
Large-scale Integrated Modeling with International Futures

Dale S. Rothman

Senior Scientist, Frederick S. Pardee Center for International Futures

Associate Professor, Josef Korbel School for International Studies

University of Denver

Gastwissenschaftler, Institut für Umweltsystemforschung

Universität Osnabrück

Three interconnected sets of issues that define our agenda for the 21st century

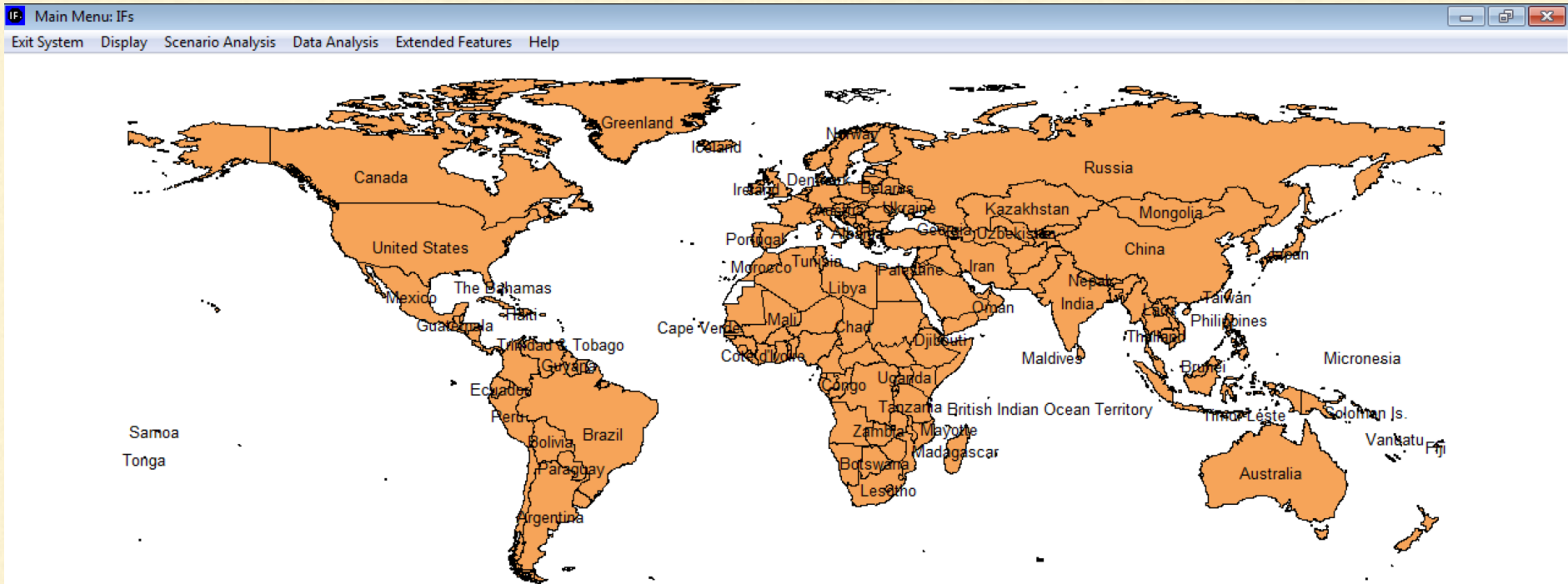
Human Development: Capacities of Selves	Reduce poverty and hunger; advance education and health
Social Development: Relationships with each other	Reduce conflict and inequality; advance capacity and inclusion
Sustainable Development: Relationships with technology and the environment	Reduce unsustainable use of resources; protect the environment; create knowledge

Some Questions of Possible Interest

- What would be the broader social and economic benefits of providing improved cookstoves and/or increasing access to improved water and sanitation?
- What is implied by the SSP assumptions for other social and economic indicators such as access to infrastructure, within country inequality, and other determinants of challenges to adaptation to climate change?
- In attaining its goal of zero hunger in Africa by 2025, what combination of supply and demand side interventions should the AU consider?
- Can societies afford large increases in life expectancy?
- What are key development imbalances that could spark abrupt political change?
- What is the likelihood of achieving the goal of eliminating poverty in fragile and conflict-afflicted states?

One Model to Address Them All?

International Futures Desktop




If you wish primarily to explore possible futures of a particular country, click on that country (right-click for features that help you control the map, including zooming).

To access the full functionality of IFs, including creating multi-country displays in specific issue areas, building new scenarios, and analyzing historical data, use the menu options.

Remember that you can select the Help option or touch the F1 key at any time.

International Futures On Line

 **Main Menu: IFs Version 7.15**

[Exit Model](#) [Display](#) [Scenario Analysis](#) [Data Analysis](#) [Help](#) [Your Feedback](#) [IFs Home](#)



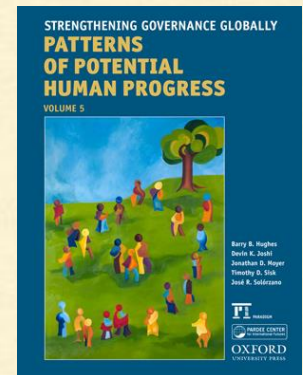
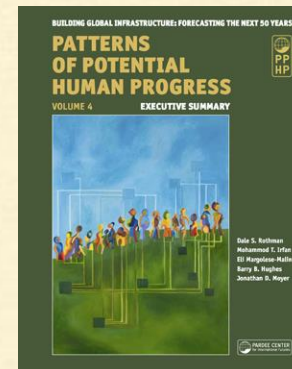
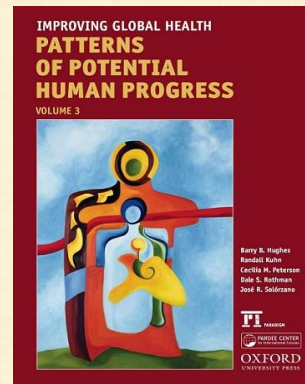
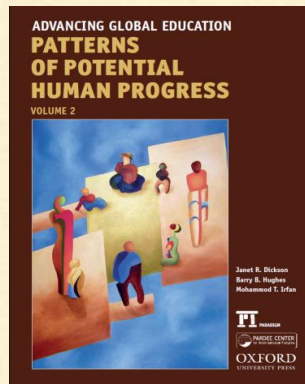
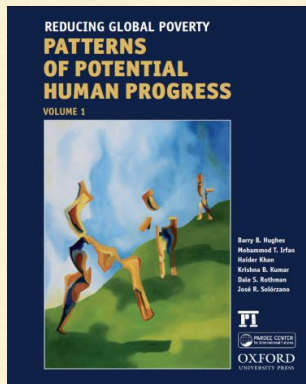
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International Futures History

- Originally developed by Professor Barry B. Hughes at the University of Denver, starting in 1980
- Roots go back to the original World Modeling exercises, which also provided much of the foundation for Integrated Assessment Models
- Since 2009, housed at the Frederick S. Pardee Center for International Futures based at the University of Denver, Barry B. Hughes is Director
- Written in MS Visual Basic with key underlying data tables stored in MS Access; runs on Windows OS (works fine in virtual machines)





INTERNATIONAL FUTURES (IFs) USERS



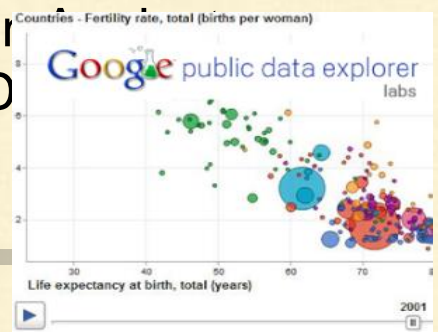
- United Nations Environment Programme: *Global Environment Outlook 4*
- United Nations Human Development Reports: *HDRs 2011 and 2013*
- European Union Commission: *New Economy and Renewable Energy Projects*
- United States National Intelligence Council Reports to the President: *Global Trends 2020, 2025, 2030*
- Others include: World Bank, Peru CEPLAN, Western Cape Provincial Government, New Partnership for African Development, Population Services International, United States Institute of Peace, Google Public Data Explorer, Inter-American Development Bank, Action



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International Futures

Basic Design Elements

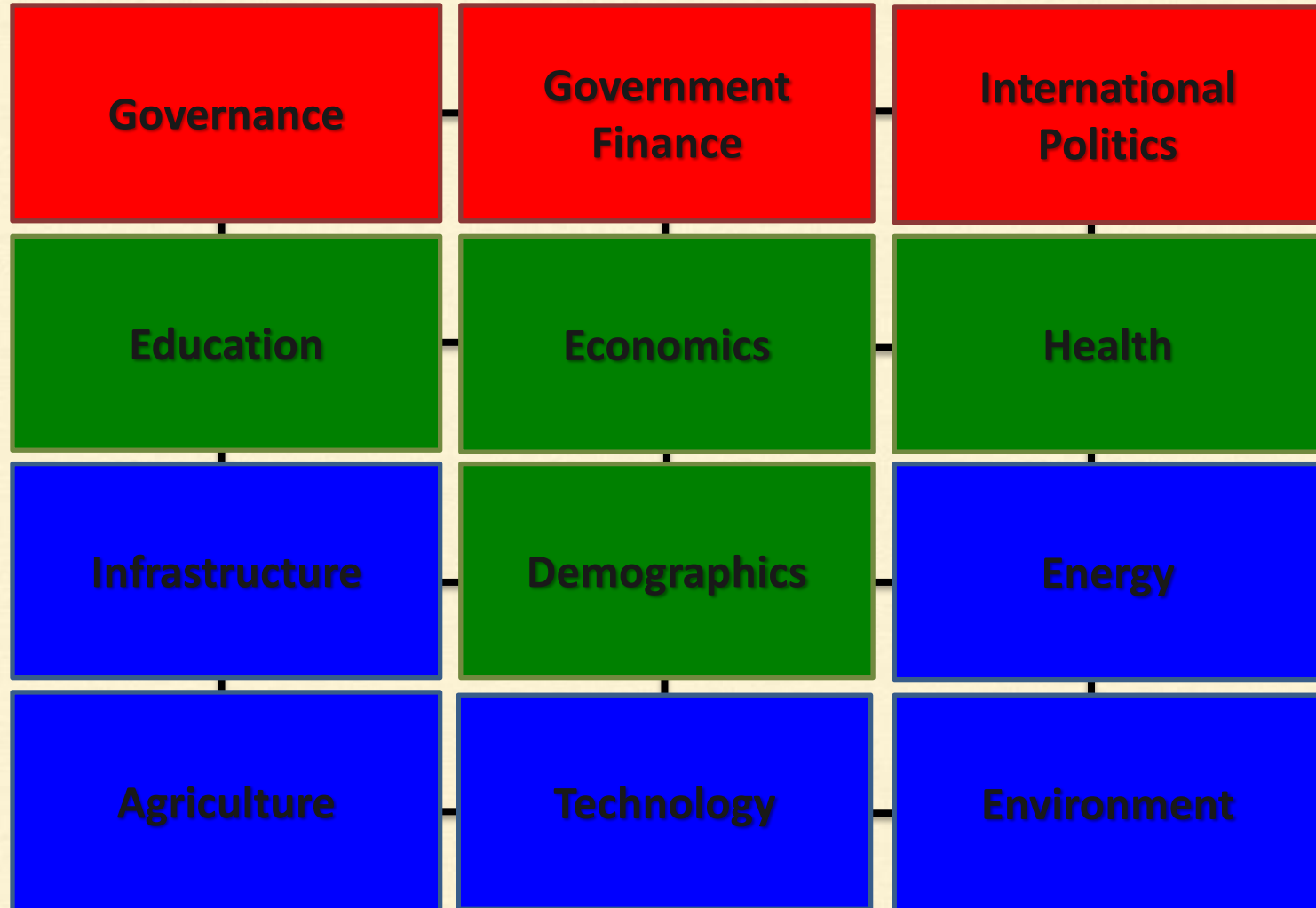
- Global (With Regional and Country Detail), 186 countries
- Integrated, Multi-Issue
- Data and Theory-Based
 - 100s of historical data sets
- Long-Term:
 - Base cases from 2010 or later
 - Scenario exploration as far out as 2100
- Hybrid model implemented with recursive, difference equations
 - Pursues equilibrium over time
- Accessible/Available
- User-Friendly
- Many Interventions Possible
- Transparent/Open

IFs mission: Create and make widely available the world's best quantitatively-based system for analyzing long-term, interacting global issues

International Futures Data Sources

- ‘Broad’ international data sets, e.g.,
 - World Bank World Development Indicators
 - More specialized international data sets from IGOs, e.g.,
 - FAO: FAOSTAT, AQUASTAT, FishStatJ
 - IEA: World Energy Balances
 - UNESCO: Institute for Statistics
 - UNPD: World Population Prospects
 - Key Research Databases, e.g.,
 - GTAP
 - State Failure Project
 - World Values Survey
 - Specialized Reports, e.g.,
 - Bundesanstalt für Geowissenschaften und Rohstoffe (BGR): Energy Resources
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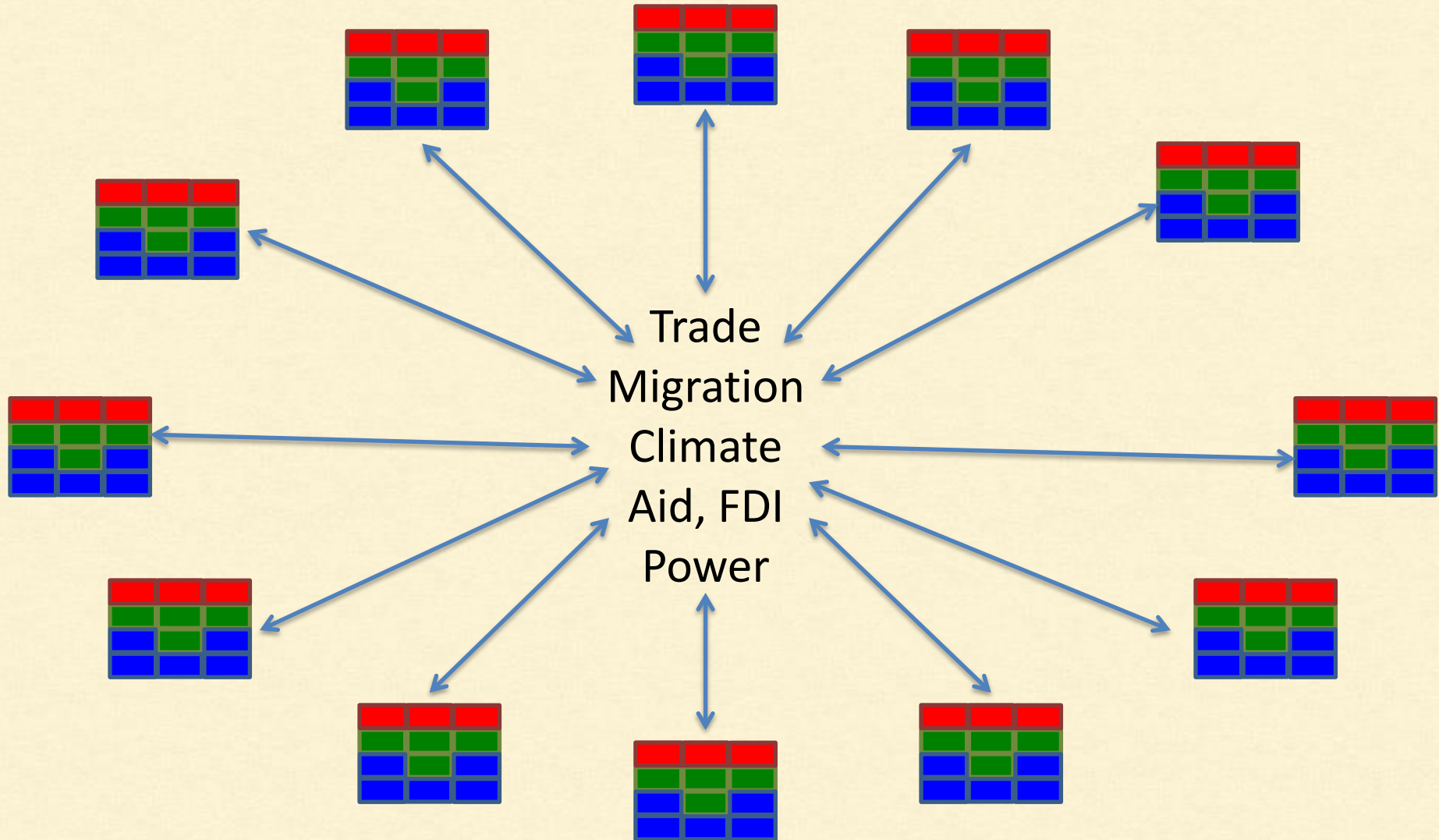
International Futures Key Modules



Links shown reflect subset of all links between modules

International Futures

International Links – 186 Countries



International Futures

Deep Endogeneity and Sample Linkages

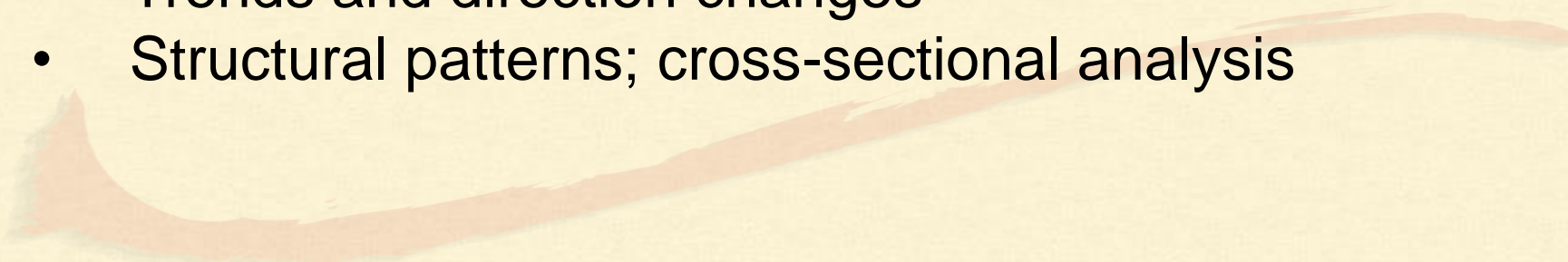
- Deep Endogeneity
 - Limited use of exogenous series – net migration rates; GDP growth in first few years
 - Model runs include full set of countries and all modules
 - Sample Linkages
 - Multifactor productivity is a function of, among other things, human, social, physical, and knowledge capital
 - Mortality, by age, gender, and disease type, is driven by income, education, and assorted risk factors (e.g., undernutrition)
 - Energy use influences crop yields via changes in climate (temperature, precipitation, and atmospheric CO₂)
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International Futures

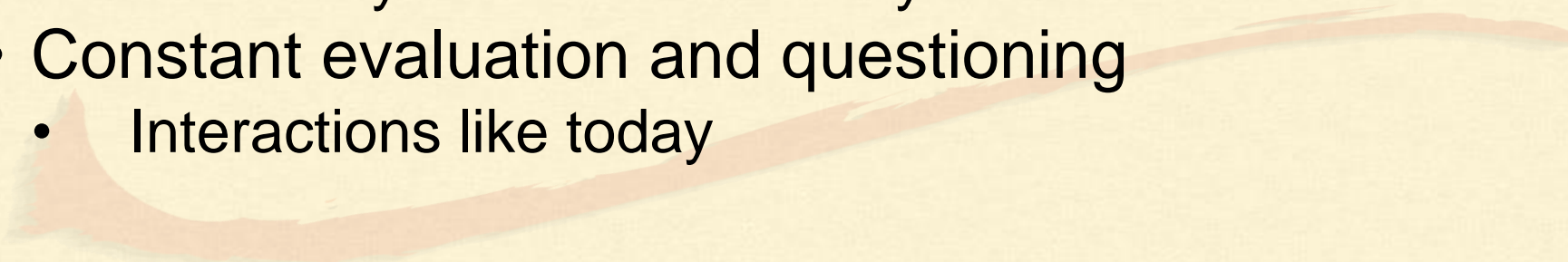
Primary Uses

- Explore Historical Data & Relationships
 - tables, graphs, maps, movies, some basic statistical capabilities
 - Develop Scenarios
 - can save parameter files and run batches of scenarios
 - Explore Scenario Outcomes
 - including comparison against selected other scenarios and forecasts
 - tables, graphs, maps, movies, specialized displays (e.g., population pyramids)
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The Art/Science of Integrated Modeling

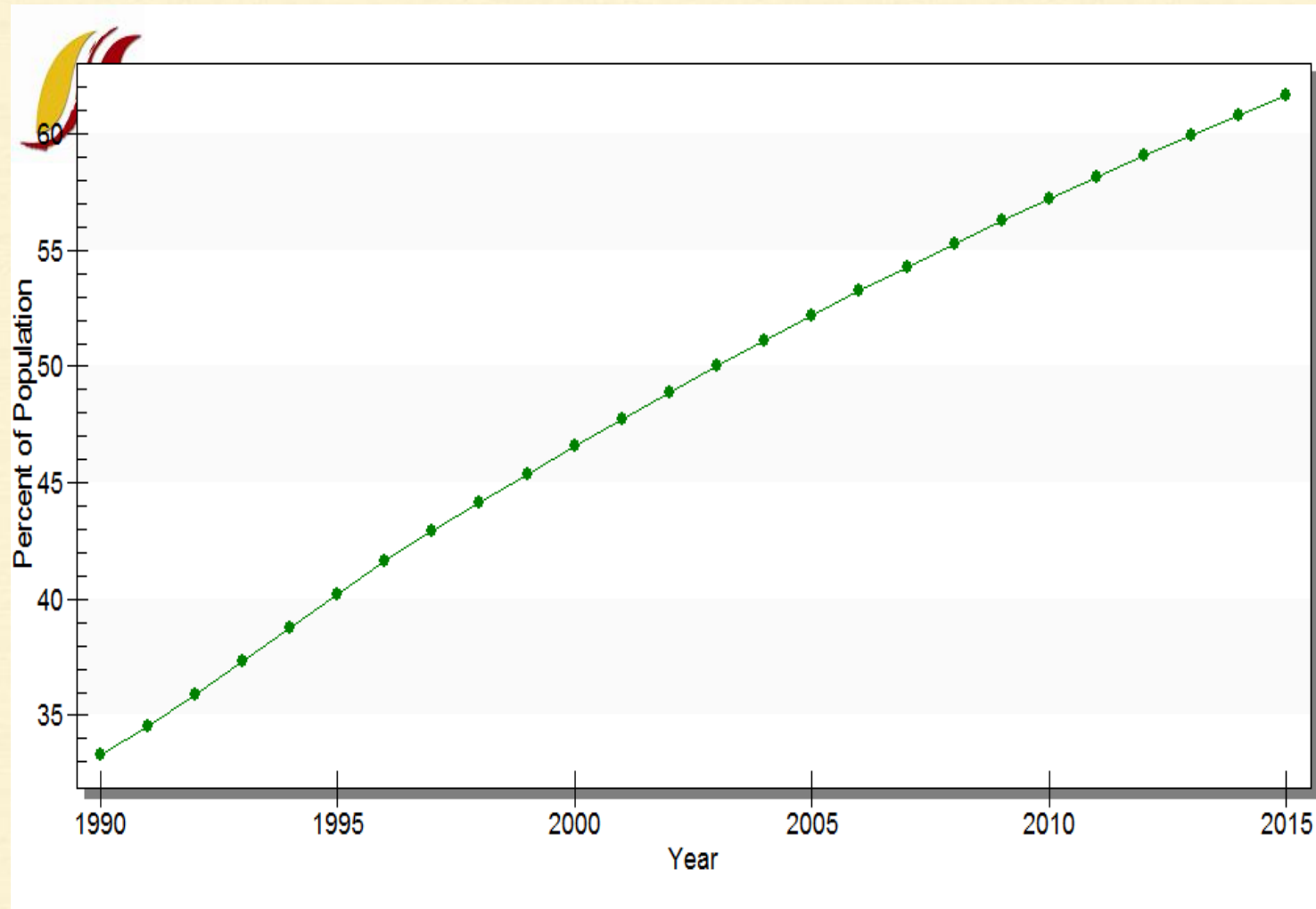
- Identifying concepts and their systems
 - Classifications/taxonomies
 - Stocks and flows
 - Accounting systems
 - Assembling data
 - Integrating multiple sources (concordance)
 - Updating initial conditions (pre-processor); hole-filling
 - Understanding past and ongoing transitions
 - Trends and direction changes
 - Structural patterns; cross-sectional analysis
- 

The Art/Science of Integrated Modeling (continued)

- Building dynamic formulations
 - Equations, of course; statistical fit not a straightjacket
 - Causal dynamics/systems; distal and proximate drivers; identification and focus on critical relationships/drivers
 - Algorithms, including equilibration (PID)
 - Refining and extending the system
 - Exploring behavior, comparing with past and others
 - Sensitivity and scenario analysis
 - Constant evaluation and questioning
 - Interactions like today
- 

**Example 1:
Accelerating Access to Improved Water
and Sanitation in Rwanda**

Historical Data on % of Population with Improved Access to Sanitation in Rwanda



Historical Data on % of Population with Improved Access to Sanitation in Rwanda

IF: Data Availability-WSSJMPSANITATIONTOTAL%IMPROVED

Data Information

Series Name: SeriesWSSJMPSanitationTotal%Improved
Definition: Proportion of Total population served with Improved Sanitation (%)

Extended Definition: Likely to ensure hygienic separation of human excreta from human contact. They include: 1) Flush/pour flush to (piped sewer system septic tank or pit latrine) 2) Ventilated improved pit (VIP) latrine 3) Pit latrine with slab 4) Composing toilet
Unit: Percent

Data Source: WSS JMP WHO/UNICEF JMP

Original Data Source: <http://www.wssinfo.org/>

Last IFs Update: 2015/08/25

Data Availability

Series Coverage

No. of Countries:	186	First Year:	1990
No. of Years:	26	Last Year:	2015
No. of Countries with data:	181		

Country and Year with Most Data

Slovak Republic (100.00%)	2000 (96.77%)
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Year by Year Availability

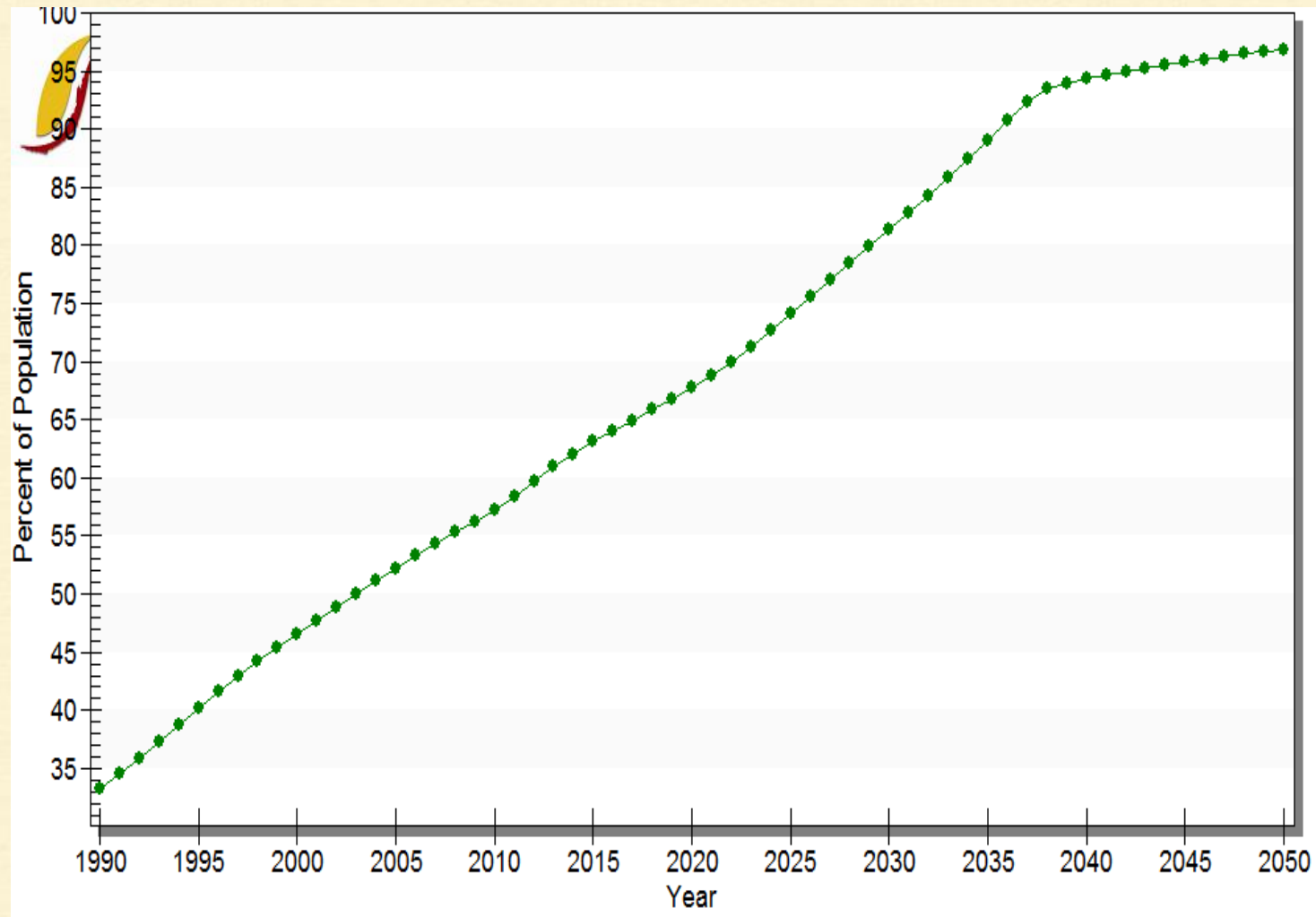
1990	78.49%
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Total Availability

Total Points:	4836	Available Points:	4523
Percentage Availability:	93.53%		

Continue

Base Case Forecast of % of Population with Improved Access to Sanitation in Rwanda



International Futures Scenario Intervention

- Set target for Rwanda of universal access to sanitation by the year 2030 starting in 2015
- Give infrastructure preference in government spending allocation

Scenario Development and Change: Untitled

Continue Scenario Files Add Scenario Components Run Scenario Delete Selection Using Countries Annotate Scenario Parameter Search

Technological Change

- ... Agriculture/Food
- ... Demographic/Population
- ... Economic
- ... Energy
- ... Military

Environmental Uncertainties

Households/Individuals

Governments/Socio-Political Systems

Firms/Businesses

Selected Initial Conditions

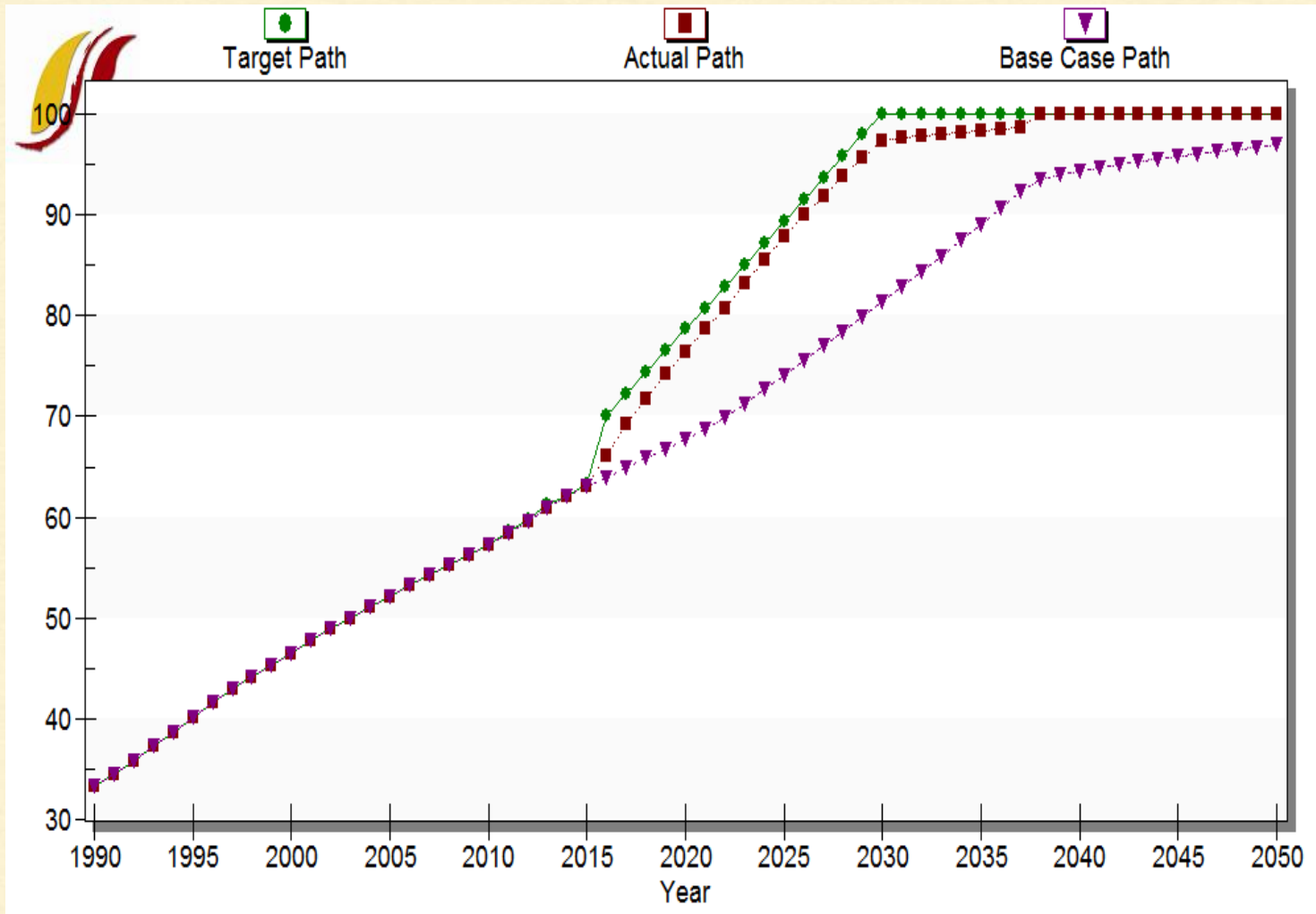
Relationship Parameters

Typical steps in scenario development:

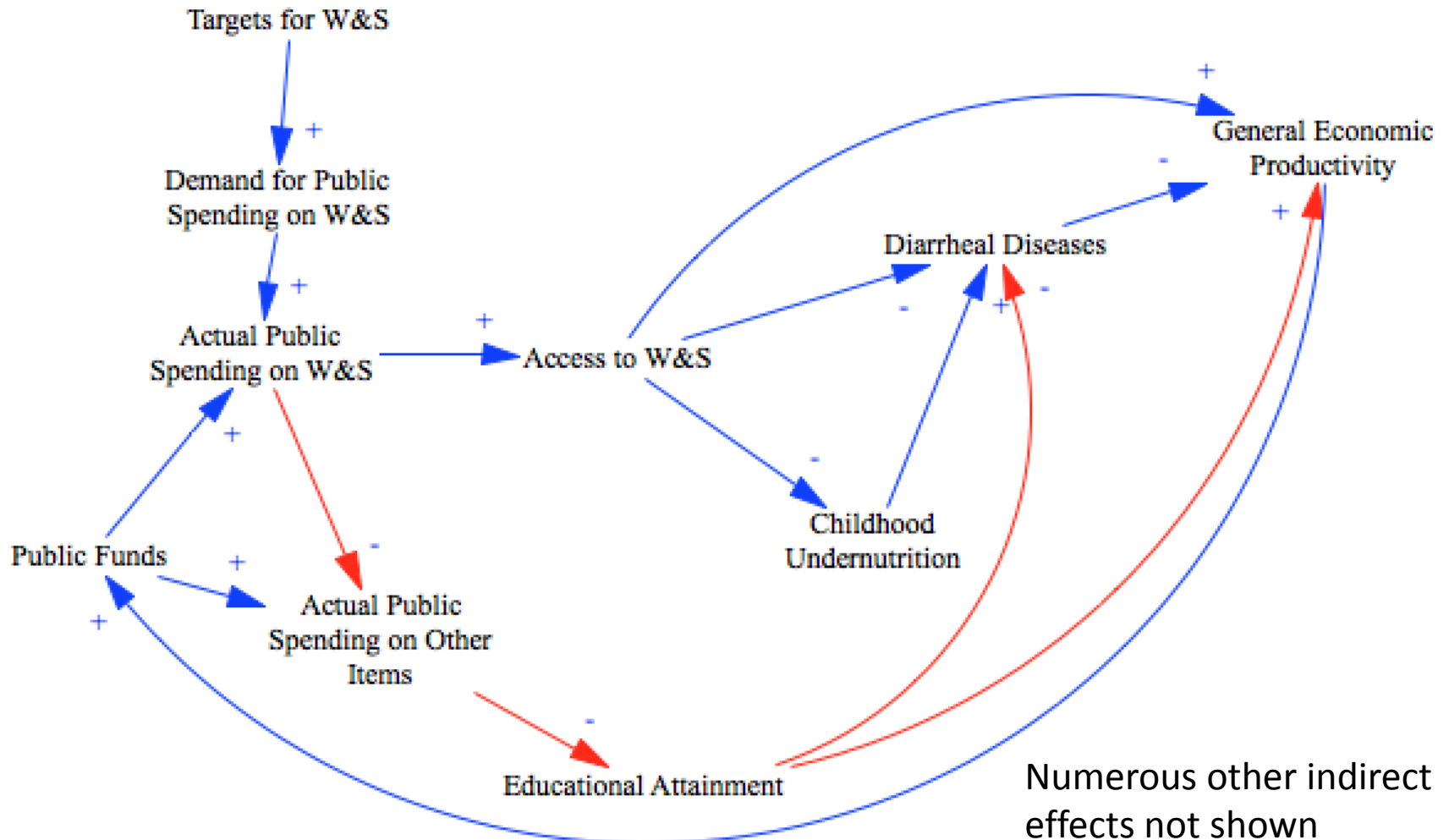
1. Select an issue area from the tree to the left.
2. Add or delete drivers and regions (use the menu option and follow instructions)
3. Repeat issue and driver/region selection to build your scenario.
4. Save your scenario.
5. Run your scenario to recompute all model values.

Scenario Results

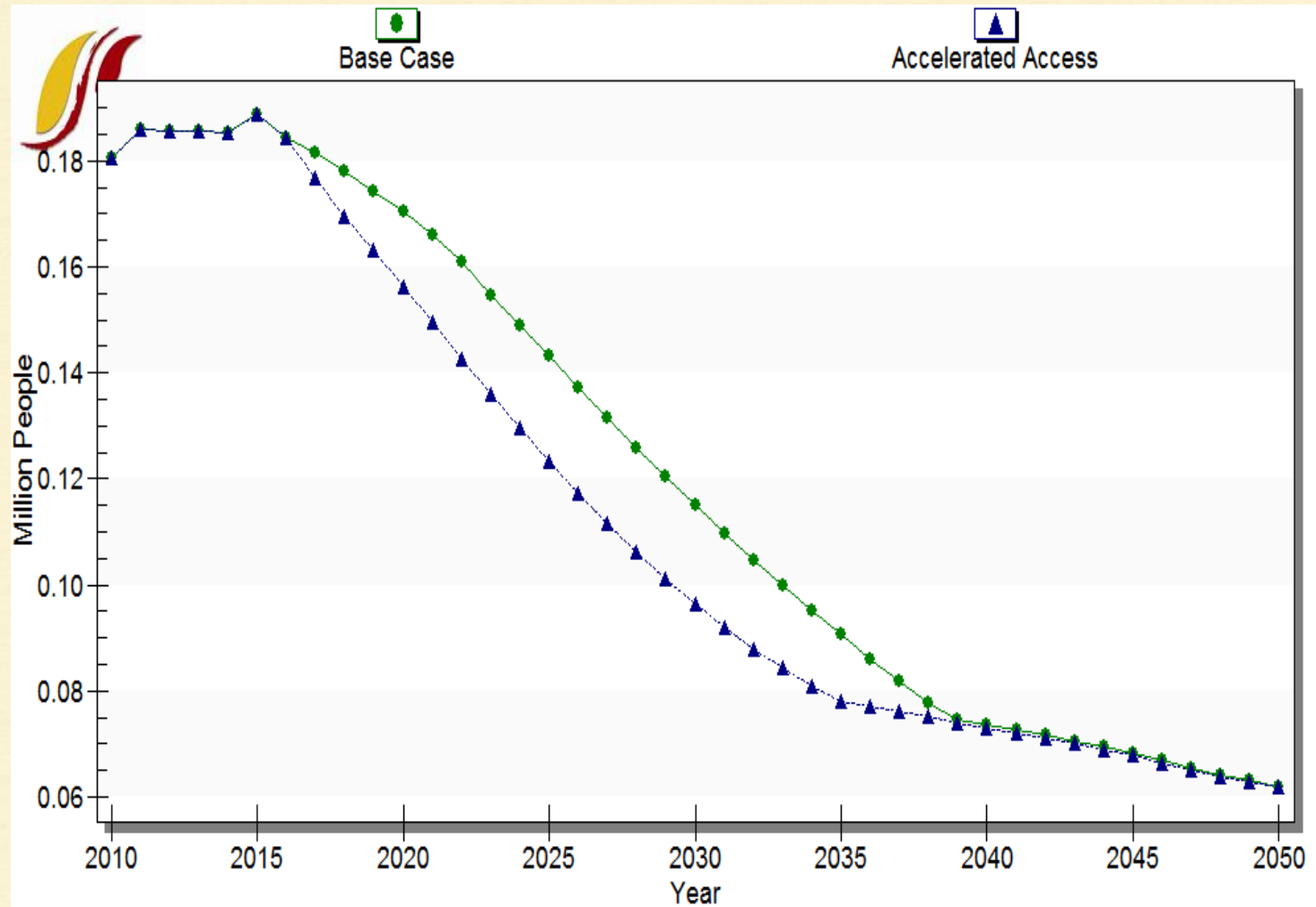
% of Population with Improved Access to Sanitation in Rwanda



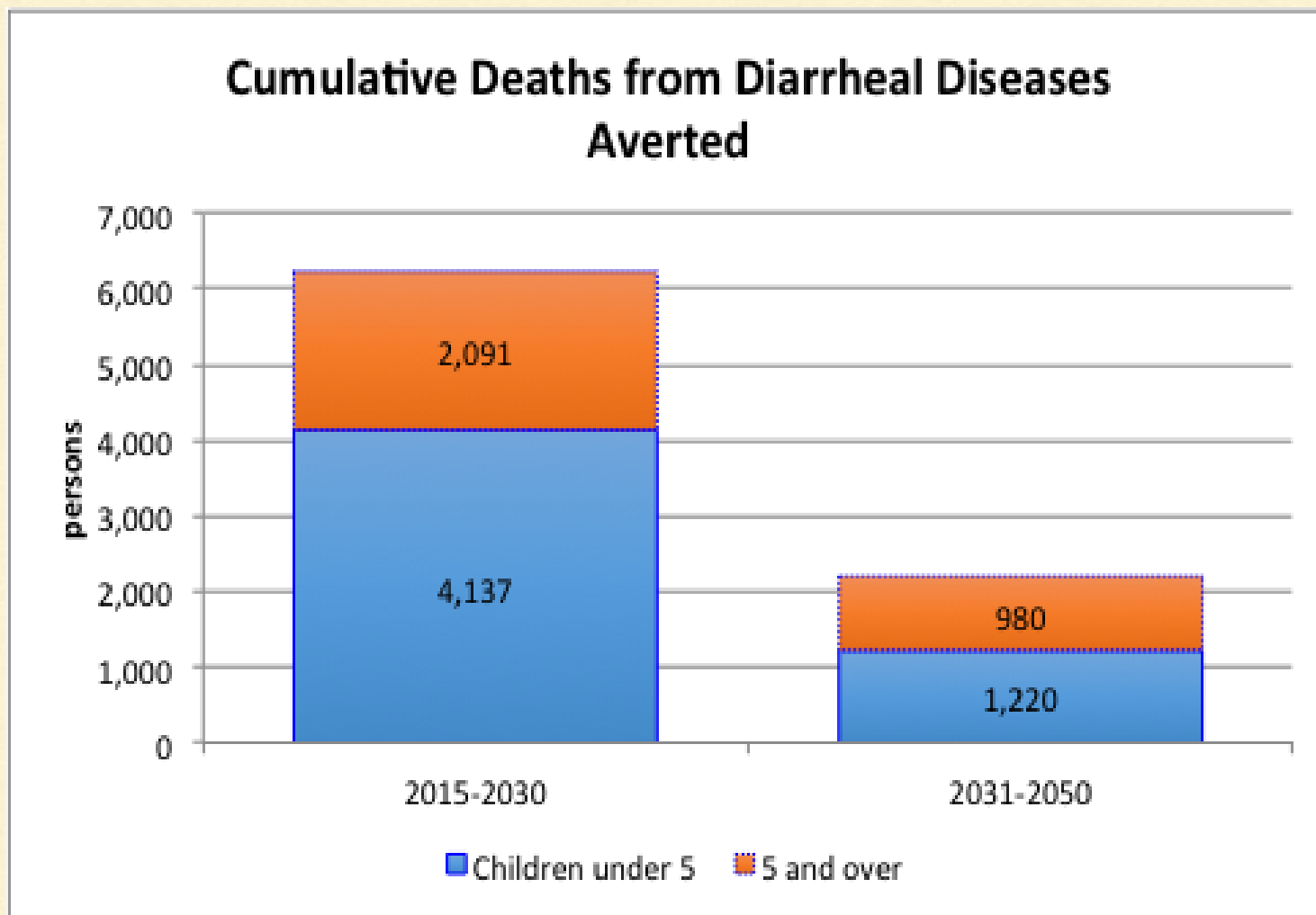
Forward Effects: Sample Chains of Causality



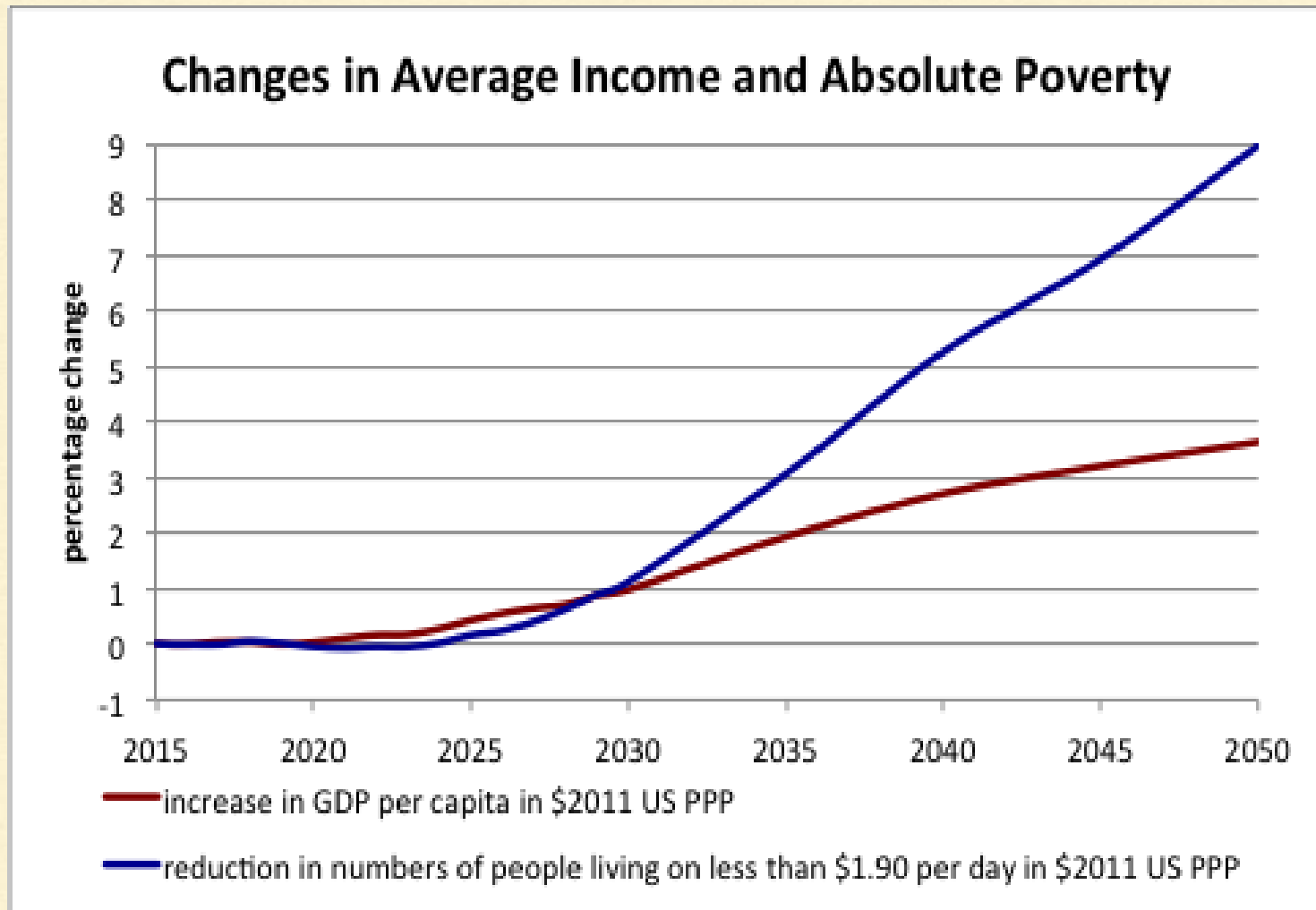
Sample Results – Reduced Childhood Undernutrition (weight for age)



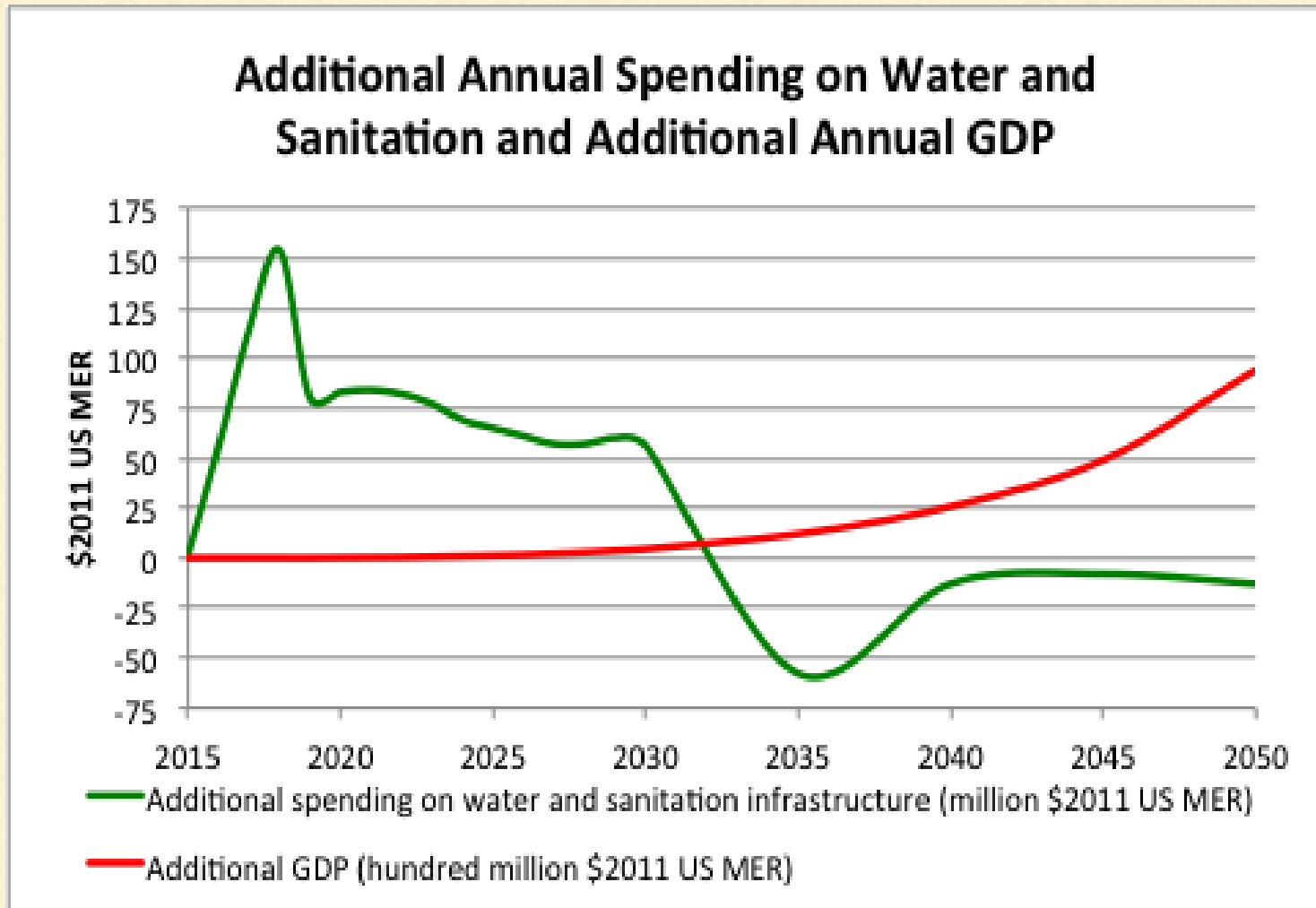
Sample Results – Reduced Deaths from Diarrheal Diseases



Sample Results – Increased GDP per capita and Reduced Absolute Poverty



Sample Results – Additional Annual Spending on Water and Sanitation and Additional Annual GDP



(Some) Advantages of a Large Integrated Model

- **Allows/forces users to:**
 - consider interactions among multiple interacting systems; e.g., the environment, the economy, and other aspects of human systems
 - consider interactions across geographic entities via issues such as trade, migration, and global pollutants
- **Provides ability to explore/identify potential:**
 - unintended consequences/policy dilemmas
 - opportunities for synergies

(Some) Disadvantages of a Large Integrated Model

- Constant need to feed the beast
 - Data, Data, Data
 - Updated relationships based on new data
 - Constant need to monitor the beast
 - Keep an eye on behavior of multiple indicators in a large number of countries
 - Since so many things are connected, any time a change is made in one part of the model, need to keep an eye on other parts
 - Difficulty in understanding and explaining particular behaviors
 - Danger of model driving your research questions
 - Danger of gross generalizations and overdependence on stylized facts
 - Limits to specificity of conclusions/recommendations
-

International Futures

(My) Areas of Interest for Refinement

- Update and improve representations of energy and water supply and demand
- Update and improve representations of climate changes and impacts
- Update and improve representations of agriculture, including fisheries
- Enhance existing and add additional feedbacks between environmental changes and other systems; e.g., environmental burden of disease, water supply constraints on agriculture, and energy constraints on economic productivity
- Update documentation of IFs and comparisons of IFs forecasts against others in literature
- Revise user interface

Potential Contributions of IFs to MOSES Project

- *Fill in based on Day 1 discussions*
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