Incorporating Quantitative Indicators into SSPs for use in Impacts/Adaptation/Vulnerability Analysis

Marc Levy

July 25, 2012

Marc A. Levy
Deputy Director, CIESIN
marc.levy@ciesin.columbia.edu

What kinds of questions depend on such indicators?

Physical
Aspects of
Climate
Change

Human
Impacts

Questions where socioeconomic conditions have high influence on the direction and/or magnitude of the relationship between physical and social impacts

Mediating /
Amplifying
socioeconomic
conditions

Food security
Migration
Mortality
Infrastructure loss
…

What kinds of things matter most?

- Expert Survey Results (41 respondents), Schweizer and O'Neill, 2011, variables that most shape adaptation challenges

    - Per-capita income (36)
    - Extreme poverty (35)
    - Quality of governance (36)
    - Coastal population (19)
    - Water availability (19)
    - Urbanization (18)
    - Educational attainment (18)
    - Innovation capacity (17)

Challenges to generating such indicators

- Endogeneity
  - These factors both shape impacts and are shaped by impacts
  - As a group, these factors are highly interdependent
- Theories are weakly predictive for most indicators
- Baseline data are poor for many indicators
- Community of practice using such indicators to do IAV analysis is thin, compared to IAM
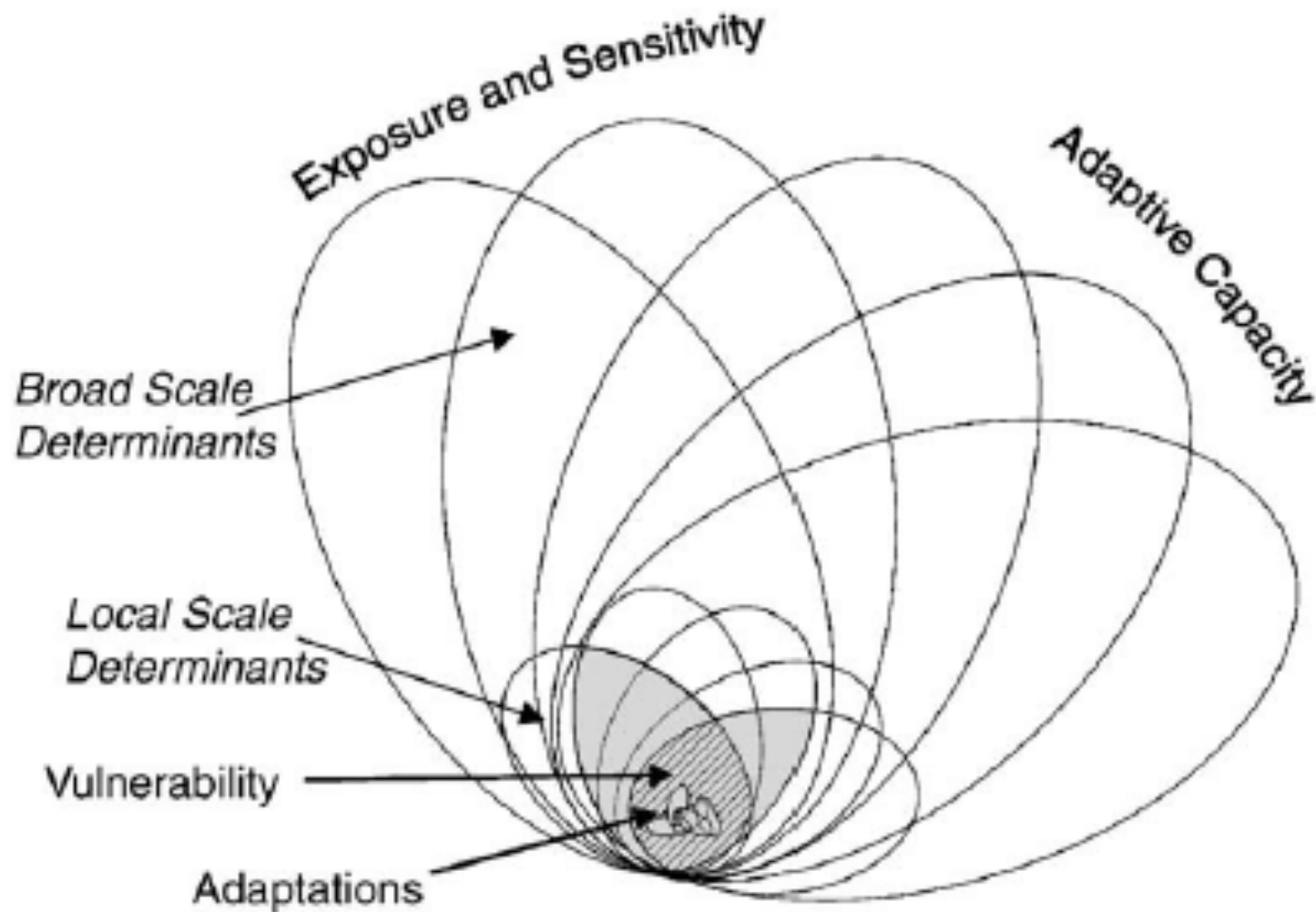- High scale dependence and interaction

Exposure and Sensitivity

Adaptive Capacity

Broad Scale Determinants

Local Scale Determinants

Vulnerability

Adaptations

Fig. 1. Nested hierarchy model of vulnerability.

Smit and Wandel
2006

Vulnerability assessments have high information demands

Therefore

- Top-down exercise doomed to failure / don't attempt it
- Facilitate emergence of community of practice through
  - Baseline data development
  - Intercomparison tools
  - Coordination with IAM community
  - Priority gap-filling

Baseline Data

- Based on survey results, focus efforts on
  - Income (level and distribution)
  - Population (level, distribution, urbanization)
  - Governance (representation and conflict)

  Maps to Schweizer/O'Neill survey results

Challenges to adaptation

- Income
  - Low per-capita income
  - High inequality
- Governance
  - Low levels of representation
  - Weak levels of government authority
  - High levels of conflict
- Population
  - Rapid levels of growth
  - High youth bulge
  - Rate of urbanization > rate of urban job growth
  - Concentration of population growth in areas of high climate hazard

Interactions matter a lot
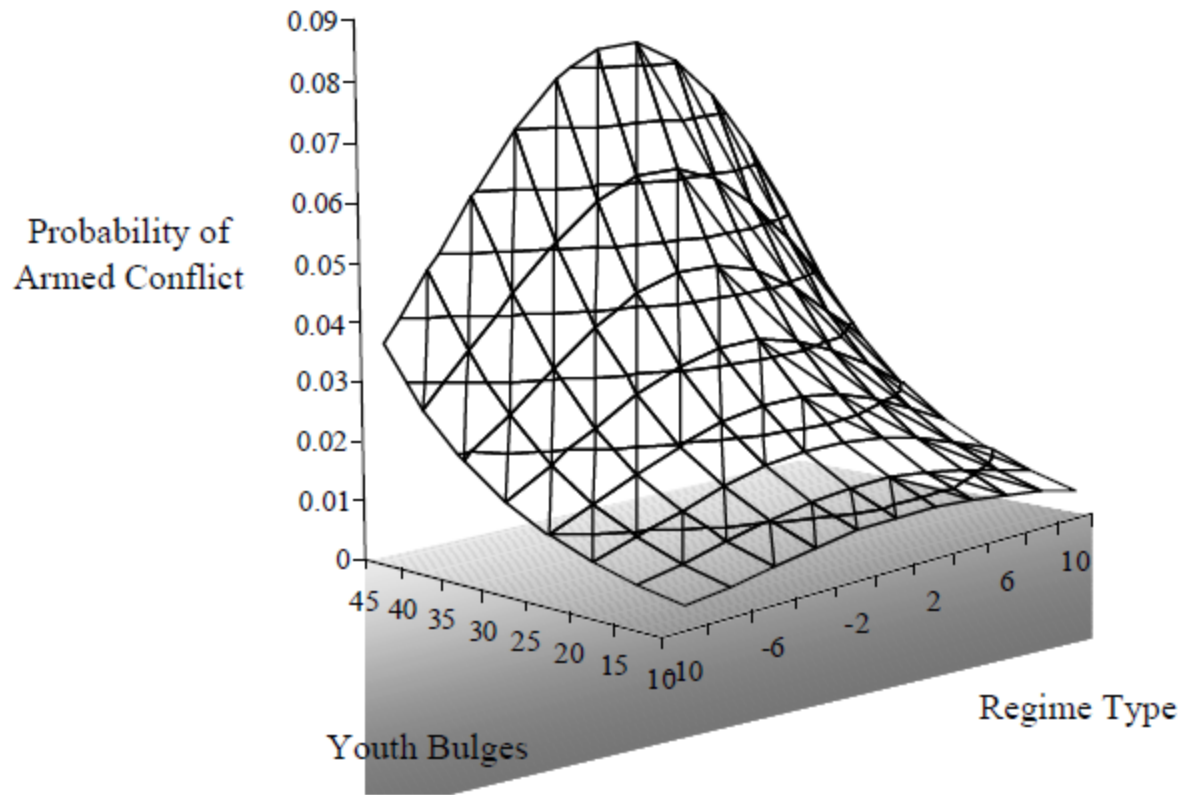
Interactions come into focus at high degree of spatial resolution (world regions are not adequate)

Urdal 2004

Intercomparison tools

- Recognize that vulnerability / adaptation studies will have widely varying scales, policy domains, research questions and therefore widely varying implementation of quantitative indicators

- Make it easier to compare choices people make to make it easier to understand results

Broad areas of intercomparison

- What is in and out? A checklist.
- What is exogenous and what's endogenous
  - For endogenous, what are the relationships?
- Distribution across units (countries / provinces / grids / households)
  - What are the patterns and how do they compare to the empirical record?
- Temporal patterns
  - What is the time trend and how does it compare to the empirical record
- Scale linkages
  - What assumptions are made about dynamics at higher and lower level scales?

Illustration: compare historical variation in per-capita income across countries with country-downscaled SRES values
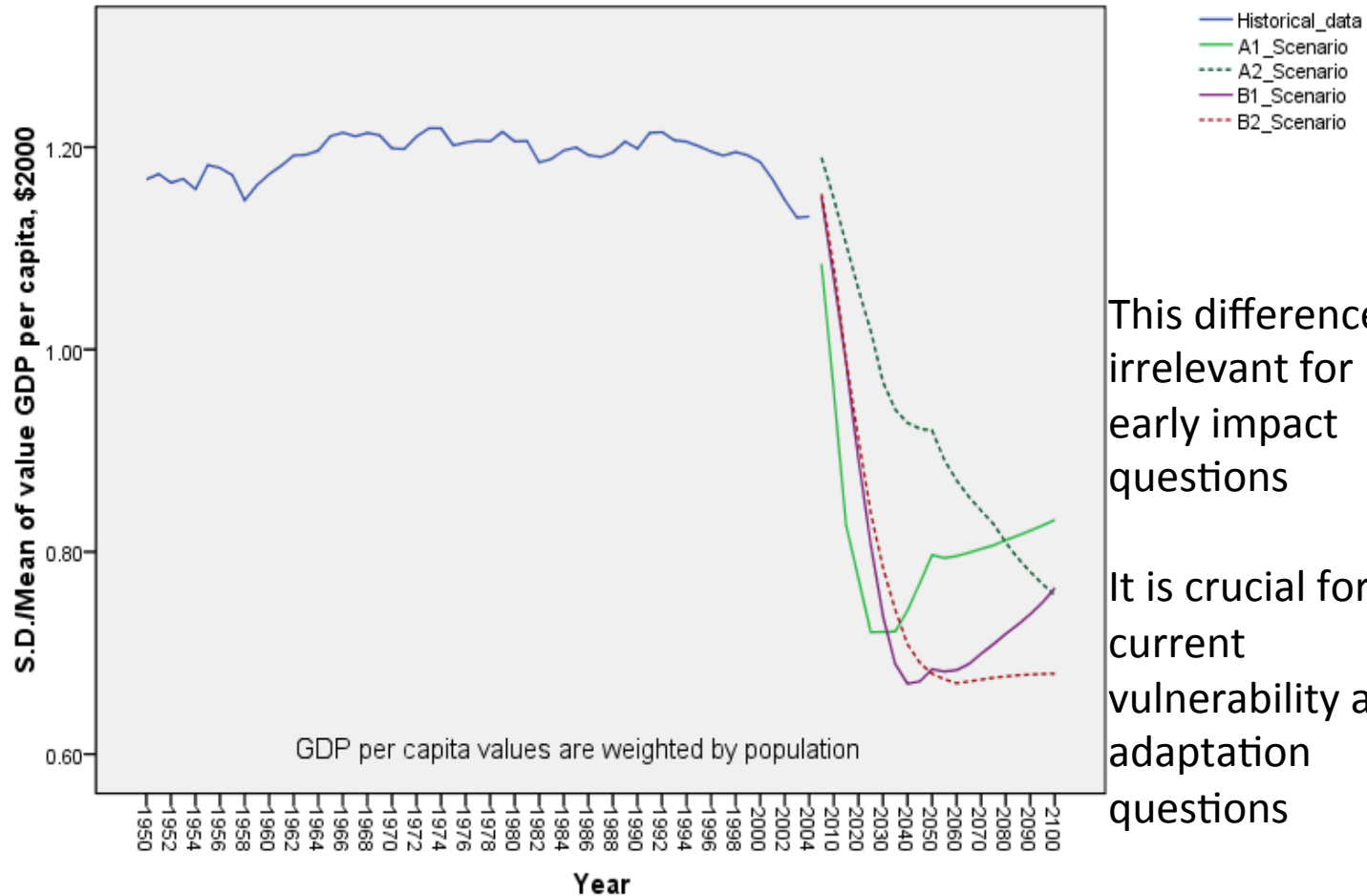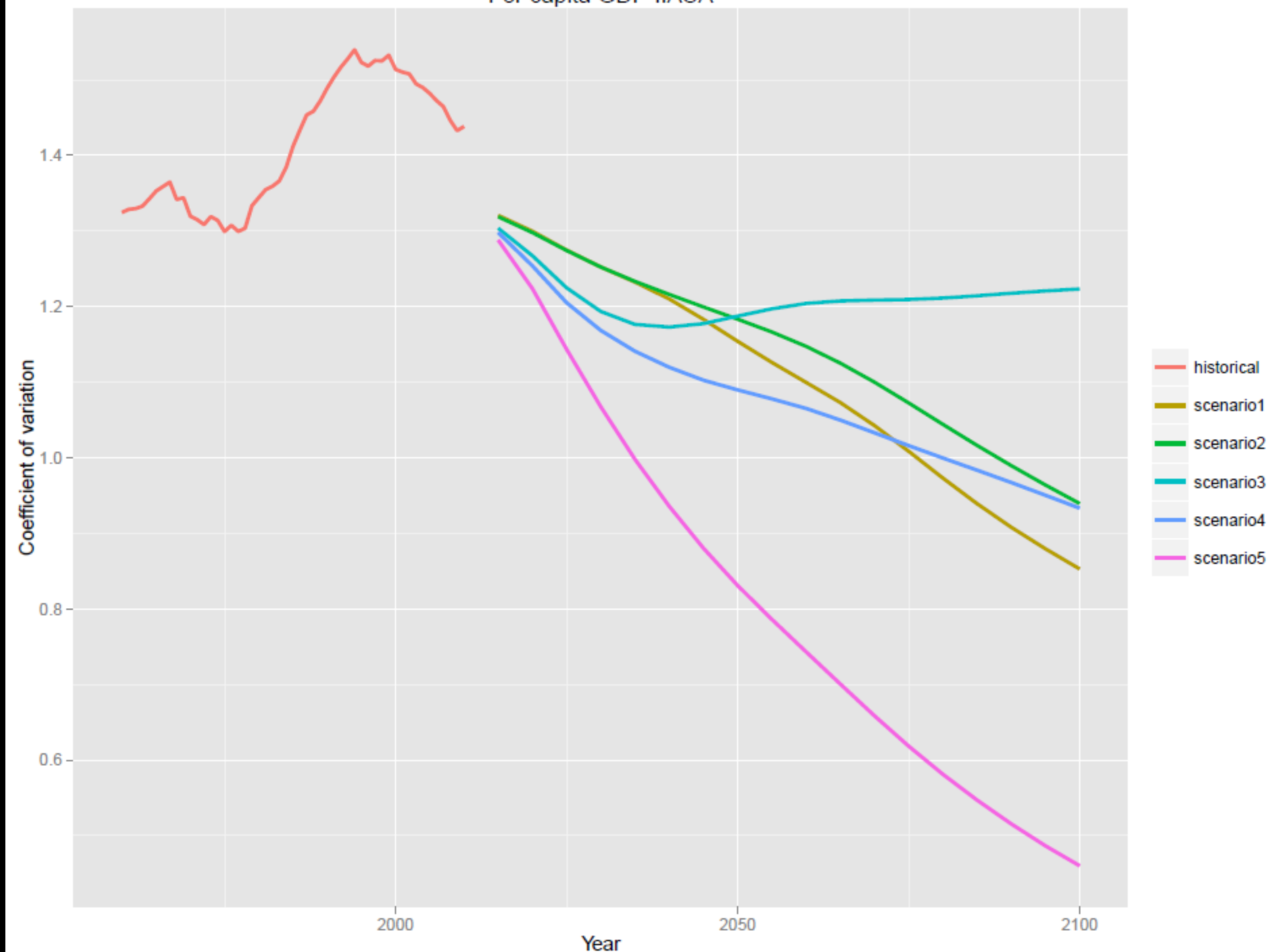

This difference is irrelevant for early impact questions

It is crucial for current vulnerability and adaptation questions

Variation = mean-normalized standard deviation.

Per capita GDP IIASA

# One way to populate SSPs with adaptation challenge indicators

- For each core indicator, benchmark against recent historical record
  - Generate scenarios that track the past
  - Generate scenarios that do better
  - Generate scenarios that do worse

For cross-national income patterns, we have more work to do

Tackling the time-steps

- SSPs are formulated primarily with respect to their endpoints

- But vulnerability case studies tell us that the dynamics matter.

NATURAL DISASTERS, INCOME AND POLITICS IN HAITI (1950 - 2009)
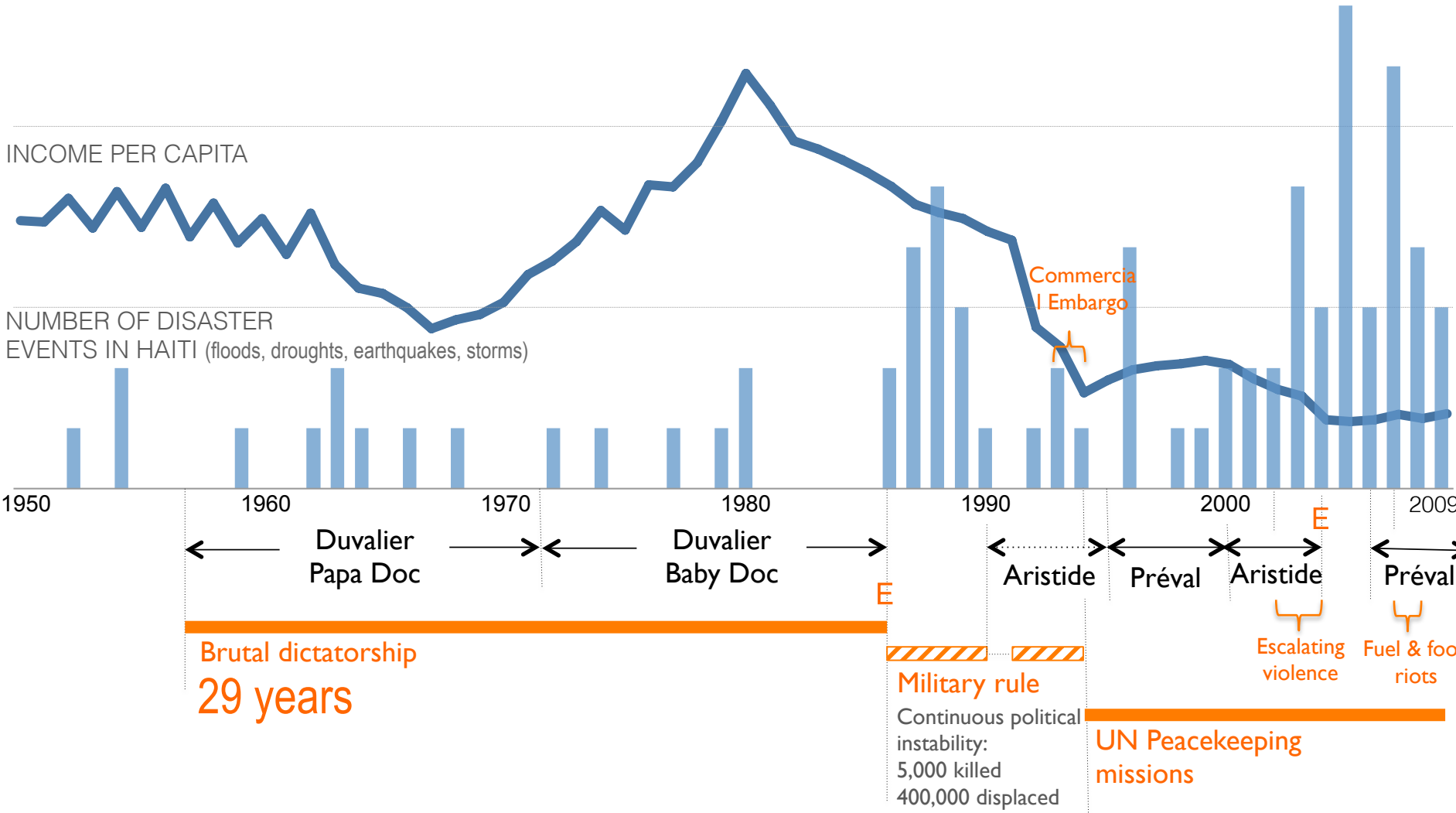
Challenge of making time steps explicit

- No basis for deterministic temporal pathways
  - The things that matter most have lots of stochasticity
- Therefore for high temporal resolution scenario analysis, use of finite marker scenarios may not be appropriate
- Such methods are available, but they make intercomparison somewhat more complicated
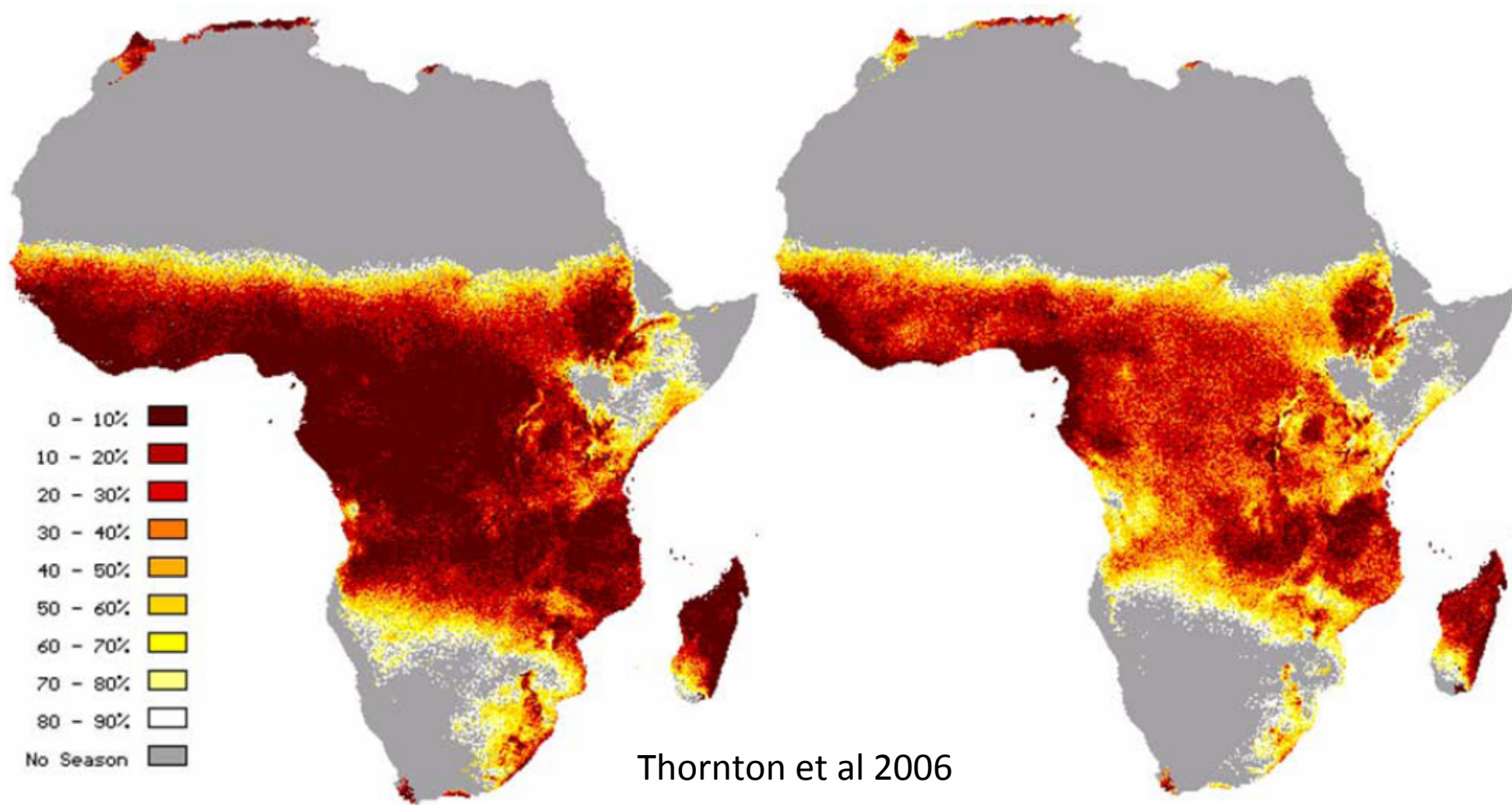
0 - 10%
10 - 20%
20 - 30%
30 - 40%
40 - 50%
50 - 60%
60 - 70%
70 - 80%
80 - 90%
No Season

Thornton et al 2006

Figure 12. Percentage of failed seasons (as defined in the text): left-hand panel, current conditions; right-hand panel, in 2050 (HadCM3, A1)

Climate scenario:
Daily time steps to 2050
Derive growing season

Socioeconomic scenario:
Zero time steps to 2050
Many elements
High spatial resolution

Typical tradeoff analysts are forced to make

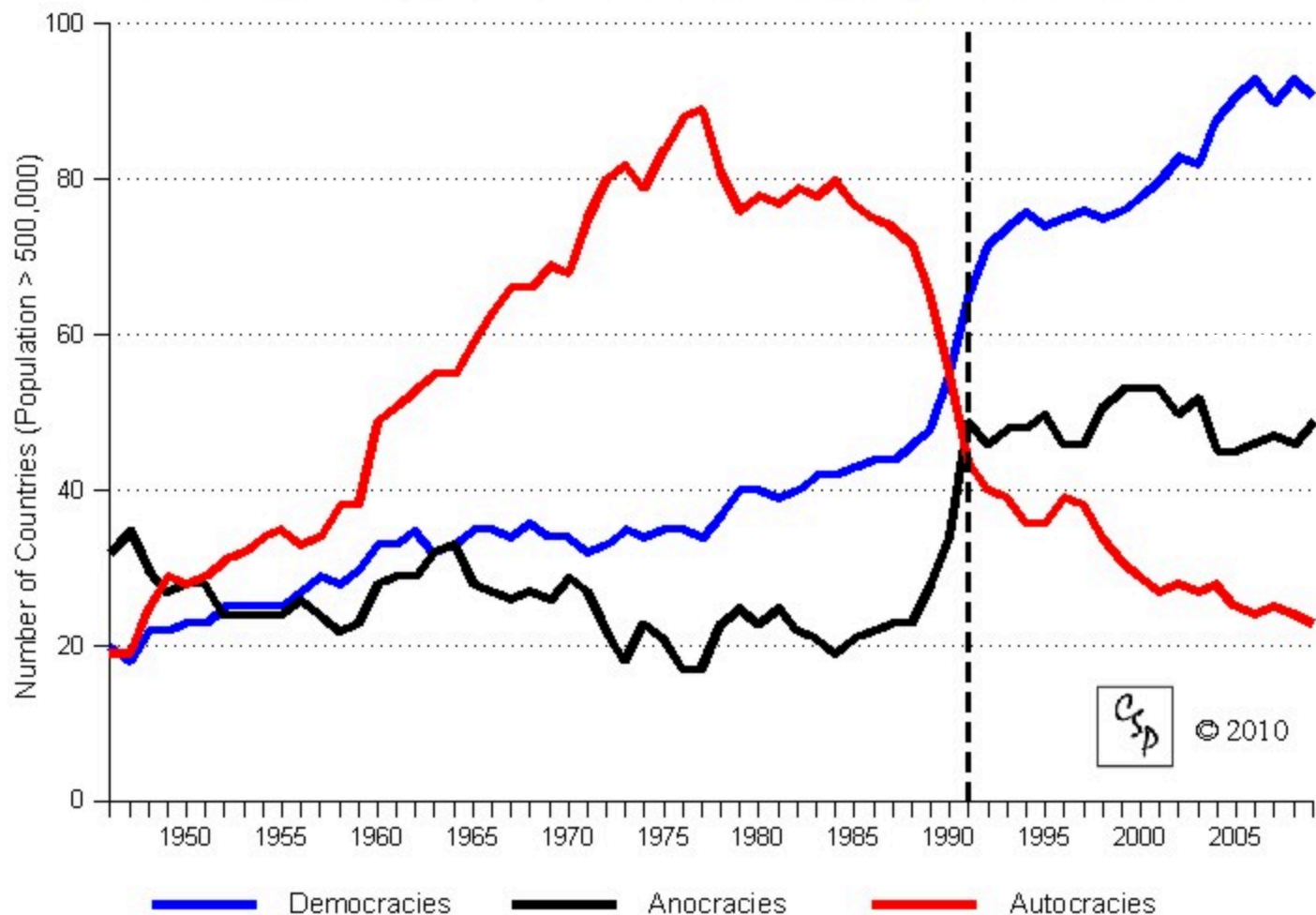# Number of countries with back-to-back years of negative growth

Governance Indicators

- Superset of candidate indicators is large (several dozen)

- Many of them covary, so can probably focus on a small number

- One possibility: representation and conflict

Global Trends in Governance, 1946-2009

Number of Countries (Population > 500,000)

— Democracies — Anocracies — Autocracies

© 2010

Global Trends in Armed Conflict, 1946-2009

Figure: Summed War Magnitude Scores, 1946–2009. Legend: Warfare Totals (dotted yellow), Societal Warfare (blue), Interstate Warfare (red).
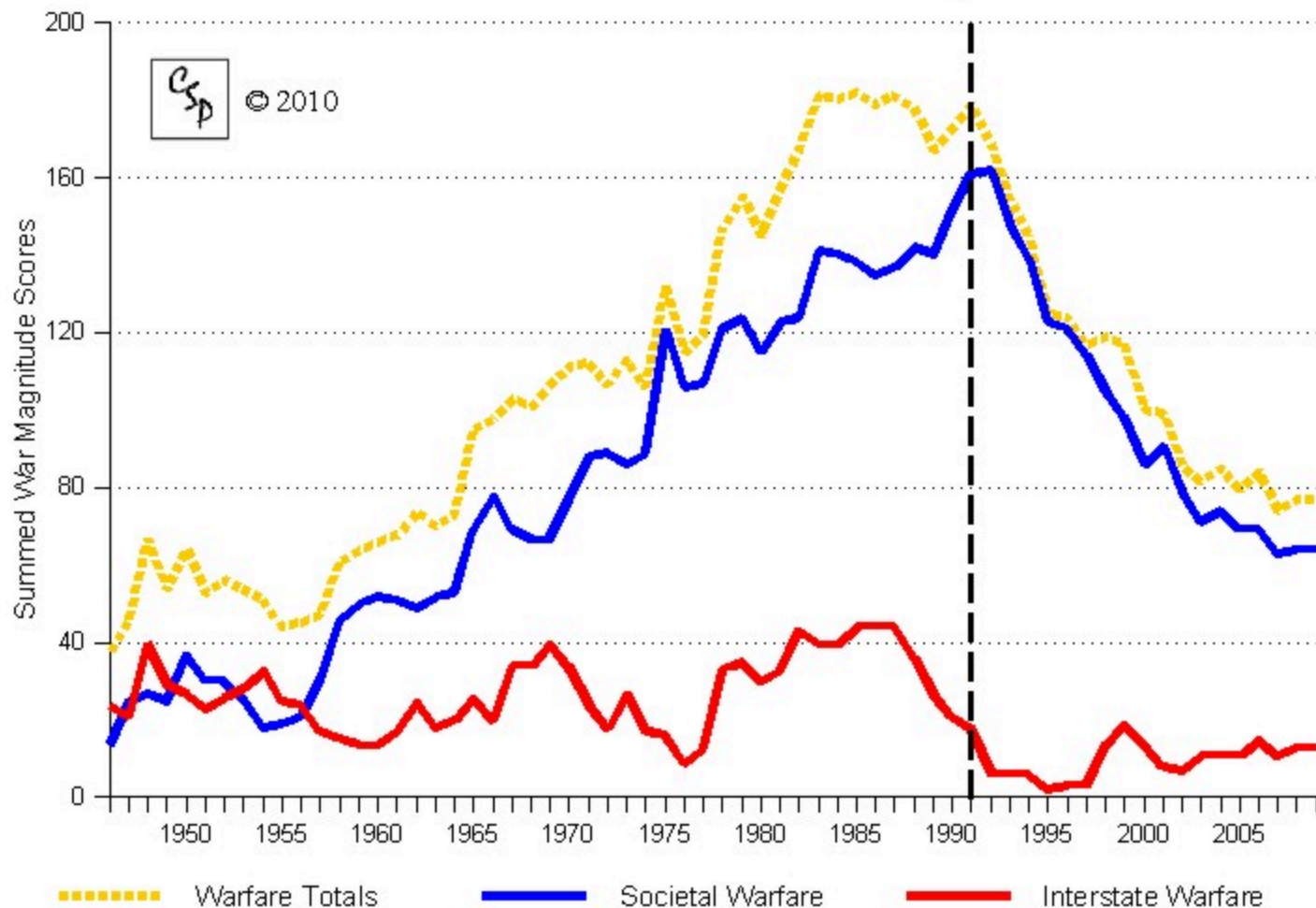
Refugees and Displaced Populations, 1964-2008

© 2009

Legend: Refugees — Internally Displaced — Total Displaced
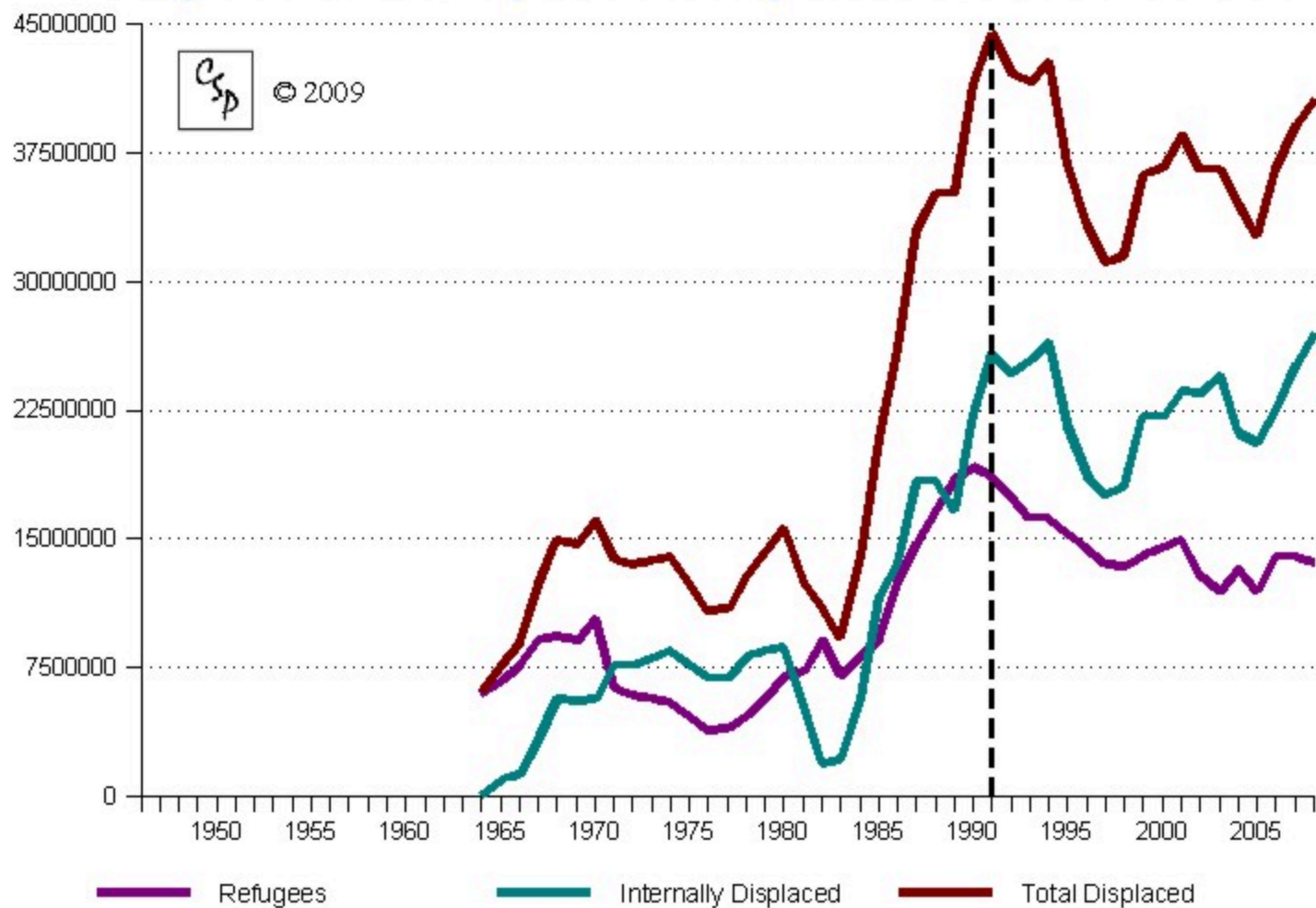
State System Membership 1816 - 2012

An example of a governance variable that may matter a lot, but is extremely hard to predict

United Nations Founded

195

Next steps

- Utilize working group to communicate common vision, concerning
  - Categories of indicators
  - Baseline data
  - Methods for generating quantitative scenarios
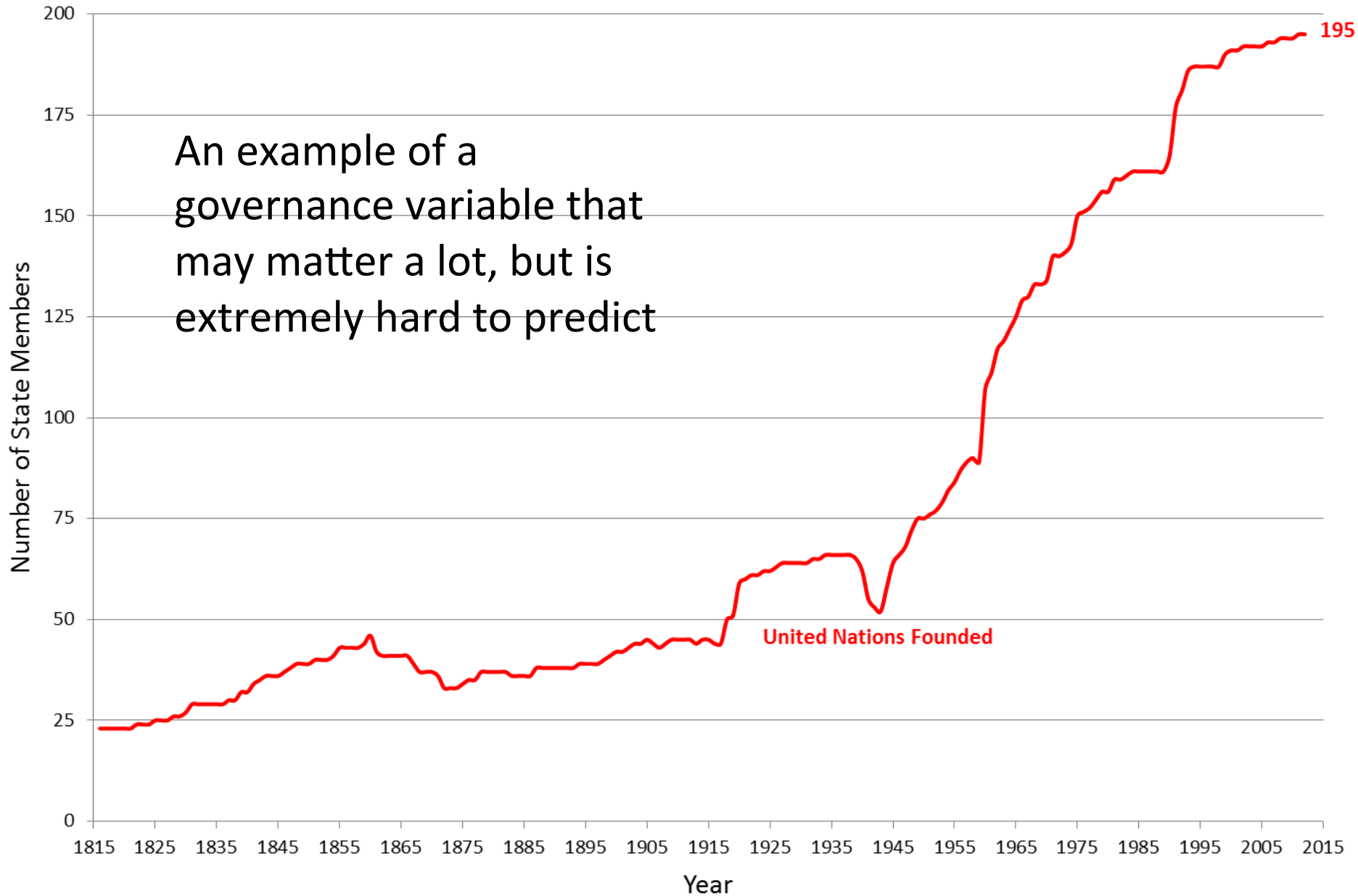 - Methods for evaluating and benchmarking quantitative scenarios
  - Create and manage repository
- Write one or two papers to serve as core reference
- Realistic goals:
  - Get some agreement on a framework
  - Get a few quantitative indicators "out there" optimized for IAV use
  - Keep the process alive so growth and improvement are possible

Method of simulation

Historical regional GDP/capita, PPP (constant 2005 international$) growth rate 1980-2007

Mean

Standard deviation

1980 regional GDP/capita

Simulated regional growth rate: normally distributed random number

Simulated regional GDP/capita

Simulated country growth rate: normally distributed random number

1980 country GDP/capita

Standard deviation of historical global conflict duration (1946-2004)

Simulated country GDP/capita

Probability of government transition from democracy to non-democracy: -0.0431*ln(GDP/capita)+0.436
Probability of government transition from non-democracy to democracy: 0.0267*ln(GDP/capita)-0.150

Probability of onset of conflict: -0.017 *ln(GDP/capita) +0.183

Duration of conflict: absolute value of normally distributed random number with mean 0

1980 type of government

Government transition: occurs if probability > random number between 0 and 1

Onset of conflict: occurs if probability > random number between 0 and 1

Simulated country type of government

Simulated country conflict

Plausibility test

Simulation of GDP per capita, instance of internal armed conflict, and governance of ▢ (2008-2100)