Measuring the Challenges to Mitigation and Adaptation

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The PNNL Joint Global Change Research Institute
At the University of Maryland in College Park

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Workshop on Climate Impacts and Integrated Assessment
Snowmass, Co

Thanks to Many

▶ DOE Integrated Assessment Research Program
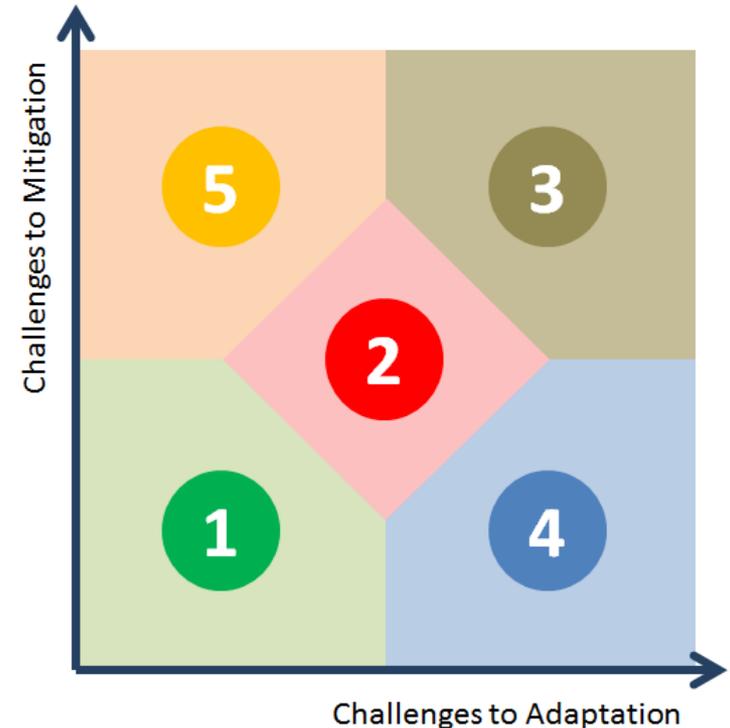
▶ John Weyant, of course.

▶ Brian O'Neill

▶ Vanessa Schweizer, Toshihiko Masui, Elmar Kriegler

The Challenge of Measuring Challenges

▶ Why measure challenges?
- ■ SSPs were designed with a concept diagram that had no units.
- ■ The SSPs themselves have units.

▶ Measurement for two purposes
- ■ Testing to see if the SSPs are what they were intended to be.
- ■ Binning and sorting.

▶ Some thoughts on measurement.

▶ Some issues of measurement.

Challenges to Mitigation

Challenges to Adaptation

► Metrics are needed to both test and to bin scenarios (the sorting hat)

► "Challenges" is a concept that by definition is a response to stress.

■ I would propose to measure challenges to mitigation and adaptation as a measured response to a standardized stress.

■ For mitigation, e.g. price of carbon in a 4.5 or 3.7 scenario, but there are others.

■ For adaptation, welfare loss after adaptation to a prescribed climate change.

► Metrics need to be practical, measurable, and routinely produced by scenarios.

■ Must be available for both models using explicit SSP assumptions, and

■ Reported in the open literature

► Unresolved questions:

■ Are these measures absolute or relative?

■ This was raised in the Netherlands Hague meeting.

■ Time: As a region develops can it change from being an SSP 3 to an SSP 1?

■ Space: Are poor regions in an SSP 2 really SSP 3?

THE CHALLENGE OF MEASURING CHALLENGES

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SSP Logic

Socio-economic challenges for mitigation

Socio-economic challenges for adaptation

Mitigation Challenges Dominate

High Challenges

Intermediate Challenges

Low Challenges
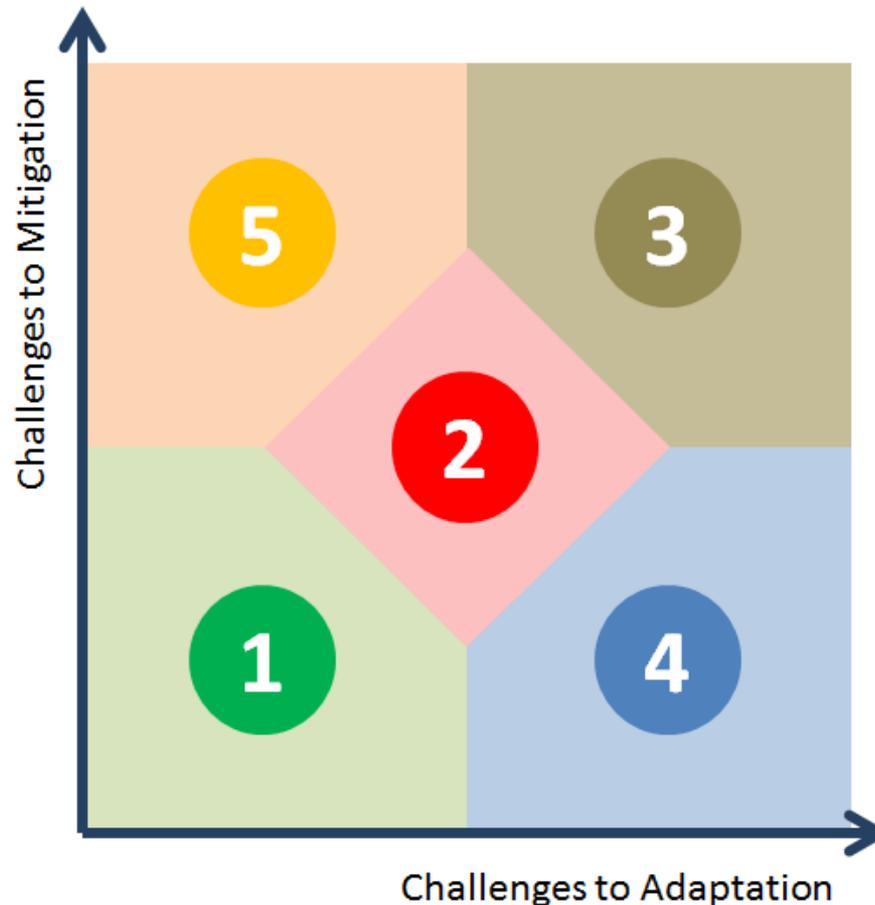
Adaptation Challenges Dominate

SSP Logic

The FRAMEWORK paper's fundamental divide: Mitigation and Adaptation Challenge

▶ I want to slightly alter the iconic figure to focus on a feature of the Framework—namely, that the Framework explores a part of a larger, and partitionalble space.

You're either an SSP2 or you belong in Gryffindor.
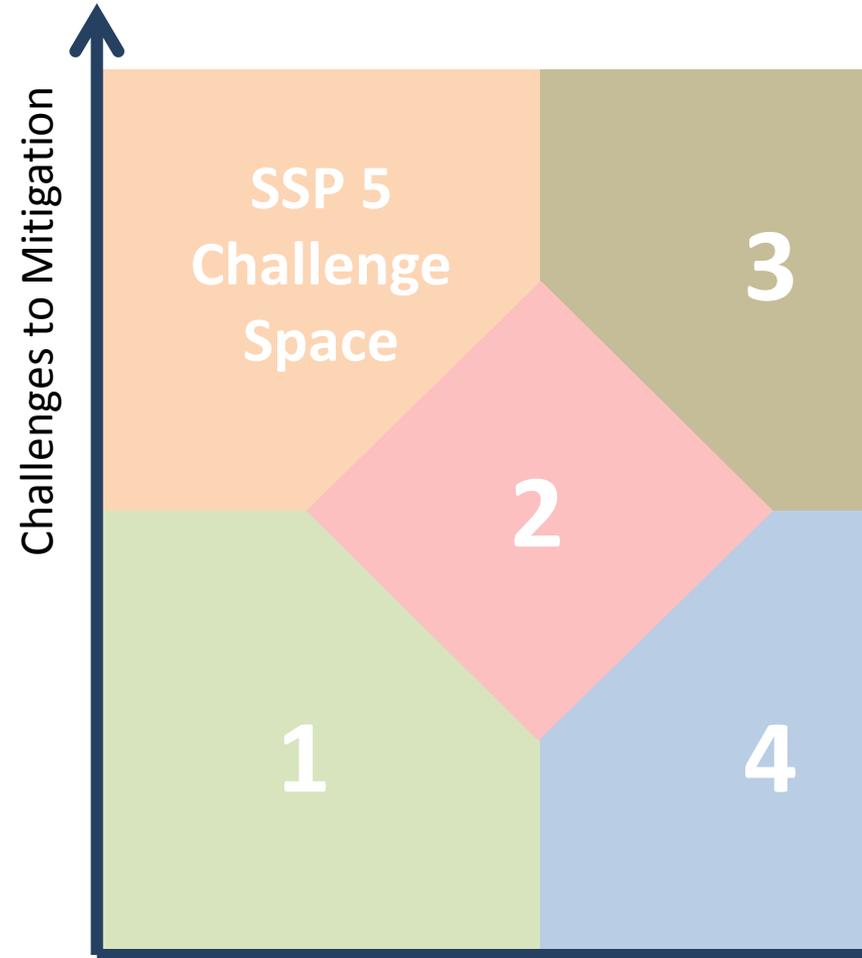
The sorting hat has spoken.

THE SORTING FUNCTION

The Sorting Function of the SSP Framework

▶ **In the AR5 there will be lots of scenarios, and most of them will not be new SSPs.**

▶ **The SSP Framework can be useful to us in thinking about how to identify comparable scenarios.**

▶ **This could be called the "Sorting Function" of the SSPs**

▶ ANYTHING that has high challenges to mitigation and adaptation belongs in Domain 3.

▶ **How to define the boundaries between SSPs?**

Challenges to Mitigation (y-axis) / Challenges to Adaptation (x-axis). Quadrants labeled 5 (top left), 3 (top right), 2 (center), 1 (bottom left), 4 (bottom right).
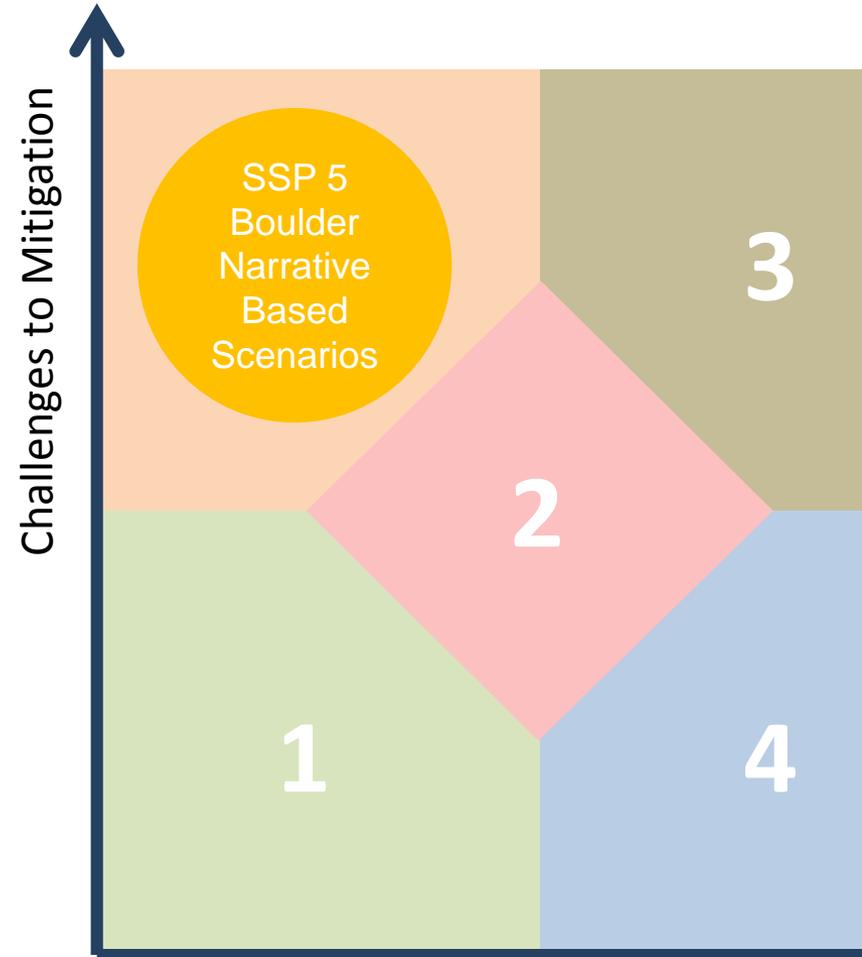
Exactly which SSP5 did you mean? Or, was that SP5?

▶ Any scenario that exhibits high challenges to mitigation, but low challenges to adaptation, regardless of who or how it was crafted, is an element of the SSP 5 Challenge Space, but is an SP, not SSP.

Challenges to Mitigation

SSP 5 Challenge Space

3

2

1

4

Challenges to Adapt

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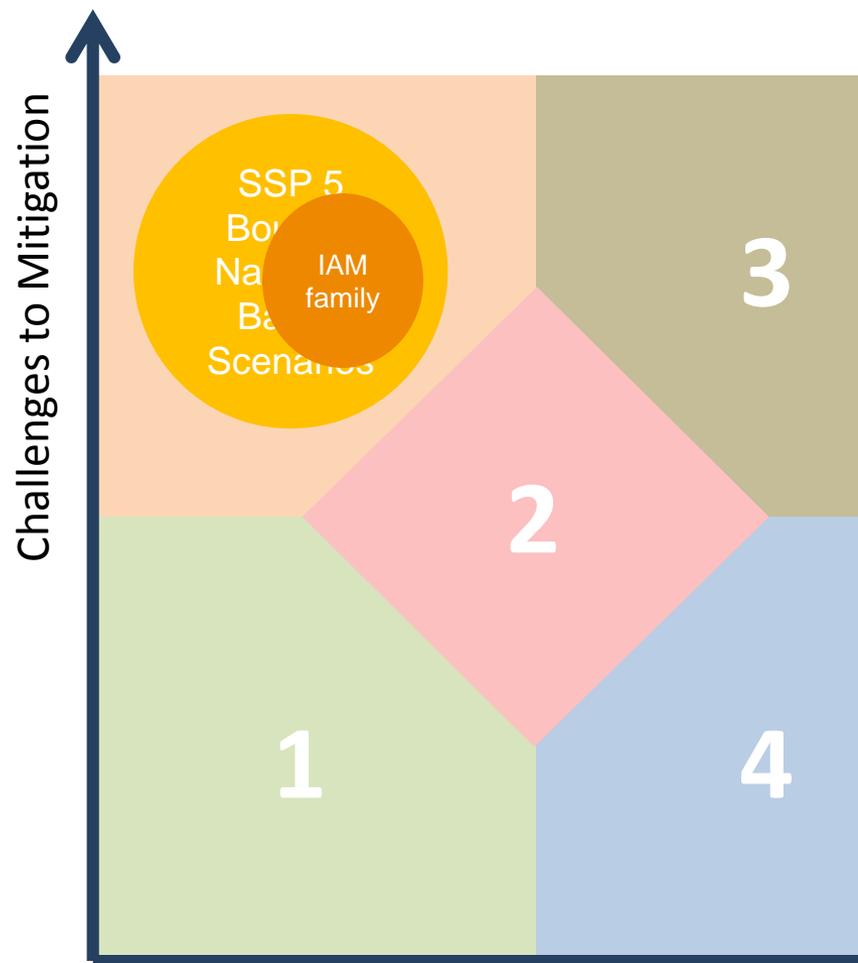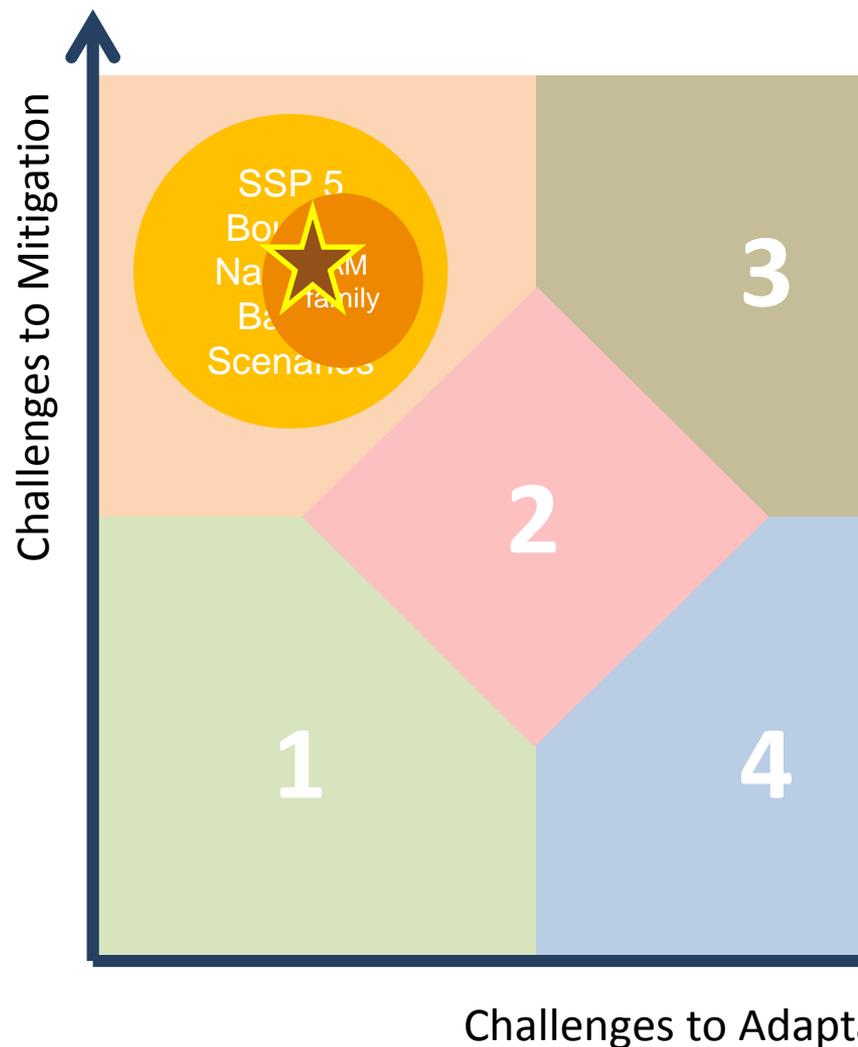
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▶ Any scenario that was build using the Boulder SSP5 **narrative storyline** would be a member of a narrower set of scenarios in the SSP 5 challenge space.

Challenges to Mitigation

SSP 5 Boulder Narrative Based Scenarios

3

2

1

4

Challenges to Adapt

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► Any scenario that used the Boulder SSP narrative storyline, and a common set of **quantitative IAM inputs**, e.g. population, econ. and tech., plus would be a member of an even narrower subset of SSP 5 challenge space.

Challenges to Mitigation

Challenges to Adapt

SSP 5 Bo
Na
Ba
Scenarios

IAM family

3

2

1

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SSP 5
Bou
Na   AM
Ba   family
Scenarios

Challenges to Mitigation

3

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1

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Challenges to Adapt

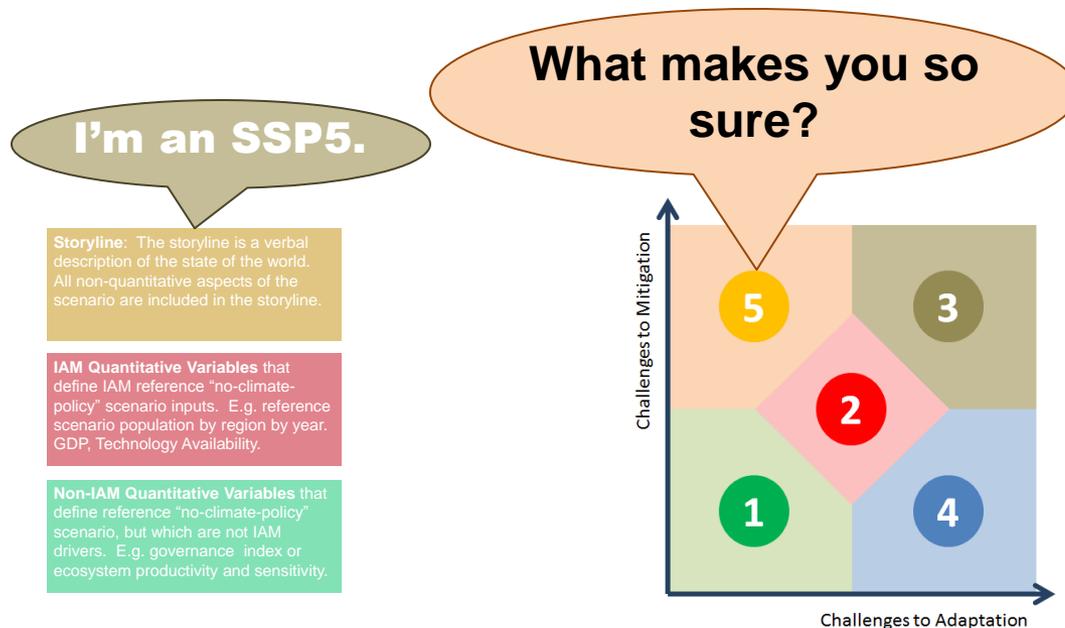▶ We might choose one **Representative Scenario Based on SSP5**.

Testing Our Work

▶ We put our best minds to work on developing our SSPs.

▶ Why do we believe that our SSP4, when combined with real models, or real analysts, actually produces scenarios that occupy the right portion of challenge space?

Testing Our Work

▶ We will have to combine our SSPs with models to produce scenarios and then produce measures for our challenges to mitigation and adaptation to test whether what we say is an SSP5, does produce scenarios in that portion of challenge space.

▶ **We will need to put units on the challenge space axes!!!!!**

I'm an SSP5.

What makes you so sure?

Storyline: The storyline is a verbal description of the state of the world. All non-quantitative aspects of the scenario are included in the storyline.

IAM Quantitative Variables that define IAM reference "no-climate-policy" scenario inputs. E.g. reference scenario population by region by year. GDP, Technology Availability.

Non-IAM Quantitative Variables that define reference "no-climate-policy" scenario, but which are not IAM drivers. E.g. governance index or ecosystem productivity and sensitivity.

Challenges to Mitigation

Challenges to Adaptation

THE CHALLENGE OF MEASURING CHALLENGES

What characteristics do we want for our metrics for both TESTING and SORTING?

▶ **They need to be practical, measurable, and routinely produced by IAMs.**

- ■ It needs to be a proxy since there is nothing that is literally challenges to mitigation or challenges to adaptation.

- ■ It needs to be reported by non-SSP researchers as well as SSPers.

▶ **They need to reflect the consequences of mitigation of climate change and adaptation to climate change.**

- ■ I propose that we measure the challenges as quantitative measures of the consequence of subjecting an SSP scenario to a **standardized stress**:

- ■ E.g. 4.5 Wm^{-2} stabilization (mitigation), or 3^oC climate change (adaptation).

- ■ Needs to incorporate the influence of the SPAs as well as the other SSP elements.

Challenges to Mitigation

▶ Our first experiment at measuring challenges used one statistic.

▶ The summary statistic was the 2015 carbon tax in the 1st region to initiate mitigation **in an SPA limiting radiative forcing to 4.5 Wm^{-2}**

- ■ Higher values imply greater challenges
- ■ More delay in global accession raises the measure.
- ■ Poorer technology raises the measure.
- ■ Higher population or economic scale raises the measure.
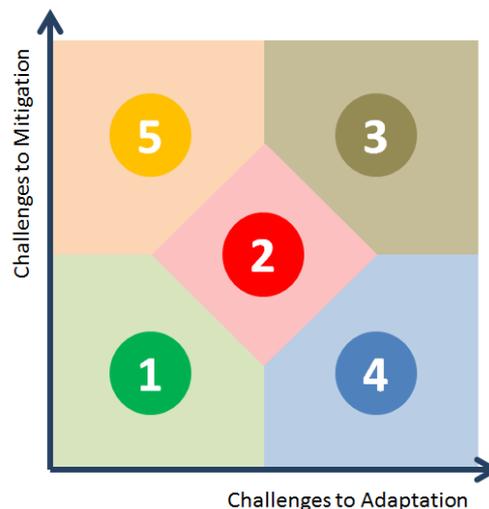
Challenges to Mitigation

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NOTE
- The effect of technology assumptions on challenges to mitigation varies with the SPA!
- Rankings are similar for limits to RF of 3.7 Wm^{-2}.

Vulnerability and Adaptation

▶ We do NOT have a single measure of adaptive challenges

- ■ Range in per capita incomes
- ■ Range in unmanaged ecosystem extent

We started to explore multi-attribute indices using VRIM to develop an index of vulnerability.

GCAM Mapping of SSPs to the Challenges Space
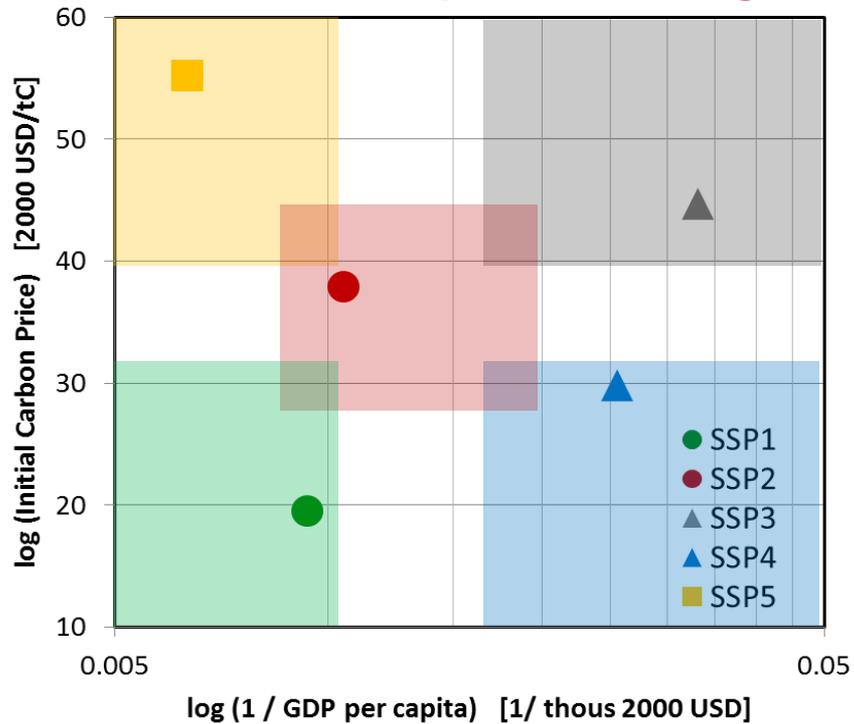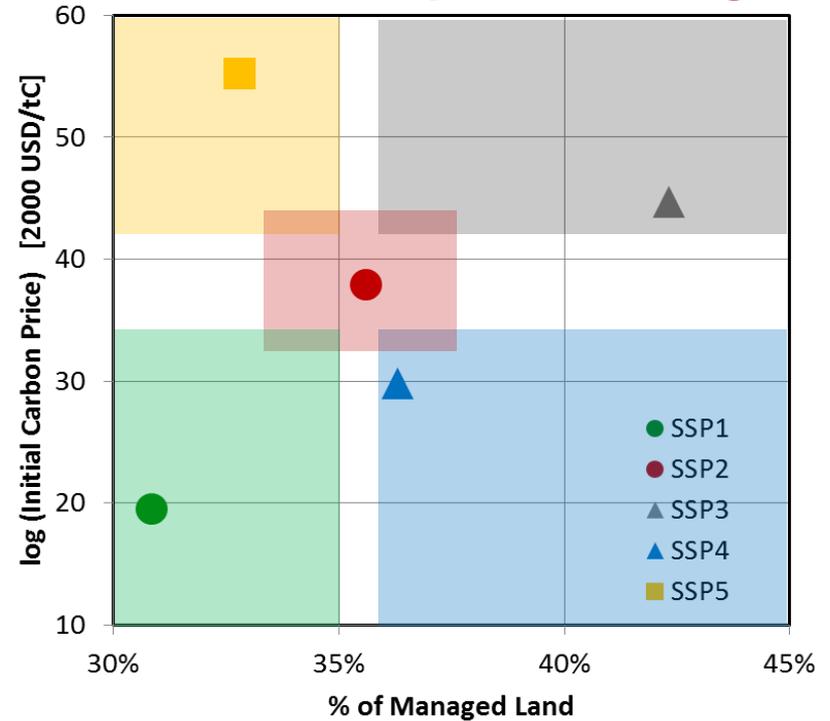
Climate Policy Assumptions Matter:
Initial Carbon Price as a Metric for Mitigative Challenges

Variety in SPAs achieving 4.5 W/m² (The same as our experiment)
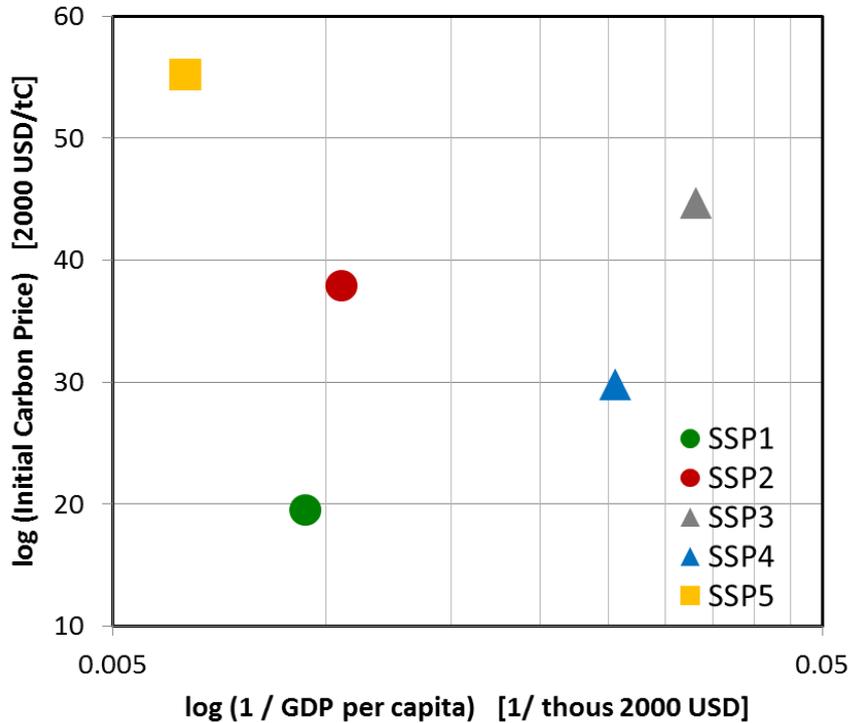
One Ideal SPA achieving 4.5 W/m²
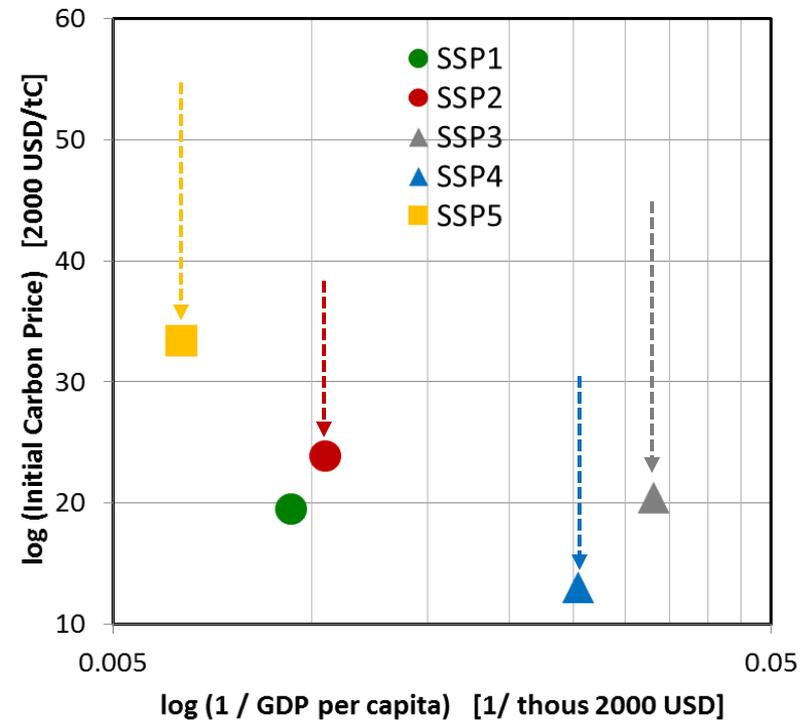
Recent experiment have explored multi-attribute indicies

	Sector	Proxy IAM Variables	Proxy for	Relationship with Capacity
Adaptive Challenges	Economic Capacity	GDP / capita	Access to markets and technologies for adaptation	Positive
		Income equality (1 - GINI coefficient)	Potential distribution in coping and adaptation capacity	Positive
	Environmental and settlement capacity	SO2 emissions / area	Stress of economic activity on ecosystem	Negative
		% of managed land	Extent of land fragmentation and ease of ecosystem migration	Negative
	Social and institutional capacity	% of non-traditional commercial energy	Modernization of social infrastructure and private access to financial resources	Positive
Mitigative Challenges	Collective capacity	Initial carbon tax	Extent of market adjustment required for mitigation	Negative
	Economic capacity	GDP growth rate	Incentives to expand the size of the economy	Negative
	Energy system capacity	Energy intensity of GDP improvement rate	Incentives to improve energy efficiency	Positive
		Carbon intensity of energy improvement rate	Incentives to de-carbonize energy systems	Positive

Moving forward

▶ There is a real need to experiment with multiple measurement regimes.

▶ Also a need to begin to use metrics to explore the distribution of open literature scenarios.
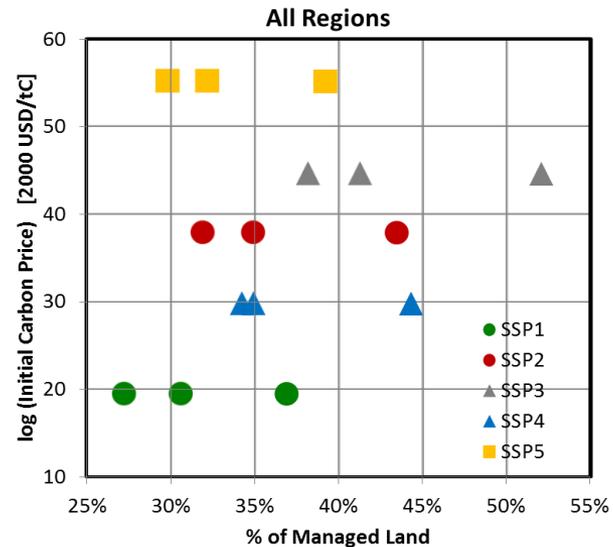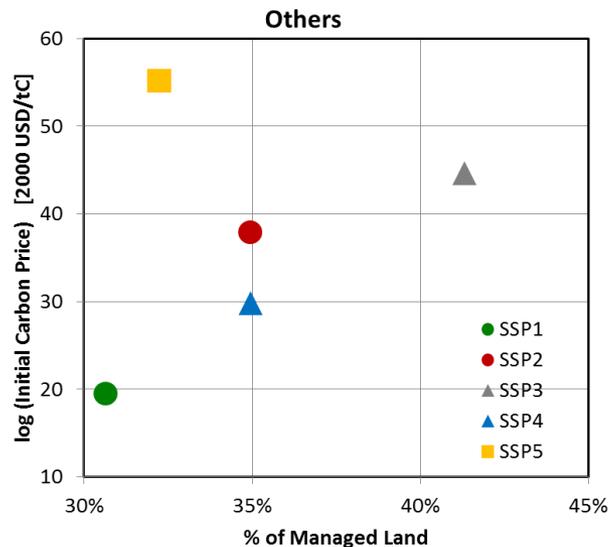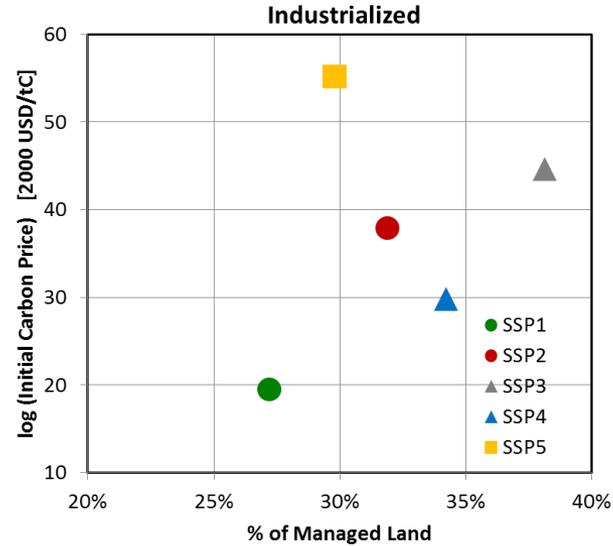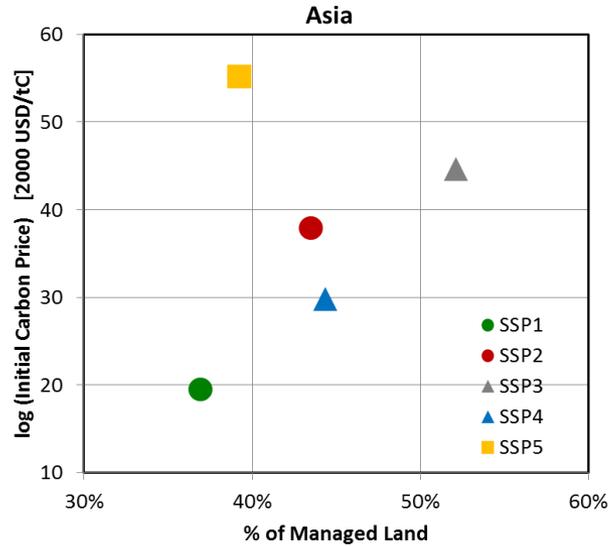
SOME ISSUES

▶ Unresolved questions:

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Disaggregation Matters:
Per capita GDP as a Metric for Adaptive Challenges
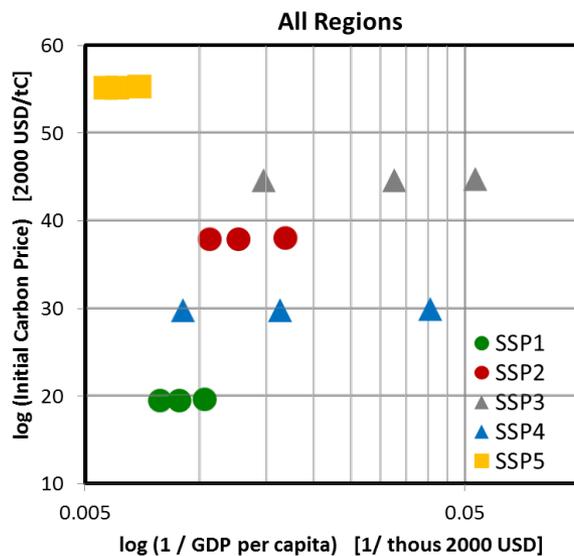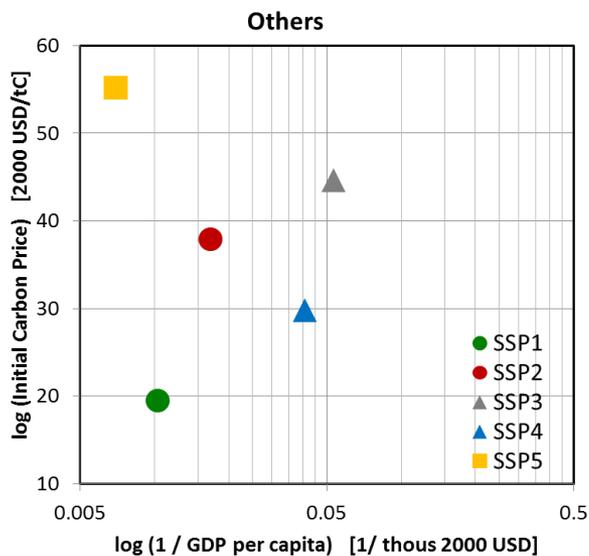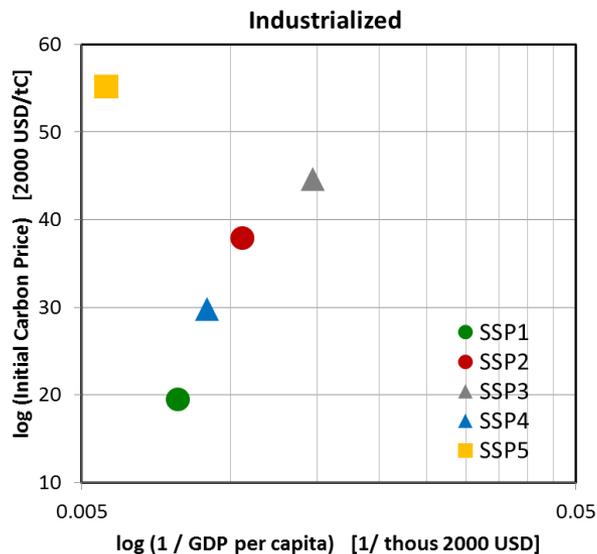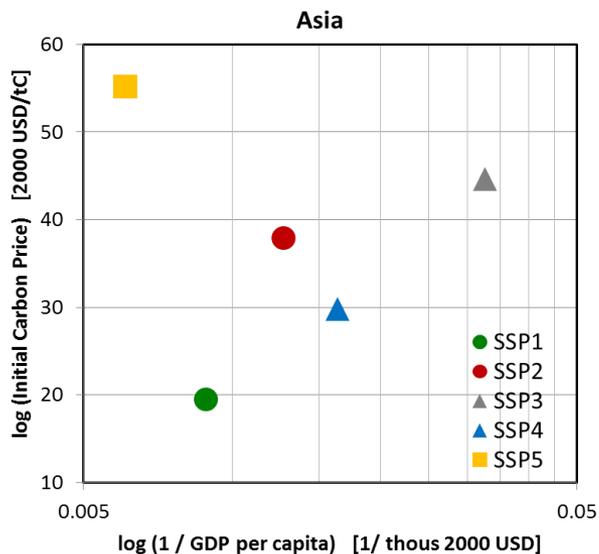
Disaggregation Matters:
% of Managed Land as a Metric for Adaptive Challenges

SUMMING UP

Summary

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DISCUSSION