A Systems Approach to Project Planning

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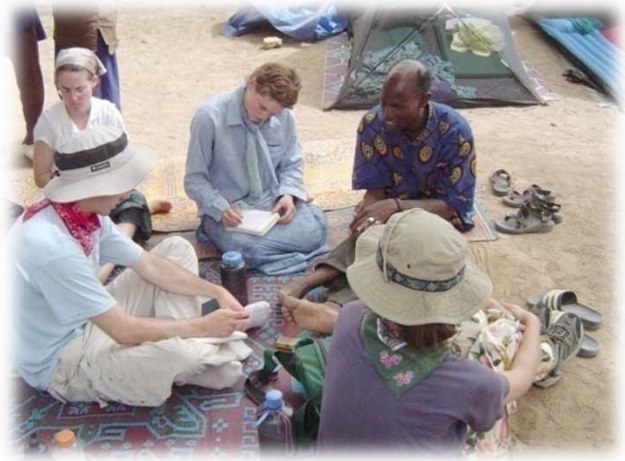
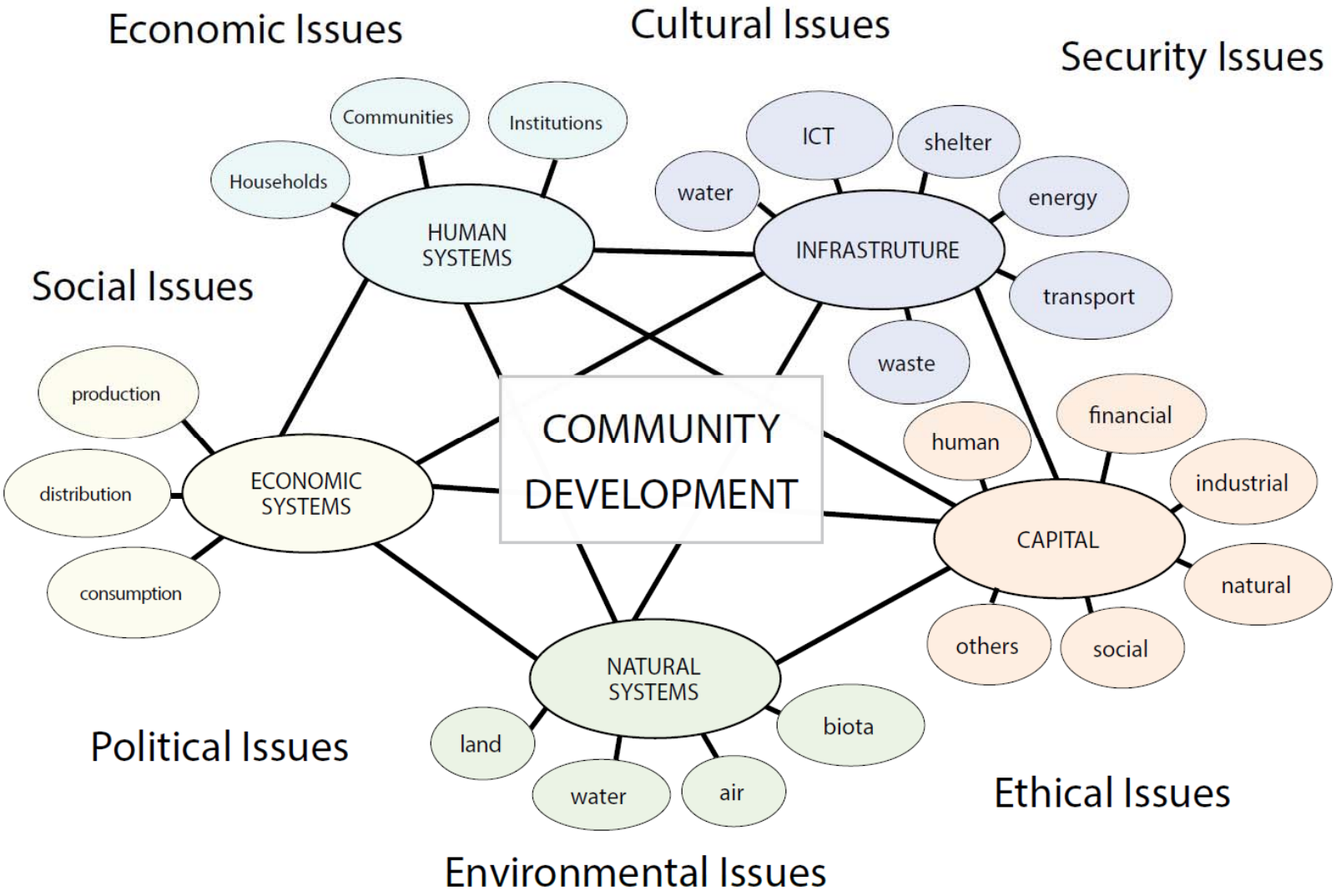
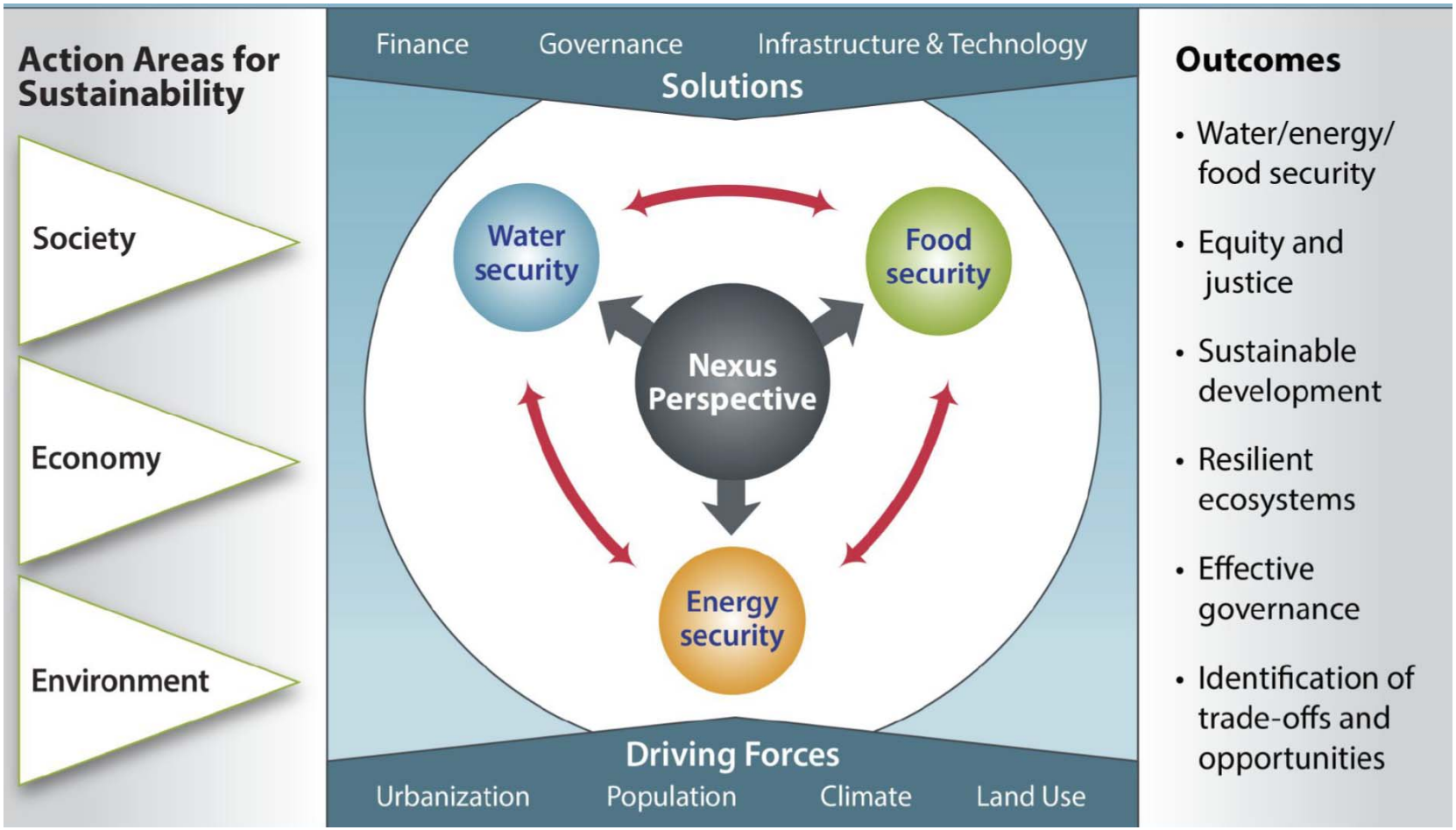
How can Pakistan leverage its existing strength and capacity in STE to address the needs of the 67% (70%) who make less than $2 a day while at the same time continue to grow a global knowledge based economy?" (STE4D Conference, Islamabad, June 3, 2014).

Creating Healthy, Stable, Equitable, Safe, Prosperous Sustainable Communities




Economic Issues
Cultural Issues
Security Issues
Social Issues
Political Issues
Ethical Issues
Environmental Issues
COMMUNITY DEVELOPMENT
HUMAN SYSTEMS
Communities
Institutions
Households
INFRASTRUTURE
ICT
shelter
energy
water
transport
waste
ECONOMIC SYSTEMS
production
distribution
consumption
CAPITAL
financial
human
industrial
natural
social
others
NATURAL SYSTEMS
land
water
air
biota



After R. Waskom, N. Grigg, and M. Akhbari, 2014

What makes a system?

- The parts or components
- The relationship between the parts
- The purpose of the system (subsystems may have several purposes conflicting or not)
- Components operate under certain rules that control their behavior

"Nothing is completely itself without everything else"

(T. Berry)

Types of Systems

- Isolated: boundaries closed to import or export of both mass and energy
- Closed: boundaries closed to import or export of mass, but not of energy
- Open: exchange of both mass and energy with surroundings

"When we try to pick up anything by itself,
we find it is attached to everything in the universe" (John Muir)

Simple, Complicated, Complex

- Simple: we know the knowns
- Complicated: we know the unknowns
- Complex: we don't know the unknowns
- Chaotic: it is all over the place

The type of system dictates the methods of intervention

Communities as Complex Adaptive Systems

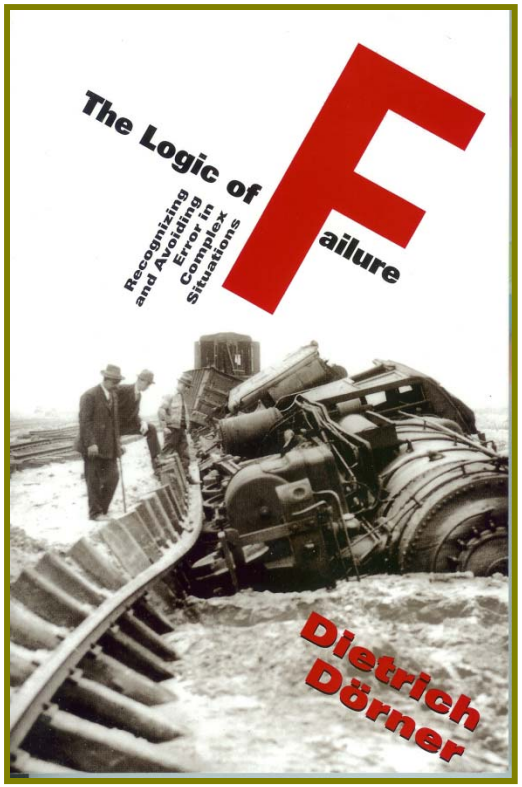
- Constantly evolve and grow
- Self-organization, self-correction, and adaptation by changing structure, behavior, rules of interaction through evolutionary and co-evolutionary change
- Communities interact with their environment through feedback mechanisms

Communities as Complex Adaptive Systems

- In order to address community issues and problems, complexity and uncertainty must be embraced and dealt with.
- Ill-defined problems, uncertainty, no unique and best solutions to complex problems exist, and satisficing (i.e., good enough) solutions.

Why Things Fail?

- Slowness of human thinking. We feel obliged to economize and simplify
- Slow speed in absorbing new material. We don't think about problems we don't have.
- Self protection. We need to have things easier and under control to preserve our expectation of success
- Limited understanding of systems: complexity, dynamics, mistaken hypotheses and ignorance



Habits of a Systems Thinker

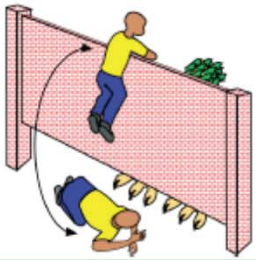
Seeks to understand the big picture

Observes how elements within systems change over time, generating patterns and trends

Recognizes that a system's structure generates its behavior

Identifies the circular nature of complex cause and effect relationships

Changes perspectives to increase understanding



Surfaces and tests assumptions

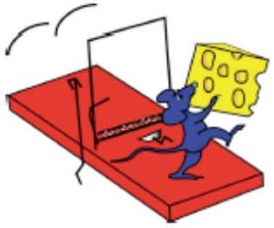
Considers an issue fully and resists the urge to come to a quick conclusion

Considers how mental models affect current reality and the future

Uses understanding of system structure to identify possible leverage actions

Considers both short and long-term consequences of actions

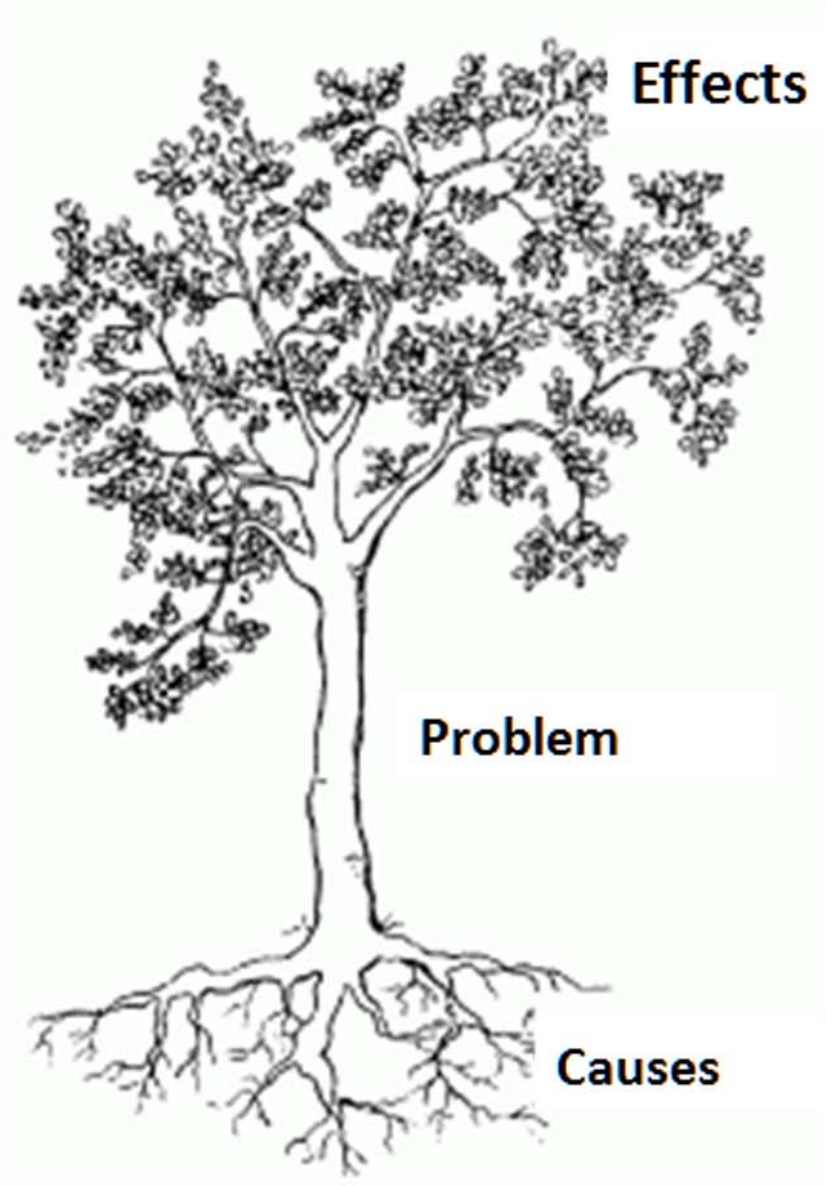
Finds where unintended consequences emerge



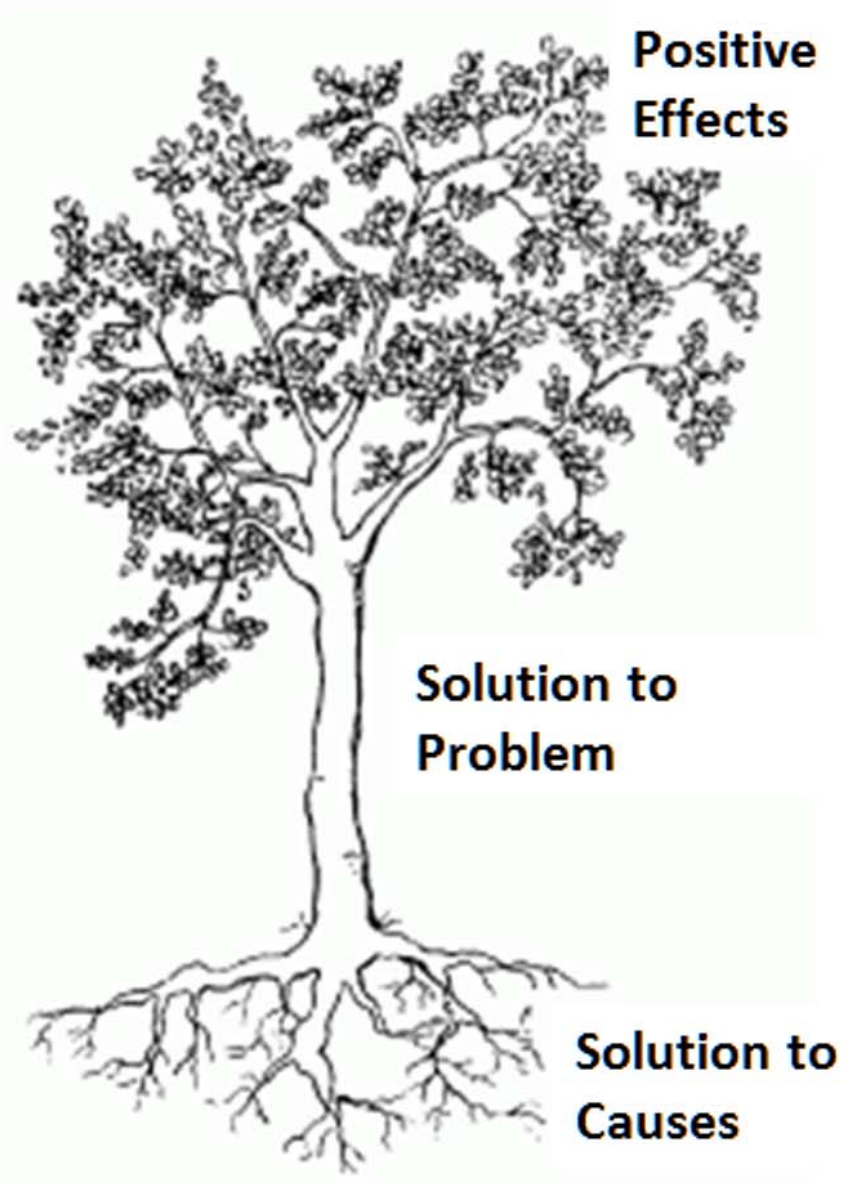
Recognizes the impact of time delays when exploring cause and effect relationships

Checks results and changes actions if needed: "successive approximation"

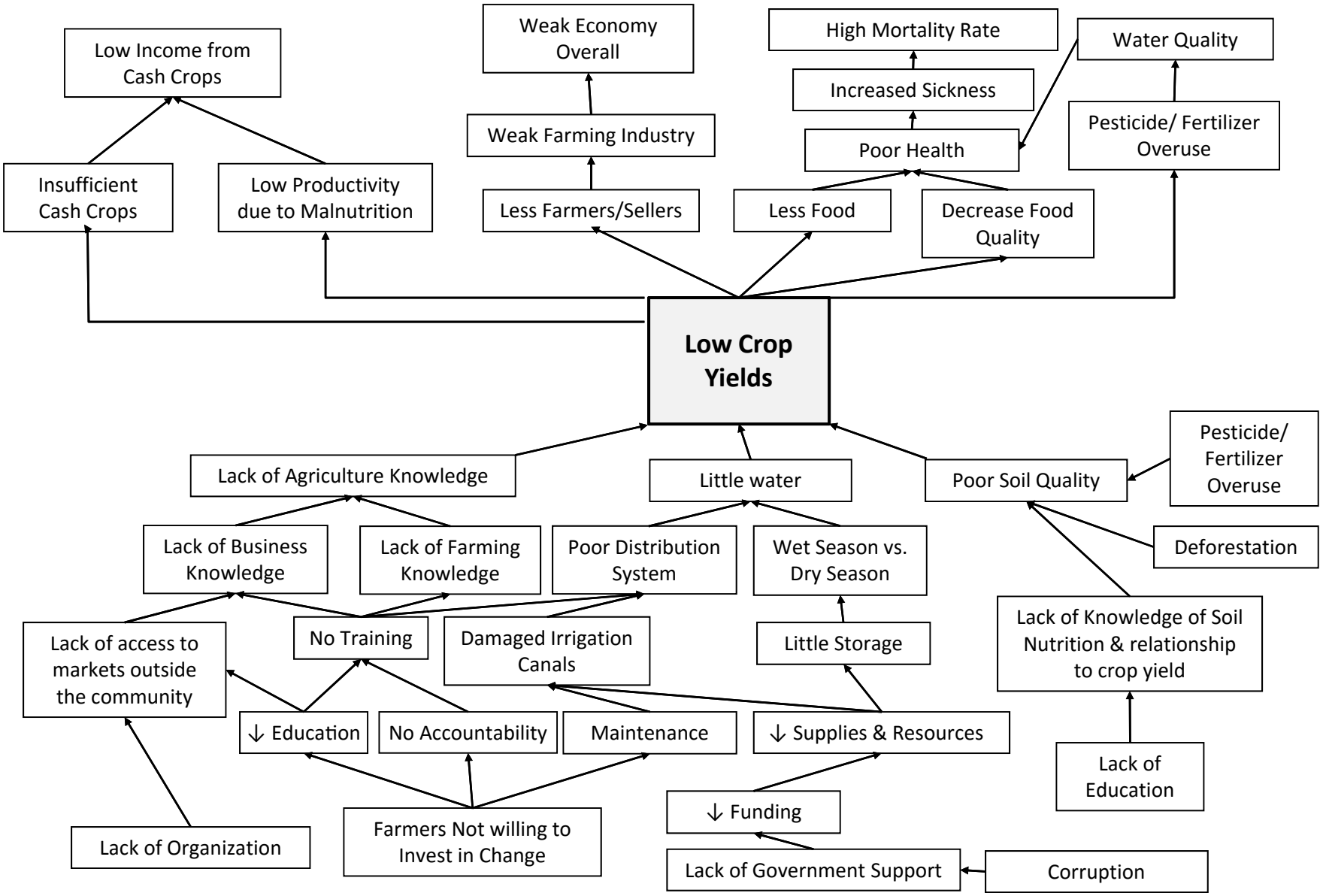
	Water	Energy	Food/Ag	Land
Water		Water used for energy extraction and production, and bio (-fuel) processing	Water used for agricultural production and irrigation	Water contributes to soil and aquifer replenishing
Energy	Energy used to run water infrastructure, pumping, irrigation, and desalination		Energy used for mechanized agriculture in land preparation, irrigation, fertilization, etc.	Energy for field preparation and harvest
Food/Ag	Agriculture requires water. Practices must be respectful of run-off, groundwater recharge	Production of biofuels and biogas uses food, agricultural residues and biomass		Agricultural practices need to be respectful of land preservation
Land	Soil type and vegetation affect soil water saturation and ground water	Soil type affects the energy consumption for land use	Soil type and characteristics affect crop yield	

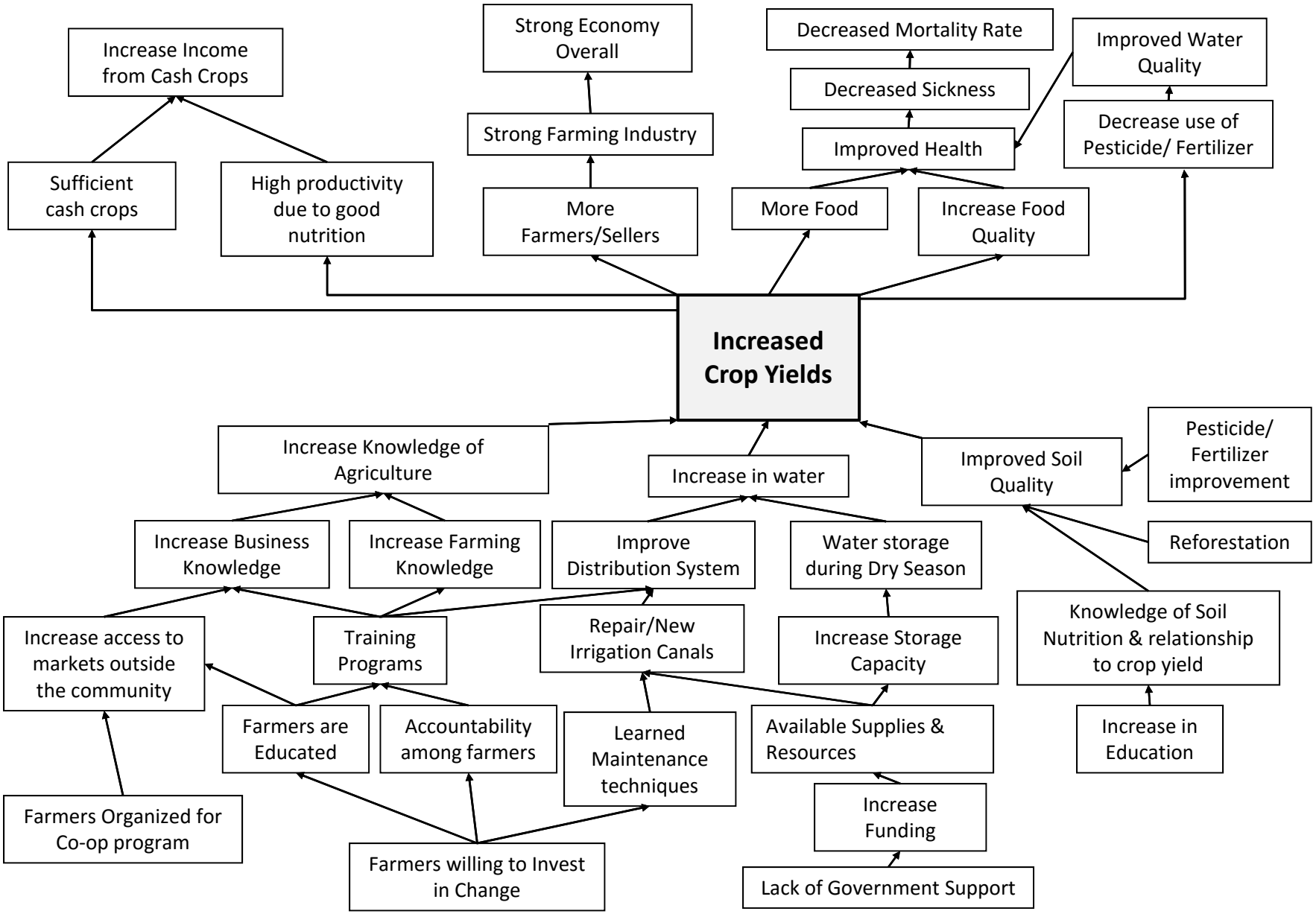

Effects
Problem
Causes

(a)


Positive
Effects
Solution to
Problem
Solution to
Causes

(b)

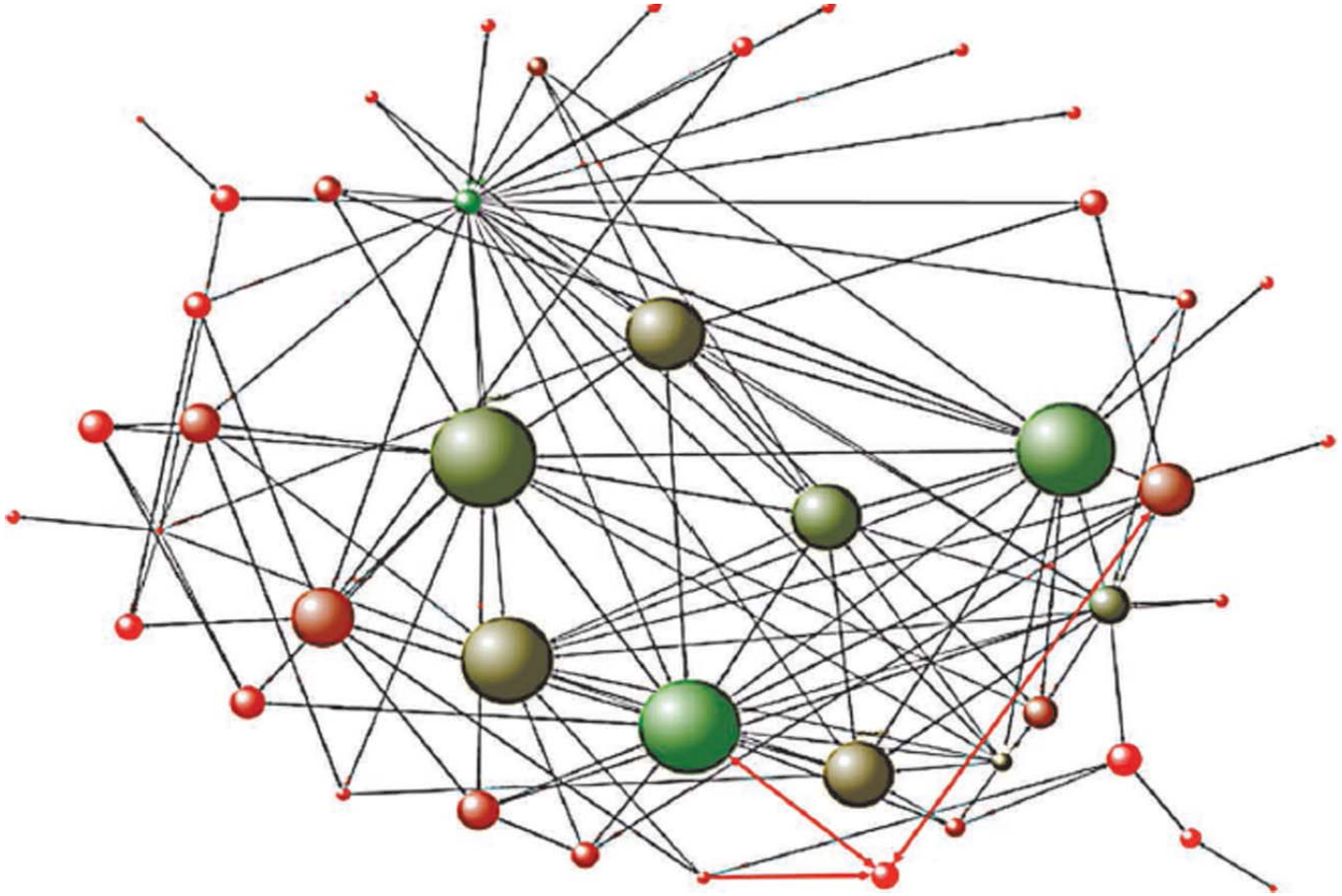

Low Income from Cash Crops
Weak Economy Overall
High Mortality Rate
Water Quality
Increased Sickness
Weak Farming Industry
Pesticide/ Fertilizer Overuse
Poor Health
Insufficient Cash Crops
Low Productivity due to Malnutrition
Less Farmers/Sellers
Less Food
Decrease Food Quality
Low Crop Yields
Pesticide/ Fertilizer Overuse
Lack of Agriculture Knowledge
Little water
Poor Soil Quality
Deforestation
Lack of Business Knowledge
Lack of Farming Knowledge
Poor Distribution System
Wet Season vs. Dry Season
Lack of Knowledge of Soil Nutrition & relationship to crop yield
Lack of access to markets outside the community
No Training
Damaged Irrigation Canals
Little Storage
↓ Education
No Accountability
Maintenance
↓ Supplies & Resources
Lack of Education
Lack of Organization
Farmers Not willing to Invest in Change
↓ Funding
Lack of Government Support
Corruption


Increase Income from Cash Crops
Strong Economy Overall
Decreased Mortality Rate
Improved Water Quality
Decreased Sickness
Strong Farming Industry
Decrease use of Pesticide/ Fertilizer
Improved Health
Sufficient cash crops
High productivity due to good nutrition
More Farmers/Sellers
More Food
Increase Food Quality
Increased Crop Yields
Increase Knowledge of Agriculture
Increase in water
Improved Soil Quality
Pesticide/ Fertilizer improvement
Increase Business Knowledge
Increase Farming Knowledge
Improve Distribution System
Water storage during Dry Season
Reforestation
Increase access to markets outside the community
Training Programs
Repair/New Irrigation Canals
Increase Storage Capacity
Knowledge of Soil Nutrition & relationship to crop yield
Farmers are Educated
Accountability among farmers
Learned Maintenance techniques
Available Supplies & Resources
Increase in Education
Farmers Organized for Co-op program
Increase Funding
Farmers willing to Invest in Change
Lack of Government Support

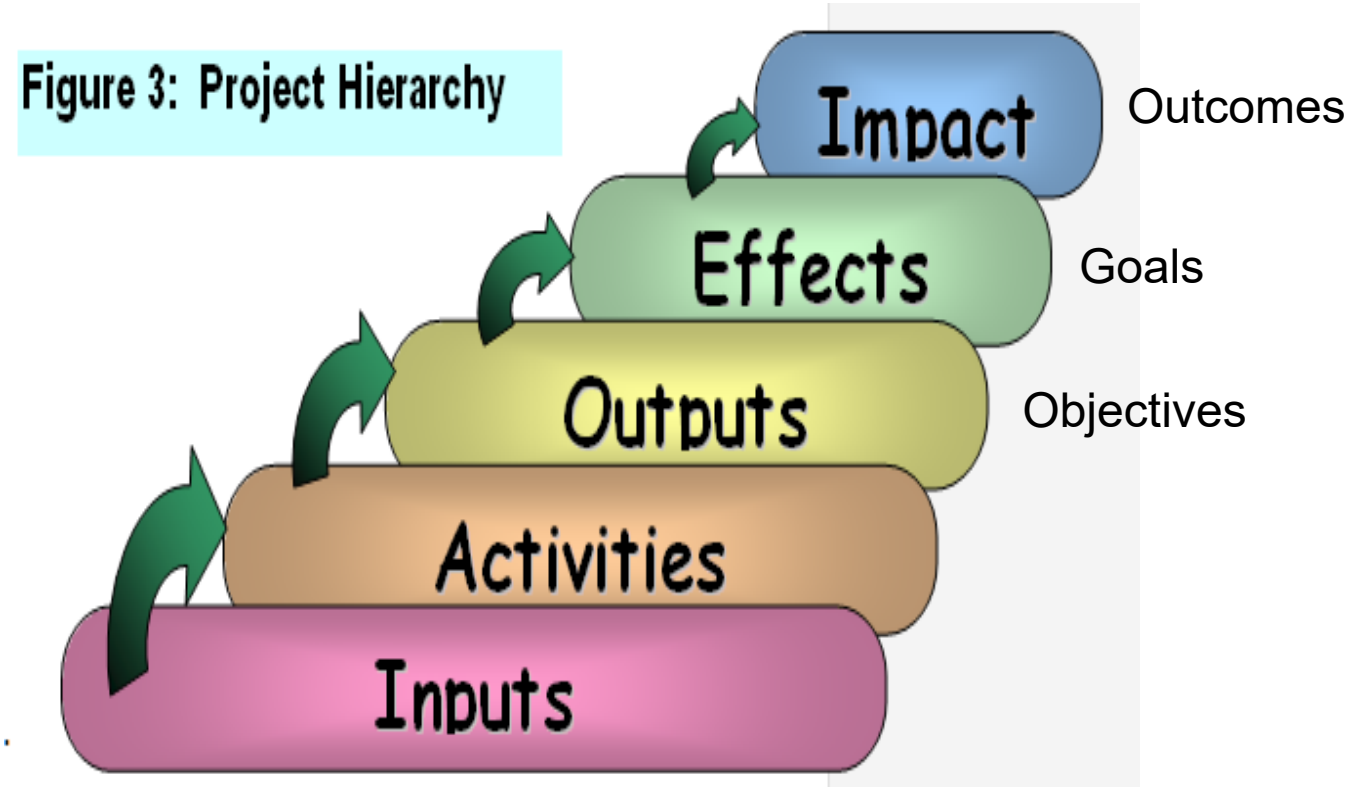
Multiple Criteria Decision Matrix

		Train maintenance person for old canals		Irrigation canals		Implement drip irrigation		Water storage facilities for year round water supply		Electrical Transmission Lines from Existing Hydro Plants		Pico-Hydro Plants		Photovoltaic Panels on Individual Homes		Combined Irrigation Canal/Pico-Hydro System	
Criteria	Weight	Score	Score x Weight	Score	Score x Weight	Score	Score x Weight	Score	Score x Weight	Score	Score x Weight	Score	Score x Weight	Score	Score x Weight	Score	Score x Weight
Cost effectiveness	3	3	9	2	6	1	3	1	3	1	3	2	6	2	6	3	9
Social acceptability	5	2	10	3	15	1	5	2	10	2	10	2	10	2	10	3	15
Operations & maintenance feasibility	4	2	8	2	8	1	4	2	8	2	8	2	8	1	4	2	8
Environmental sustainability	5	3	15	1	5	3	15	2	10	3	15	3	15	3	15	2	10
Community participation	4	1	4	3	12	2	8	2	8	3	12	3	12	2	8	3	12
Impact on community health	4	1	4	2	8	2	8	1	4	1	4	2	8	1	4	2	8
Economic impact	3	1	3	3	9	2	6	1	3	2	6	2	6	2	6	3	9
Number of people impacted	4	2	8	2	8	2	8	2	8	3	12	2	8	3	12	3	12
Total			**61**		**71**		**57**		**54**		**70**		**73**		**65**		**83**

Social Network Analysis



Logical Decision Framework



Outcome/Impact: *Improved household livelihood security through increased income opportunities and increased food security.*

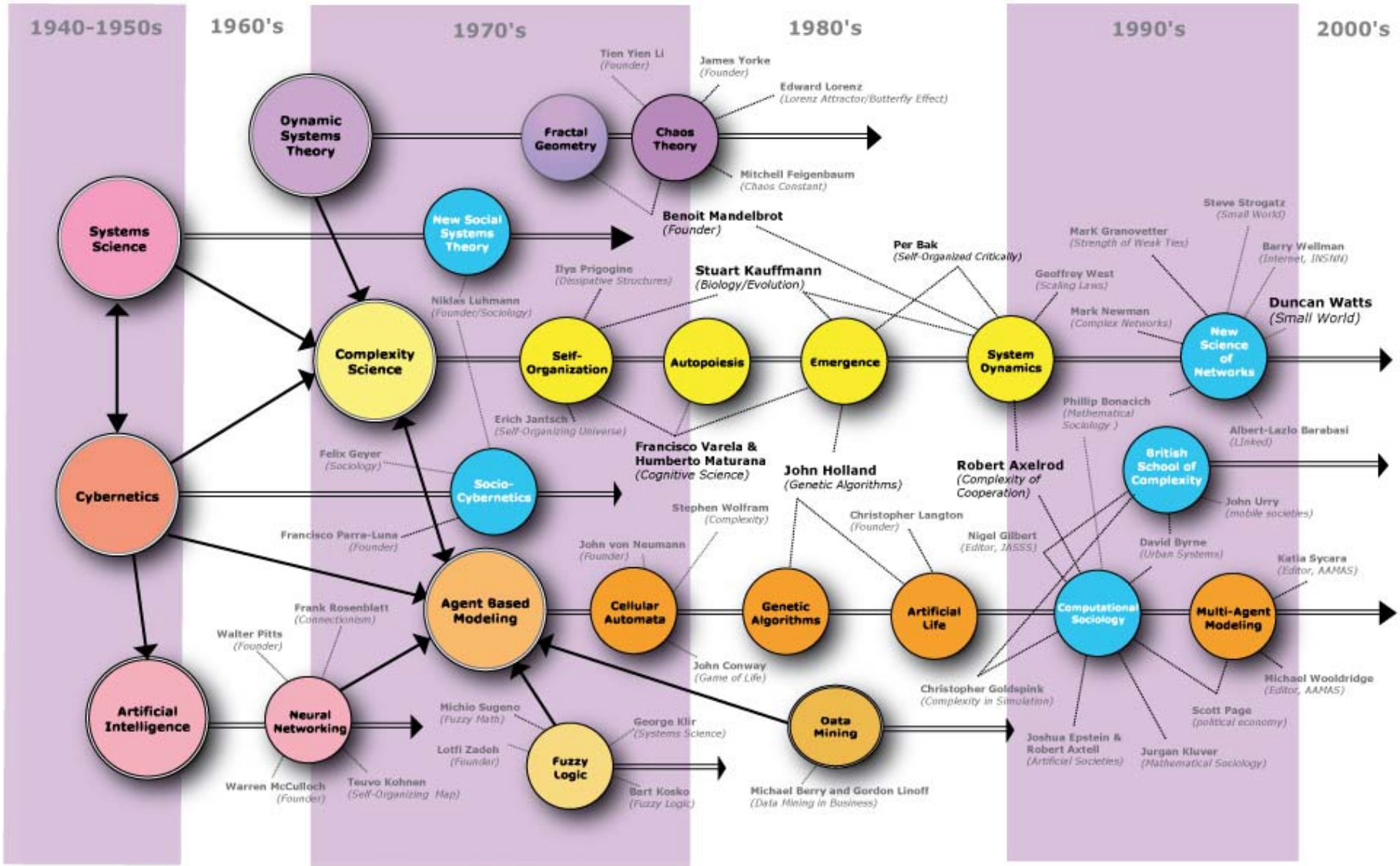
Project Hierarchy		Indicators	Means of Verification	Assumptions
Goals	1. Improved standard of living of irrigators	1. 5 years after project: • 95% of Irrigators are able to meet their needs for food and are able to produce a surplus for sale. • 80% of irrigators have reduced their use of pesticides and fertilizers	1. • Community wide survey in project area 4-5 years after implementation when system operating at full potential by (NCDC)	1. • Baseline community wide survey in project area was carried out at beginning of project • Irrigated fields produce higher yields
	2. Provide electricity to homes	2. 10 years after project: • 30% increase in electricity production in Mabu	2. • Count number of houses with electricity available • Survey community members and identify trained personnel	2. • Community will continue to desire electricity for use in homes and businesses
	3. Support development of small businesses	3. 10 years after project: • 6-9 new businesses operating	3. • Count operating businesses began within the last 10 years	3. • Five year SDPs will continue and will be a long term data source

Project Hierarchy		Indicators	Means of Verification	Assumptions
Sub-Goals	1.1 Increased crop yields and irrigator incomes 1.2 Reduce use of chemical pesticides and fertilizers 1.3 Technical and Environmental Sustainability	1.1 Five years after end of project: • 25% increase in number of ropanis receiving water from irrigation canals • Exceed or achieve project IRR and timely loan repayment • 25% reduction in instances of disruptions to the irrigation system • 30% reduction in usage of chemical pesticides and fertilizers	1.1 • Direct observations of land usage and canals • Survey farmers • Soil chemical tests • Purchase receipts	1.1 • Disruptions to irrigation system are caused by poor maintenance practices • Surveys will result in reliable data as to pesticide usage • Able to determine levels of disruption to system prior to project
	2.1 Electric lighting available for all homes served by pico hydro system and other electric appliances supported in subset of homes	2.1 Five years after end of project: • Electric lighting available in 75% of homes not previously lit • Electric amenities available in 50% of homes • 10 electric blenders available within given community for use in shared applications or private enterprise	2.1 • NCDC surveys and photographs of homes served by system to count number of homes served with various electric appliances	2.1 • Electric cook-tops will provide incentive for community members to pursue electricity • Pico-hydro system will be properly maintained by community
	3.1 Growth of small businesses using both electricity and mechanical shaft energy	3.1 One small business using mechanical shaft energy at each plant		3.1 • Community members will pursue small businesses using the pico hydro system • Users willing to pay electric fees for system maintenance

Project Hierarchy		Indicators	Means of Verification	Assumptions
Outputs	1.1.1 Irrigation canals built	1.1.1 • 3 canals built at project completion	1.1.1 Observation by SCD team, EWB Nepal, or NCDC	1.1.1 • Records from training programs exist • Knowledge of alternatives will result in changed behaviors
	1.1.2 Maintenance workers trained to operate and repair canals and pico-hydro system	1.1.2 • 12 - 15 workers completed training program at time canals are completed		
	1.2.1 Behavior change campaign created for pesticide use	1.2.1 • 3 training workshops held for farmers and posters and brochures distributed throughout town	1.2.1 • Training program records • Surveys of farmers	
	2.1.1 Pico-hydro system installed	2.1.1 • 2-3 pico-hydro plants built per canal	2.1.1 • NCDC surveys and photographs of plants	2.1.1 • Head and flow are sufficient for system
	2.1.2 Transmission lines for distribution built	2.1.2 • Transmission lines built for each pico-hydro unit	2.1.2 • NCDC surveys and photographs	
	2.1.3 Behavior change campaign created for: • electric appliance • technology adoption	2.1.3 • All houses served received training for use of electric appliances	2.1.3 • NCDC surveys and photographs	2.1.3 • Community members will discontinue use of kerosene lamps and firewood and utilize electric lighting and burners, respectively
	3.1.1 Business training programs	3.1.1 • 50 -60 people trained in new business development		3.1.1 • Community members will invest microloans in new businesses
	3.1.2 Microloans for entrepreneurs			

Project Hierarchy		Assumptions
Activities	1.1.1 Irrigation Canals: • 1.1.1.1 Site selection and mapping • 1.1.1.2 Sizing and demand modeling • 1.1.1.3 Source labor and materials • 1.1.1.4 Design and build irrigation canal 2.1.1/2.1.2 Pico-Hydro System: • 2.1.1.1 Site selection and mapping • 2.1.1.2 Sizing and demand modeling • 2.1.1.3 Select picohydro unit • 2.1.1.4 Source labor and materials • 2.1.1.5 Design housing and transmission • 2.1.1.6 Install systems • 2.1.1.7 Build transmission lines 1.1.2 Maintenance Training 1.2.1.1 Train community members in canal maintenance practices 2.1.3.1 Train electric maintenance workers 1.2.1/2.1.3 Behavior Change: • 1.2.1.1 Develop messages for change (reduce chemical pesticides and fertilizers) • 1.2.1.2 Hold workshops for farmers • 2.1.3.1 Develop messages for change (electricity adoption) • 2.1.3.2 Develop posters and brochures • 2.1.3.3 Hold workshops for electricity use 3.1.1. Business Training • 3.1.1.1 New business training for local community 3.1.2 Microloan Program • 3.1.2.1 Develop structure for microloan distribution	All data necessary to design picohydro/canal system will be collected Irrigation Canals/Pico-Hydro System Firms/NGOs exist with proper experience for designing and building a canal based picohydro system Timely acquisition of funding and materials A sufficient number of community members will want to train to become maintenance technicians Community members will remain engaged in the program and will participate in behavior change activities Community interest in the project remains high

System Science(s): Study of systems

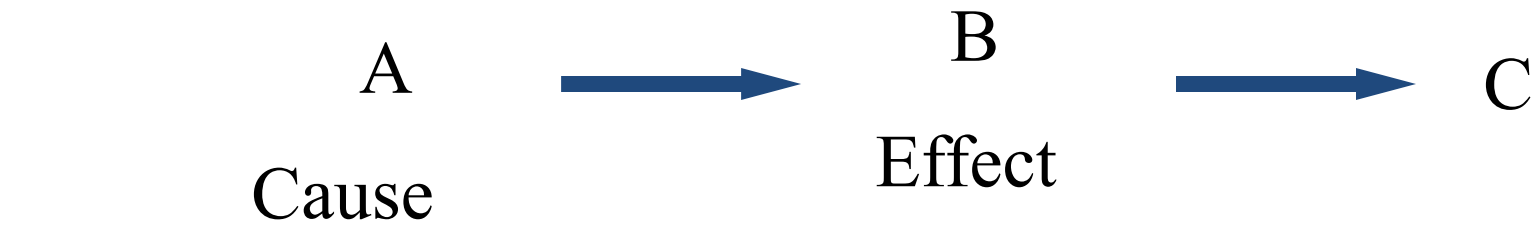


System Dynamics

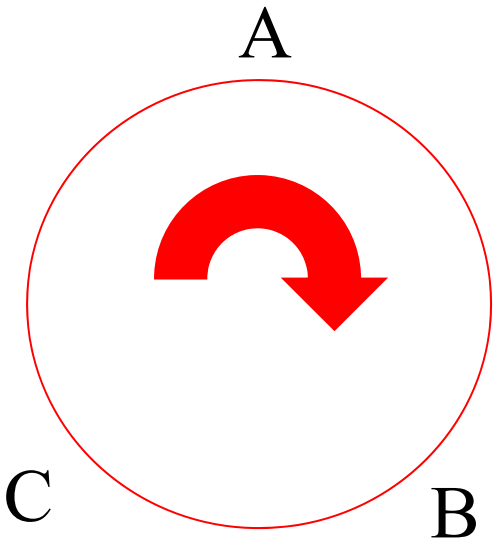
"An approach to understanding the behaviour of complex systems over time. It deals with internal feedback loops and time delays that affect the behaviour of the entire system. What makes using system dynamics different from other approaches to studying complex systems is the use of feedback loops and stocks and flows. These elements help describe how even seemingly simple systems display baffling nonlinearity." (Wikipedia, 2014)

http://www.iseesystems.com

Linear Causality



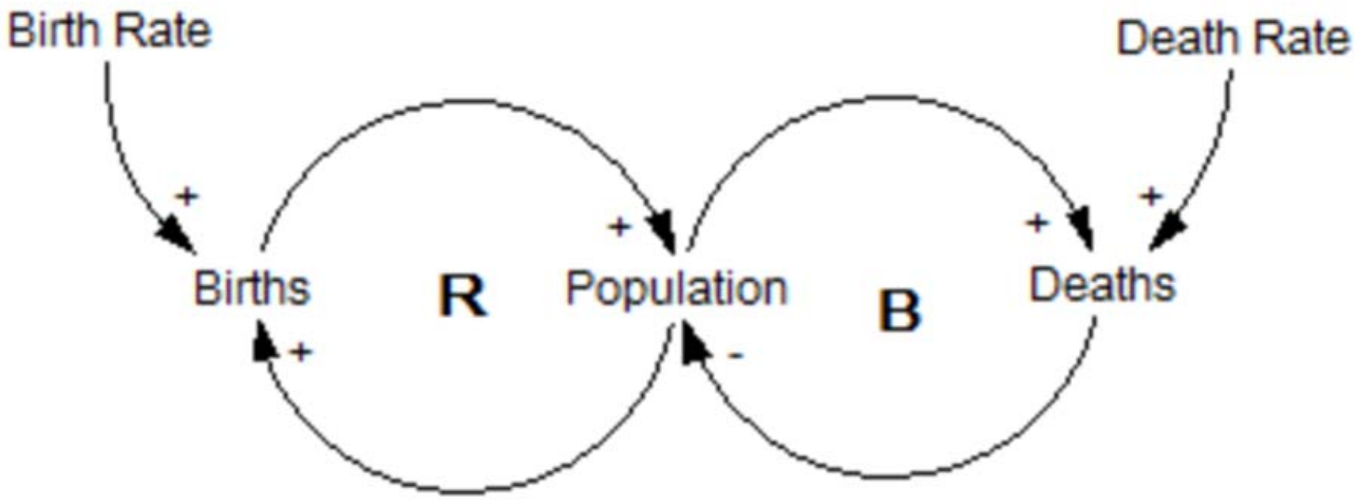
Circular Causality



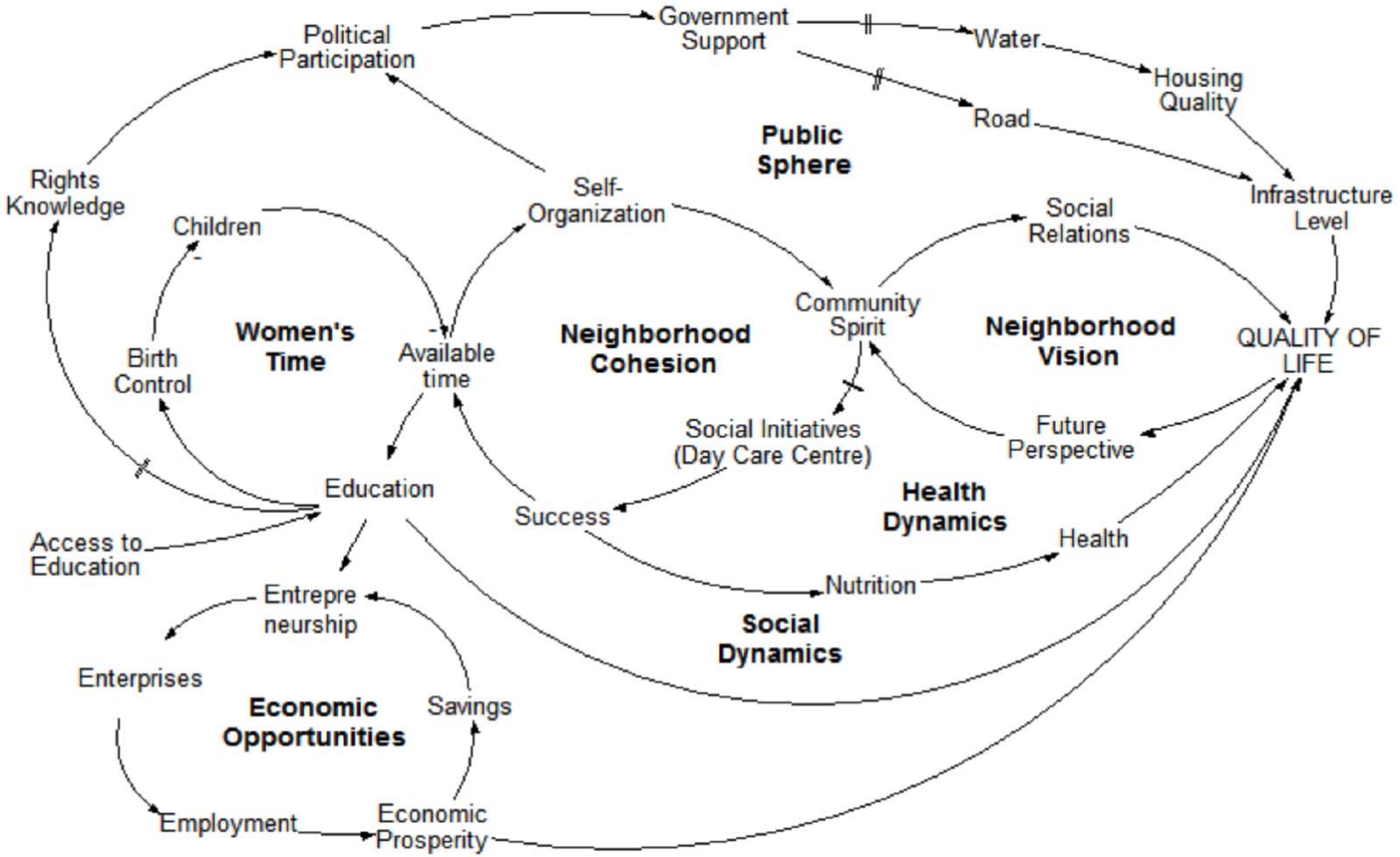
Feedback: shows how actions can reinforce (positive feedback) or counteract (balance through negative feedback) each other

Variables are organized in a circle or loop of cause-effect relationship called a "feedback process"

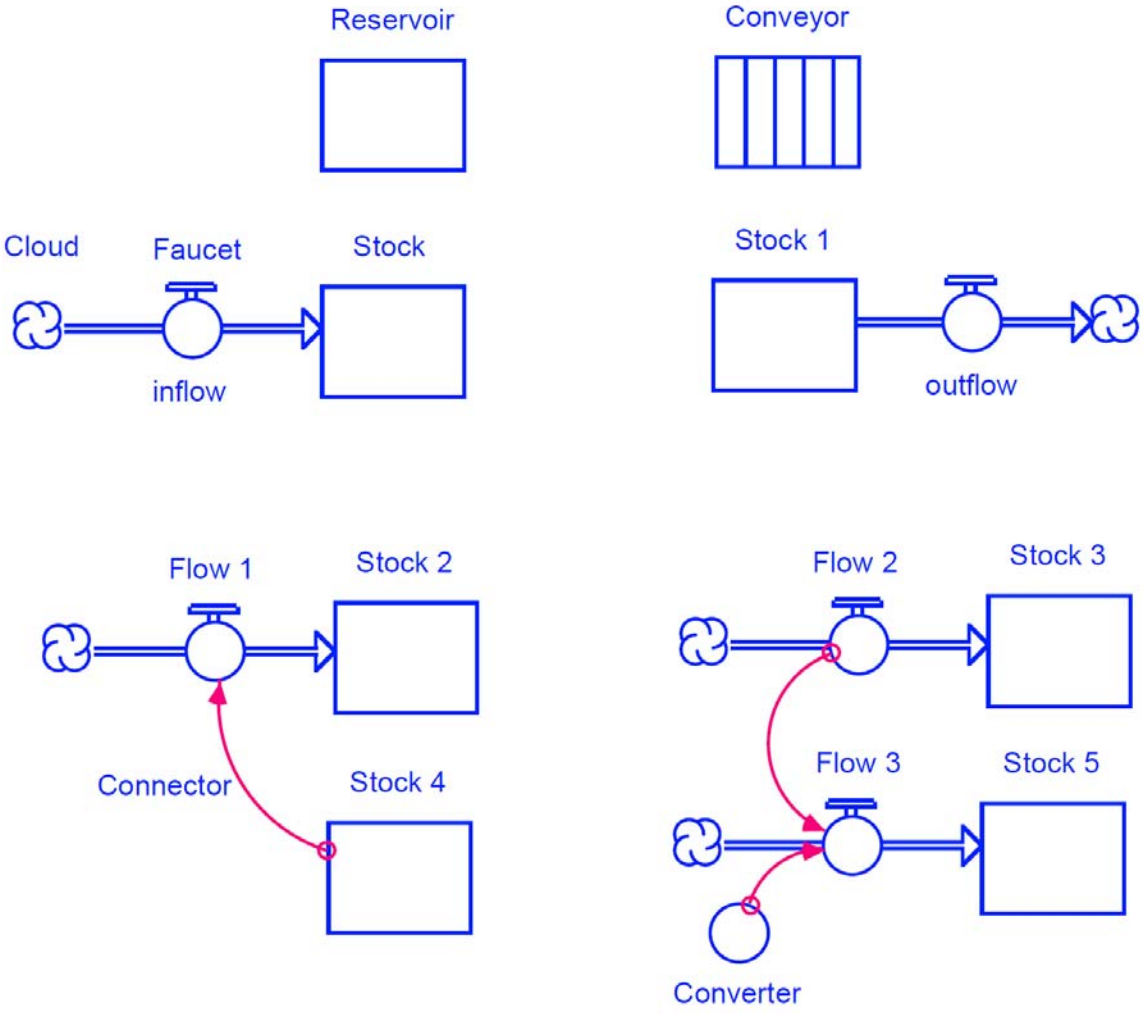
Causal Loop Diagrams (CLDs)

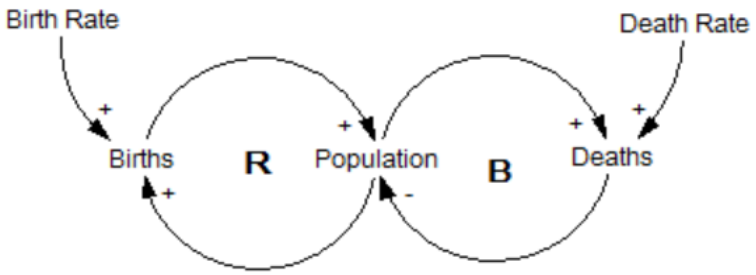


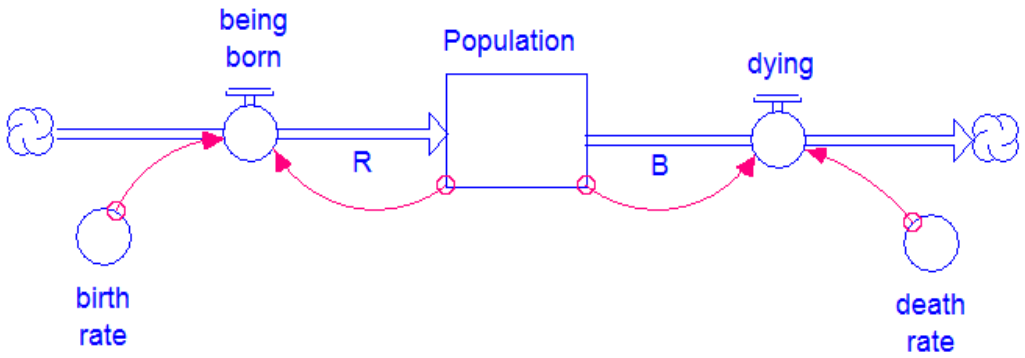
Causal Loop Diagrams

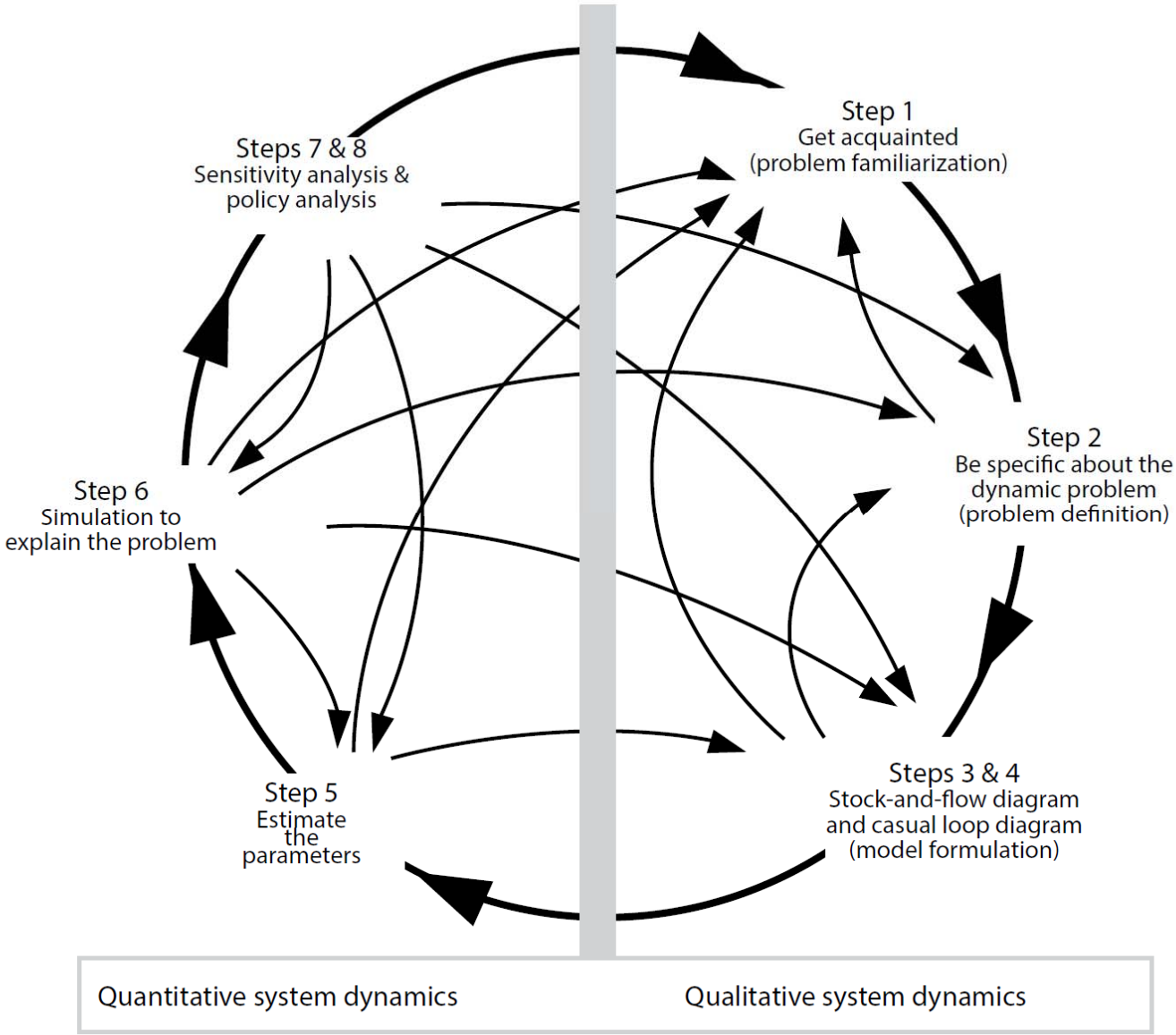


Stock and Flow Diagrams

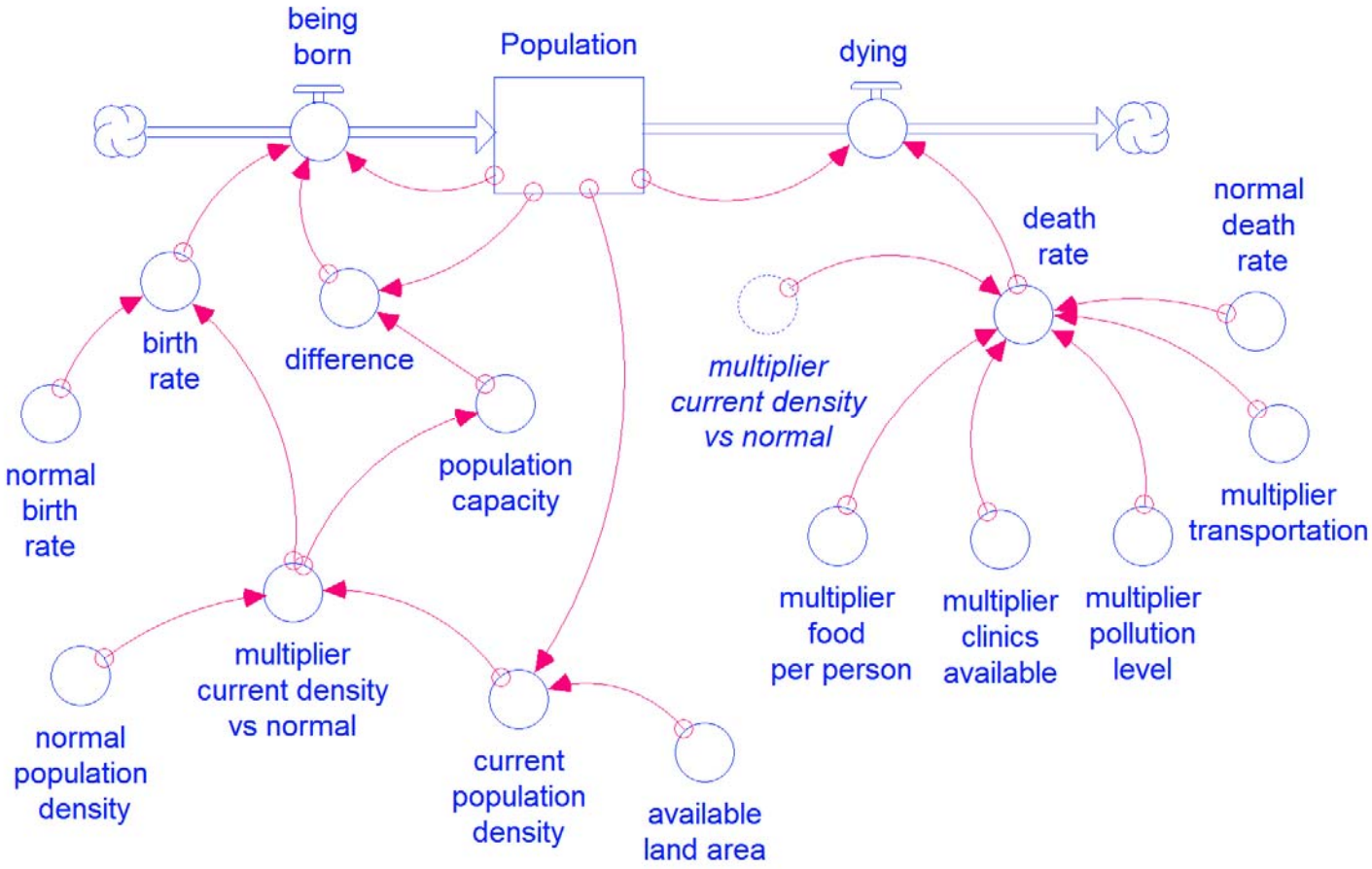


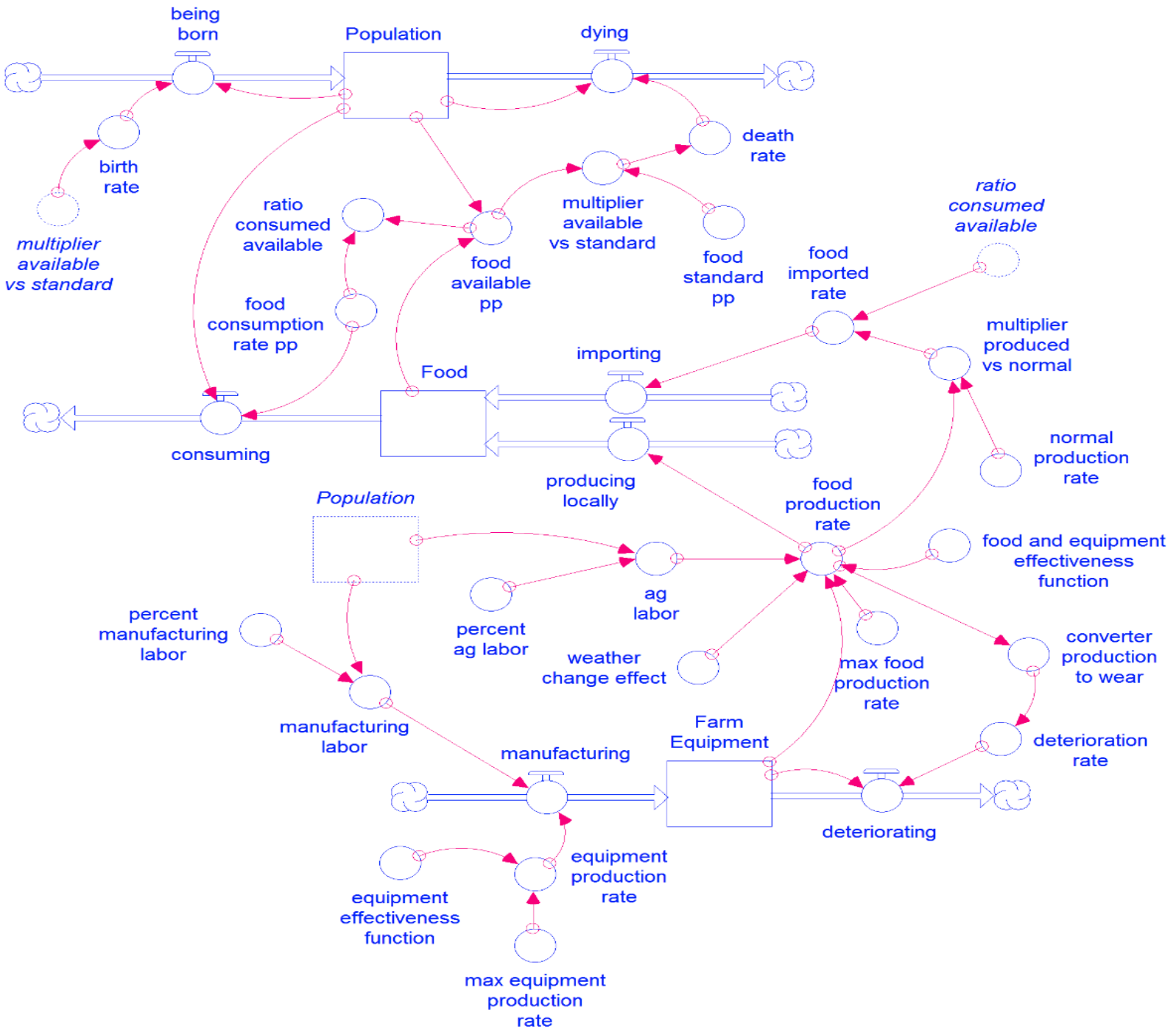

Birth Rate
Death Rate
Births
R
Population
B
Deaths
+
+
+
+
+
-

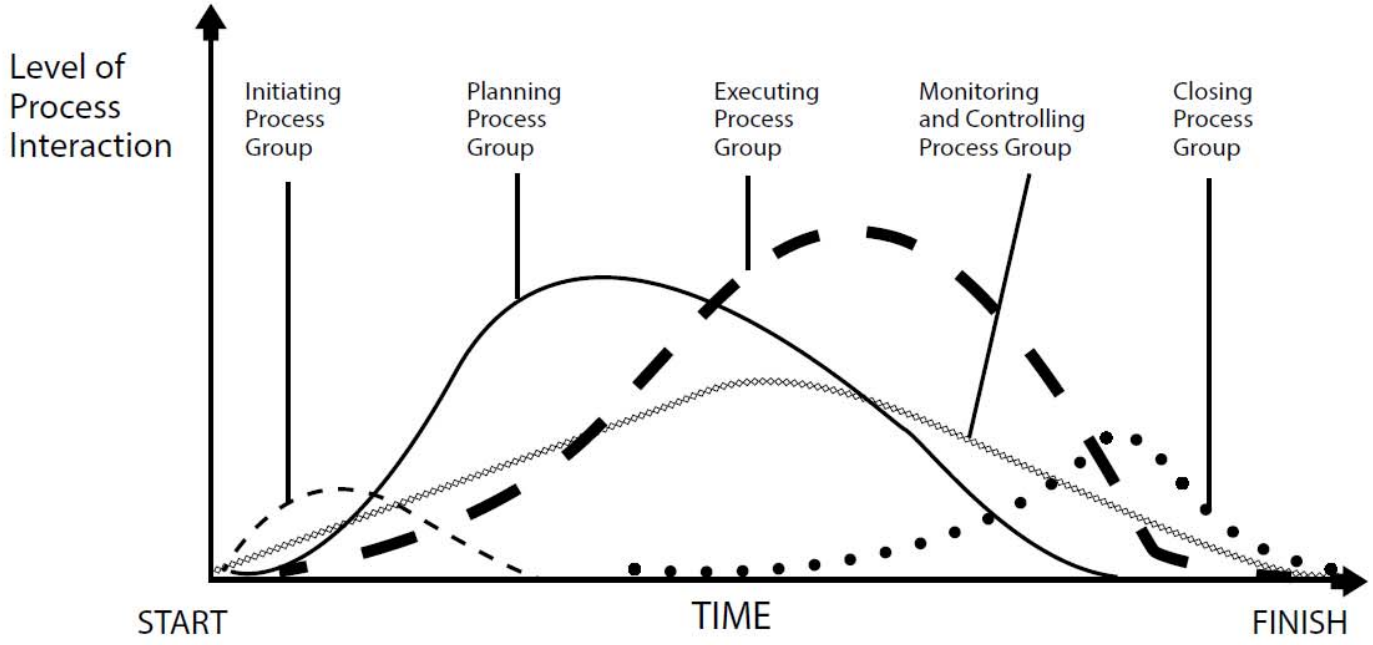

being
born
Population
dying
R
B
birth
rate
death
rate


Step 1
Get acquainted
(problem familiarization)
Step 2
Be specific about the
dynamic problem
(problem definition)
Steps 3 & 4
Stock-and-flow diagram
and casual loop diagram
(model formulation)
Step 5
Estimate
the
parameters
Step 6
Simulation to
explain the problem
Steps 7 & 8
Sensitivity analysis &
policy analysis
Quantitative system dynamics
Qualitative system dynamics

Stock and Flow Diagrams




being born
Population
dying
death rate
birth rate
multiplier available vs standard
ratio consumed available
food available pp
multiplier available vs standard
food standard pp
ratio consumed available
food imported rate
multiplier produced vs normal
food consumption rate pp
importing
Food
consuming
producing locally
normal production rate
Population
food production rate
food and equipment effectiveness function
ag labor
percent ag labor
percent manufacturing labor
weather change effect
max food production rate
converter production to wear
manufacturing labor
Farm Equipment
deterioration rate
manufacturing
deteriorating
equipment production rate
equipment effectiveness function
max equipment production rate


Level of Process Interaction
Initiating Process Group
Planning Process Group
Executing Process Group
Monitoring and Controlling Process Group
Closing Process Group
START
TIME
FINISH

0. Project Initiation and Identification
Purpose: Pre-Feasibility and Pre-Appraisal
Outcome: Decision to proceed forward

1. Community Appraisal
Purpose – Develop a comprehensive community baseline profile
Output: Problem identification and ranking

2. Project Hypothesis
Purpose – Prioritize problems and develop feasibility of solutions
Outcome: Problem statement, preliminary design, and work plan

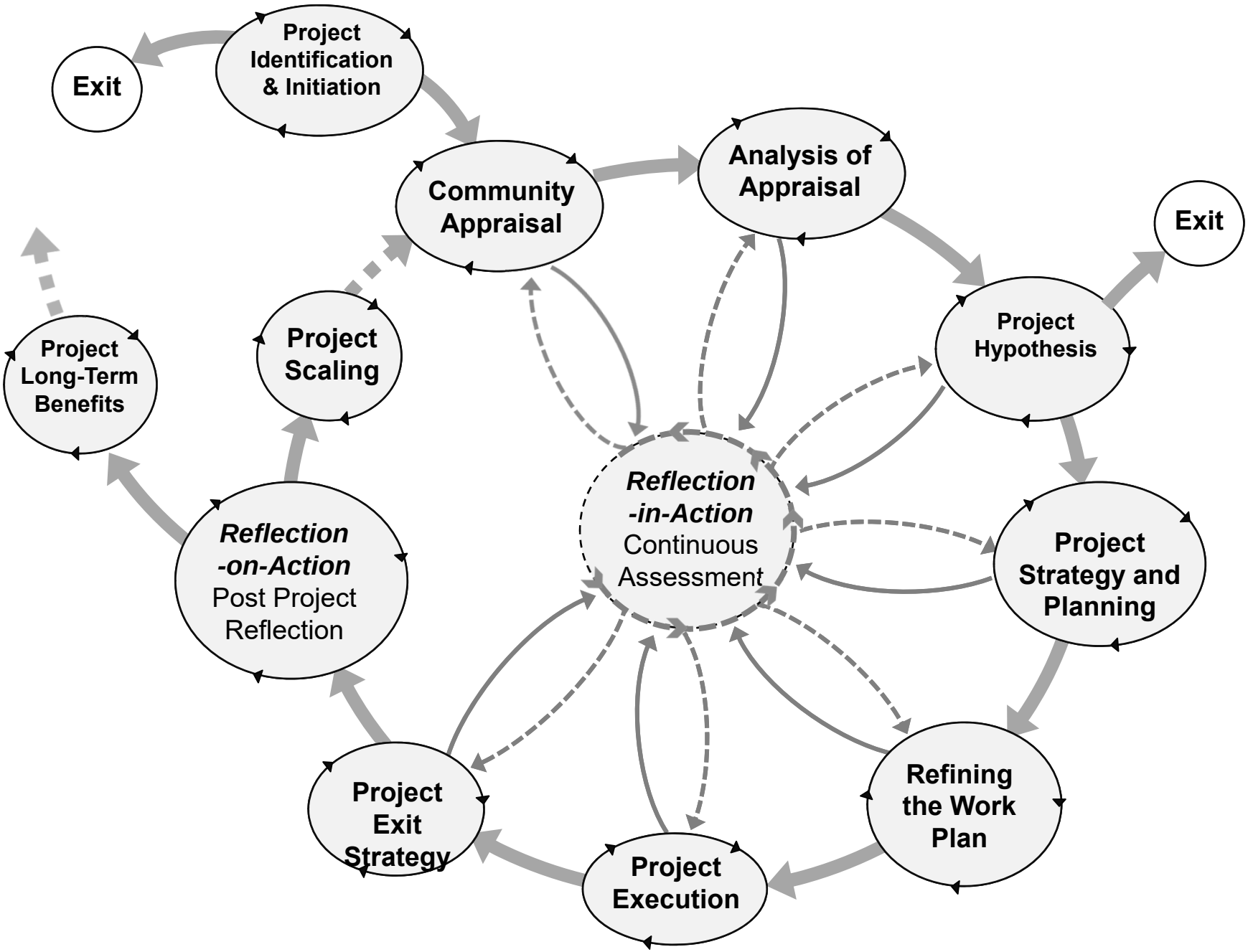
7. Reflective Practice
Purpose – Reflect on action and identify lessons learned
Outcome: Better practices and more qualified practitioners

3. Strategy and Planning
Purpose - Identify project interventions, project design, and develop an operational plan
Outcome: Comprehensive work plan

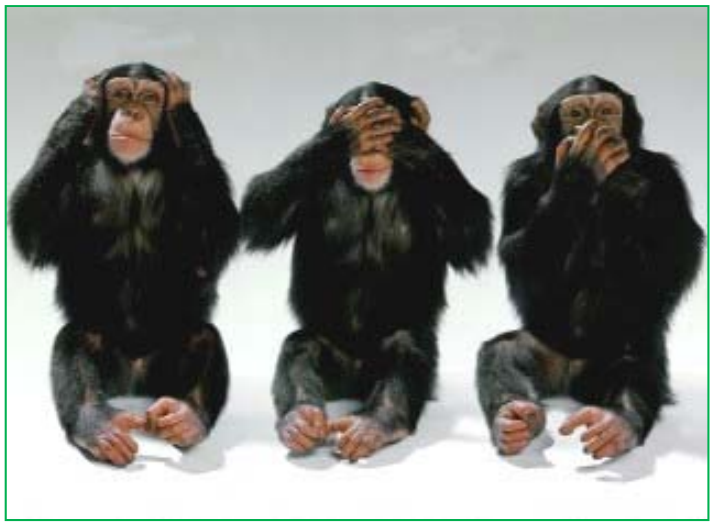
6. Exit Strategy, Sustainability, and Scaling Up
Purpose – Plan for project closure and ensure long-term project benefits for an "extended" period of time
Outcome: Refined project work plan, execution, closing, sustainability, and scaling up

4. Capacity Analysis - Risk Analysis - Resilience Analysis
Purpose – Refine project work plan and identify enabling, constraining, and risk environment
Outcome: Refined project work plan

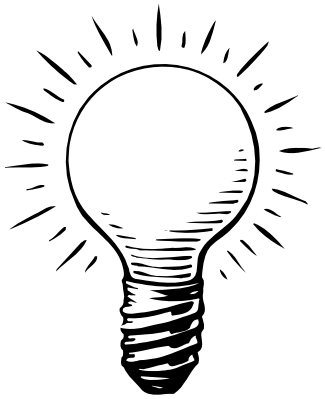
5. Project Execution and Assessment
Purpose – Deliver sound and long-lasting solutions with assessment of project progress and impact
Outcome: Refined project work plan and execution


Exit
Project Identification & Initiation
Community Appraisal
Analysis of Appraisal
Exit
Project Hypothesis
Project Strategy and Planning
Refining the Work Plan
Project Execution
Project Exit Strategy
Reflection-on-Action Post Project Reflection
Project Long-Term Benefits
Project Scaling
Reflection-in-Action Continuous Assessment

"The significant problems we face today cannot be solved at the same level of thinking we were at when we created them."



Albert Einstein



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