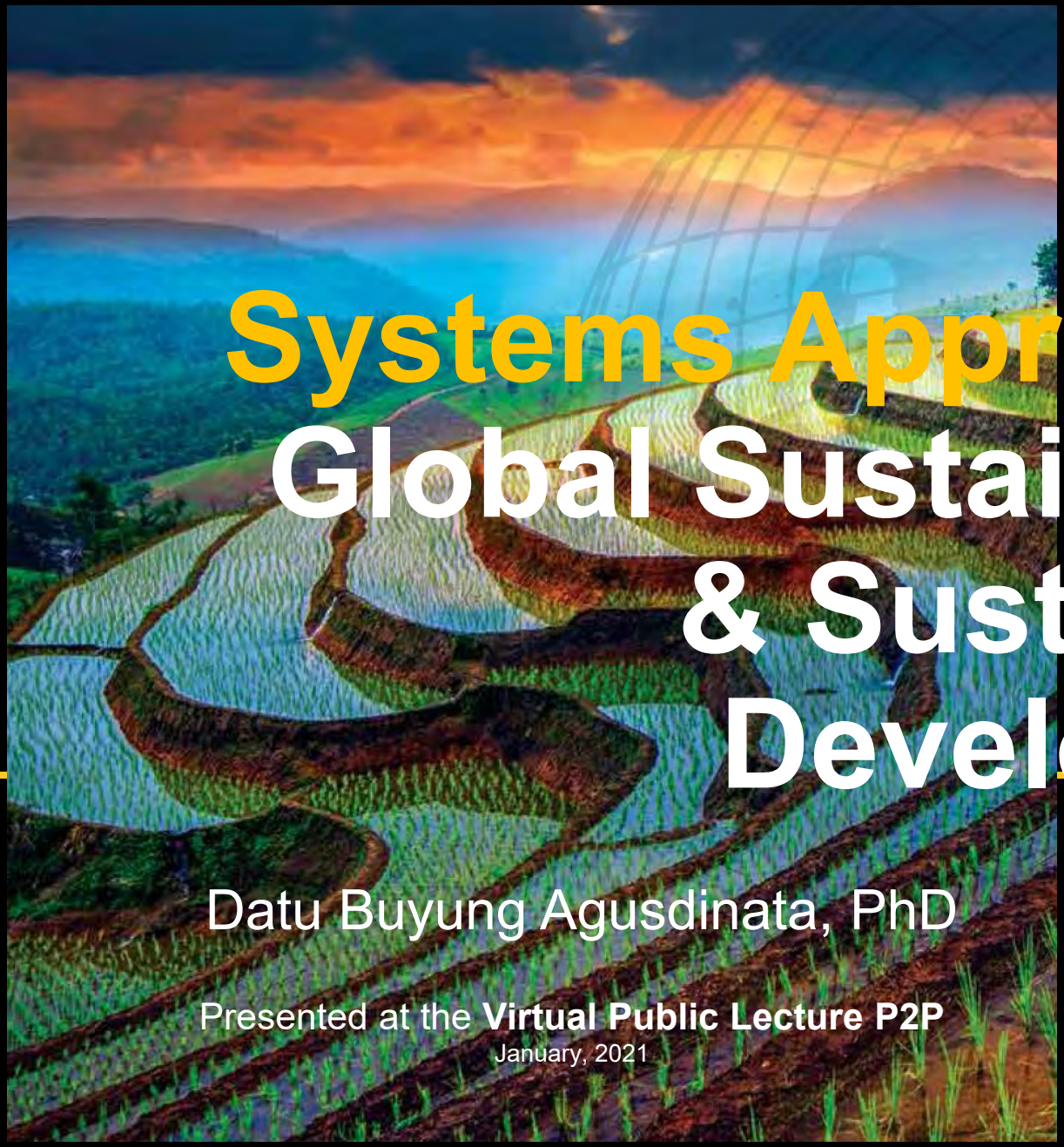


Systems Approach to Global Sustainability & Sustainable Development

Datu Buyung Agusdinata, PhD

Presented at the **Virtual Public Lecture P2P**
January, 2021

Arizona State University

Sustainability: “the integration of environmental health, social equity and economic vitality in order to create thriving, healthy, diverse and resilient communities for this generation and generations to come. “

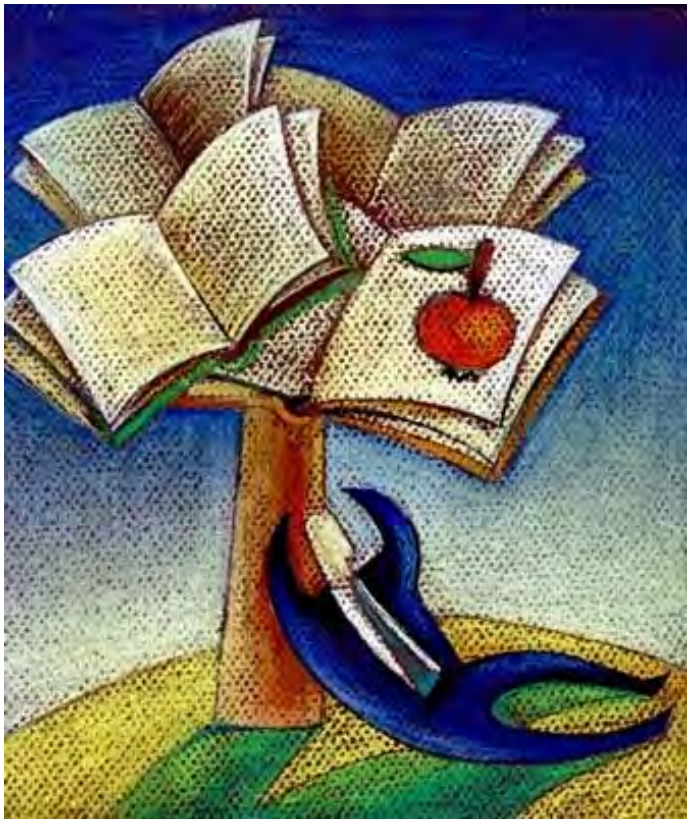
Sustainable development: “the pathway to sustainability”

How to move forward for achieving Sustainable Development?

How can system perspectives and approaches help inform design and implementation?

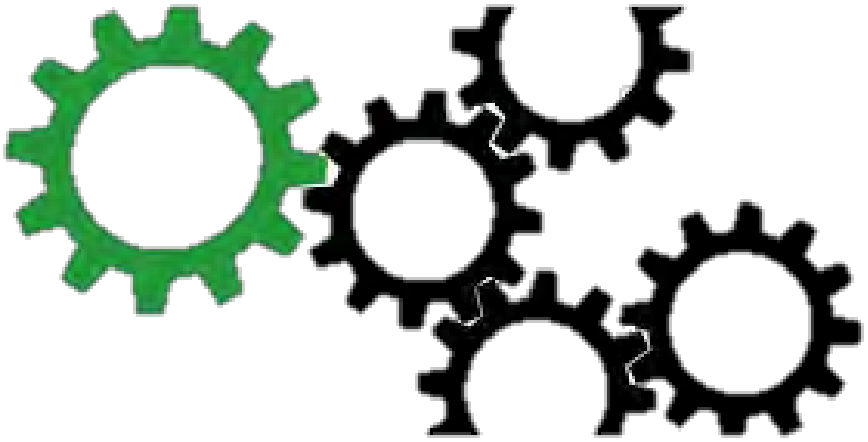
Frequently Asked Question

- WHAT IS A SYSTEM?



What is a System?...

- *"An **interconnected** set of **elements** that is coherently organized around some **purpose**." - Dana Meadows*



SDGs = a System

- World Agenda
  - Where we are now and Where we want to be
- Links between human well-being, economic prosperity and a healthy environment

Challenges SDGs Implementation

- Goals are too broad, isolated, unfocused, and unrealistic
- Ensure policy coherence
- Integrated **pathways** to attain all 17 goals within planetary boundaries
- Need: an **integrated framework** to better understand the inter-connections among the seemingly disparate SDGs

System thinkers and the SDGs

- Big Picture
- Change with time
- System's structure
- Interdependencies and Connections
- Change perspectives
- Mental models
- Leverage
- Accumulations
- Delays
- Consequences
- Dynamics

Benson and Marlin, 2017

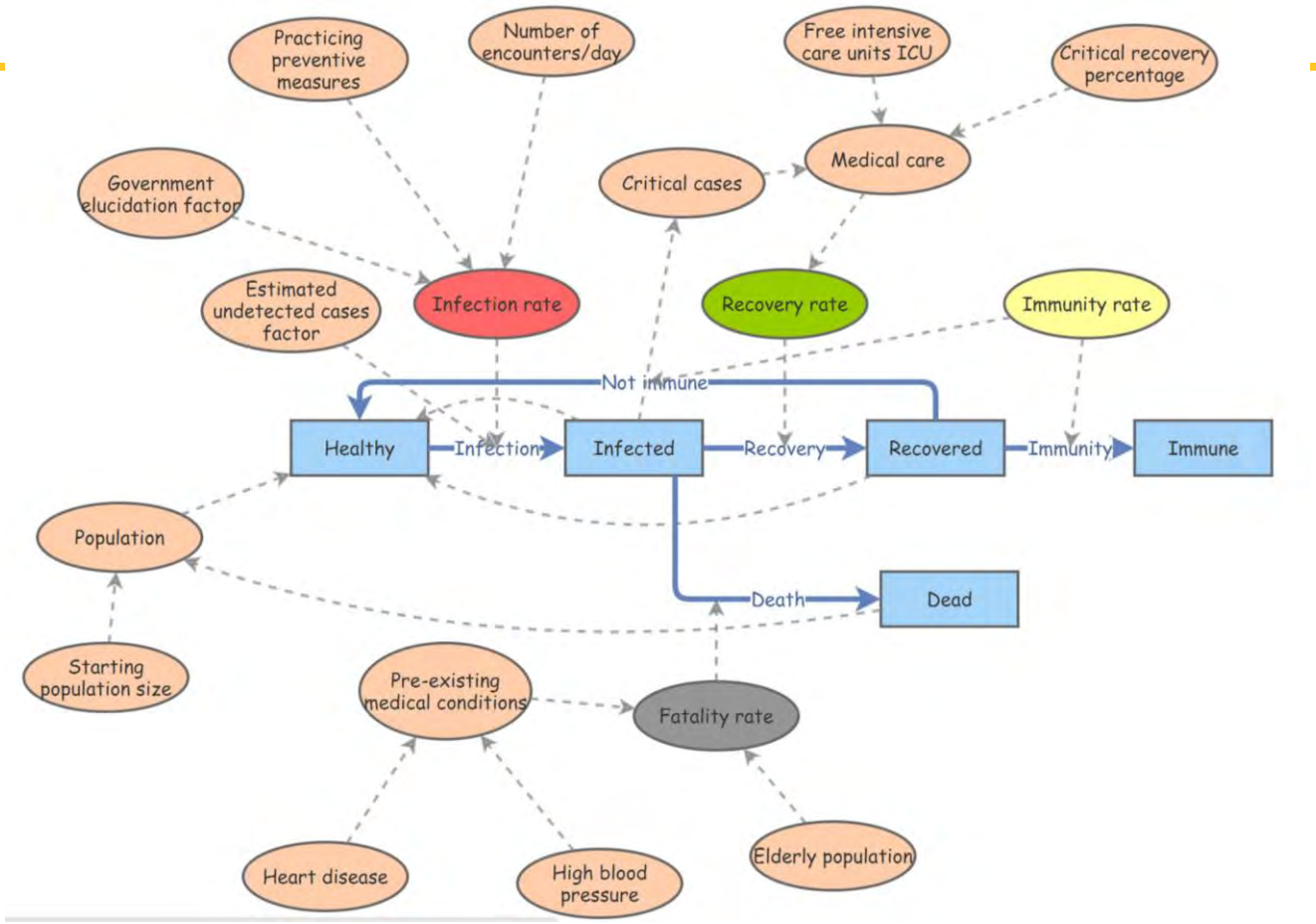
SDGs - Big Picture

- Minor, medium, major linkages

- Earth. Social, and Economic System

Analyze All/Sub-sets of the SDGs

System's structure

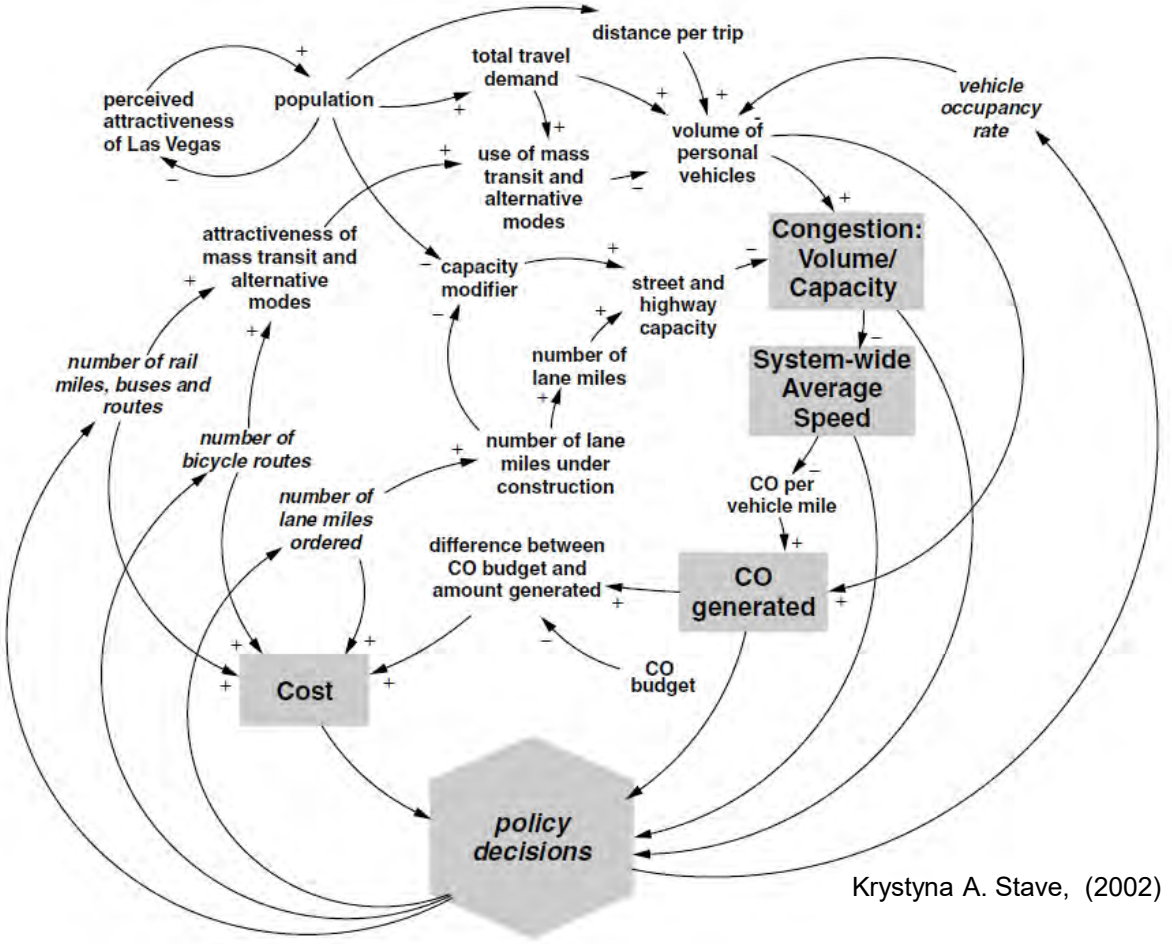


- Structure determines behavior

Leverage: Policy Options

Policy Levers:

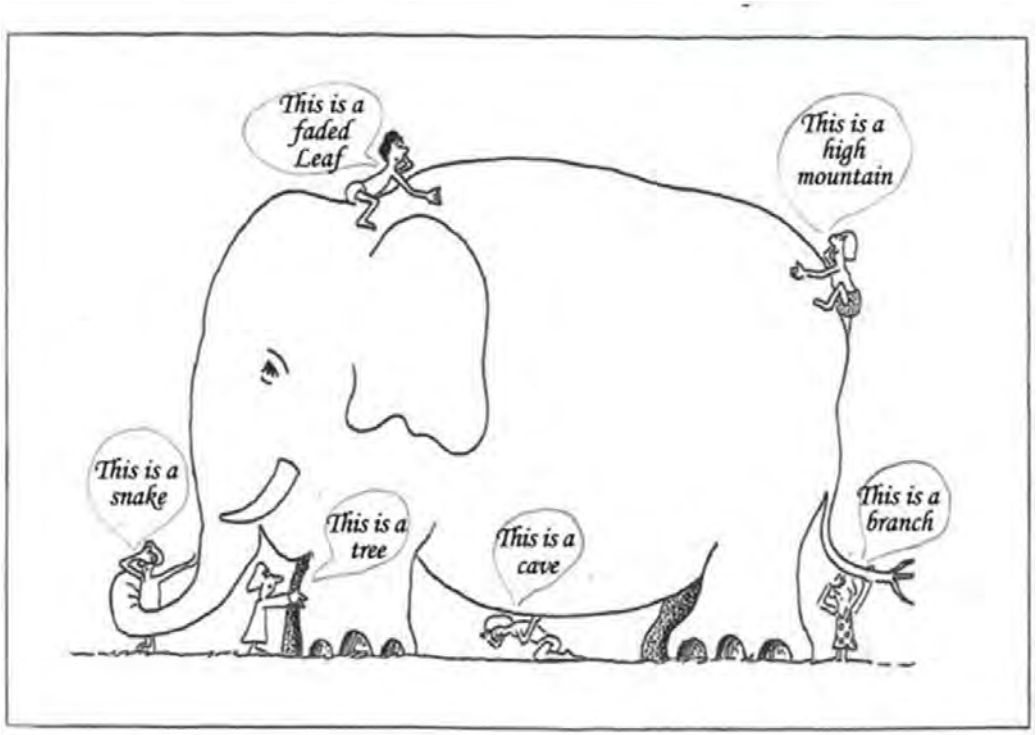
- High speed lane miles
- Low speed lane miles
- Rail miles
- Bike routes
- Mass transit buses
- Regional Transportation (RT) buses and routes
- Car pool
- Traffic signals



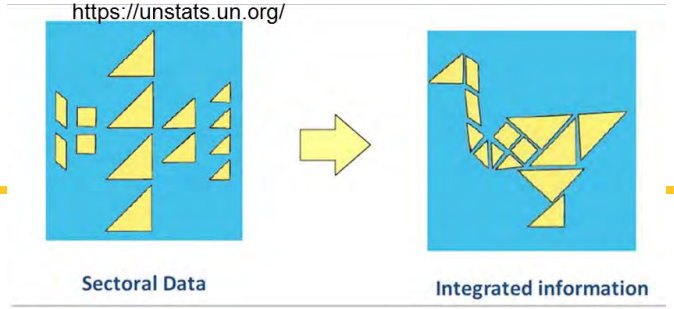
Krystyna A. Stave, (2002)

Identify leverage points for the SDGs

Mental Model

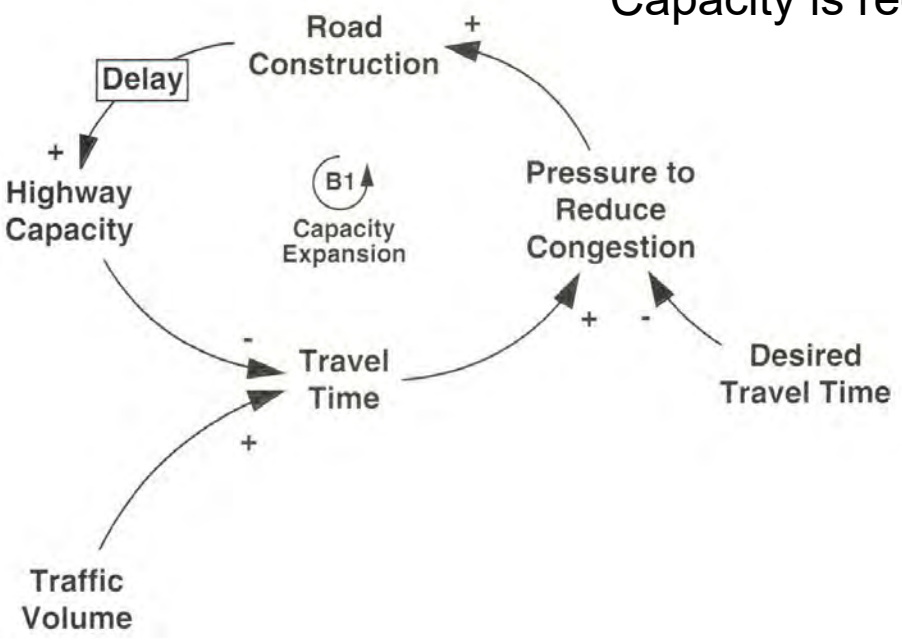


https://unstats.un.org/



- Mental models influence perspectives and ultimately any actions taken

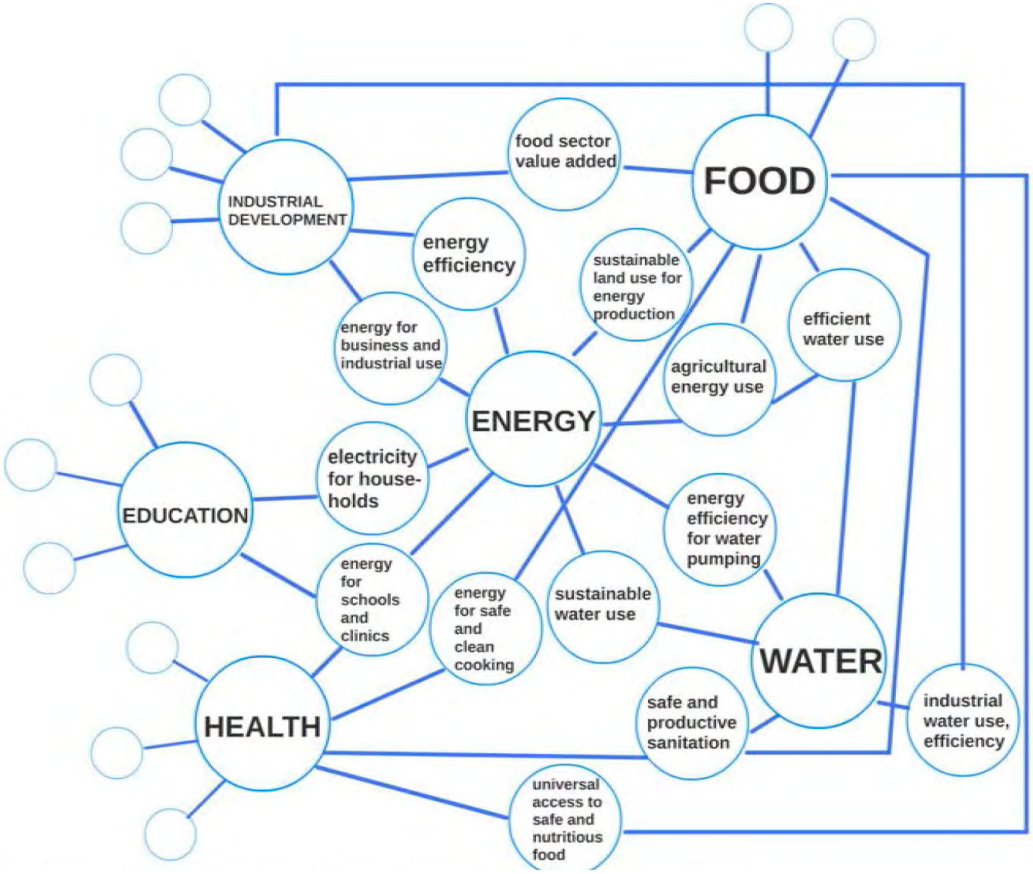
Time Delay



Due to delay:
Capacity is reduced In the short term

- Implementing policies for the SDGs will take time
- The effects of those policies will take time to be felt

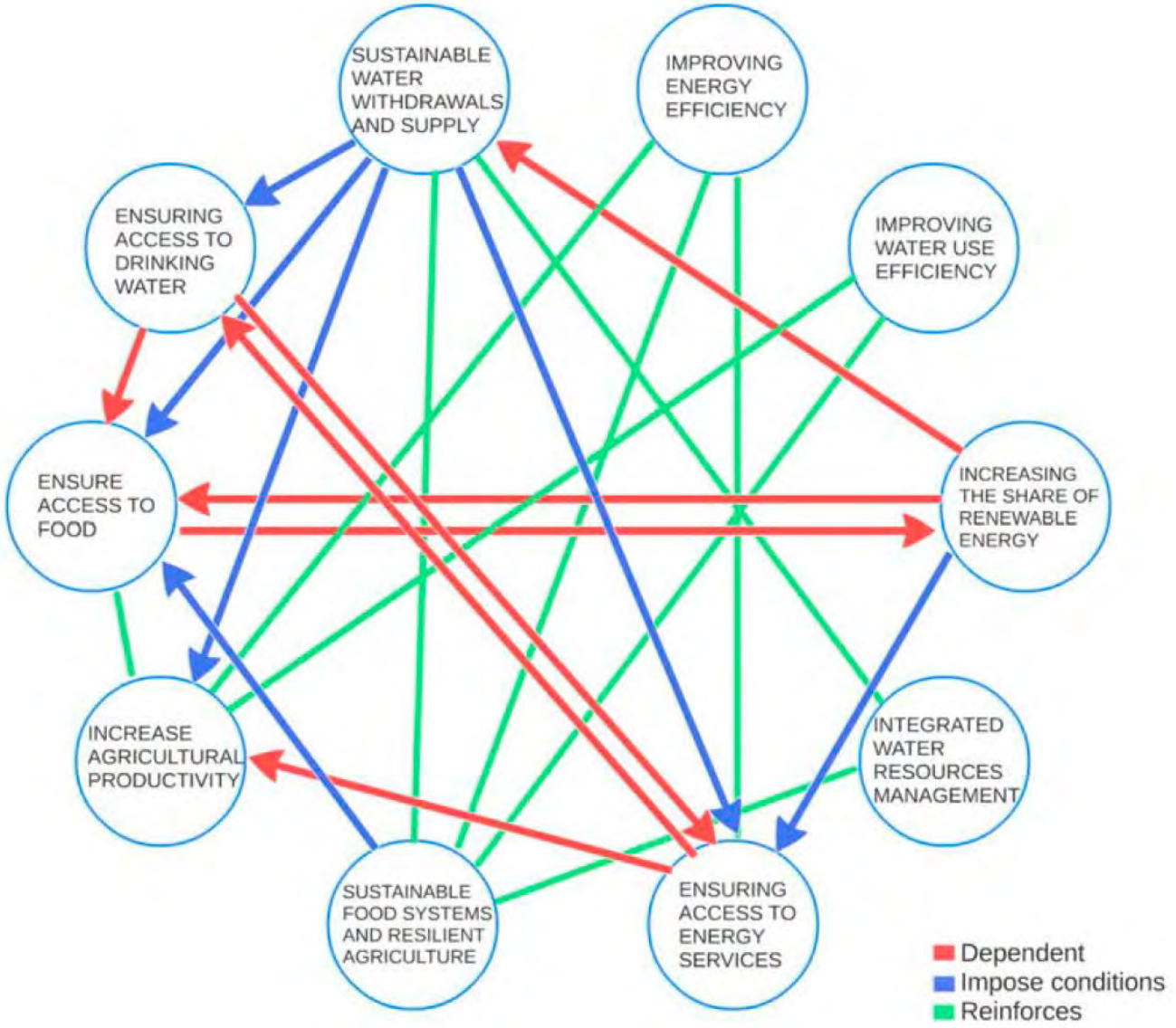
Interconnections



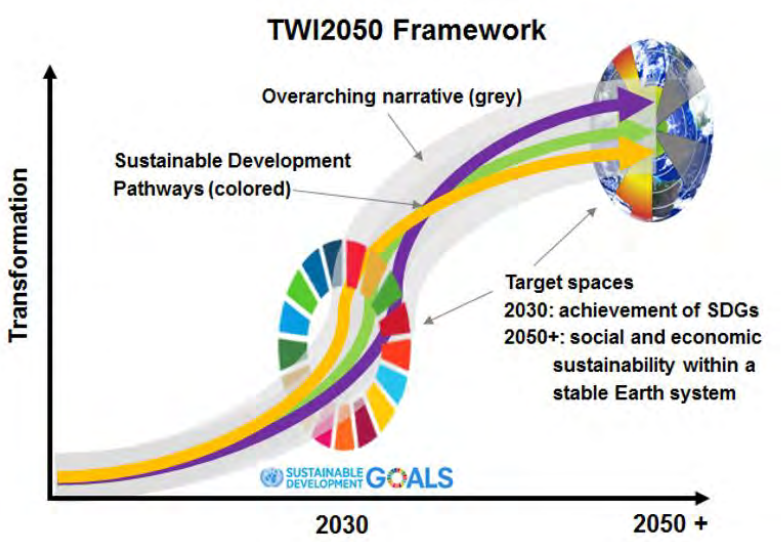
Weitz et al., 2014

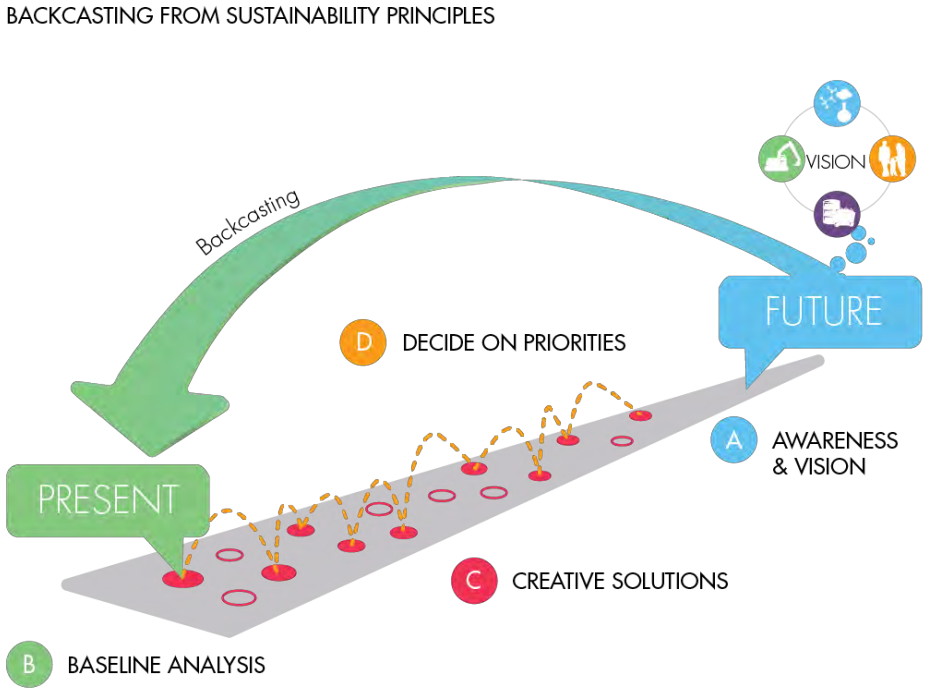
- Food-Energy-Water-Health Nexus

Interdependencies



Change with time

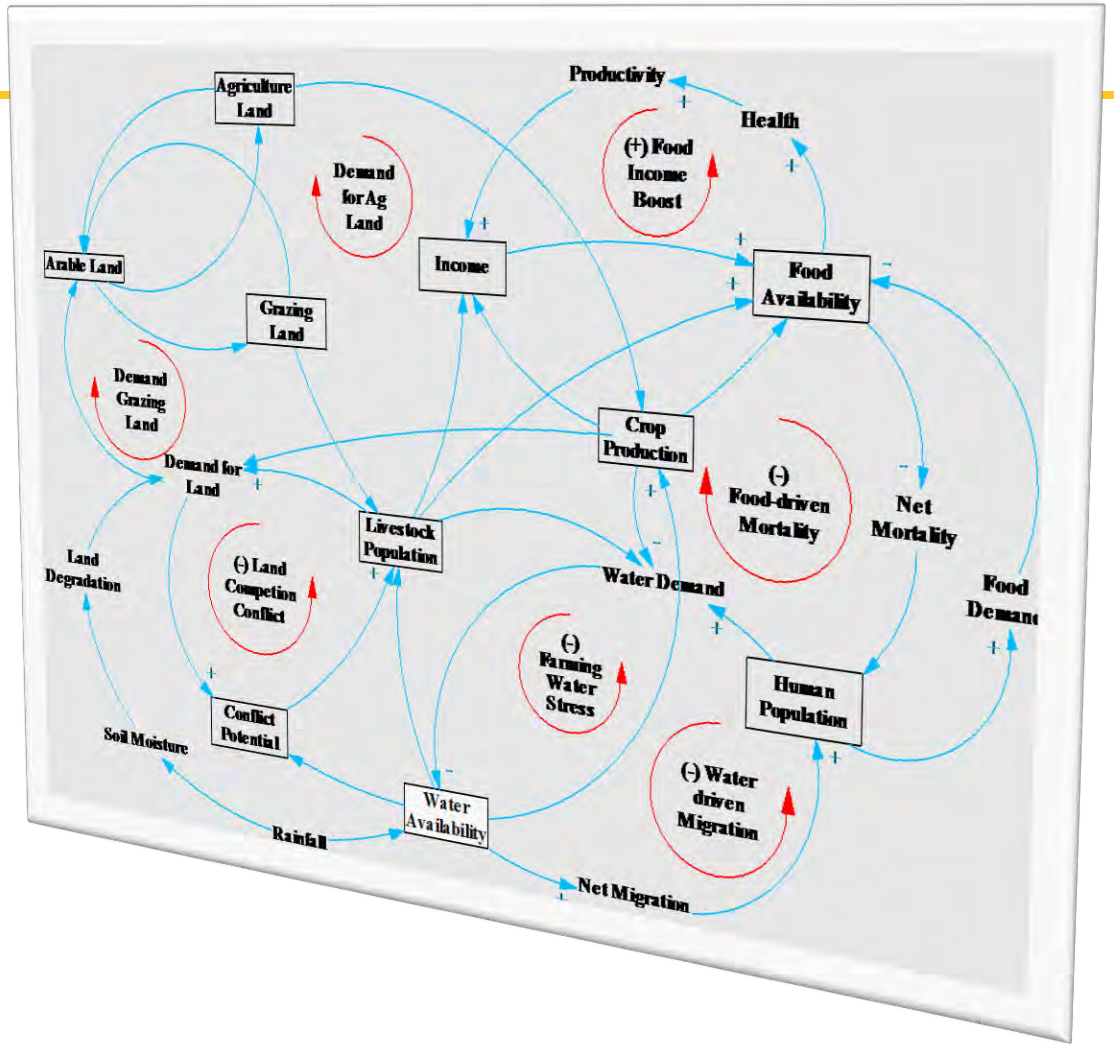




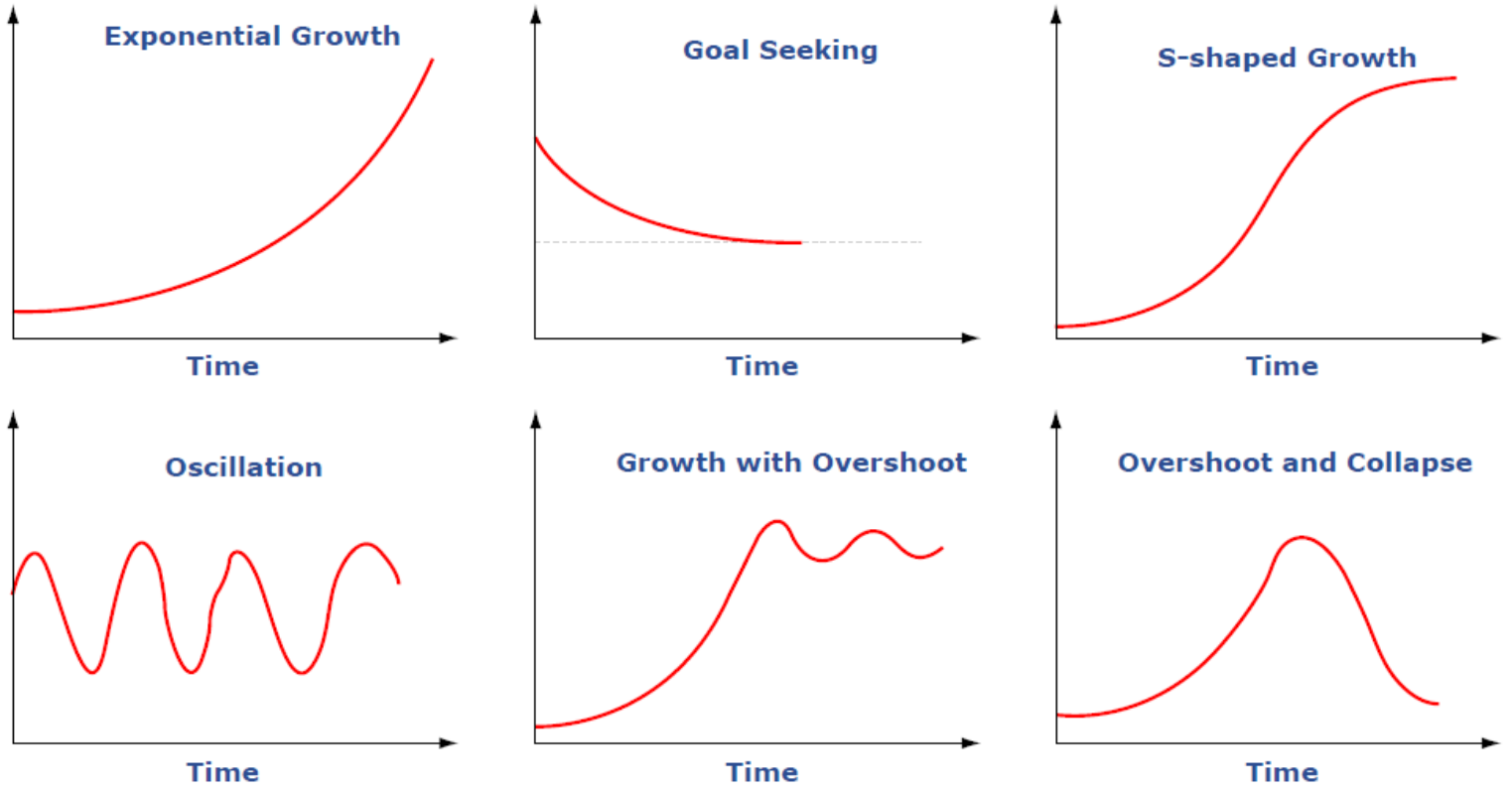
- Focus on areas of uncertainties that are most important in choosing among a range of alternative options

Consequences

- Weighs the possible short-term, long-term, and unintended outcomes of the action



Dynamics: Modes of System Behavior



Conversation CAFÉ

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Arizona State University

Case Study-1

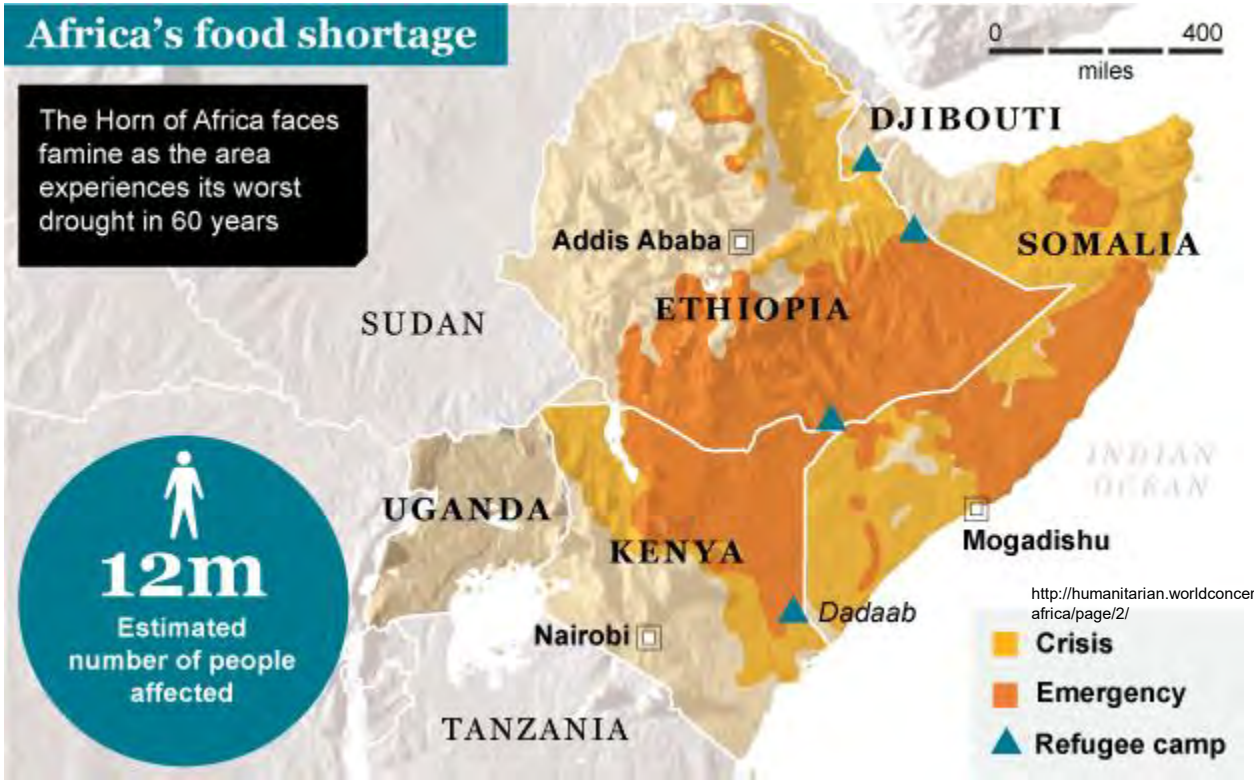
Drought Adaptation Policies in East Africa

Gies, L., Agusdinata, D. B., & Merwade, V. (2014). Drought adaptation policy development and assessment in East Africa using hydrologic and system dynamics modeling. Natural hazards, 74(2), 789-813.

Case study Summary

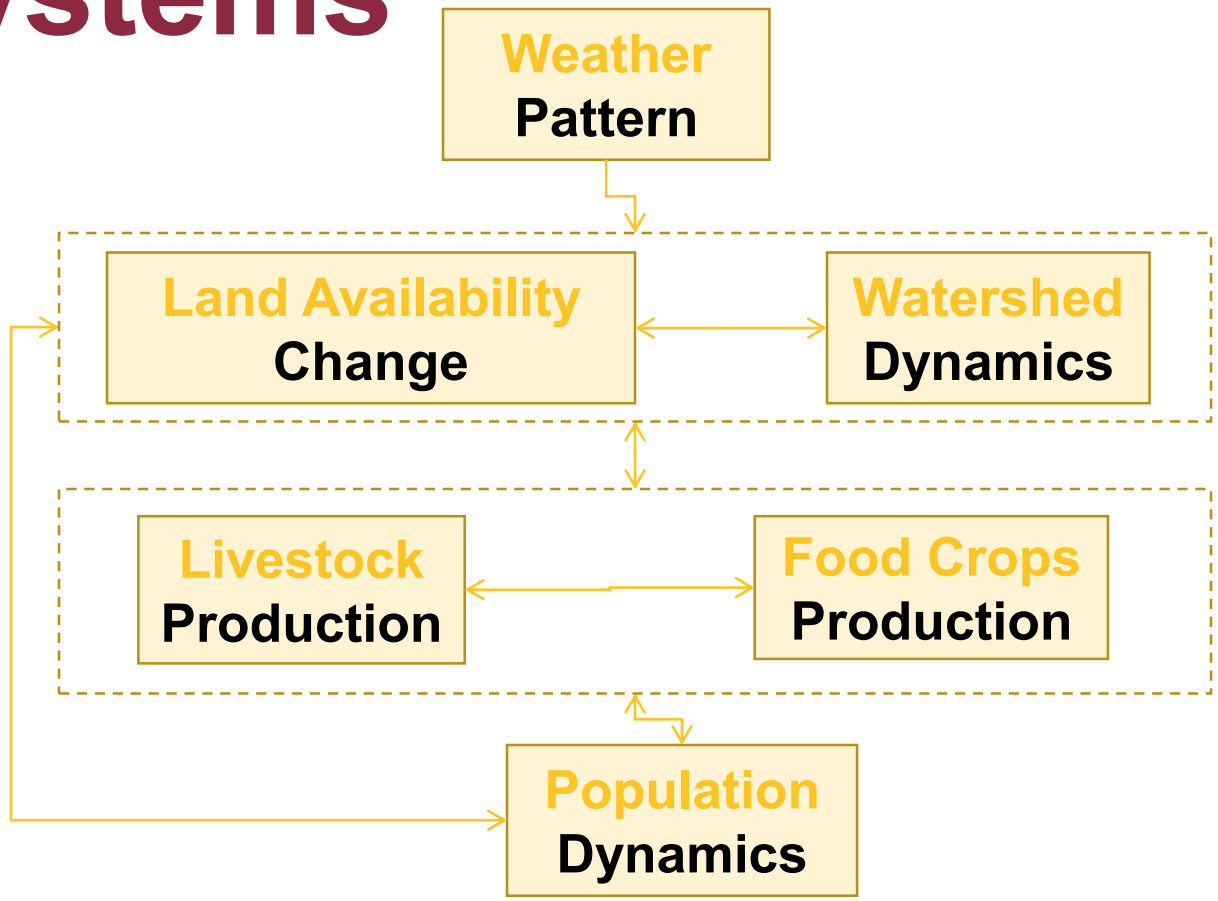
- Research questions:
  - What are the effects of drought due to limited water availability to livelihoods?
  - What are the most cost-effective policies to support drought adaptations?
- Method:
  - Hydrological model
  - System dynamics
- Results:
  - Dynamics of policy impacts
  - Distribution of costs and benefits among stakeholders

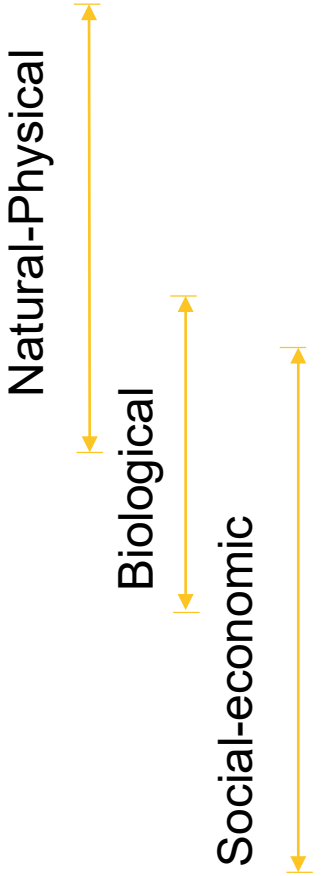
Background



Build a system-based tool to support policies to mitigate drought impacts in East Africa

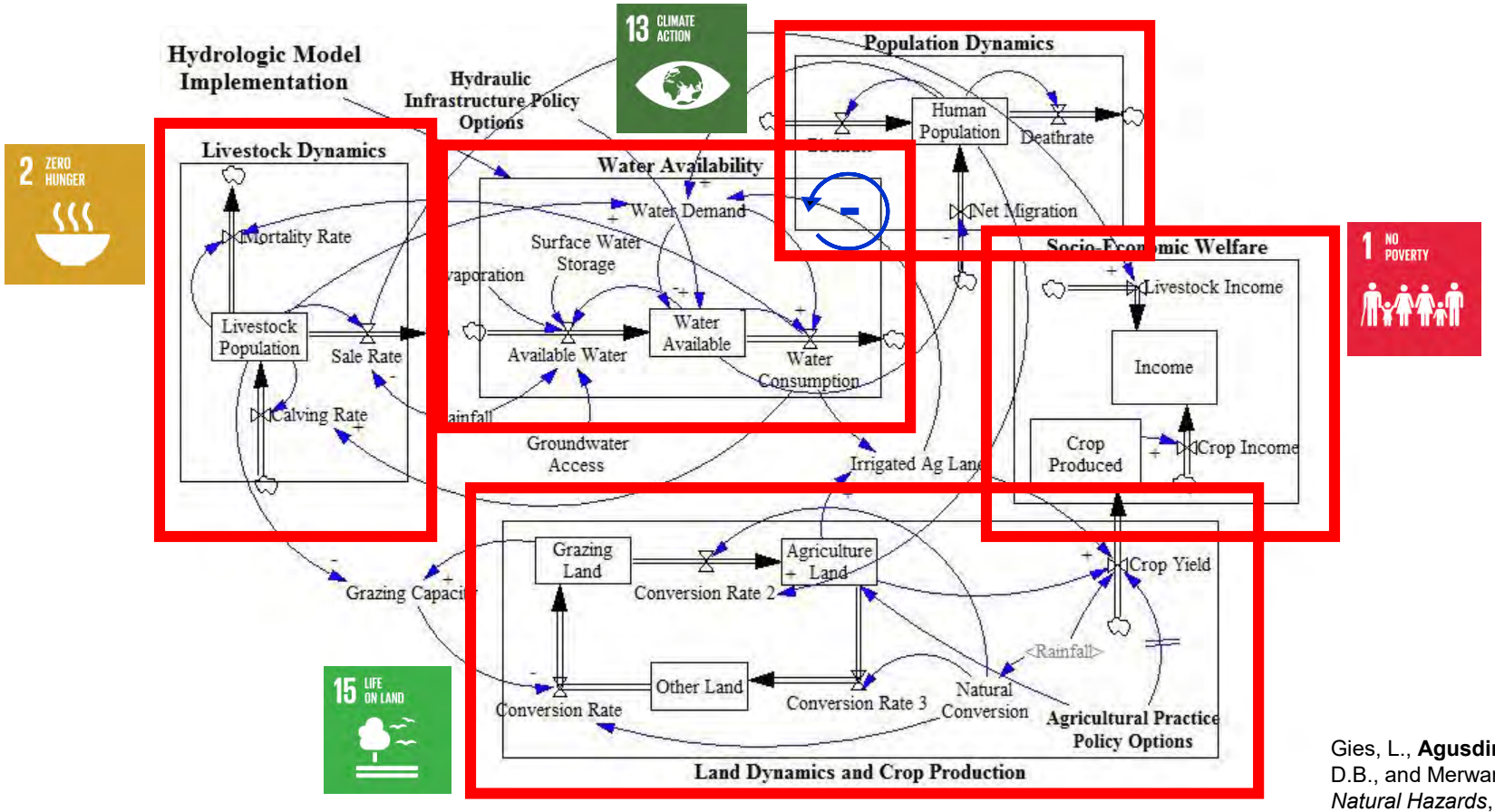
Systems





- Understand fundamental causes, process, interdependencies, and impacts of drought
- Build a representative systems model

An Intermediate Outcome: A System Dynamics Model

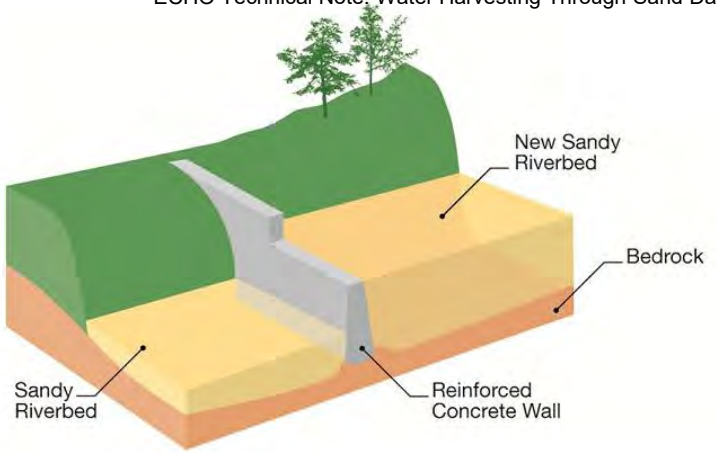


Gies, L., **Agusdinata**, D.B., and Merwarde, V., *Natural Hazards*, 74 (2), 2014

Adaptation Policy Options

- Hydraulic Infrastructure
  - Sand dam
    - Dam built along river, must have a sand bed
    - Stores water in “perched” aquifer
    - Natural filtration
    - Evaporation is less of a factor
    - Multiple extraction options

ECHO Technical Note: Water Harvesting Through Sand Dams

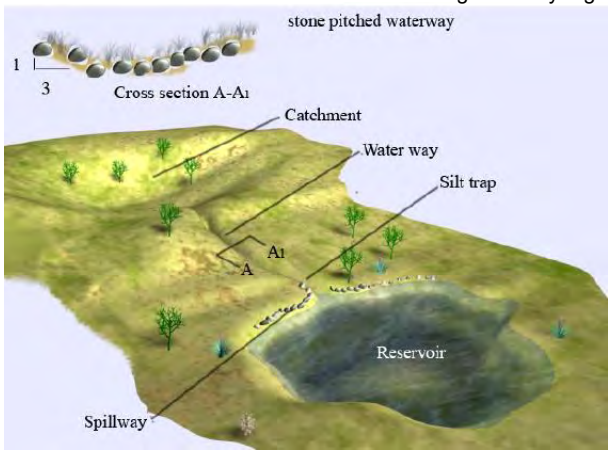


Excellenteducation.co.uk

Adaptation Policy Options

- Rainwater Harvesting (RWH)
  - Rooftop
    - Tanks store rainwater runoff from impermeable surfaces
    - Ideal for towns/settlements
  - Ponds / Pans
    - Strategically dug to collect surface runoff
    - Key issues: evaporation, siltation

Worldagroforestry.org



FAOSWALIM.org

Adaptation Policy Options

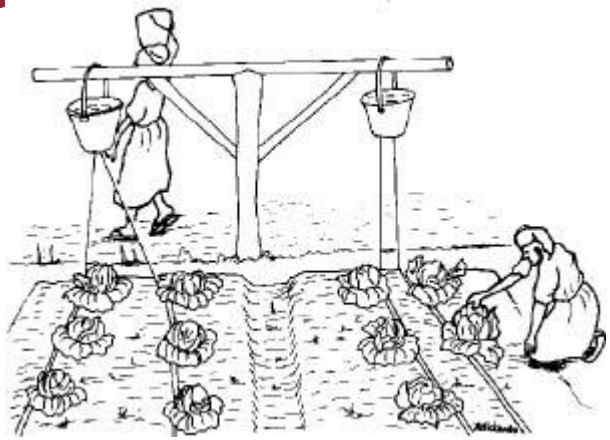
- Wells
  - Shallow / Hand dug
    - require little technical skills and are inexpensive
    - Access shallow aquifers, can dry up during drought
  - Boreholes
    - costly, require high technical skills, knowledge of surrounding subsurface hydrology
    - Much more reliable but encourage settlement

www.investinpeople.ca

Unicef.org

Adaptation Policy Options

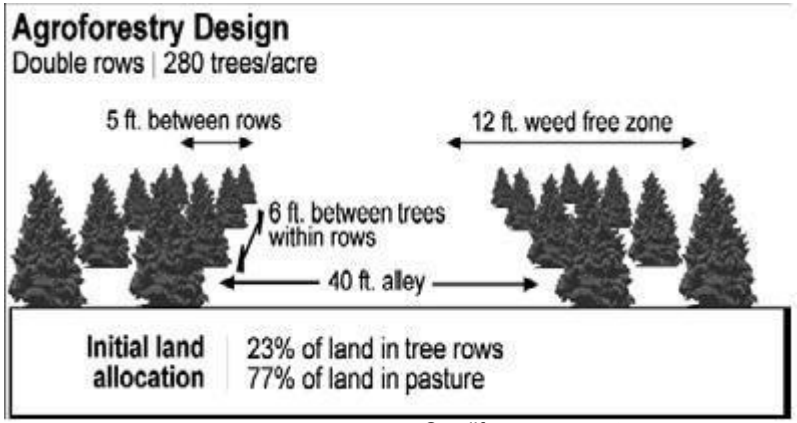
- Drip Irrigation
  - Drip irrigation is a unique method suitable for use as “supplementary irrigation”
  - Crop yield improvement up to 98%
  - Water saving up to 79%



www.hortinews.co.ke

Adaptation Policy Options

- Agroforestry
  - Combining trees and shrubs with crops and/or livestock
  - Benefits
    - Reduce soil erosion
    - Decrease runoff
    - Increase crop yield

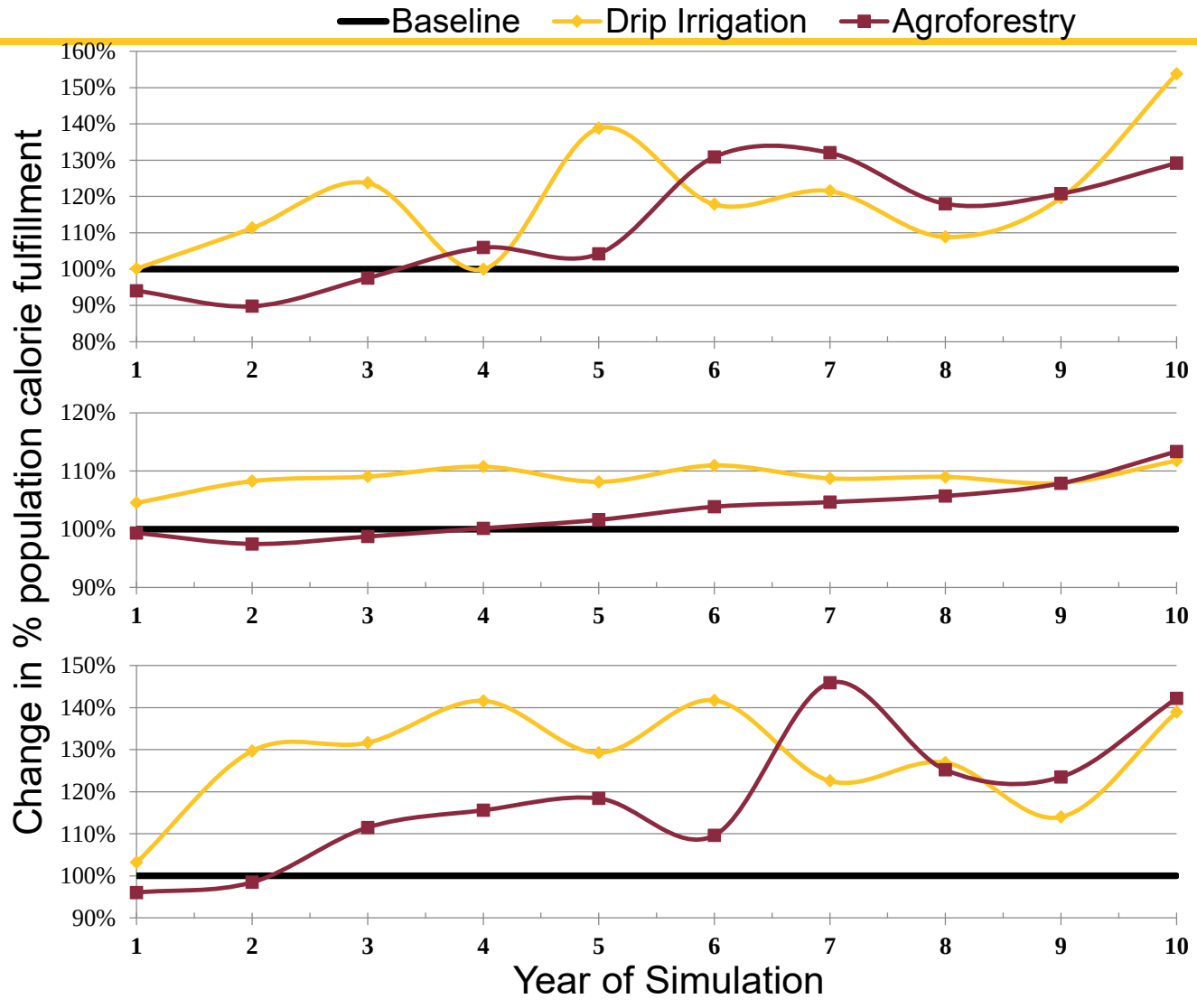


Smallfarms.oregonstate.edu

http://www.abc.net.au/rural/content/2008/s2502403.htm

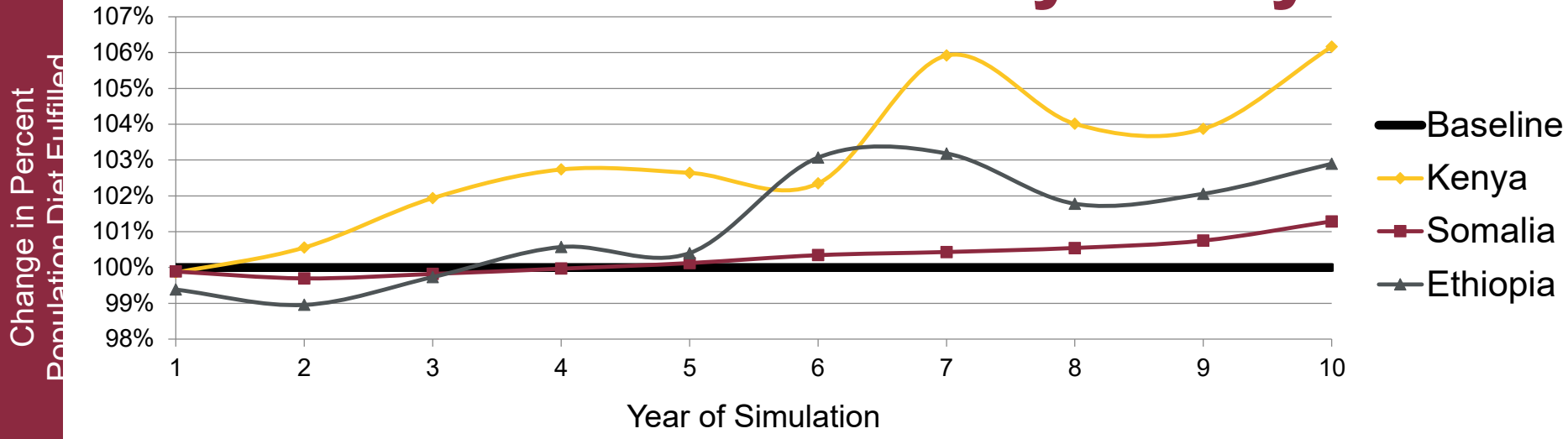
Study Results

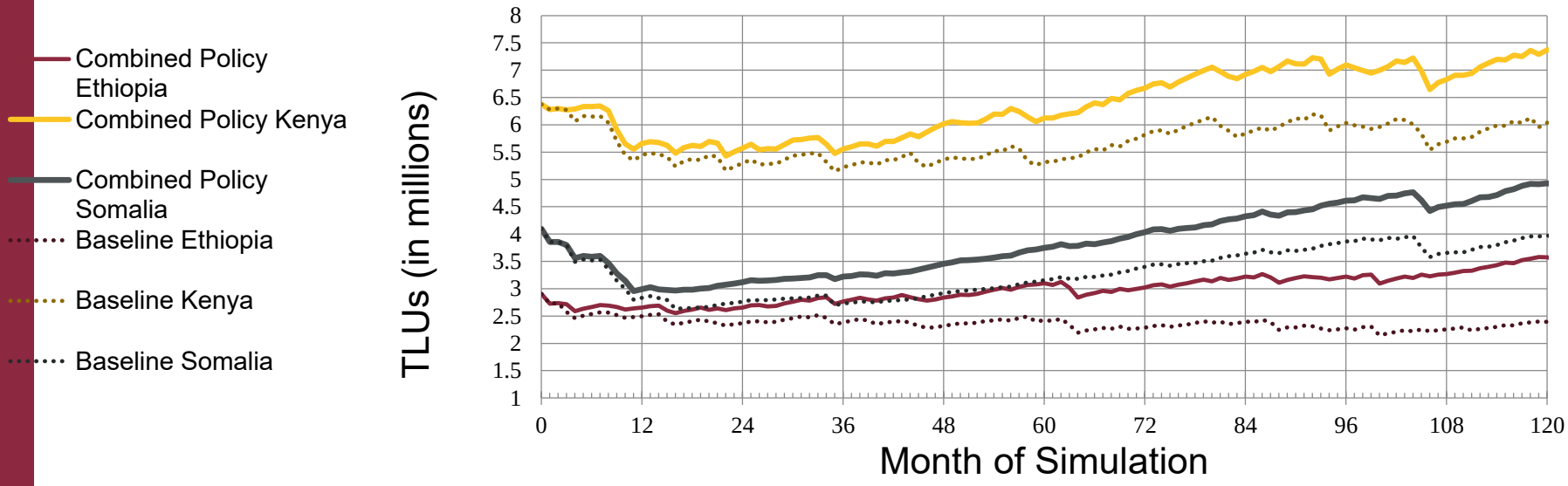
Policy – Improved Agricultural Practice Food Availability Analysis



- Yield still fluctuates with rainfall
- More cultivated land in Ethiopia and Kenya
- Gradual increase with agroforestry
- Consistently higher yields with drip irrigation

Policy – Combined Policy
Food Availability Analysis





Policy – Increased Hydraulic Infrastructure Livelihood Income Analysis

	Ethiopia			Somalia			Kenya		
	AP	Pastoral	Farmer	AP	Pastoral	Farmer	AP	Pastoral	Farmer
Baseline Income	$558	$95	$704	$125	$368	$143	$668	$456	$444
Sand Damn Income	$562	$107	$705	$130	$396	$143	$708	$510	$458
	0.8%	13.0%	0.1%	3.5%	7.6%	-0.2%	6.0%	11.9%	3.1%
RWH Tank Income	$558	$97	$704	$123	$354	$143	$669	$457	$44
	0.1%	2.0%	0.0%	-1.9%	-3.9%	-0.1%	0.1%	0.2%	0.0%
Shallow Well Income	$577	$153	$705	$143	$477	$143	$755	$580	$471
	3.5%	61.4%	0.2%	14.0 %	29.6%	-0.4%	13.1 %	27.1%	6.0%
Pond Income	$570	$132	$704	$136	$431	$143	$720	$536	$457
	2.2%	38.5%	0.1%	8.1%	17.1%	-0.2%	7.8%	17.5%	2.9%
Borehole Income	$581	$169	$705	$168	$629	$142	$798	$676	$467
	4.3%	77.8%	0.1%	33.6 %	70.8%	-0.7%	19.4 %	48.0%	5.1%

*Per capita income over 10 year simulation

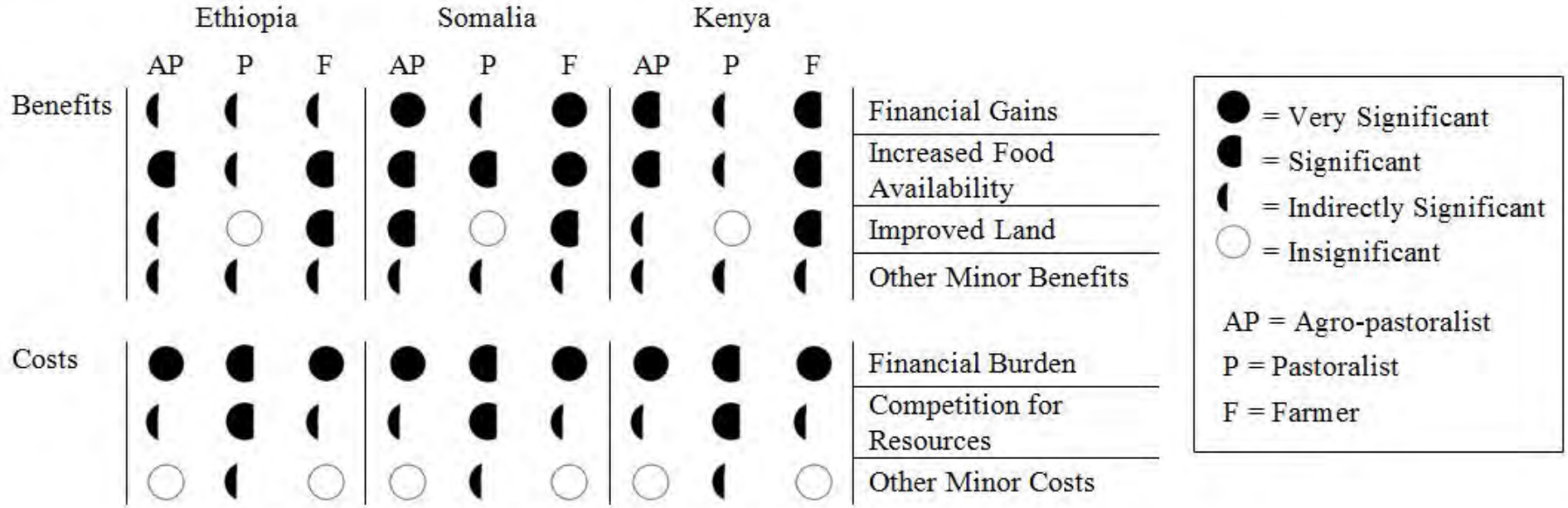
Policy – Improved Agricultural Practice
Livelihood Income Analysis

	Ethiopia			Somalia			Kenya		
	AP	Pastoral	Farmer	AP	Pastoral	Farmer	AP	Pastoral	Farmer
Baseline	$558	$95	$704	$125	$368	$143	$668	$456	$444
Drip Irrigation	$842	$24	$1,112	$257	$214	$487	$1,087	$177	$1,001
	51.0%	-74.3%	58.0%	104.8%	-41.9%	240.1 %	62.8%	-61.3%	125.2 %
Agroforestry	$661	$95	$842	$208	$368	$324	$1,240	$456	$1,017
	18.6%	0.0%	19.7%	65.8%	0.0%	126.4 %	85.7%	0.0%	128.8 %

*Per capita income over 10 year simulation

- Agricultural water demand competes with livestock & domestic demands

Summary of Results



- Farmers and Agro-pastoralists are direct beneficiaries
  - Increased and diversified income
  - More food and water availability
- Pastoralists are indirect beneficiaries
  - Lower herd mortality with increased water
  - Still suffer from competition of resources
    - Land and water

Conversation CAFÉ

School of Sustainability
Arizona State University

Case Study-2

Economic Growth-Inequality-Environmental Quality Nexus

Agusdinata, D. B., Aggarwal, R., & Ding, X. (2020). Economic growth, inequality, and environment nexus: Using data mining techniques to unravel archetypes of development trajectories. *Environment, Development and Sustainability*, 1-25.

Case study Summary

- Research questions:
  - What are the different kinds of sustainable and unsustainable development pathways followed by countries around the world?
  - What do these different pathways reveal about tradeoffs and synergies between growth, inequality and climate action?
- Methods:
  - Data mining
  - Archetype analysis
- Result:
  - Country's development trajectories

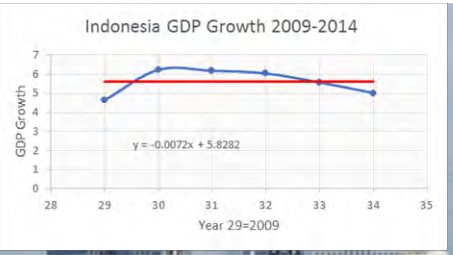
Environment, Development and Sustainability
https://doi.org/10.1007/s10668-020-00775-1

Check for updates

Ecosystem services and trade-offs: implications for land dynamics and sustainable livelihoods in Northern Lombok, Indonesia

Puyang Li[1] · Datu Buyung Agusdinata[2] · Putu Hery Suditha[3] · Yujia Zhang[1]

Received: 15 October 2019 / Accepted: 12 May 2020

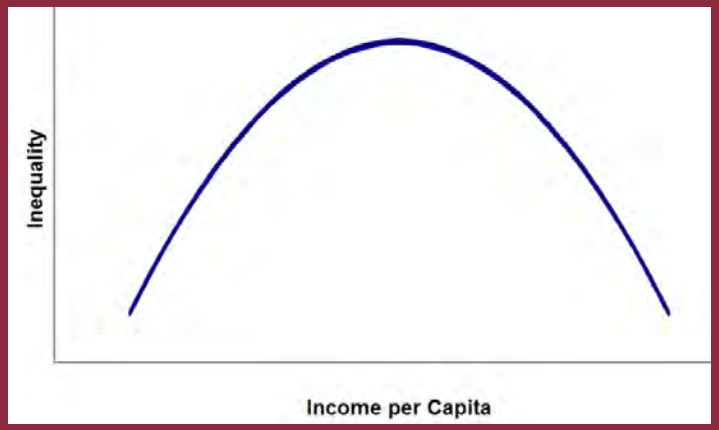


Economic growth & inequality

Environmental impact

Kuznets Curve

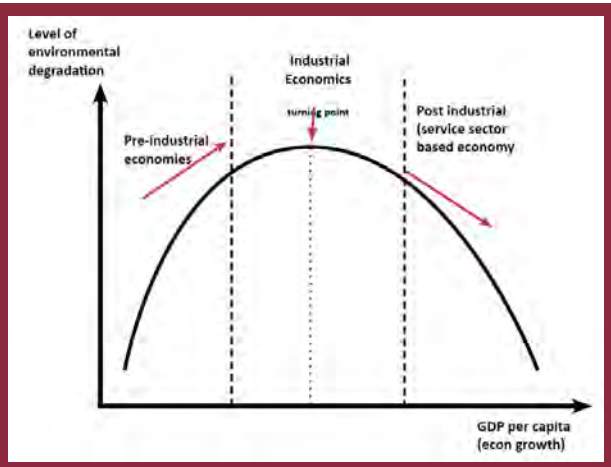
(Simon Kuznets, 1955)



- Cross-sectional data for US, England, Germany, India, Ceylon and Puerto Rico
- Late 19th century- first half of 20th century
- Inequality first increases up to certain threshold then declines
- Weak support in later studies [Saith,1983, Anand & Kanbur, 1993)]
- Piketty (2013) refuted its universal applicability

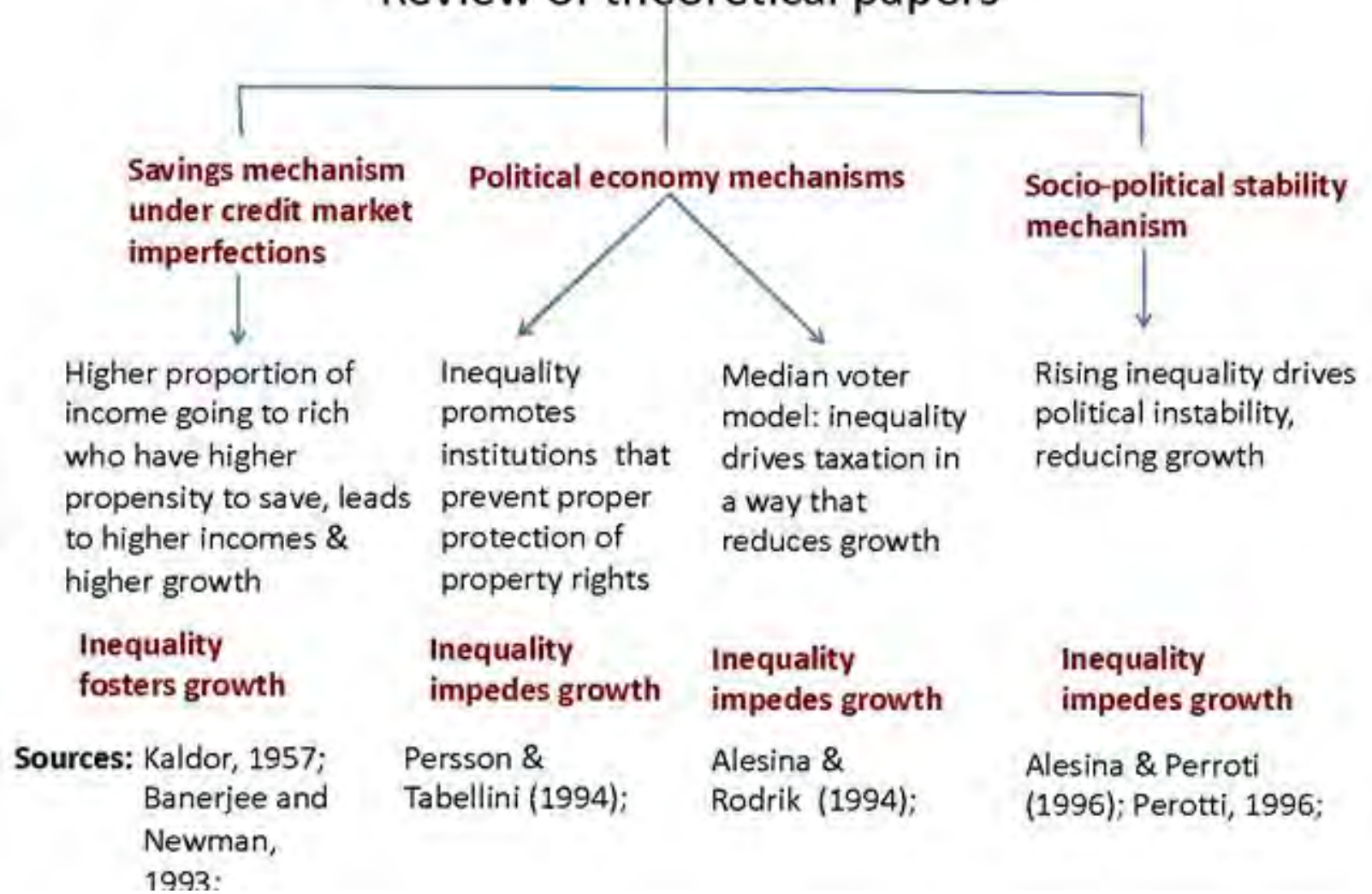
Environmental Kuznets Curve

Grossman & Krueger (1991, 1995)

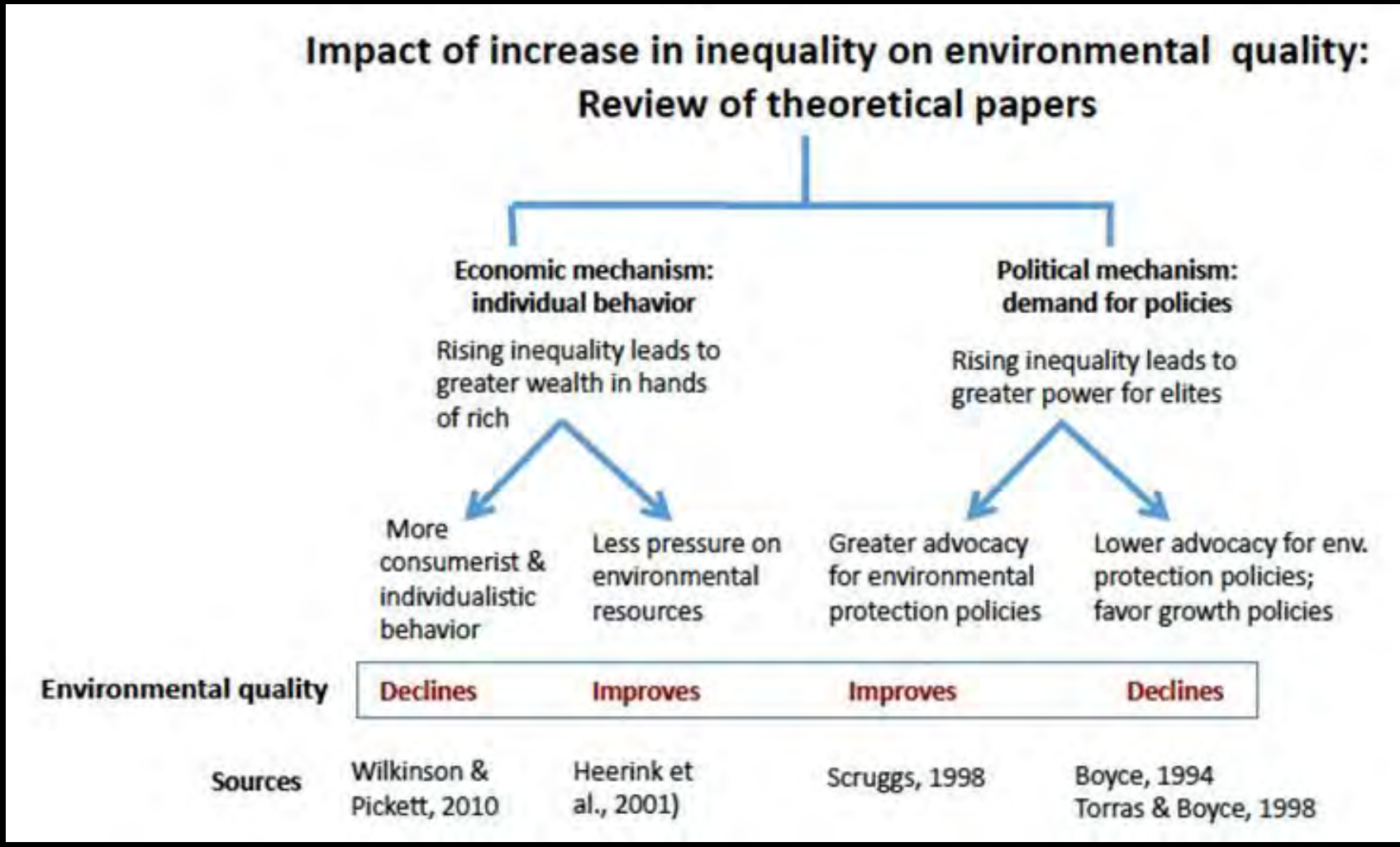


- Environmental quality declines in the early stage of economic growth, but beyond certain level of income per capita, the trend reverses
- Results vary depending on samples of countries/ regions, time periods, and type of pollutant
- Out of 8 studies on emissions, 3 studies could not verify EKC [Shafik, 1994, De Bruyn et al. 1998, Friedl and Getzner, 2003]

Impact of increase in inequality on income growth: Review of theoretical papers



Impact of increase in inequality on environmental quality: Review of theoretical papers



The Model & Data

Dependent variable = {PerCapita_CO_2_Slope_post_ 2008}

Independent variables = {PerCapita_CO2_Slope_pre,
Avg_CO2/GDP _pre,
Avg_CO2/GDP _post
GDP_Growth_Slope_pre,
GDP_Growth_Slope_post,
GDP_Growth_SD_pre,
GDP_Growth_SD_post,
Gini_Slope_pre,
Gini_Slope_post}

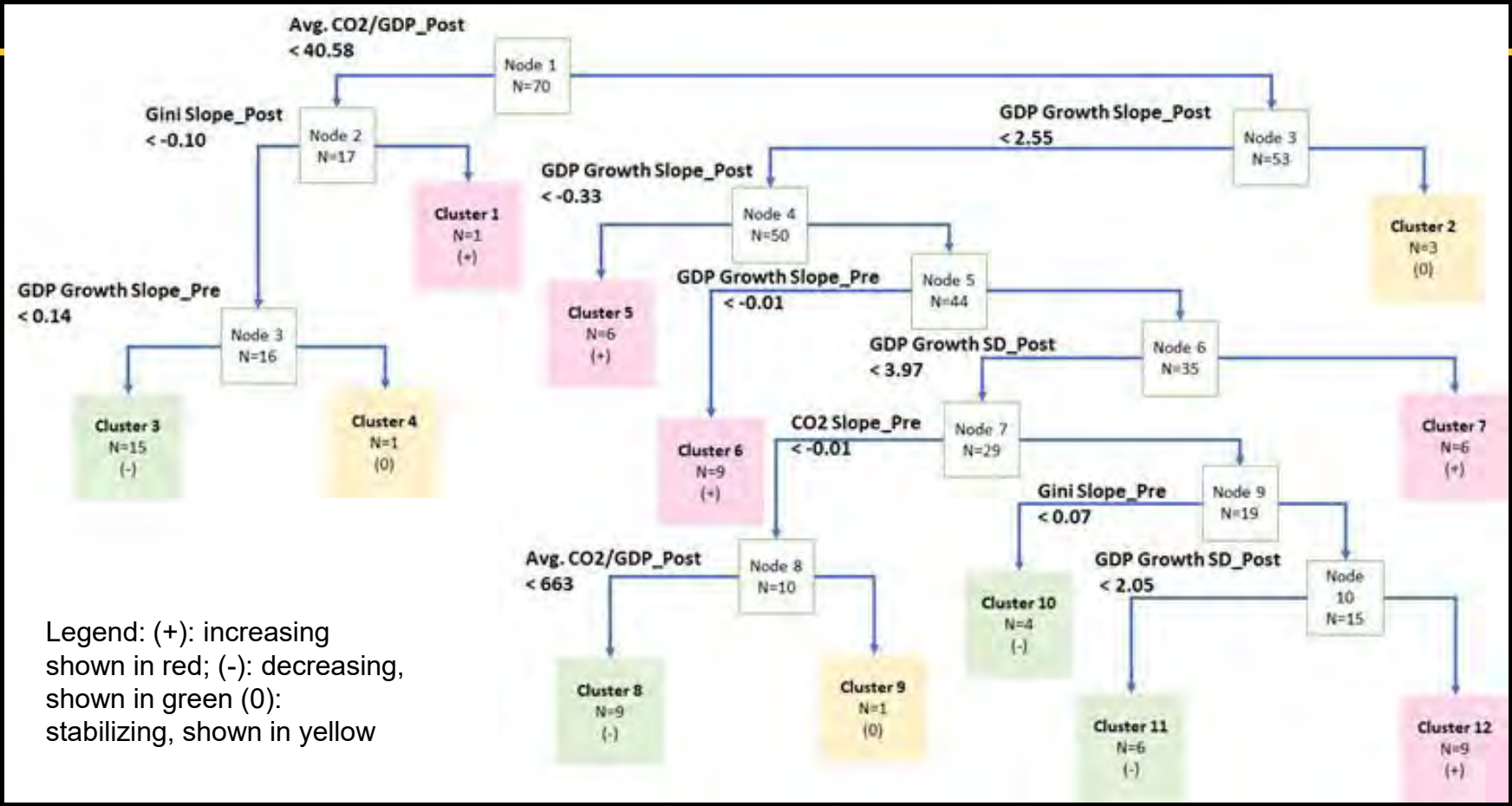
Data Source = World Income Inequality Database (Gini)
World Bank (GDP growth rate, and per capita CO2 emissions

Time period = 1980-2014

Total countries = 70

Countries' Carbon Emissions Trajectories

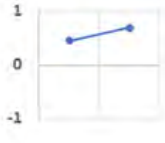
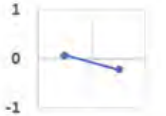
12 Development Pathways



Legend: (+): increasing shown in red; (-): decreasing, shown in green (0): stabilizing, shown in yellow

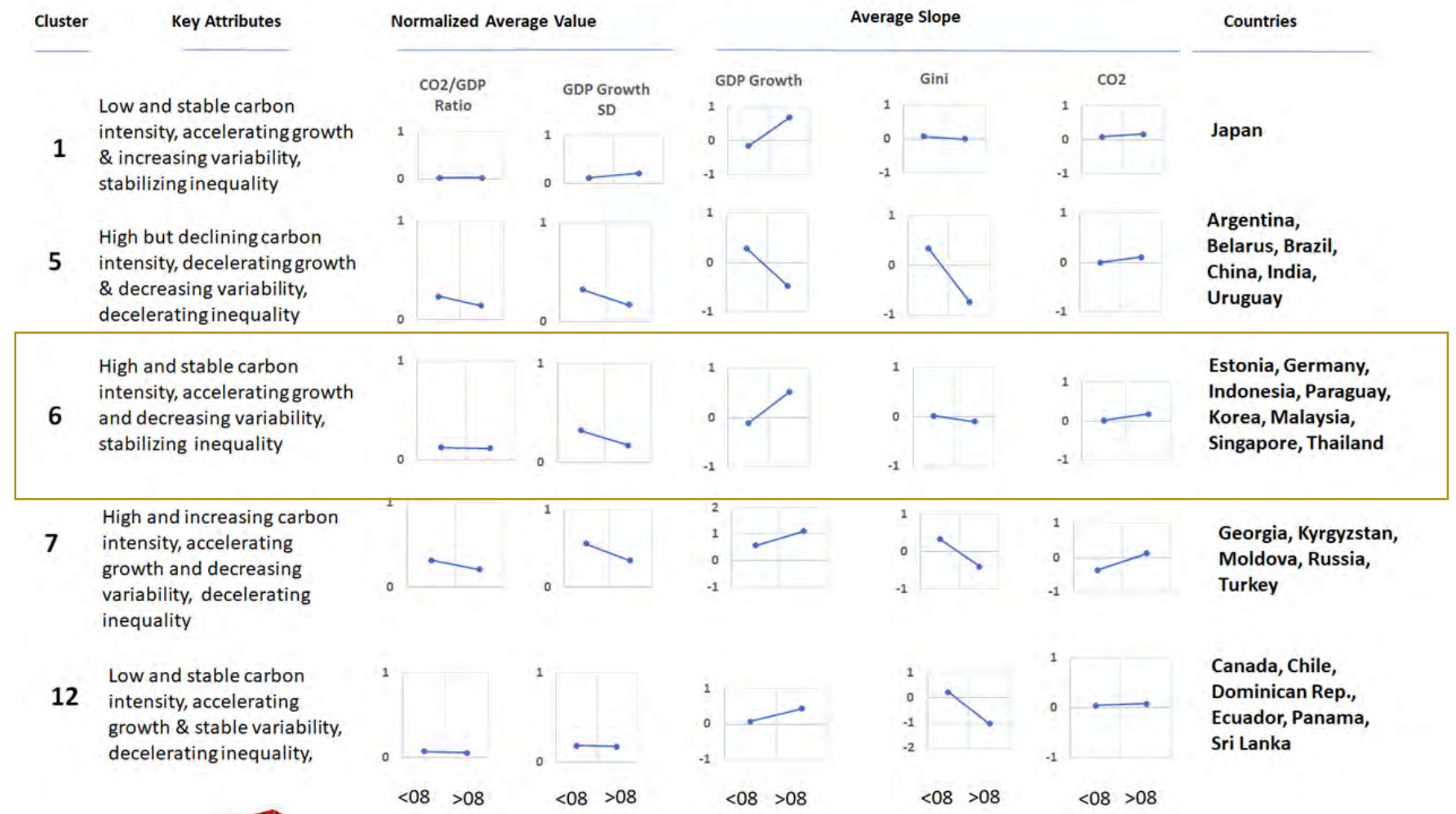
Economy energy intensity is the most important factor

Cluster (-)

Cluster	Key Attributes	Normalized Average Value		Average Slope			Countries
		CO2/GDP	GDP Growth SD	GDP Growth	Gini	CO2	
3	Low and stable carbon intensity, accelerating growth & increased variability following period of stable growth pre-recession, decelerating inequality						Austria, Denmark, Finland, France, Ireland, Italy, Luxembourg, Netherland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK
8	High but declining carbon intensity, accelerating growth & decreasing variability, decelerating inequality						Belgium, Czech Rep., Hungary, Macedonia, Kazakhstan, Poland, Venezuela, Romania, Slovakia
10	High but declining carbon intensity, accelerating growth & stable variability, stabilizing inequality						Greece, USA, Jordan, Slovenia
11	High but declining carbon intensity, accelerating growth and decreasing variability, decelerating inequality,						Australia, Israel, South Africa
		<08 >08	<08 >08	<08 >08	<08 >08	<08 >08	

More equal society is associated with increasing environmental quality

Cluster (+)



More complexity and diversity in country experiences

Summary

CO2 per Capita

- High-medium income countries with positive & accelerating GDP growth
- Decreasing Gini

- Lower-middle, upper-middle (Brazil), and high (Canada) income countries
- Mixed Gini trajectories

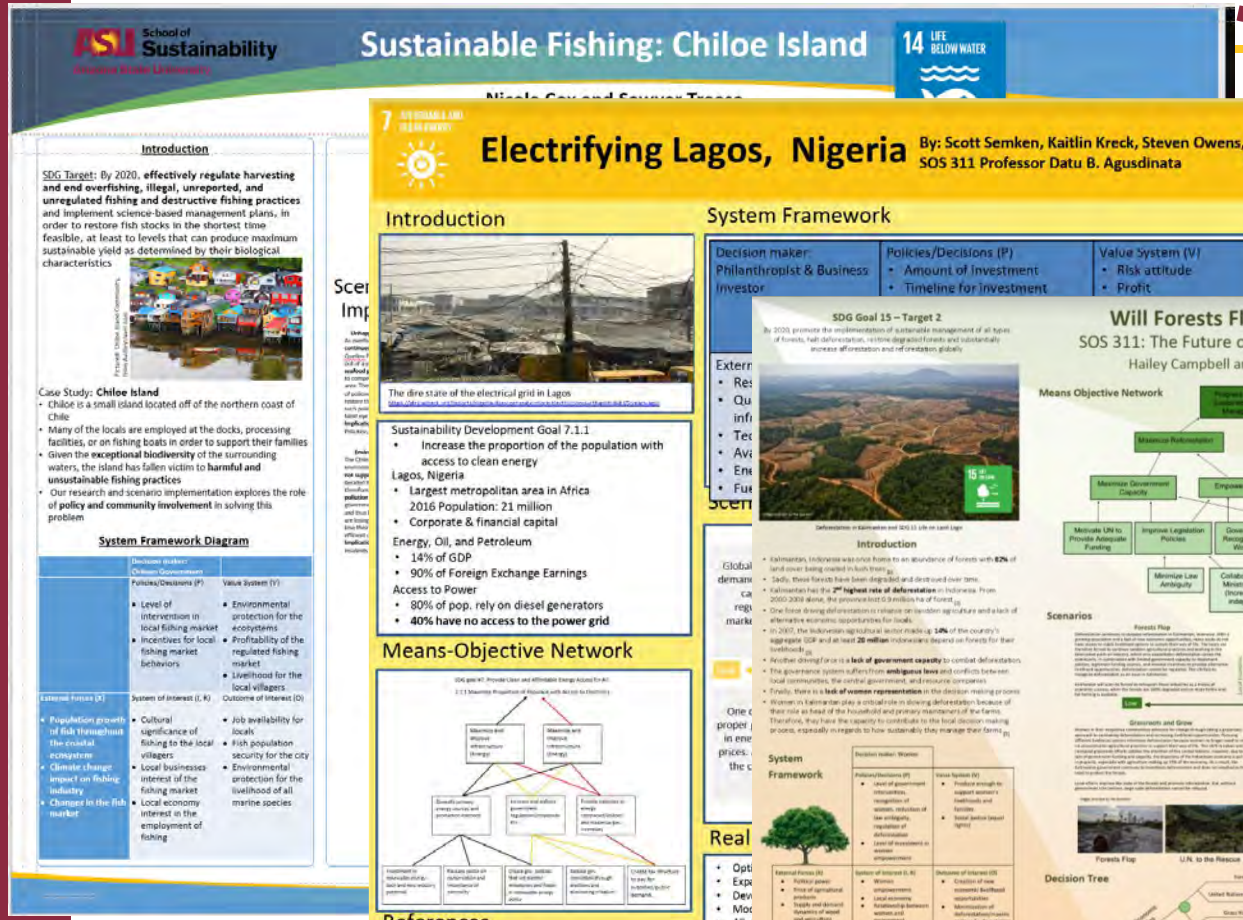
- 12 country clusters with distinctive characteristics
- Direction and Rate of Change vs. Level

SDGs Integration into Learning

“Universities can play a crucial role for successful implementations of SDG initiatives through a meaningful engagement with diverse stakeholders ”

Leal Filho, et al., 2019

SDGs Student Projects



- SDGs Posters

SDGs Student Projects

Student-led SDGs Projects

U.S. GLOBAL DEVELOPMENT LAB Powered by USAID

ASU Global Development Research
Arizona State University

Delivering impacts with Co-design & partnership

Building livelihood skills

- Gumantar, North Lombok

School of Sustainability
Arizona State University

GlobalResolve
ASU Barrett The Honors College
Arizona State University

Solving Challenges Impacting Lives

Cocoa Bean Drying Greenhouse for West Papuans

FREEPORT-McMoRan

1 NO POVERTY | 8 DECENT WORK AND ECONOMIC GROWTH | 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

How can we increase the efficiency and yield of the cocoa processing system in West Papua to aid economic independence?

Dryer Design Solution

- **20-30%** of the yield is lost in the drying stage.
- **Natural convection greenhouse** allows for a low-tech method of controlling humidity.
- Allows for **consistent** cocoa bean drying despite da f e rai c % co'ver.

- **Simple** and **low-cost** design
- **Locally-sourced** materials
- **No-electricity**

Potential benefits:
- Shorten drying time by half
- Reduce loss. Target: reduced the spoilage rate to 7%
- Increase quality of cocoa beans

Working with the Komoro Tribe in the Lowland region

Concluding points

SDGs as a System

Synergies-and-Trade offs

Policy Implementation

SDGs as a Learning Platform

Thank You