Pursuing the SDGs: Integrated Scenario Analysis

Professor Barry B. Hughes
Senior Scientist and Mentor
Frederick S. Pardee Center for International Futures
Josef Korbel School of International Studies
University of Denver

Analytical support by Kaylin McNeil

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Motivation for Today’s Discussion and the Project

Humanity is pursuing all 17 SDGs with a wide range of initiatives. Analysis must recognize:

- Complex dynamics link indicator variables across the goals
- Trade-offs and synergies characterize dynamics
- Countries have extremely different starting points
- Explored/proposed interventions should be aggressive, but reasonable

Much existing analysis of SDGs involves:

- Extrapolation of indicators related to specific goals/variables
- Nexus analysis (e.g. water, energy, food)
- Relationships among the SDGs using expert judgment scaling or correlation analysis
- Some model use (e.g. CD-LINKS; TWI2050)
The SDGs vary greatly in character, affecting model/scenario structure.

**Human Development target specification**

- **1. No Poverty**
- **2. Zero Hunger**
- **3. Good Health and Well-being**
- **4. Quality Education**
- **5. Gender Equality**
- **6. Clean Water and Sanitation**
- **7. Affordable and Clean Energy**

**Socio-economic targets (also instrumental support for other targets)**

- **8. Decent Work and Economic Growth**
- **9. Industry, Innovation and Infrastructure**
- **10. Reduced Inequalities**
- **16. Peace, Justice and Strong Institutions**
- **17. Partnerships for the Goals**

**Sustainable Development target specification (often without quantitative targets)**

- **11. Sustainable Cities and Communities**
- **12. Responsible Consumption and Production**
- **13. Climate Action**
- **14. Life Below Water**
- **15. Life on Land**
THE INTERNATIONAL FUTURES (IFs) MODEL SYSTEM HAS RELATED STRUCTURE

- Education
- Demographics
- Health
- Governance
- Financial flows
- International politics
- Technology
- Economics
- Infrastructure
- Agriculture
- Environment
- Energy

Hard-linked models; 186 interacting countries

Human Development target specification

Generalized socio-economic support (also instrumental)

Sustainable Development target specification
DESIRED ANALYTICAL ELEMENTS

1. Comprehensive system representation
   - Three issue domains with hard-linked models
   - Extensive causal linkage elaboration; feedback loops
   - Stock and flow basis of temporal dynamics representation
     - Demographics with endogenous fertility/mortality
     - Economics with endogenous capital/labor/productivity
     - Productivity = F(human, social, physical and knowledge capitals)

2. Fiscal and physical resource/flows accounting
   - Fiscal: Social accounting matrix with households, firms, and government (elaborated revenue and expenditure streams)
   - Physical: land and water usage; fossil fuels; carbon cycles

3. Context sensitivity
   - Dramatically different country starting points (also within)
   - Culture (shared cognitive constructs and behaviour patterns)
ANALYSIS WITH IFs (MANY OF DESIRED ELEMENTS)

1. Indicators identified across all 17 goals
   - Appendix A of paper (Selected subset next slide)

2. Scenarios (Interventions in Appendix B of paper)
   - Current Path (CP) - like SSP2/RCP 4.5-6.0
   - Human Development (HD)
   - Natural System Sustainability (NSS)
   - Combined SDG (CSDG) – much like SSP1

3. “Aggressive but reasonable” interventions sought
   - Past experience of countries at leading edge
   - Different potential at different development stages

4. Exploration of global and country-specific progress
   - Today focus on portion of countries meeting goals
     (exception: global fish catch)
   - Question: Tension between HD and NSS scenarios?
ANALYSIS WITH IFS: ILLUSTRATIVE RESULTS WORLD POPULATION (2050)

Insights:

- Now far from global goal accomplishment
- Current path makes progress, at least toward human development goals
  - Much greater challenges on natural systems side
  - Far from natural systems goals globally even in 2050 (most progress on urban air)

Scale is percentage of global movement from 2000 values toward SDG targets

Parentheses indicate selected target indicator
**Insights:**
- Now far from goal accomplishment across countries and will be in 2050
- Current path makes progress, mostly toward human development goals
  - Far from even human development goals in 2050 across countries, much further than looking only at the global population totals would suggest

Scale is percentage of 186 countries reaching selected target except fisheries (% movement to 50 mmt)

Parentheses indicate selected target indicator
Analysis with IFs: Illustrative Results World Population (2050), Comparative Scenario Analysis

Scale is percentage of global movement from 2000 values toward SDG targets

Parentheses indicate selected target indicator

Insights:

➢ Integrated analysis of SDGs requires representation of and drilling down into complex causal dynamics

➢ In integrated analysis, synergies across human development and sustainability interventions prevail strongly over trade-offs
Insights:

- At the country analysis level, even the combined scenario cannot reach universal target attainment by even 2050 (infant mortality and sanitation access close).
- Human development does intensify challenge for some sustainability goals, including global fisheries and carbon emissions.

Scale is percentage of 186 countries reaching selected target except fisheries, carbon (movement to global goal)

Parentheses indicate selected target indicator.
**Next Steps (Working with UNDP, Others)**

1. Refine targets and scenario interventions
   - Identifying natural system goals/interventions challenging
   - Specialized scaling for country/country grouping interventions now limited

2. Elaborate causal stories around scenario contribution to goal attainment
   - Also country-level, income-grouping level stories

3. Review and enhance modeling/data
   - Causal stories will assist identification of missing elements/weaknesses

**www.pardee.du.edu** (on-line and download versions of IFs open for use)
**bhughes@du.edu** for evolving analytical paper
Extra Slides for Q&A
## GOALS, INDICATORS, AND TARGETS

Goals by number, targets by name, and associated Indicator variables

<table>
<thead>
<tr>
<th>Goal Number</th>
<th>Goal Description</th>
<th>Associated Indicator Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Poverty</td>
<td>% of countries &lt; 3% living on &lt;$3.10/day</td>
</tr>
<tr>
<td>2.2</td>
<td>Hunger</td>
<td>% of countries with undernourished children &lt;3%</td>
</tr>
<tr>
<td>3.2</td>
<td>Health</td>
<td>% of countries with mortality per 1000 births&lt;25</td>
</tr>
<tr>
<td>4.1</td>
<td>Education (Girls)</td>
<td>% of countries with gross secondary completion of girls &gt;97%</td>
</tr>
<tr>
<td>5.2</td>
<td>Gender Equality</td>
<td>% of countries with deaths from violence against women&lt;1/100,000</td>
</tr>
<tr>
<td>6.2</td>
<td>Safe Sanitation</td>
<td>% of countries with improved sanitation &gt;97%</td>
</tr>
<tr>
<td>7.2</td>
<td>Renewable Energy</td>
<td>% of countries with non-carbon energy shares &gt;50%</td>
</tr>
<tr>
<td>8.3</td>
<td>Growth and Work</td>
<td>% of countries with informal labor share &lt;10%</td>
</tr>
<tr>
<td>9.1</td>
<td>Resilient Infrastructure</td>
<td>% of countries with pop within 2 km of all-weather road &gt;97%</td>
</tr>
<tr>
<td>10.4</td>
<td>Inequality</td>
<td>% of countries with GINI &lt;.35</td>
</tr>
<tr>
<td>11.6</td>
<td>Safe Cities</td>
<td>% of countries with urban pollution (PM2.5) &lt;12mg/cm</td>
</tr>
<tr>
<td>12.3</td>
<td>Food Loss Reduction</td>
<td>% of countries with crop loss chain&lt;10%</td>
</tr>
<tr>
<td>13.2</td>
<td>Carbon Emissions</td>
<td>% of countries with carbon emissions below their 2015 values</td>
</tr>
<tr>
<td>14.4</td>
<td>Overfishing</td>
<td>% progress of global fish catch to 50 mmt from 2015 level</td>
</tr>
<tr>
<td>15.1</td>
<td>Protection of Forests</td>
<td>% of countries with forest area above &gt;2015 value</td>
</tr>
<tr>
<td>16.5</td>
<td>Corruption</td>
<td>% of countries with values &lt;4 on inverted TI scale</td>
</tr>
<tr>
<td>17.2</td>
<td>International Aid</td>
<td>% of OECD countries giving&gt;0.7% of GDP</td>
</tr>
</tbody>
</table>
**Productivity Drivers in IFs**

\[ Y = aMFP * K^\alpha * L^\beta \]

\[ MFP = f (\text{Human capital, Social capital, Institutional capital, Infrastructure capital, Natural capital, Knowledge}) \]
# SOCIAL ACCOUNTING MATRIX IN IFS

## Social Accounting Matrix World, 2030

| SAM | Working File | Sectors | Agriculture | Energy | Materials | Manufacture | Services | ICTech | Unskilled | Skilled | Total | Firms | FDI Outflow | Equity Outflow | WR Subscription | Worker Remittances | Capital Formation | Government | Govt | Welfare | Pension | Aid Donations | World Bank Repay | IMF Repay |
|-----|--------------|---------|-------------|--------|-----------|-------------|----------|--------|----------|---------|-------|-------|-----------|-----------------|-----------------|-----------------|-----------------|----------------|----------|--------|---------|---------|-------------|-----------------|-----------|
| World | 2030 | Agriculture | 4.852 | 1.430 | 2.581 | 0.001 | 7.968 | 584.388 | 542.085 | 788.099 | 4.255 | 3.646 | 552.895 | 253.927 | 403.637 | 0 | 0 |
| Energy | 113 | 375 | 182.147 | 167.600 | 17.286 | 0.243 | 412.602 | 32.243 | 862.808 | 666.143 | 242.561 | 0 | 0 |
| Materials | 107.699 | 10.760 | 127.849 | 264.174 | 363.903 | 26.940 | 146.709 | 0.071 | 90.004 | 183.739 | 0 | 0 |
| Manufactures | 651.908 | 155.595 | 327.730 | 577.727 | 385.724 | 507.600 | 251.102 | 270.063 | 178.229 | 0 | 0 |
| Services | 725.300 | 117.699 | 290.240 | 311.961 | 613.946 | 146.709 | 200.753 | 4.036 | 102.742 | 194.748 | 0 | 0 |
| ICTech | 22.793 | 12.673 | 15.752 | 250.408 | 612.254 | 679.315 | 422.984 | 406.533 | -13.246 | 0 | 0 |
| Households | Unskilled | 323.694 | 119.434 | 120.163 | 110.925 | 149.023 | 397.501 | 942.752 | 0 | 0 | 10043.651 | 3913.303 | 0 | 0 |
| Skilled | 557.370 | 1061.755 | 720.869 | 566.705 | 2354.302 | 2011.629 | 8484.484 | 0 | 0 | 0 | 5329.349 | 4586.726 | 0 | 0 |
| Total | 942.752 | 2011.629 | 3526.952 | 3180.086 | 0 | 27463.117 | 526.564 | 0 | 0 | 0 | 5329.349 | 4586.726 | 0 | 0 |

## Social Accounting Matrix Botswana, 2030

| SAM | Working File | Sectors | Agriculture | Energy | Materials | Manufacture | Services | ICTech | Unskilled | Skilled | Total | Firms | FDI Outflow | Equity Outflow | WR Subscription | Worker Remittances | Capital Formation | Government | Govt | Welfare | Pension | Aid Donations | World Bank Repay | IMF Repay |
|-----|--------------|---------|-------------|--------|-----------|-------------|----------|--------|----------|---------|-------|-------|-----------|-----------------|-----------------|-----------------|-----------------|----------------|----------|--------|---------|---------|-------------|-----------------|-----------|
| Botswana | 2030 | Agriculture | 0.506 | 0.000 | 9 | 0.002 | 0.352 | 0.189 | 0.000 | 0.160 | 1.554 | 0.000 | 0.367 | 0.000 | 0.987 | 0 | 0 |
| Energy | 0.009 | 0.191 | 0.327 | 0.179 | 0.118 | 0.001 | 0.618 | 0.378 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Materials | 0.444 | 0.021 | 0.140 | 0.688 | 0.188 | 0.000 | 0.001 | 0.000 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Manufactures | 0.157 | 0.018 | 0.005 | 0.183 | 0.181 | 0.000 | 0.624 | 0.307 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Services | 0.164 | 0.052 | 0.000 | 0.795 | 2.307 | 0.000 | 6.006 | 4.003 | 0.235 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ICTech | 0.057 | 0.005 | 0.000 | 0.020 | 0.259 | 0.000 | 0.934 | 0.589 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Households | Unskilled | 0.546 | 0.460 | 0.068 | 2.953 | 6.599 | 0.424 | 0.356 | 0 | 0 | 0.365 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skilled | 0.046 | 0.158 | 0.186 | 0.407 | 5.739 | 0.273 | 3.294 | 0 | 0 | 0 | 1.467 | 0.086 | 0 | 0 | 0 | 0 | 0 |
| Total | 0.546 | 0.608 | 0.134 | 3.294 | 12.365 | 0.483 | 0.656 | 0.053 | 0.061 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## PARDEE CENTER FOR INTERNATIONAL FUTURES