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Agenda

- Conceptualization
- Ecological Models
- Macroeconomic Models
- Micro, Distributional Impacts Models
- Demographics
- Model Examples
Thinking About Models for Linking Natural Capital and the Socio-Economic

- Natural Capital Model
- Macroeconomic Model
- Distributional Impacts
- Policy, Intervention
- Demographics Dynamics

Connections:
- NC-MA
- MI-MA
- DE-MA
- DE-MI
Linking Natural Capital and the Macro Economy

- **NatCap ➔ Macro**: Impacts of Natural Capital Depletion, Pollution, Emissions on Factor Productivity, Input and factor supply (e.g. Jorgeson IGEM)

- **Macro ➔ NatCap**: Impacts of Economic Activity on Pollution, Emissions, Natural Capital Depletion

- **NatCap ➔ Macro**: Integrated Assessment Methods (e.g. Nordhaus DICE, RICE Models; World Bank’s ENVISAGE)
Feed Backs: Economy and Climate

- Emissions
- Economy
- Productivity
- Carbon Cycle
- Atmospheric Concentration
- Climate
- Temperature
- Damage Function
- Policy
Ecological Model

Kobe Process. Philippines, 2014

- Bio-economic modeling framework
- Vibrant Oceans Initiative

https://www.bloomberg.org/program/environment/vibrant-oceans/
https://www.rare.org/our-work#WWnv-0u5uUc
Ecological Model

InVEST
integrated valuation of ecosystem services and tradeoffs

- Carbon
- Coastal Vulnerability
- Crop Pollination
- Fisheries
- Habitat Quality
- Habitat Risk Assessment
- Malaria
- Marine Fish Aquaculture
- Marine water quality
- Offshore wind energy
- Water purification

https://www.naturalcapitalproject.org/invest/
## Macroeconomic Models (3/6)

### Macro Model

<table>
<thead>
<tr>
<th></th>
<th>Simple</th>
<th>Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orthodox</strong></td>
<td>• SAM, I-O Multiplier</td>
<td>• CGE Model (Static, Dynamic)</td>
</tr>
<tr>
<td></td>
<td>• Neoclassical Growth Model</td>
<td>• Large-scale macro-econometric model</td>
</tr>
<tr>
<td><strong>Heterodox</strong></td>
<td>• Simple SysDyn</td>
<td>• System Dynamics</td>
</tr>
<tr>
<td></td>
<td>• Simple ABM</td>
<td>• Agent-based, computational models</td>
</tr>
</tbody>
</table>
Continued Reliance on Social Accounting Matrices for Registering Economic Transactions Across Sectors, Institutions and Factors of Production

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>COMMODITIES</th>
<th>FACTORS</th>
<th>INSTITUTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITIES</td>
<td>DOM SUPPLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMMODITIES</td>
<td>I-O</td>
<td></td>
<td>DEMAND</td>
</tr>
<tr>
<td>FACTORS</td>
<td>VALUE ADDED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSTITUTIONS</td>
<td>SUBSIDIES</td>
<td>INDIRECT TAX, IMPORTS</td>
<td>DIRECT TAX, TRANSFERS, SAVINGS, CAB</td>
</tr>
</tbody>
</table>

- At one point in time (Does not pick up changing technologies, supply / demand relationships)
- Not all factors of production included (Labor, Capital, Sometimes Land)
- Retains all faults and weaknesses attributed to national accounts to deal with natural phenomena
Circular Flow Diagram

Factor Markets

- Factor earnings (Value Added)
- Indirect Taxes

Productive Activities
- Intermediate Demand

Commodity Markets
- Sales Income
- Exports
- Imports
- Private Consumption
- Government Consumption

Households
- Household Savings
- Subsidies

Rest of the World
- Remittances
- Grants, Loans
- FDI

Government
- Investment Demand
- Investment

Private Consumption
- Consumption

Investment
- Investment
Welfare Considerations as Ultimate Goals for Modeling Process

\[ FTG_\alpha = \frac{1}{N} \sum_{i=1}^{H} \left( \frac{Z - y_i}{Z} \right)^\alpha \]

- \( N \) = Total population
- \( z \) = Poverty line ($$)
- \( y_i \) = Income of HH or individual
- \( H \) = Number of poor (number of people with \( y_i < z \))

\( \alpha = 0 \), FTG = poverty headcount: Fraction of population in poverty

\( \alpha = 1 \), FTG = poverty gap: Area up to \( z \) divided by total area

\( \alpha = 2 \), FTG = poverty gap, squared: Higher weight for those farther below poverty line
Poverty and Distributional Impacts. Top-Down Approach: ADePT Simulation

Micro data (e.g. HH Survey)
- Labor Force Status Module
- Earnings Equation
- Remittances

Macro Projections
- Change in Labor Force Status
- Change in Real Earnings
- Change in Remittances

Price Data
- Income and Consumption
- Individuals and Households

Population Growth
Rule: Replicate macro-proportional changes at micro level

Rule: Best fit to micro data

Results
- Income and Consumption distributions
- Poverty, inequality measures

http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Development+Impact
An ongoing Demographic, affects the age structure of population and dependency ratios has important implications about the supply of labor and employment dynamics:

- Demographic Dividend in Developing Countries
- Post Transition - Aging in Advanced Economies
A Model for Socio-Economic Analysis of Policies for Sustainability of Fisheries in the Philippines

**Ecological Model:**
Vibrant Oceans Initiative
Sustainable Fisheries Group, UC-SB - RARE

**Macro Model:**
Unconstrained SAM Multiplier
RARE Organization (VENSIM)

**Micro Model:**
Distributional Impacts
RARE Organization (ADePT Simulation)

**Policies for Sustainability, VOI:**
Financing, CRM
RARE Organization (VENSIM)

**User Engine**
Policy Analysis
RARE Organization (FORIO)

**Exogenous Demographics:**
United Nations, DESA
Population Projections
Medium Variant Scenario
The Model in VENSIM
Outcomes from Socio Economic Model

- **BaU**: Do Nothing, Over-fishing
- **VOI Pessimistic**: Sustainable fishing, no VOI Financing, no Efficiencies
- **VOI Optimistic**: Sustainable fishing, VOI financing, Efficiencies
Distributional Impacts Model

UN Population Projections, through 2050, by Age Groups and Gender, Rural and Urban

Household Survey Data, 2011, with Population Weights, by Age, Gender, Area, and Regions

Recalibrated population by categories, Entropy Method: Pop. by years, areas, age groups

World Bank, WDI; PHL Labor Force Survey Data: Labor Force, Participation Rate, Employment

Welfare Measures: Consumption, Income, Distribution

Macro Model: Multiplier Analysis Results (Value Added, Consumption…)

Household Survey: Simulated Changes in Mean and Distribution (Poverty and Inequality)
Some Outputs from ADePT Simulation

**Probability Density Function**

- Welfare aggregate, poverty line
- Y-axis: Probability density function
- X-axis: 0 to 0.8

**Growth Incidence Curve**

- Y-axis: Annual growth rate, %
- X-axis: Expenditure percentiles

**Lorenz Curve**

- Y-axis: Lorenz curve
- X-axis: Cumulative population proportion

**Table: Poverty Headcount Rate**

<table>
<thead>
<tr>
<th></th>
<th>PHL2006</th>
<th>PHL2012</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>5.4</td>
<td>4.8</td>
<td>-0.6</td>
</tr>
<tr>
<td>Rural</td>
<td>26.9</td>
<td>20.1</td>
<td>-6.9</td>
</tr>
<tr>
<td>Total</td>
<td>16.3</td>
<td>13.2</td>
<td>-3.1</td>
</tr>
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**Table: Poverty Gap**

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<tr>
<td>Total</td>
<td>3.8</td>
<td>3.0</td>
<td>-0.8</td>
</tr>
</tbody>
</table>

Poverty line = poverty line in local currency per month. Equivalent to $1.9*365/12 = 57.7917$/m
Unlocking the Potential of Philippines Coastal and Marine Resources through Enhanced Planning and Sustainable Financing - A joint study between RARE and the National Economic and Development Authority of the Philippines (NEDA)

User defined inputs related to Financing and Efficiency Measures for VOI Scenario

The VOI Scenario includes an injection of financing resources (either from government, foreign donors, or both) that are expected to support livelihood of those whose welfare is affected in the short to medium from reduction in catch, and to pay for initiatives aimed to increase the revenues of fishermen for a given fishing effort. User has the possibility of defining assumptions on financing and efficiency gains fro policies for sustainability of VOI. Predefined values are those in Model Baseline.

**Financing Options**

- **Fraction of Financing from Foreign Donors**: 50.0%
- **Amount of Financing in support of VOI in US$**: $488,560,000.00

**Efficiency Measures**

- **Target Increase in Revenues from Decreased Spoilage**: 17.0%
- **Target Increase Revenues from Quality Improvements**: 7.0%
A Model for Ex-Ante Analysis of Shocks and Development Policies in Ethiopia

**CGE Macro Model, Static. GAMS**
- Social Accounting Matrix
- Initial Conditions
- Model parameters

**System Dynamics Macro-Micro Model. VENSIM**
- Disaggregated sectors
- Market disequilibrium: Delays, Sticky prices, Stock accumulation, non-linearity
- Different closures

**Household Level Data**
- Household Heterogeneity in Utility Maximization Problem

**Policies and Shocks**

**User Engine**
- FORIO Interface

**Calibration**

**Extension, Changes in model structure**
### Main Features of Model

<table>
<thead>
<tr>
<th>Static CGE Model</th>
<th>System Dynamics Model (Changes CGE)</th>
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</thead>
<tbody>
<tr>
<td>HH Utility Maximization (Stone Geary)</td>
<td>Sticky Prices, elasticities</td>
</tr>
<tr>
<td>Firms take demand as given, Maximize Profit</td>
<td>Stock accumulation (inventories by tradable commodities)</td>
</tr>
<tr>
<td>12 activities, commodities</td>
<td>Full developed sectors</td>
</tr>
<tr>
<td>Open Economy, Armington, CET</td>
<td>(Exogenous) Changes in Price of X, M</td>
</tr>
<tr>
<td>Government collects taxes, spends</td>
<td>Debt accumulation</td>
</tr>
<tr>
<td>Different closures: Savings – Investment; RER – Foreign Savings</td>
<td>Additional closure to Model: Restricted vs unrestricted Government Expenditure</td>
</tr>
<tr>
<td>Model calibrated to SAM values</td>
<td>Dynamic calibration to historical period</td>
</tr>
<tr>
<td>Micro-Macro linkages from SAM, HH data (Replicate Consumption by Commodity, Income)</td>
<td>Top-Down, Bottom-Up model results emerge from feed-back structures, calibration rules, closures and scenarios</td>
</tr>
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Using Ethiopia Model for ex-ante assessment of policies as shocks

- For assessing expected impacts of policies included in Ethiopia Long Term Development Plan
- Model versatile to “connect” to fully fledged sectors (including agriculture), modules linked to provision of environmental goods and services
- Convenience of carrying on policy, shock analysis with Tod-Down, Bottom-Up structures, under a consistent Macro-Micro framework and given “rules” or “closures”
- Model amenable to compute several indicators included among Sustainable Development Goals
Some Preliminary Charts

Headcount Poverty from Consumption (Based on 1.9$/day Poverty Line)

Quantity of Labor by Education Type

Aggregate Demand Components: Model

Log Total Real Exports: Hist vs Model

Model Example 2 (6/6)
Thank You!