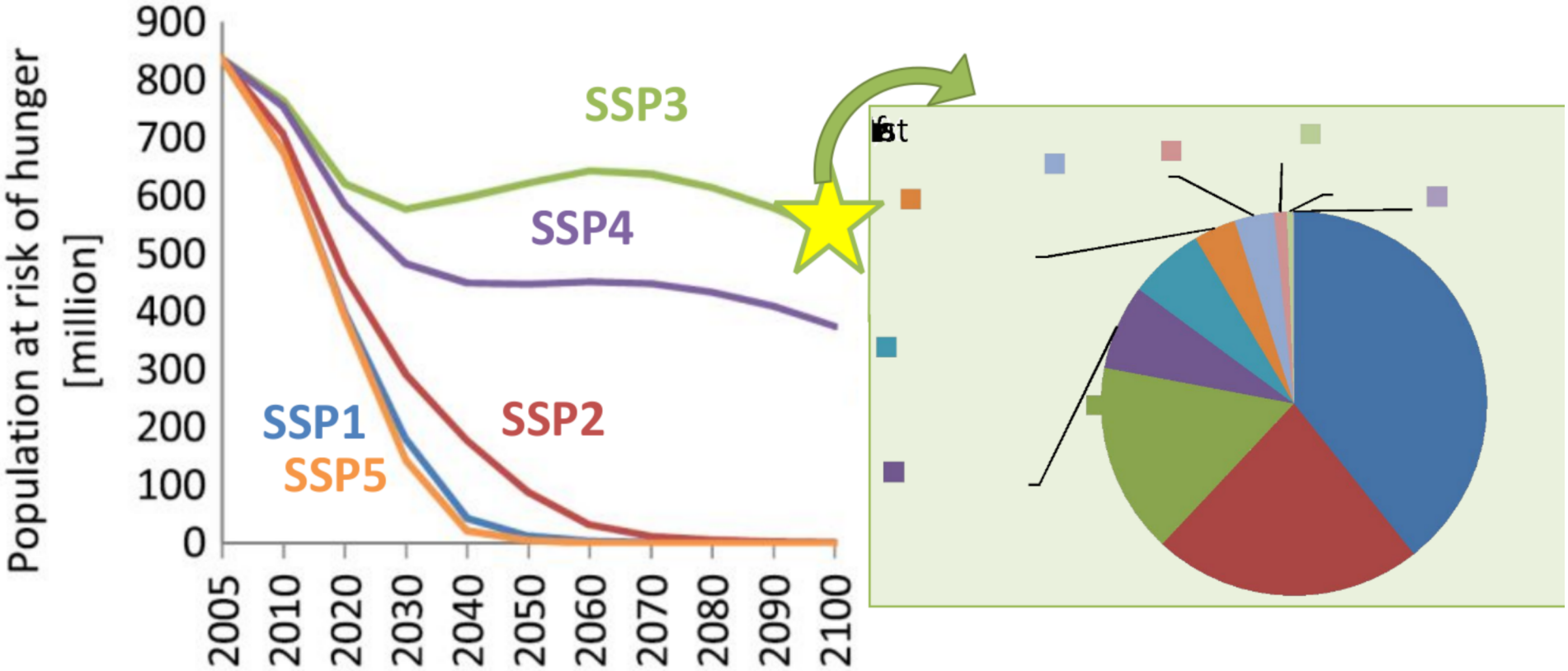
Risk of hunger in the 21st century

The 21st-century risk of hunger strongly differs among different socioeconomic conditions.



Hasegawa et al., 2015 ERL

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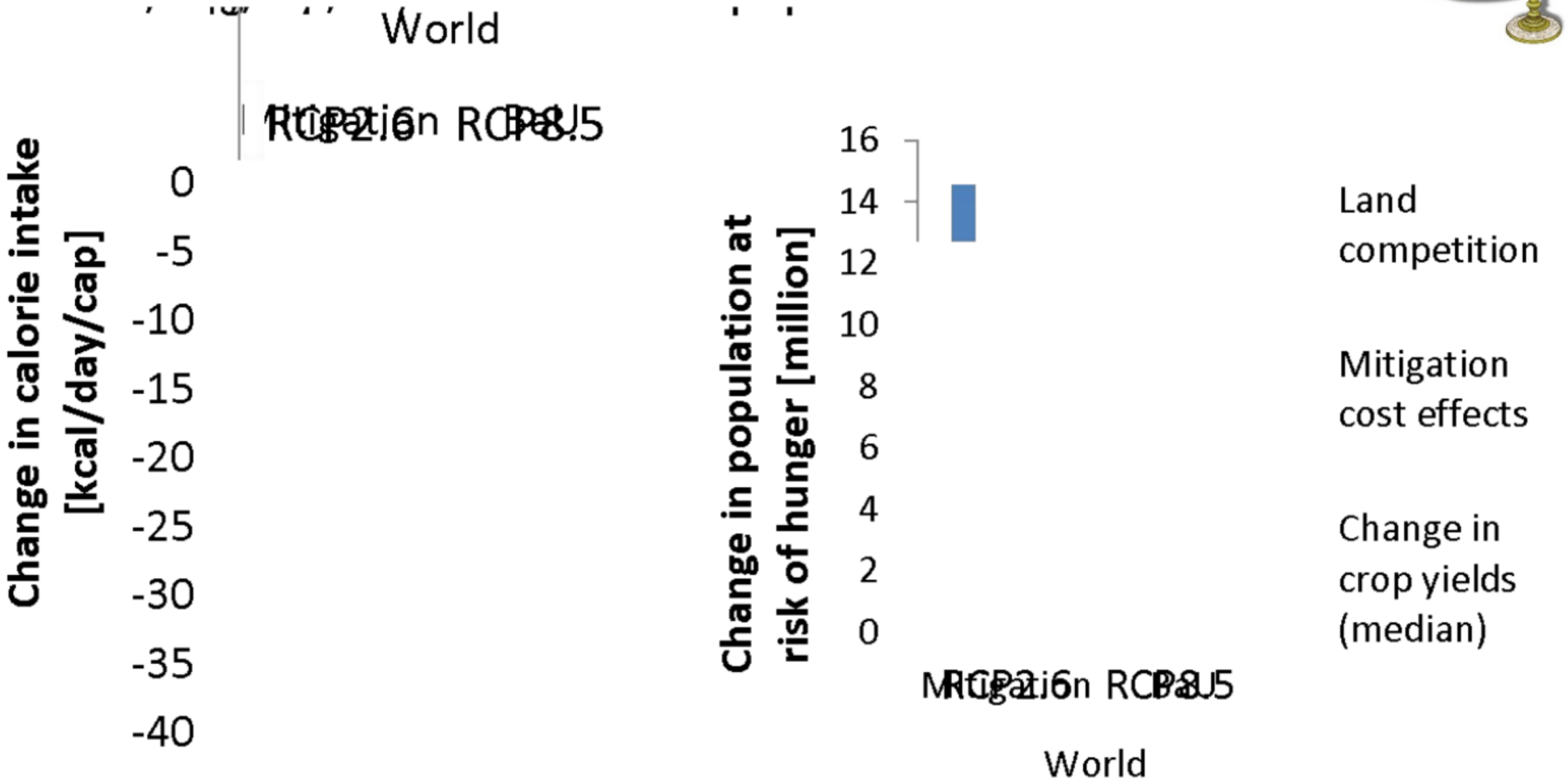
Consequence of Climate Mitigation on the Risk of Hunger



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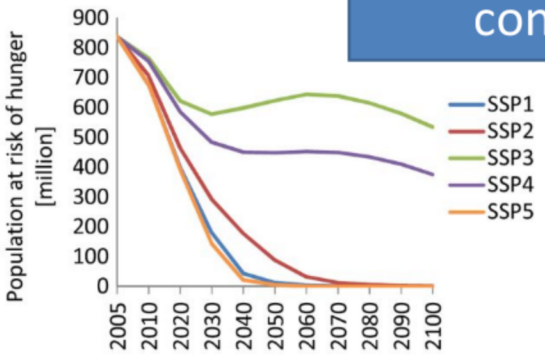
Hasegawa et al., 2015 EST

Earlier studies about undernourishment



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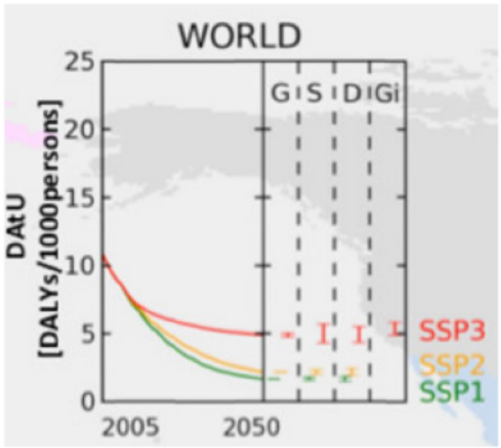

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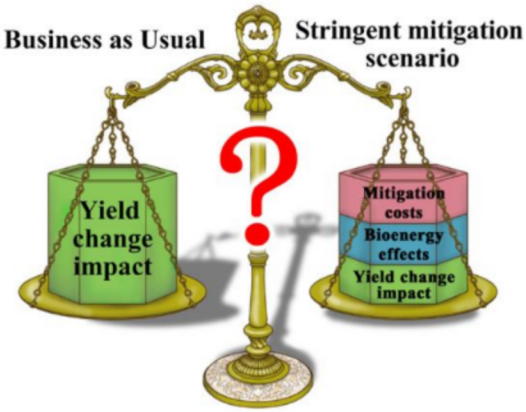

Health impacts of undernutrition/under weight

Economic implications

Hasegawa et al., 2016

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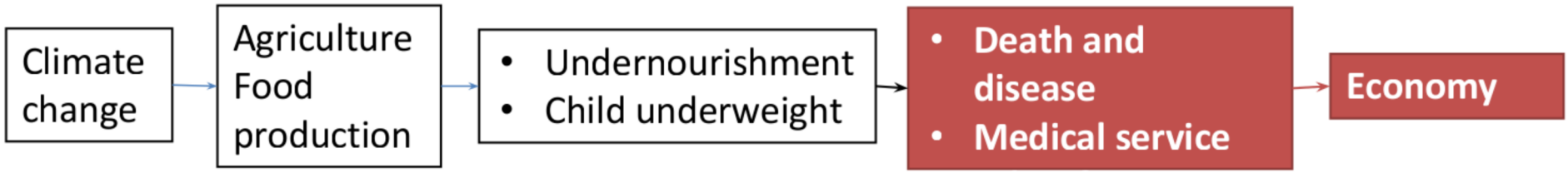
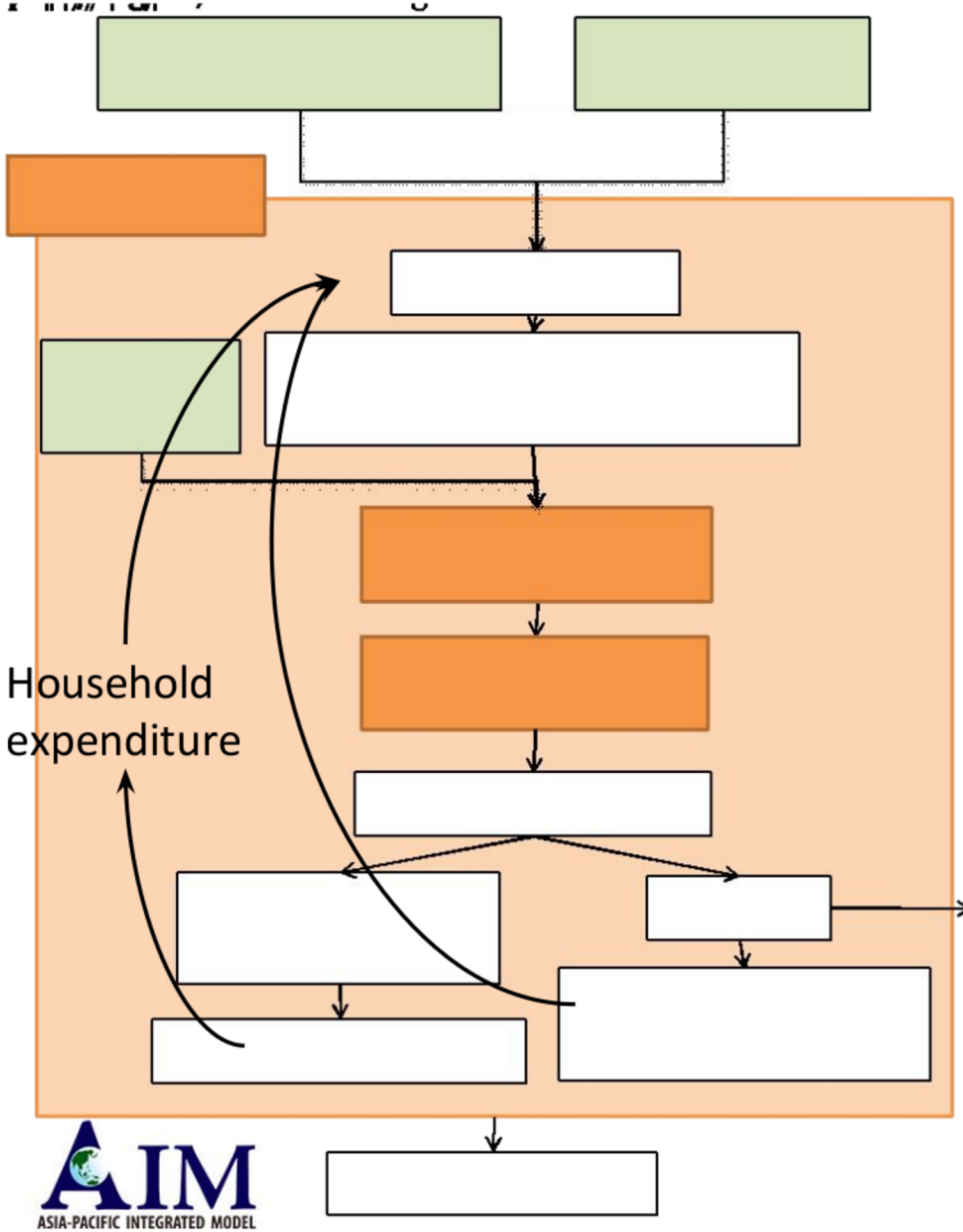
Research question

"How much climate change impact on undernutrition and economy?"

- Decreased labor force and increase in medical cost
- Value of lives lost.



Modeling framework



Health-related items

- Population at risk of hunger
- DALY
- Medical expenditure
- Mortality
- value of life lost

Two feedbacks

- 1) Mortality fed back to population and labor force
- 2) Medical cost fed back to household expenditure

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Hasegawa et al. 2016

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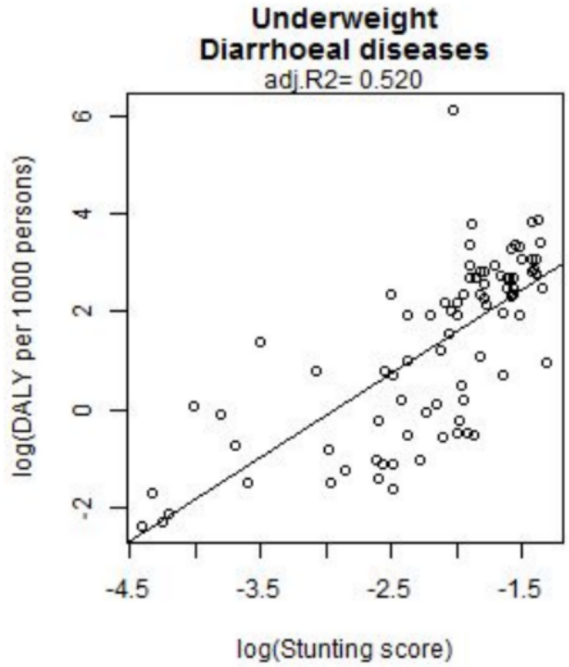
DALY model

- Ishida et al. (2014)

$$\log\left(\frac{DALY_{t,c,d}}{POP_{t,c}}\right) = \varphi_d + \psi_d \cdot \log\left(Y_{t,c}\right)$$

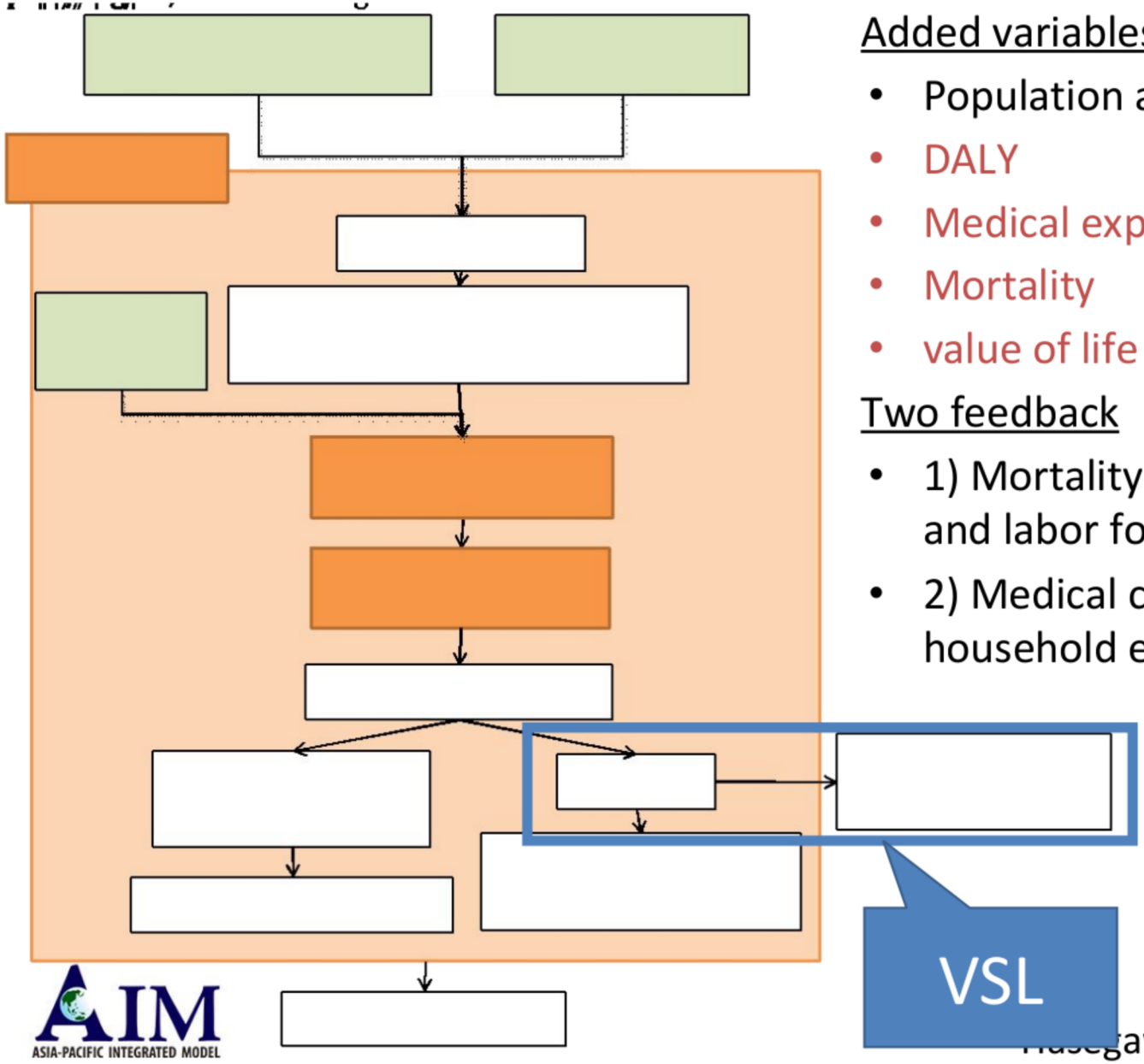
- t: year, c: country, d: disease;
- $DALY_{t,c,d}$: DALY due to disease d (year)
- $POP_{t,c}$: population
- $Y_{t,c}$: Proportion of children stunted.



Disease (d)	φ	ψ	Adjusted R^2	t-value
Diarrhoeal diseases	5.03	1.71	0.52	9.47
Pertussis	2.68	1.90	0.41	7.63
Measles	3.11	2.53	0.23	4.37
Tetanus	3.93	3.20	0.38	6.98
Meningitis	2.27	1.49	0.45	8.30
Malaria	4.32	3.80	0.38	7.05
Lower respiratory infections	4.98	2.02	0.52	9.51
Birth asphyxia and birth trauma	2.70	2.12	0.70	13.52
Protein-energy malnutrition	3.38	0.98	0.44	8.10

Log(Proportion of children under 5 year of age stunted)

Modeling framework



Added variables

- Population at risk of hunger
- DALY
- Medical expenditure
- Mortality
- value of life lost

Two feedback

- 1) Mortality fed back to population and labor force
- 2) Medical cost fed back to household expenditure

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Scenario settings

Socioeconomic conditions

Climate conditions	SSP2	SSP3
No change		
RCP8.5		
RCP2.6		

Uncertainty considered

- 4 crop models
- 5 climate models
- RCP2.6, RCP8.5
- Uncertainty ranges of VSL.

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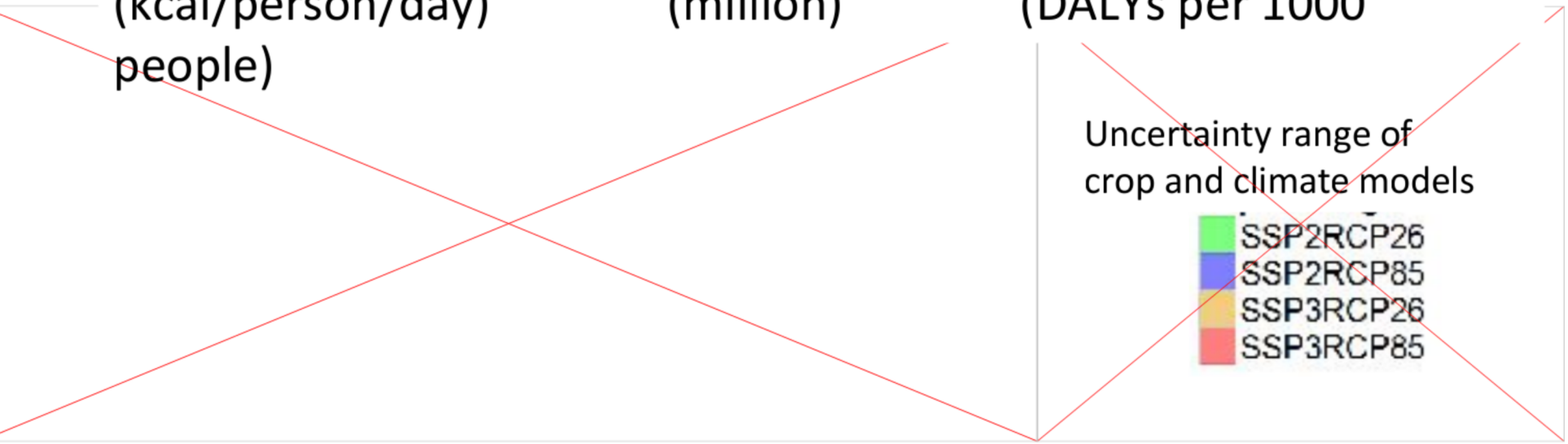
Effects of climate change impacts on food and human health

- Climate change decreases food calorie intake and increase hunger and undernutrition.
- The negative effects are reduced in mitigation case (RCP2.6).
- Future undernutrition depends on socioeconomic conditions rather than climate conditions.

Food intake (kcal/person/day)

Undernourishment (million people)

Undernutrition (DALYs per 1000



Black line represents a case with no climate change; ranges show crop and climate model uncertainty.

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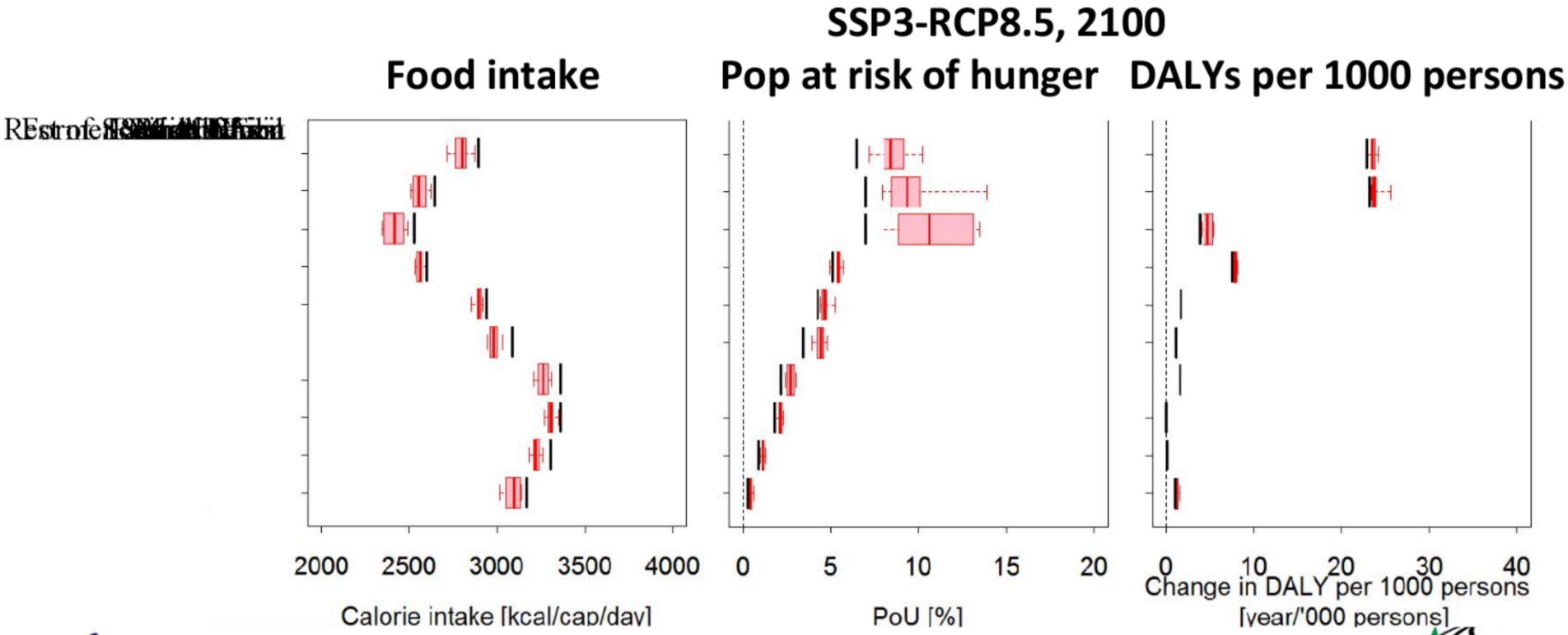
Hasegawa et al. 2016 NIES JAPAN

Regional distribution: climate impacts

- Widely different among regions
- Large impacts in India, South Asia and Africa

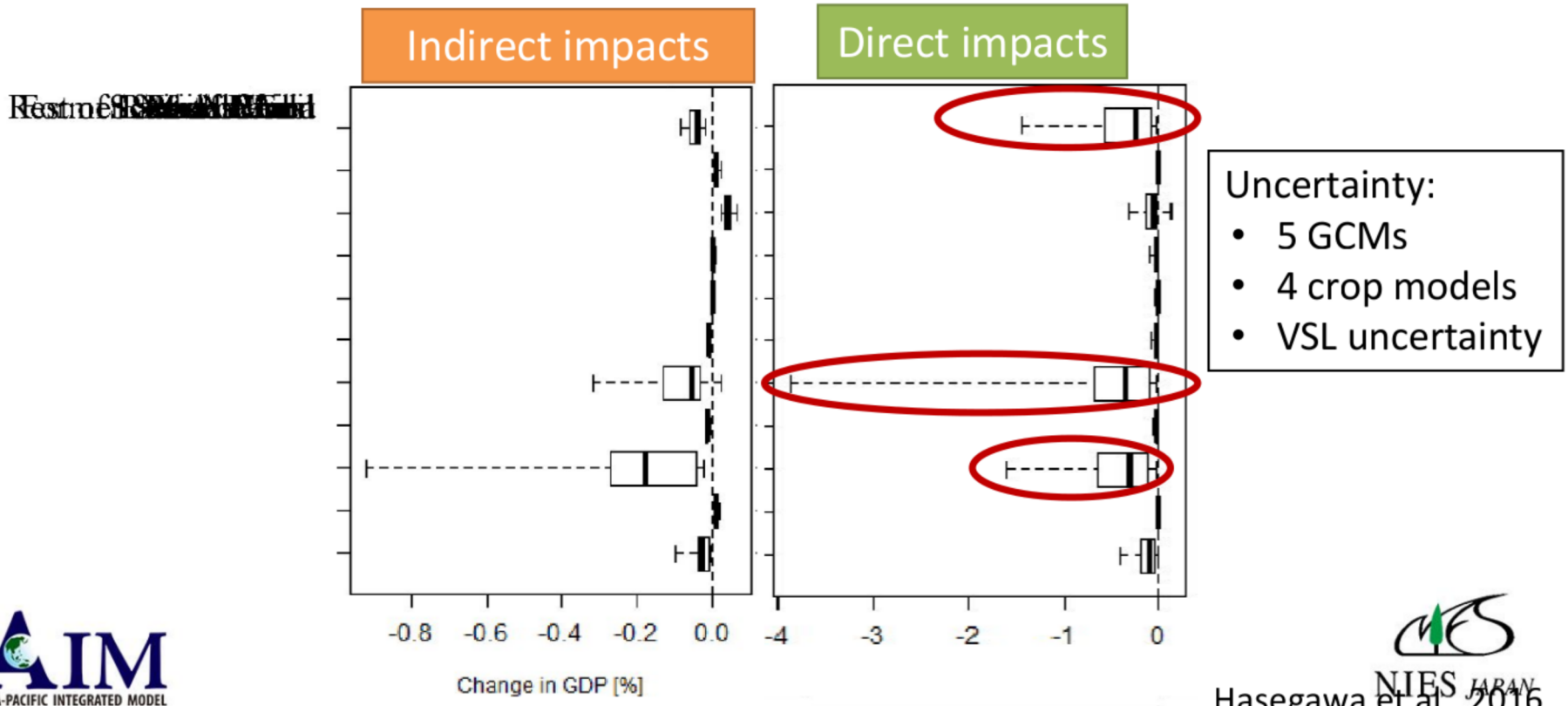


Black lines: NoCC case; box plots show climate change impacts.

Hasegawa et al. 2016

Economic implications of health impacts through undernourishment: SSP3-RCP8.5 in 2100

- **Indirect impacts (changes in labor force & healthcare costs):** -0.1–0.0% of Global GDP
- **Direct impacts (value of lives lost)**: -0.4-0.0% of Global GDP; -4.0% at highest at regional levels

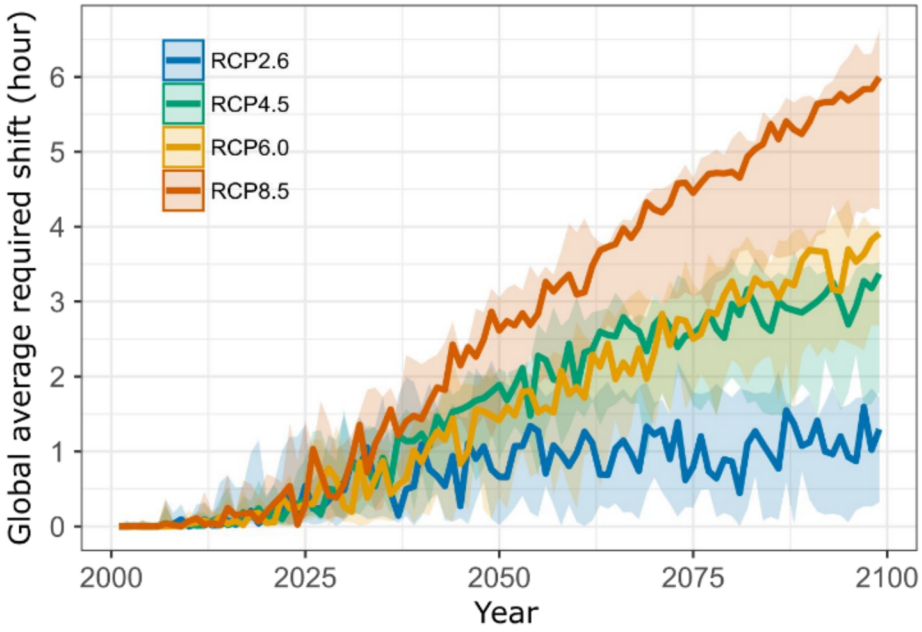


Hasegawa et al., 2016

Labor productivity loss caused heat stress: Shifting working time as an adaptation measure

Daytime excessive heat can be avoided by working in early morning.

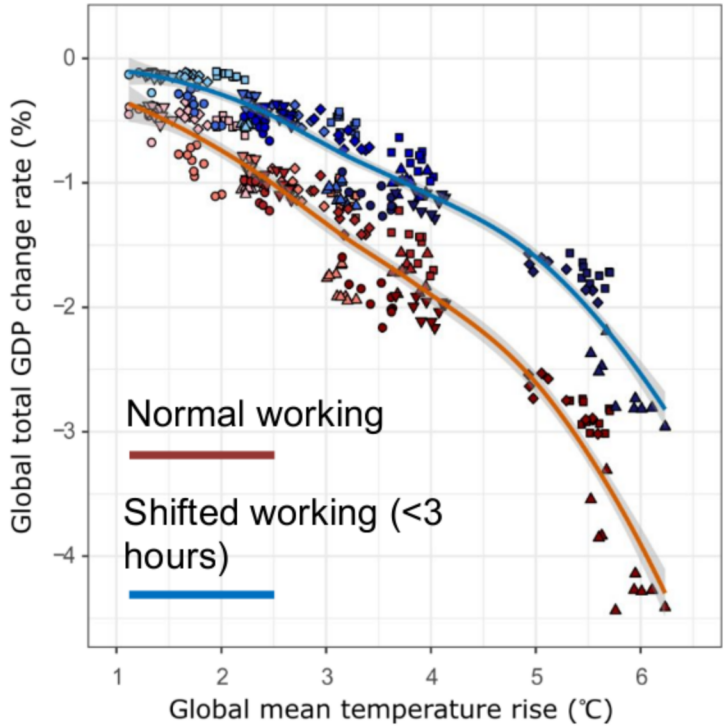
Required shift of working time to keep current-level workable time.



Under RCP8.5, start time of working has to be shifted by 6 hours.

start working at 3:00AM

Effectiveness of realistic (<3 hours) shift on the GDP loss reduction.



3-hour shift is effective, but climate-change mitigation is still important.

Takakura et al. (under review)

Summary

- A first study to evaluate economic impacts of undernutrition and mortality.

- Climate change impact on undernutrition is not negligible if considering mortality.
- Climate change impact on undernutrition can be reduced by climate mitigation.

- But the strict emissions cuts toward Paris Agreement could indirectly lead to more people at hunger and undernutrition.

- Highlight importance of implementing complementary measures (e.g. food aid) together with mitigation measures.

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ご清聴ありがとうございました

Thank you for your attention

This work was supported by the Global Environment Research Fund of the Ministry of the Environment of Japan, Integrated Climate Assessment–Risks, Uncertainties and Society (ICA-RUS) (S10), and the Research on the development of an integrated assessment model incorporating global-scale climate change mitigation and adaptation (S-14–5)

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Asia-Pacific Integrated Model

http://www-iam.nies.go.jp/aim/index.html

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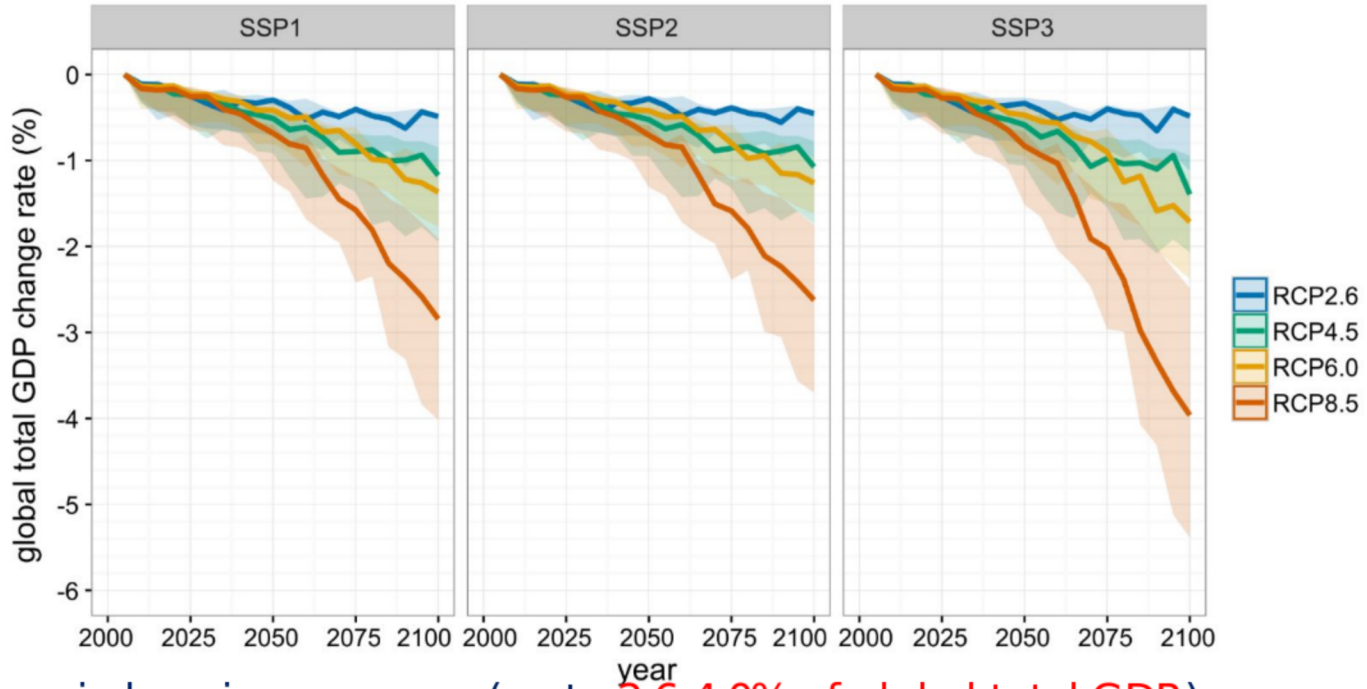
Impacts of labor productivity loss due to heat stress

Under the harsh hot environment, taking breaks is recommended by ISO to prevent heat-related illnesses. labor productivity loss

Its economic impact is quantified by the AIM/CGE model.



Takakura et al., (2017) ERL.

Economic loss is enormous (up to 2.6-4.0% of global total GDP).
Outdoor work (e.g. construction) is the primary cause of the loss.
The loss rate is comparable to the cost of the climate mitigation.

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Summary

- We estimated the economic cost of workplace heatstroke prevention.
- Construction sector showed a large impact.
  - Separating construction section from industrial sector would be nice for more detailed analysis.
- Air conditioning device will play important role as an adaptation measure for indoor work.
- Adaptation measures for outdoor work (e.g. shifting worktime) will need further study.

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Socioeconomic conditions

Climate conditions	SSP1	SSP2	SSP3
NoCC			
RCP8.5			
RCP6.0			
RCP4.5			
RCP2.6			

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Economic value of Life lost

- **Value of Statistical Life (VSL)**
  - based on the WTP to avoid the risk of death.
  - High income countries are able to place a higher value on their lives and cost to save a life can be lower in low income countries.

- VSL is adjusted according to income levels (OECD, 2012).
  - An observed data in China was used as a reference and applied to other mid- or low- income regions.

- Uncertainty of VSL is considered by using a range of its observation.

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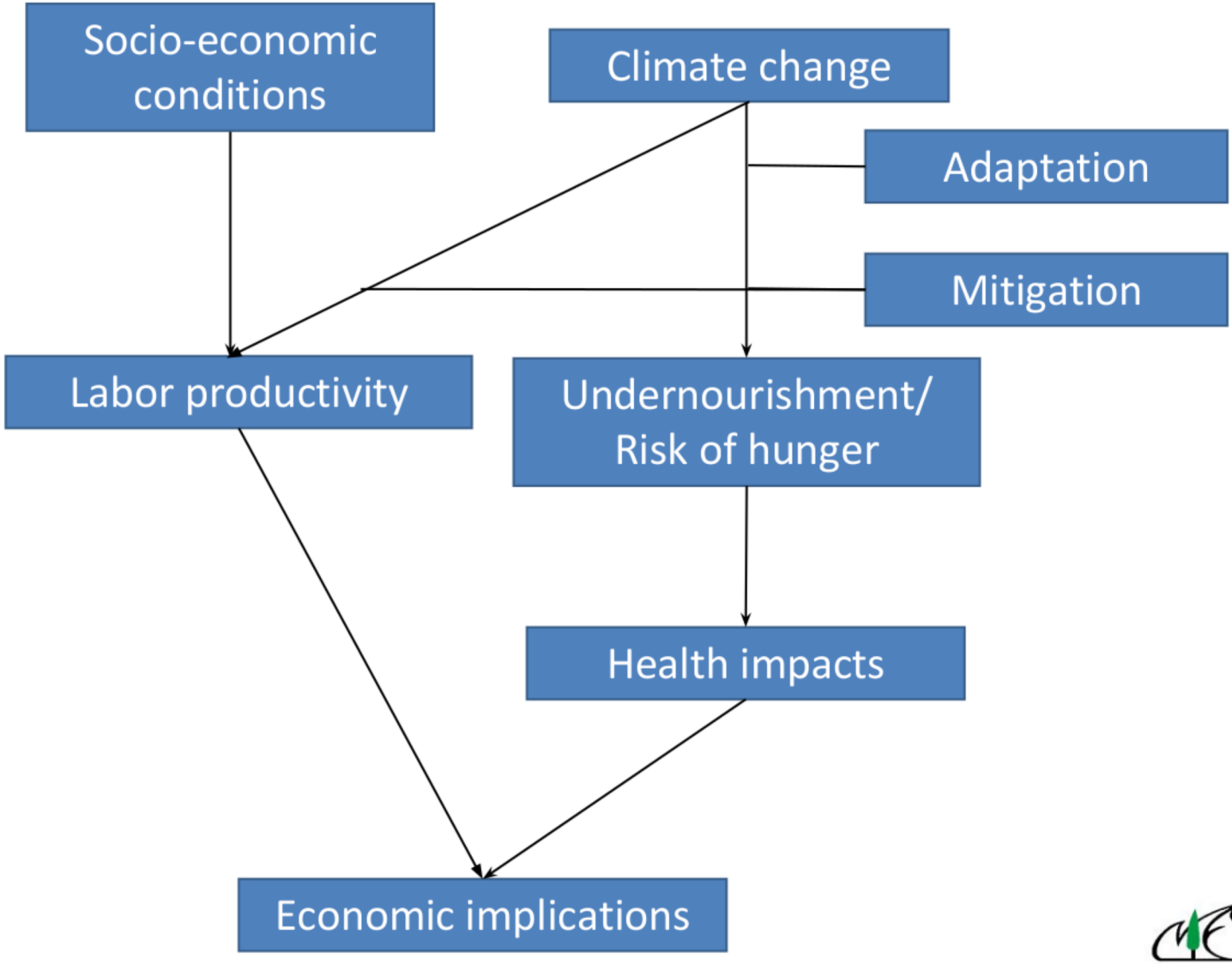
Earlier studies about undernourishment



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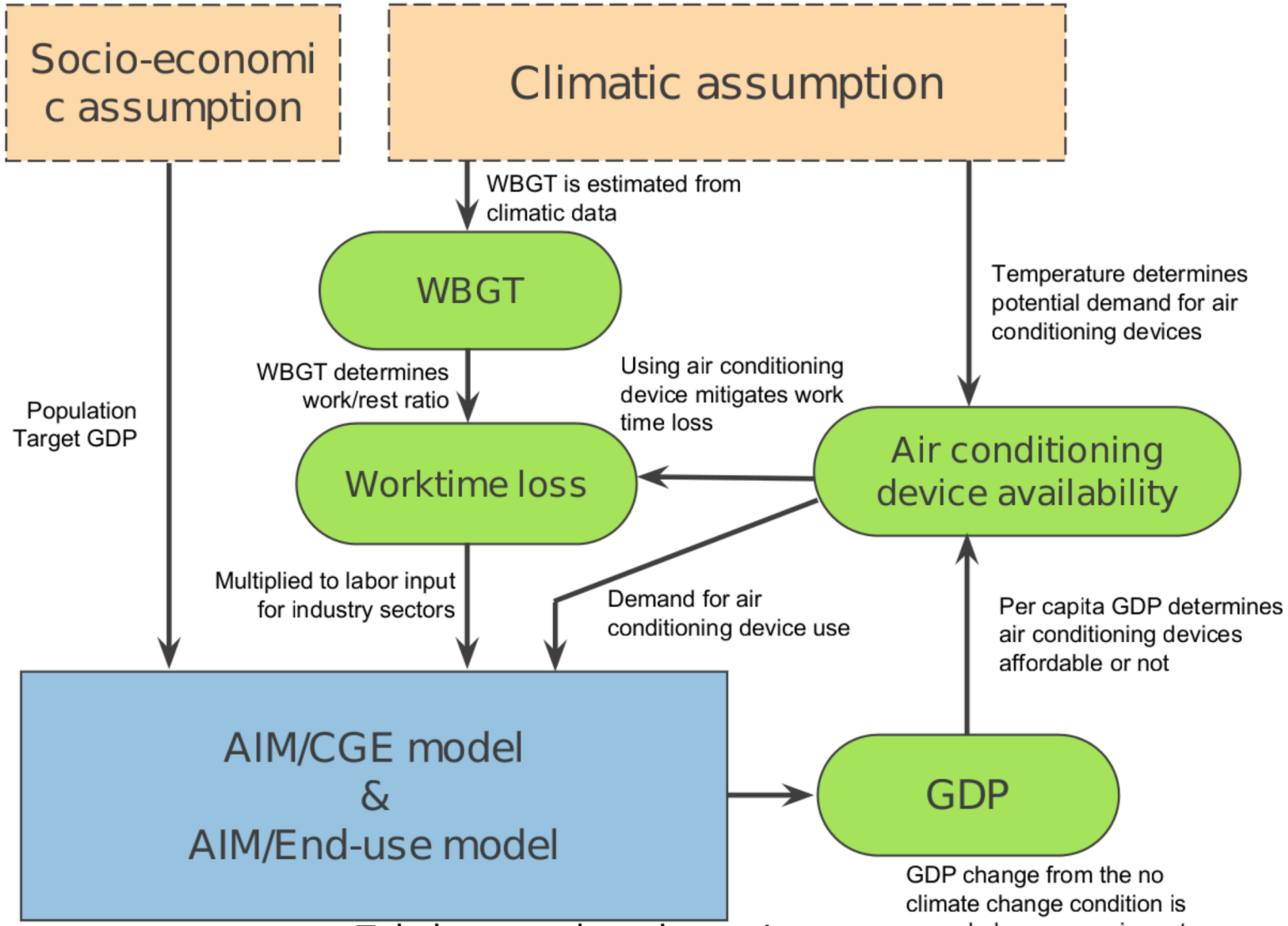
Framework for economic cost estimation



Takakura et al. under review

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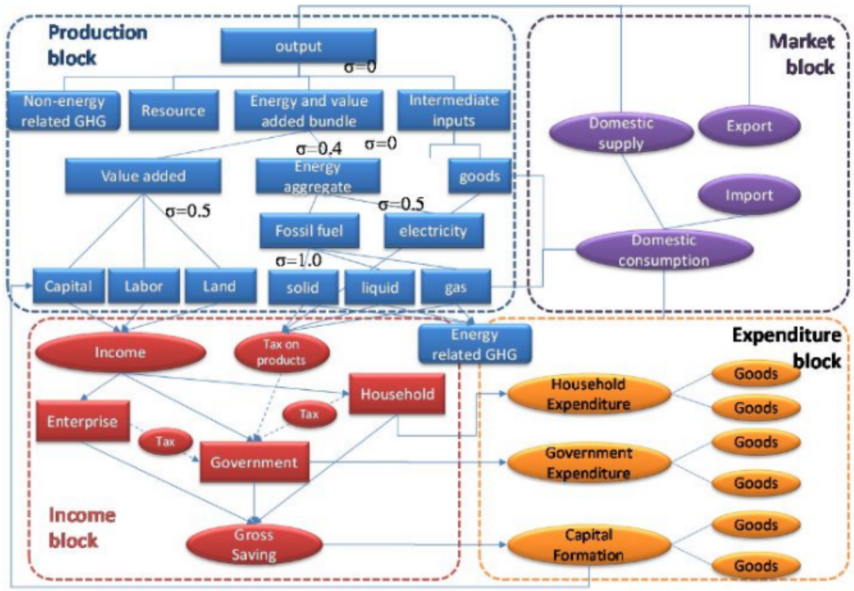
the Asia-Pacific integrated model/computable general equilibrium (AIM/CGE)

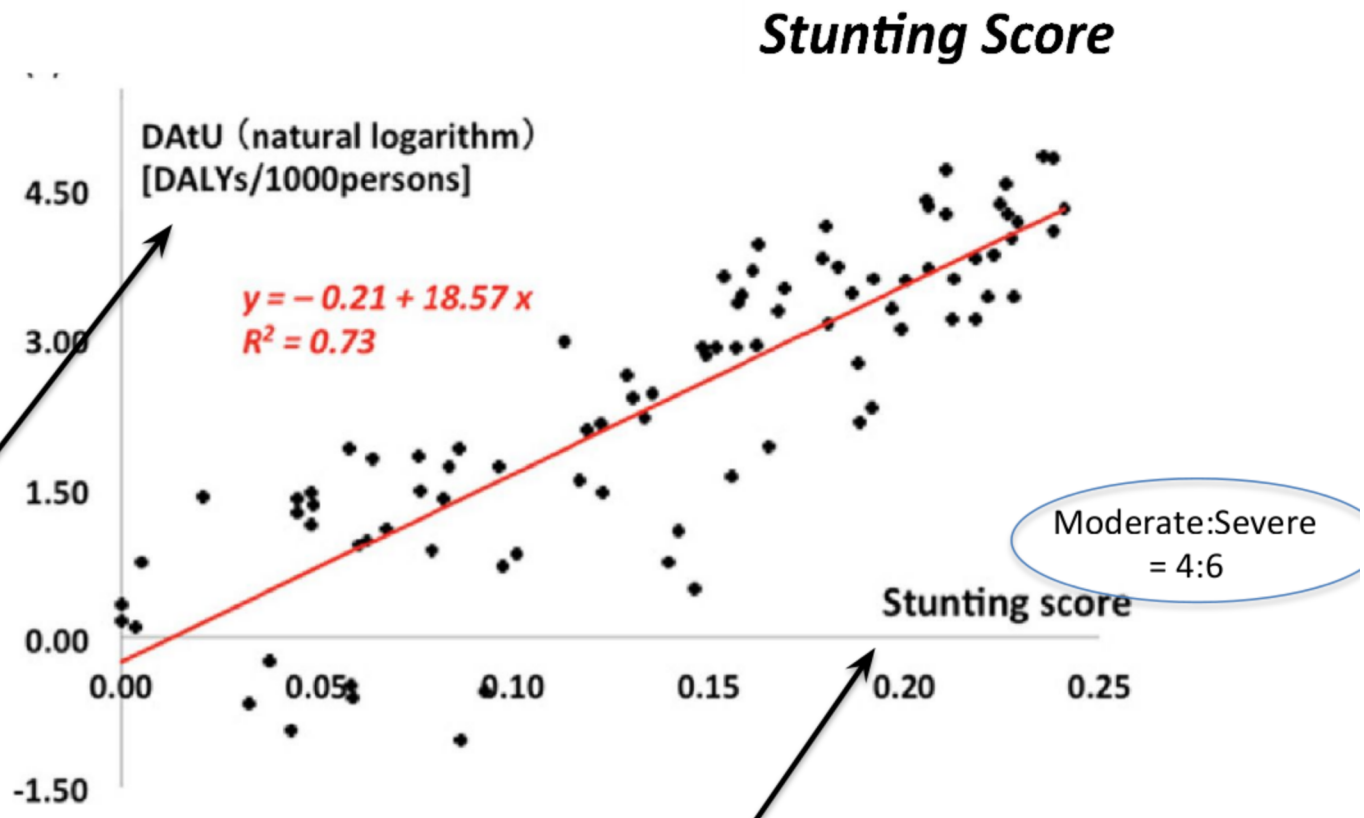
- Computable General Equilibrium model
- Global
- Whole economy
  - 42 industrial classifications incl. 10 agricultural sectors
- Fundamental idea:
  - supply = demand, balanced by price mechanism
    - Household: utility maximization
    - Enterprise: profit maximization
- Economic structure is described with consistency.
- Recursive dynamic (1 year step)



Model description

- Country-level
- 90 Samples
- Only in 2004*

* DALYs data are available only in 2004



Estimated from
- **Region-level DAtU****
- **PAF (Population Attributable Fraction)**
- **Per capita GDP**

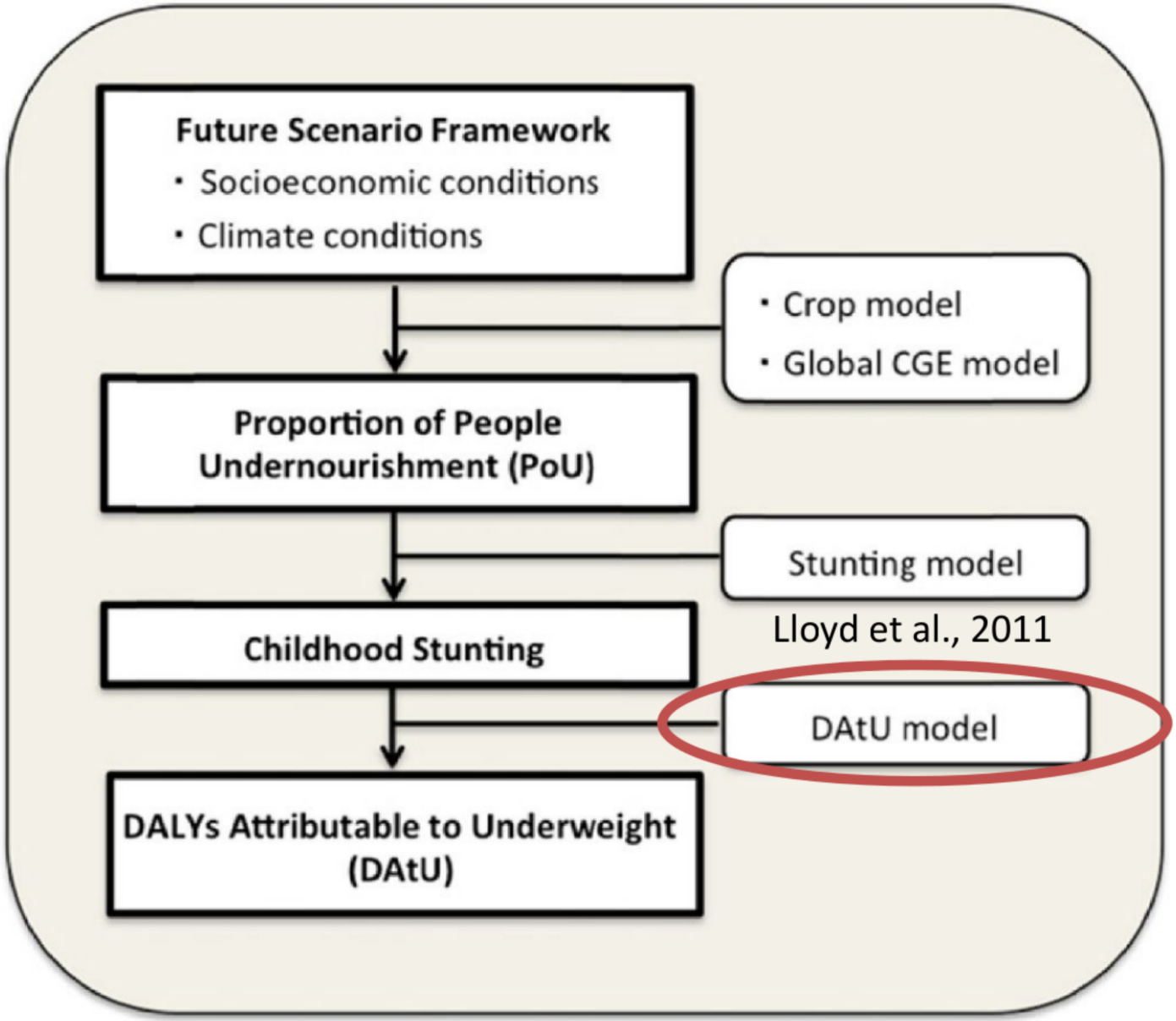
** Because country-level DAtU data are not available

Calculated from
- **Proportion of Undernourishment**
- **Per capita GDP**
- **GINI coefficient** **(Lloyd et al., 2011)**

Ishida et al. 2014

2. Method

Research framework



Lloyd et al., 2011

Ishida et al. 2014

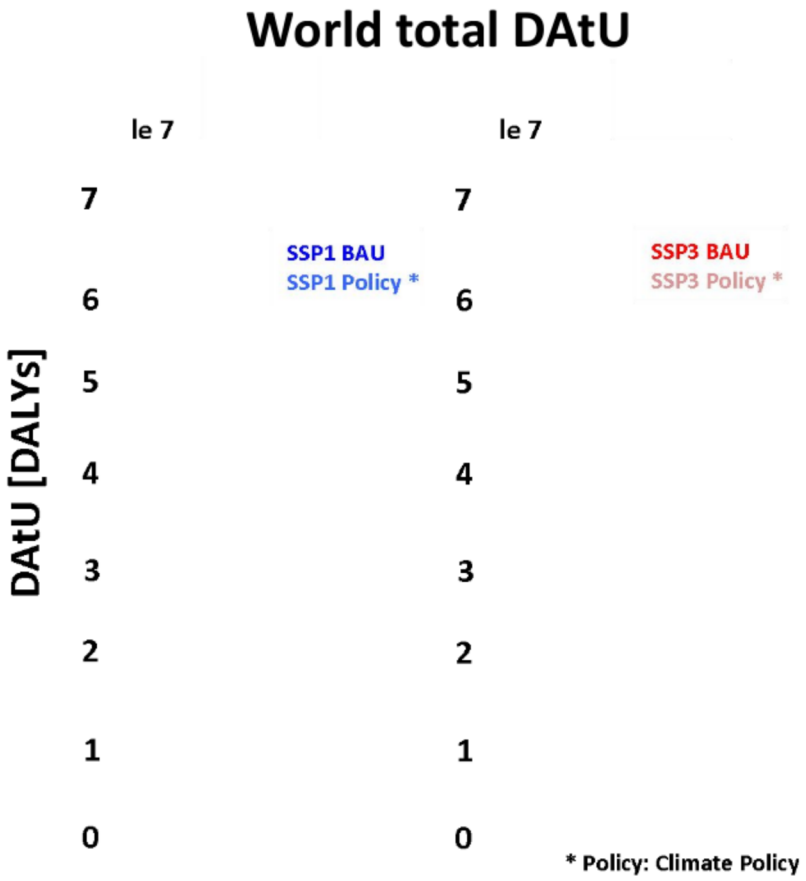
Combination of the scenarios

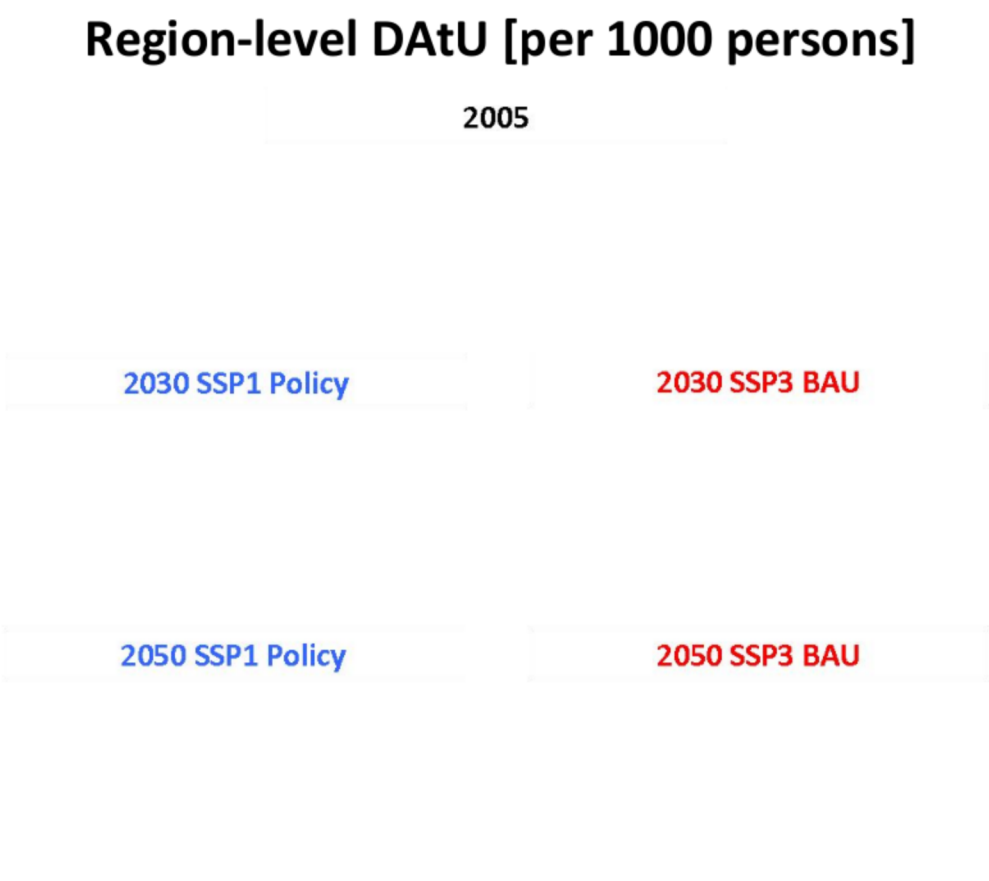
	RCP2.6	RCP4.5	RCP8.5
SSP1	SSP1 Policy	SSP1 BAU	
SSP2		SSP2 Policy	SSP2 BAU
SSP3		SSP3 Policy	SSP3 BAU

SSP: Shared Socio-economic Pathways
RCP: Representative Concentration Pathways
BAU: Business As Usual

Ishida et al. 2014

3. Results&Discussion World & Region-level DAtU





Little impact of Climate Change (Differences between BAU and Policy)

Ishida et al. 2014