International Institute for Applied Systems Analysis
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science for global insight

Comments on Modeling Uncertainty Project (MUP)

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Yale Modeling Under Uncertainty Project

Snowmass – 27 July 2015

Modeling Uncertainty Project

- "Uncertainty is pervasive in (the economics of) climate change and yet is poorly quantified and interpreted
- It is wrought with deep uncertainties and there are both known and almost certainly important unknown unknowns (Granger Morgan, Snowmass)
- Human intentionality is a major uncertainty influencing both parameters and structure
- Project essential for IAMs and understanding deep uncertainties of climate change

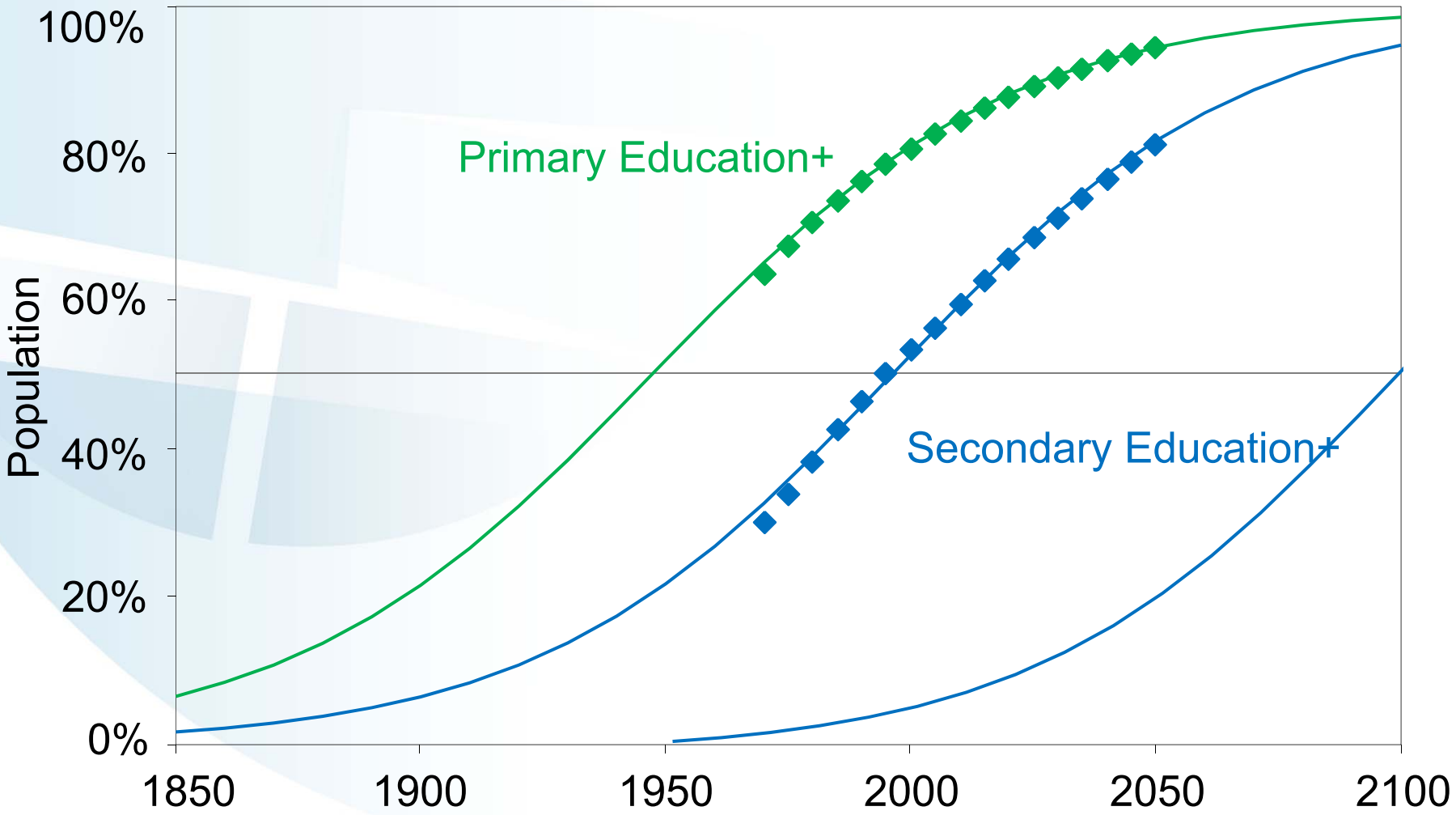
Modeling Uncertainty Project (MUP)

- Much greater parametric than structural uncertainties across all models
- Economic variables and damage function higher uncertainty than climate variables
- Similar projections of baseline parameters, diverging in alternative cases (high levels)
- Distributions of key outputs very similar, e.g. quantiles vary by less than ½°C
- Doubling all uncertainties results in almost doubling of the output uncertainties
- Little evidence for “fat” tails of outputs

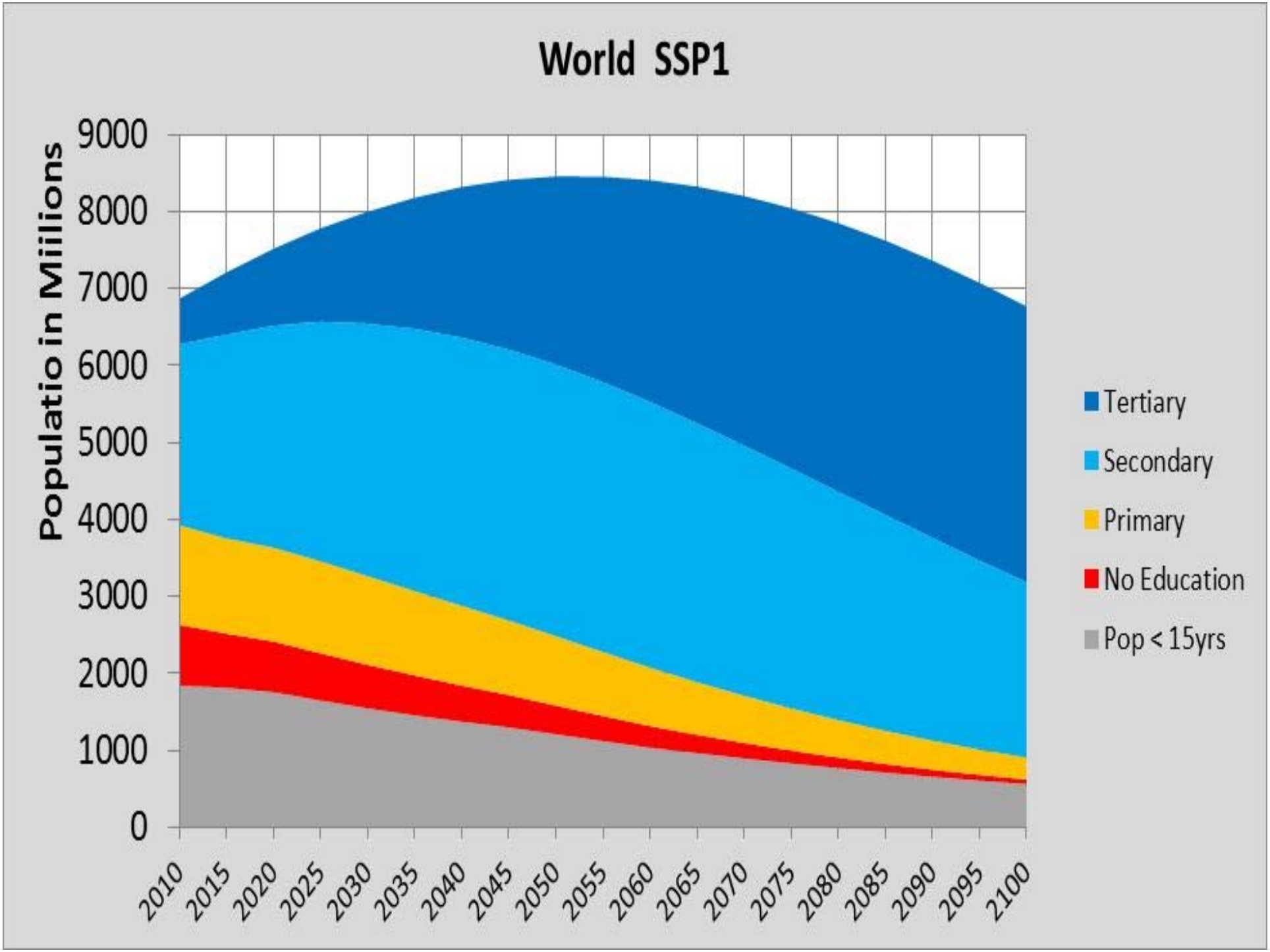
Modeling Uncertainty Project (MUP)

- Much greater parametric than structural uncertainties across all models
  - ➢ All models are "top-down" macroeconomic approaches; other approaches would likely increase the structural uncertainties, but make comparisons much more difficult
  - ➢ More detailed human capacity and technological learning could lead to richer structural variability and diversity
  - ➢ Human capacity has is important for productivity, environmental awareness, etc.

Global Educational Attainment



Source: Lutz et al., 2007


World SSP1
Populatio in Miilions
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2010
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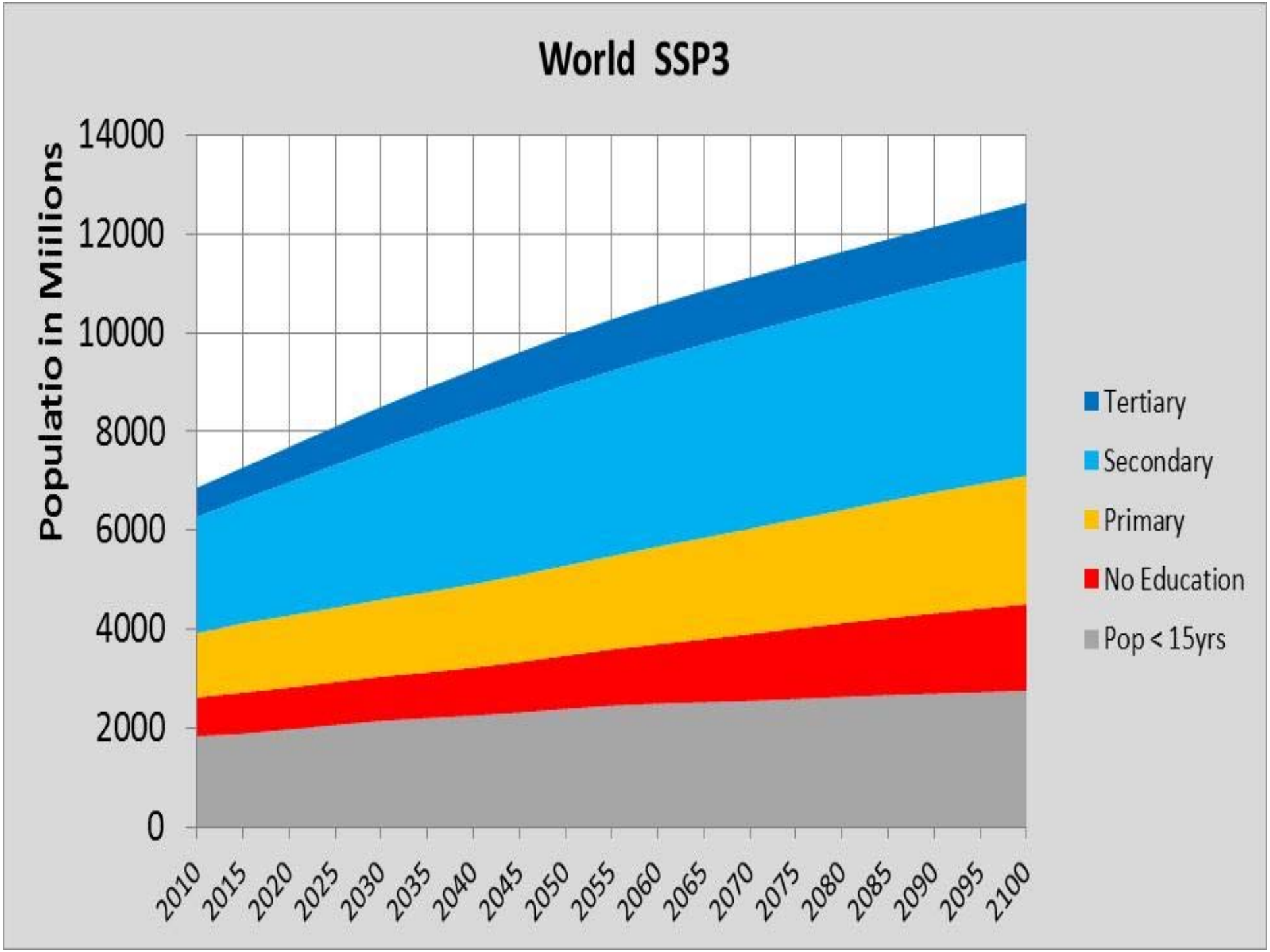
Tertiary
Secondary
Primary
No Education
Pop < 15yrs


World SSP3
Populatio in Miilions
14000
12000
10000
8000
6000
4000
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2075
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2085
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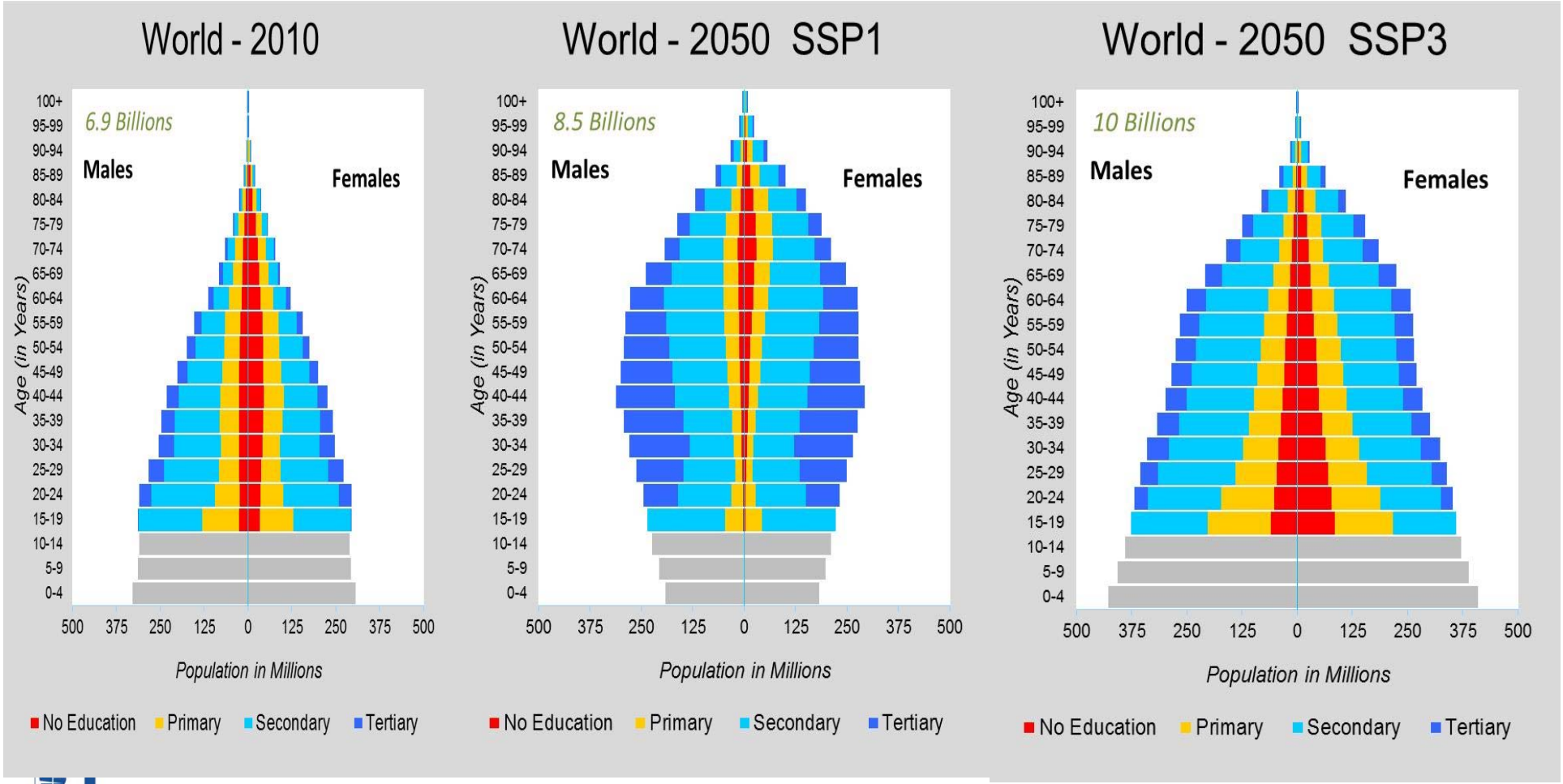
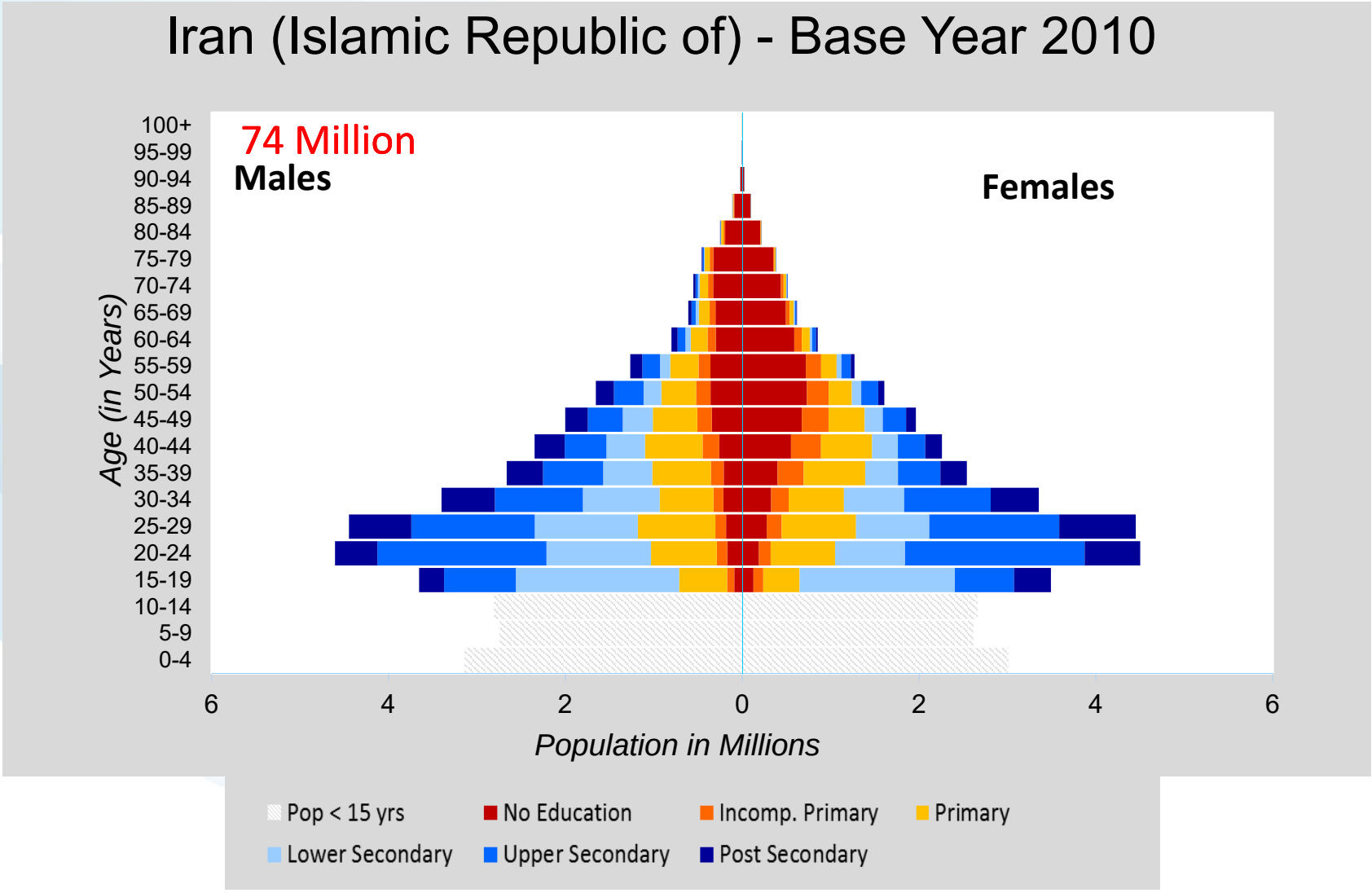
2100
Tertiary
Secondary
Primary
No Education
Pop < 15yrs

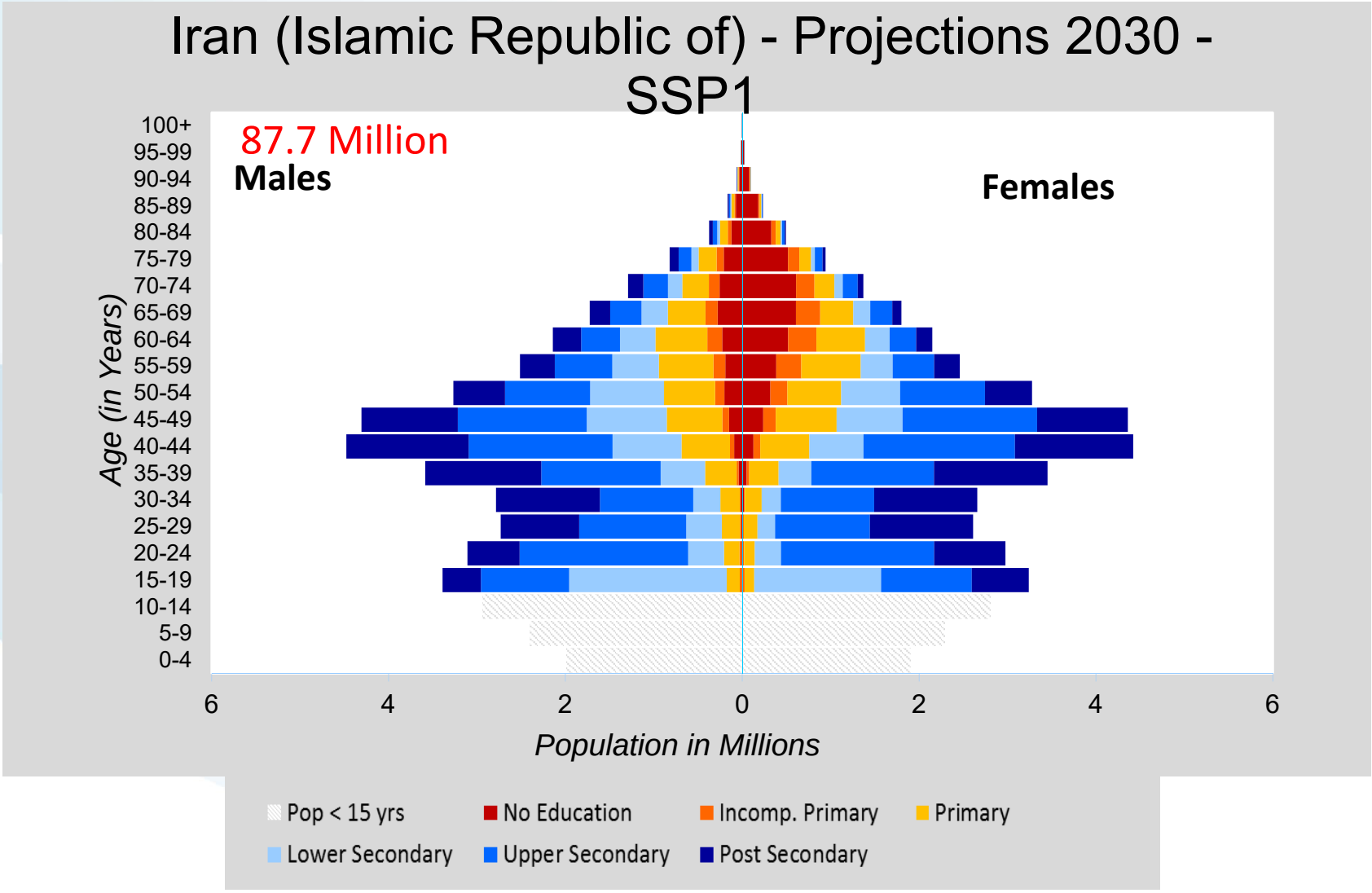
Shared Socioeconomic Pathway (SSP) Scenarios:
SSP1: Rapid Development
SSP3: Stalled Development



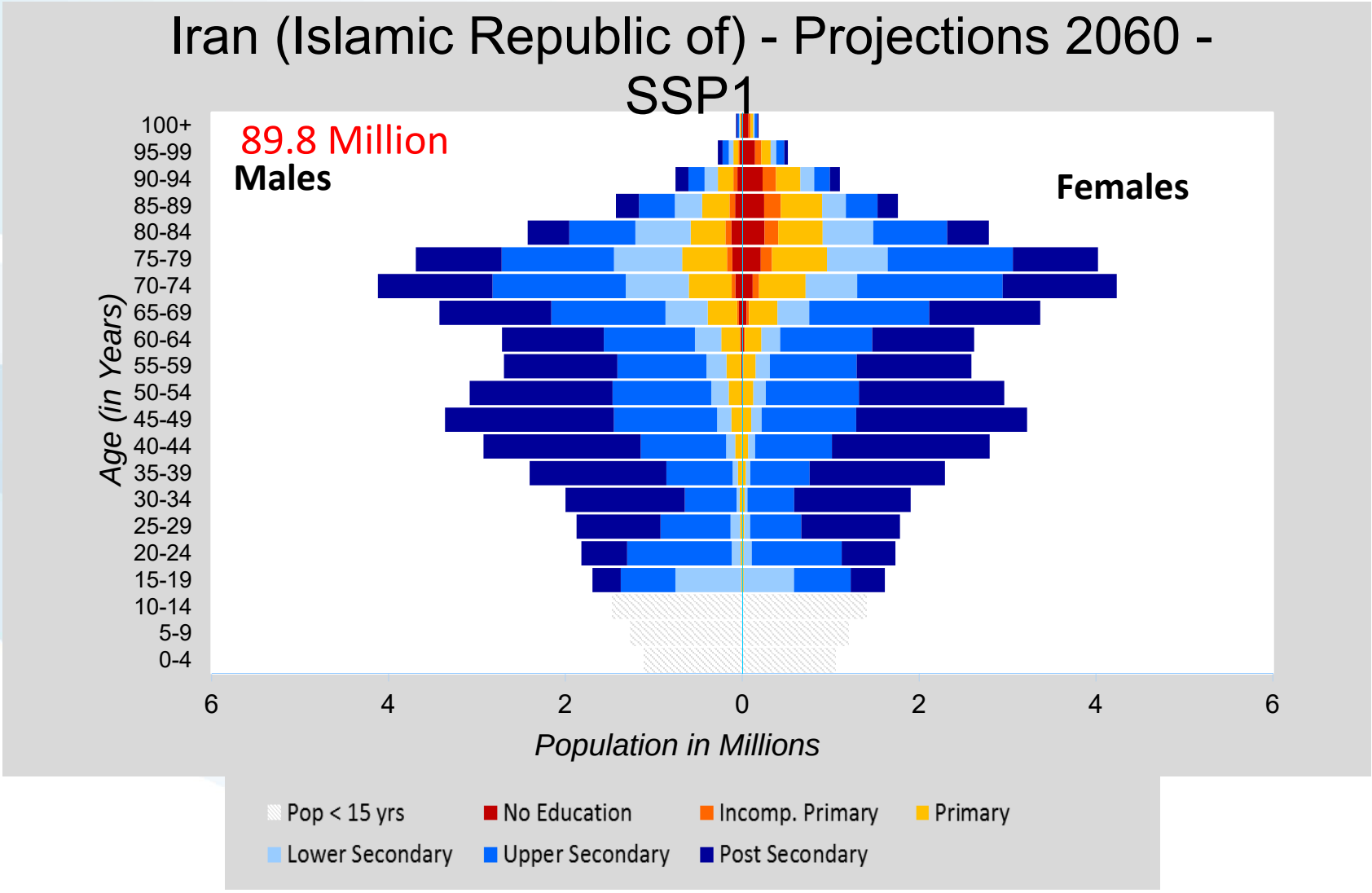
Population of Iran



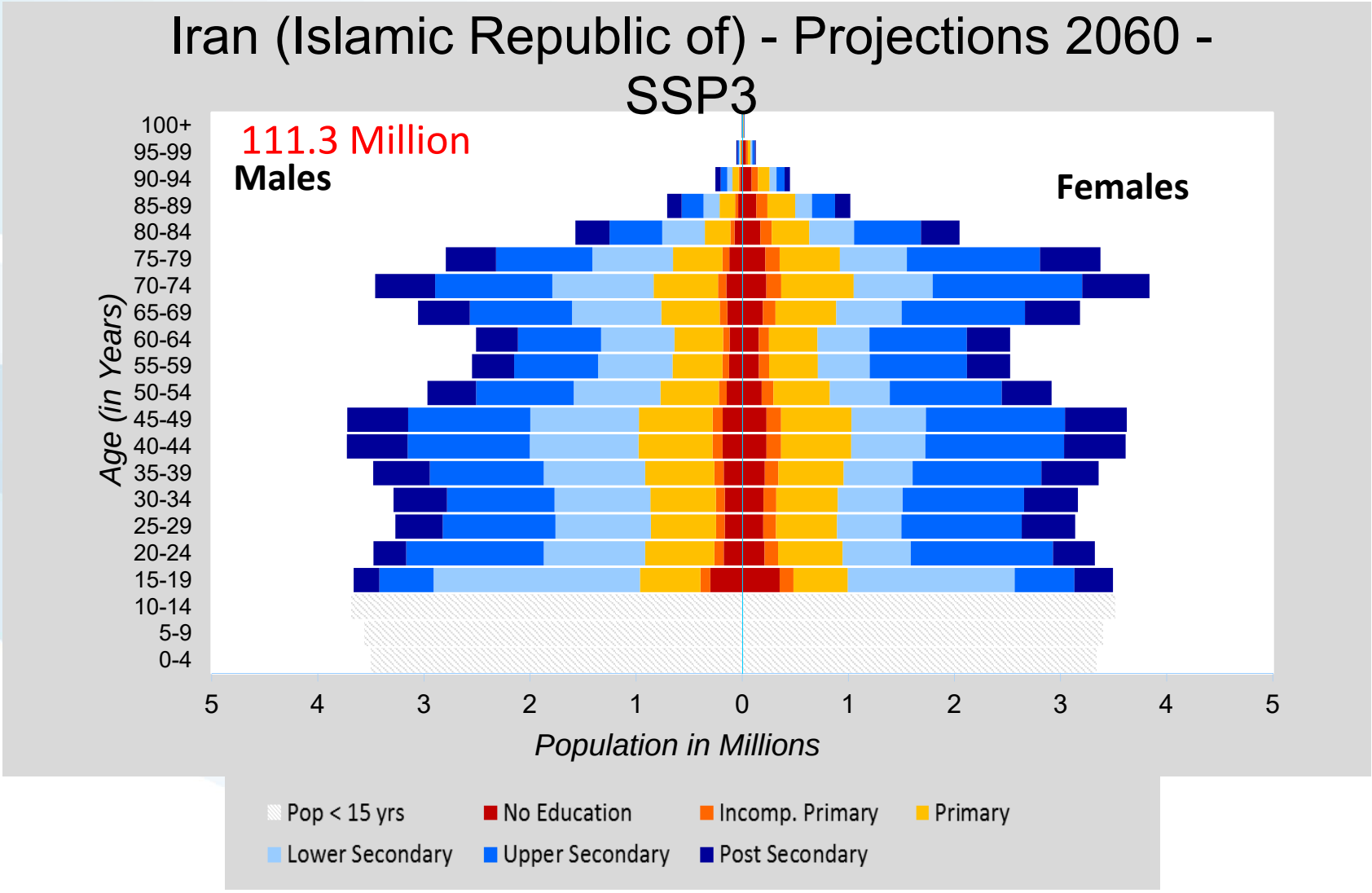
Population of Iran



Population of Iran



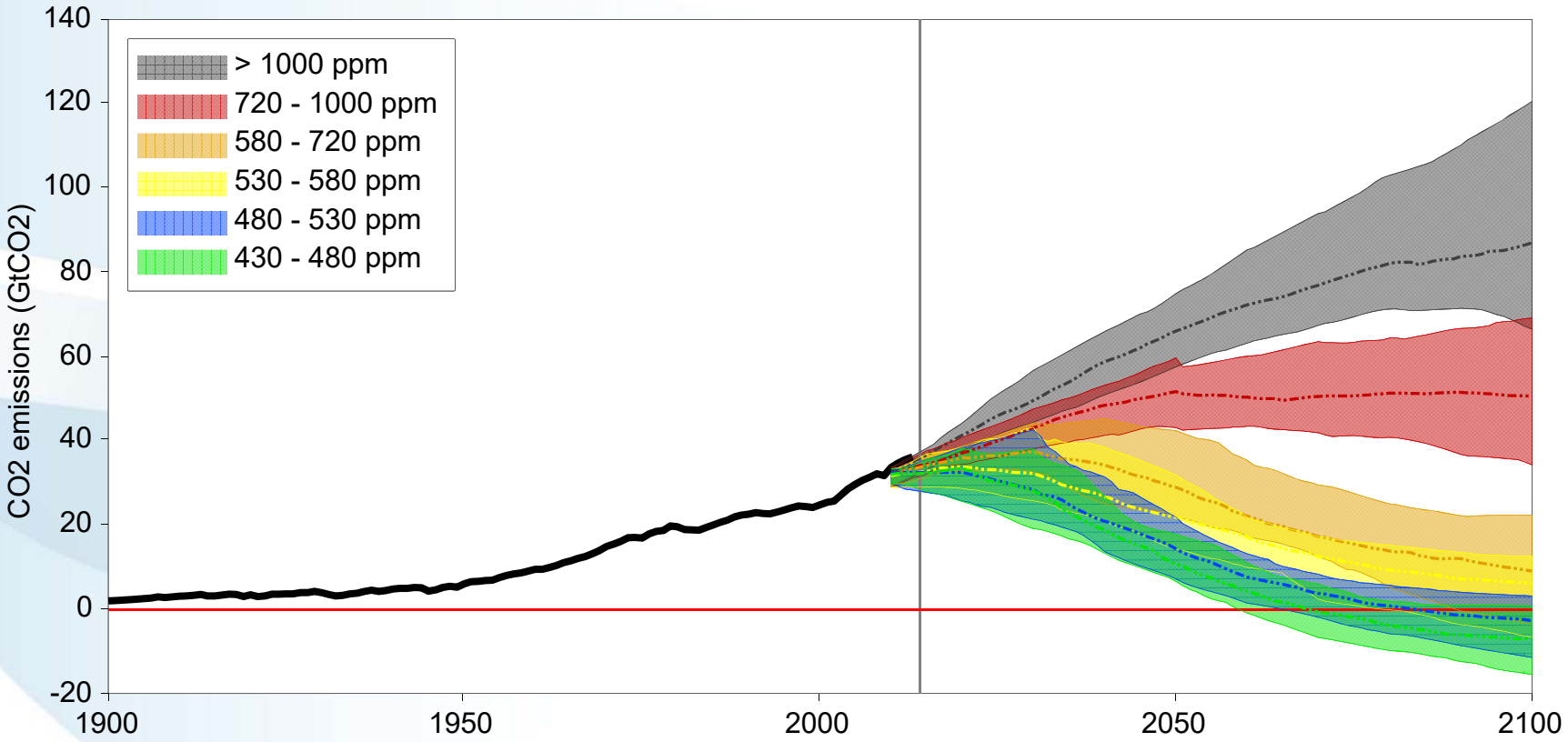
Population of Iran



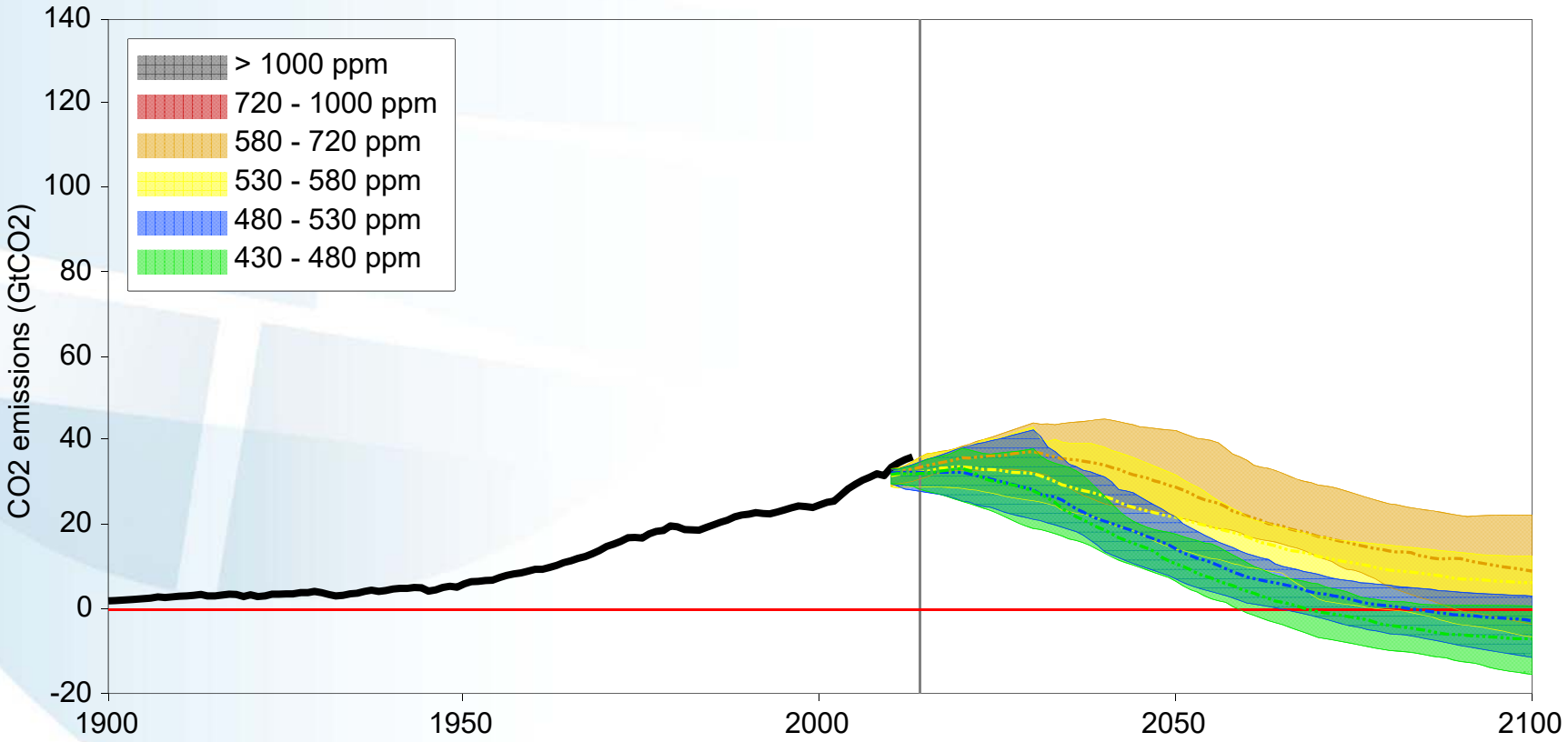
Modeling Uncertainty Project (MUP)

- Economic variables and damage function higher uncertainty than climate variables
  - Half of the uncertainty is due to climate and earth systems models (climate and earth-systems sensitivity) while the other half is related to the range of alternative scenarios
  - Half of the scenario uncertainty is reduced by eliminating low stabilization alternatives or vice versa – normative assumptions result in reduced conditional uncertainties

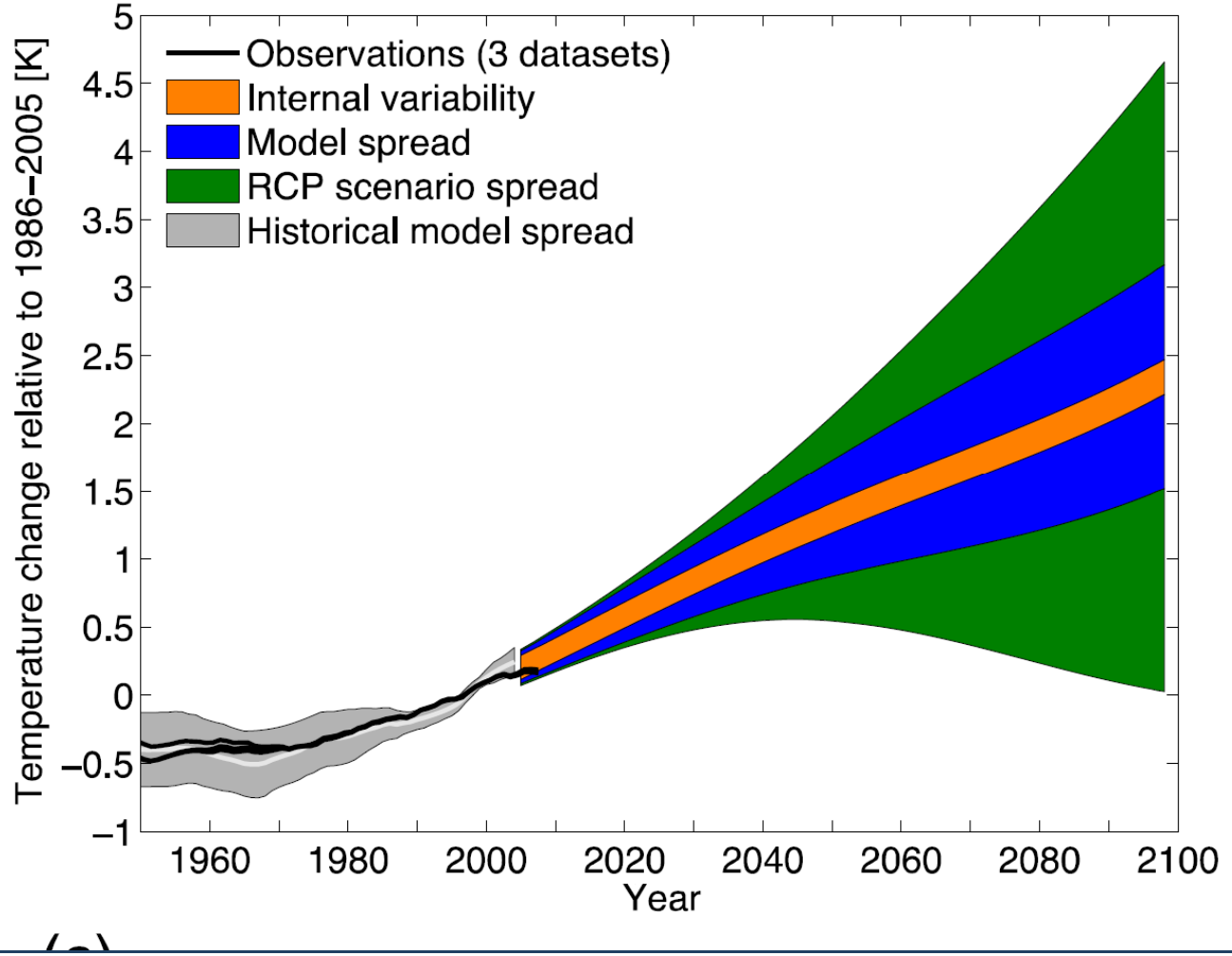
Global CO_2 Emissions
IPCC AR5



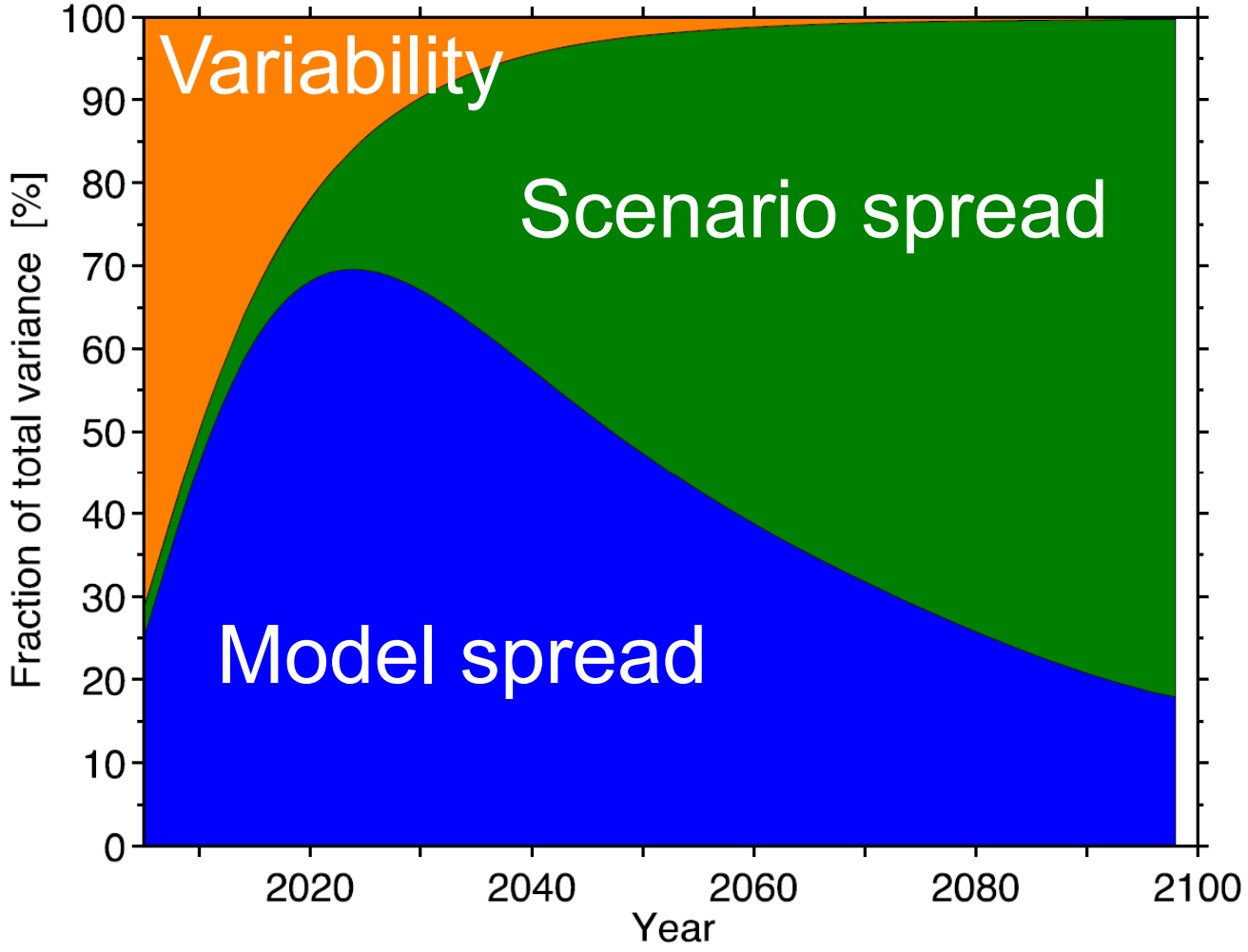
Global CO_2 Emissions
IPCC AR5



Sources of Uncertainty in Future Global Mean Temperature



Uncertainty in Global Mean Decadal Temperature



Modeling Uncertainty Project (MUP)

- Similar projections of baseline parameters, diverging in alternative cases (high levels)
  - Model comparisons ("aerobics") and ensembles with similar (harmonized) assumptions would tend to eliminate the "tails" and emphasize central assumptions
  - They may even lead to "shared" functional relationships
  - Model "parameterizations" may be favored that result in "stability" of outputs incase of great variations of input assumptions

Modeling Uncertainty Project (MUP)

- Distributions of key outputs very similar, e.g. quintiles vary by less than ½°C
- ➢ Climate "modules" may be very similar as they are often "models" of models, e.g. resulting from CMIP exercises
- ➢ May be case of another dimension of model comparisons that clip the tails and strengthen central estimates

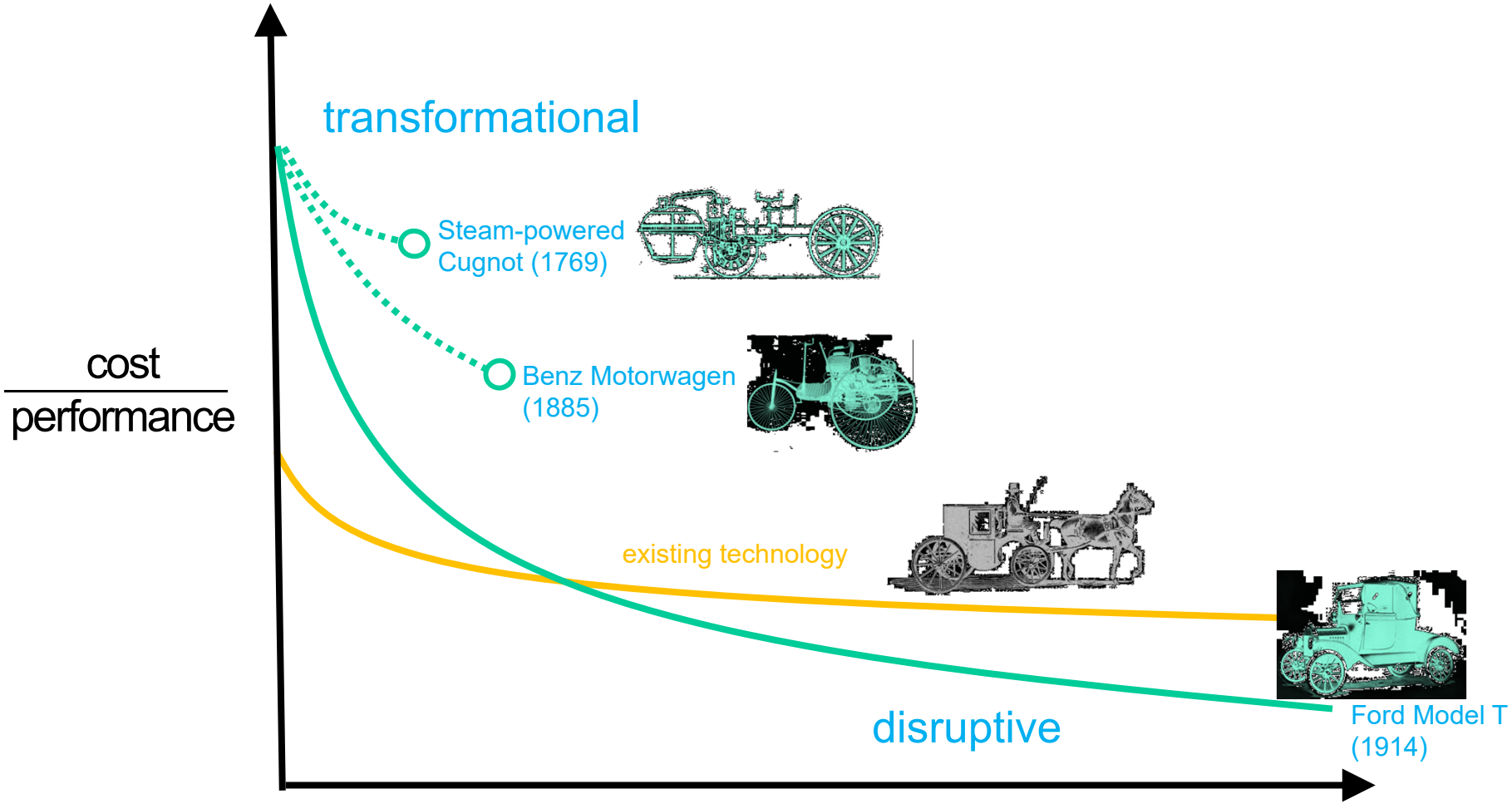
Modeling Uncertainty Project (MUP)

- Doubling all uncertainties results in almost doubling of the output uncertainties
- Little evidence for “fat” tails of outputs

➢ Going beyond the “black box” of technology important to capture sources of uncertainty

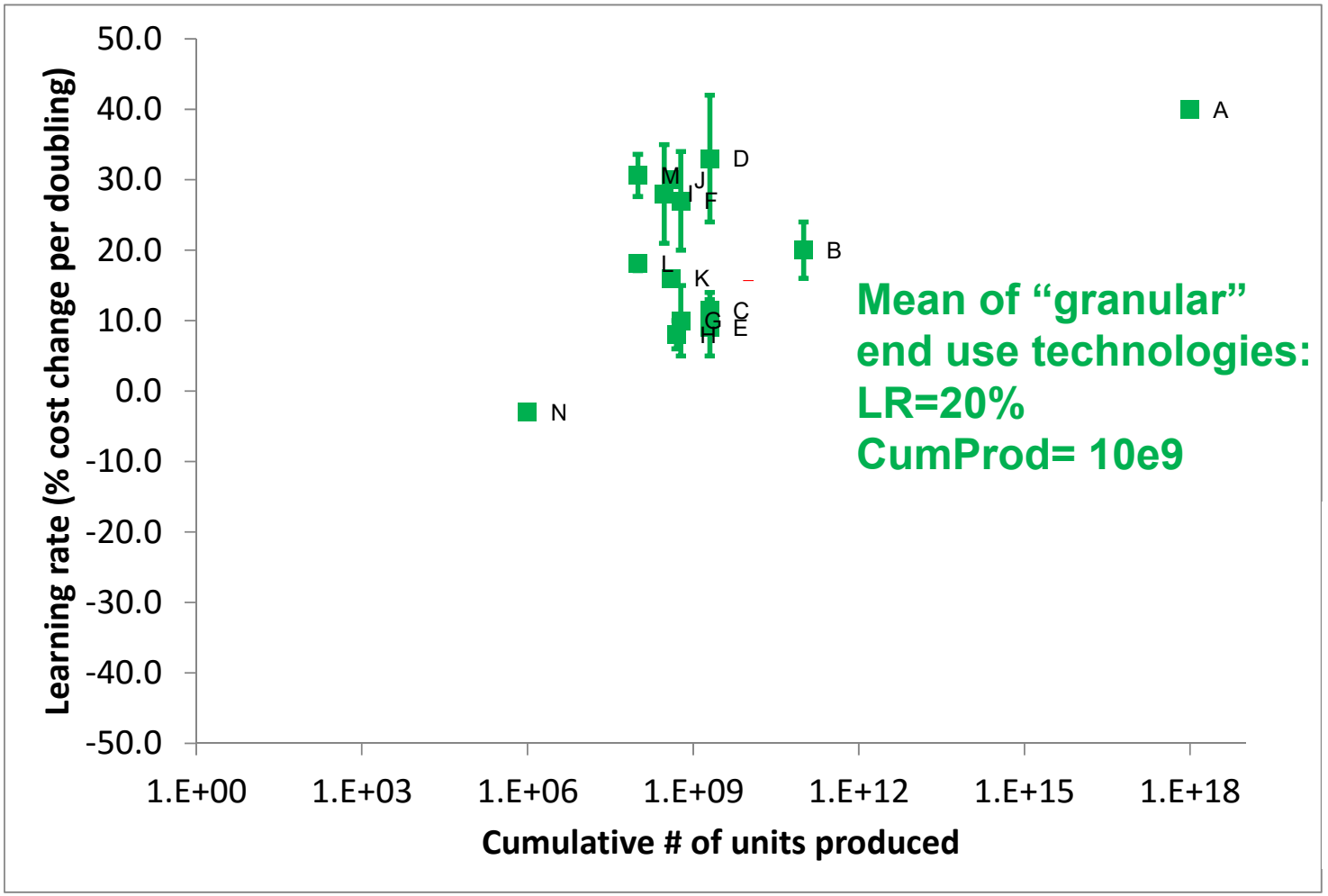
➢ Paradox of technology: a source and solution of development and climate change

Incremental & Disruptive Technologies



Cumulative Experience and Learning

The Importance of "granularity



A Transitors
B DRAMs
C Automobiles
D Washing machines
E Refrigerators
F Dishwashers
G Freezers (upright)
H Freezers (chest)
I Dryers
J Calculators
K CF light bulbs
L A/C & heat pumps
M Air furnaces
N Solar hot water heaters

Source: Wilson et al, Nature CC, 2012

Going "Beyond" Climate Uncertainties

- **Better integration across science communities**

  "Climate or development first" approach too narrow
- **More integrated & holistic assessment of climate change policy in the context of other priorities:**
  - **Multi-objective & multi-policy framing to better understand climate policy tradeoffs & benefits**
  - **"Nexus" approaches to reach multiple objectives simultaneously: energy, water, food & urbanization**
- **Challenges are huge:**
  - **Different constraints and priorities across scales**
  - **Normative goals involved in policy prioritization**