NORTHERN ILLINOIS UNIVERSITY
Institute for the Study of the Environment, Sustainability & Energy

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Supporting Drought Adaptation Policies

Dynamic Systems – Conflict Resolution – Policies

Illinois Lake Management Association
28th Annual Conference, 4-6 April 2013, Bloomington IL

- **Background**
- **Project objective, approach, tools, and models**
- **Demo of the tool prototype**

Source: africa.theworldatlas.net

Lessons Learned?

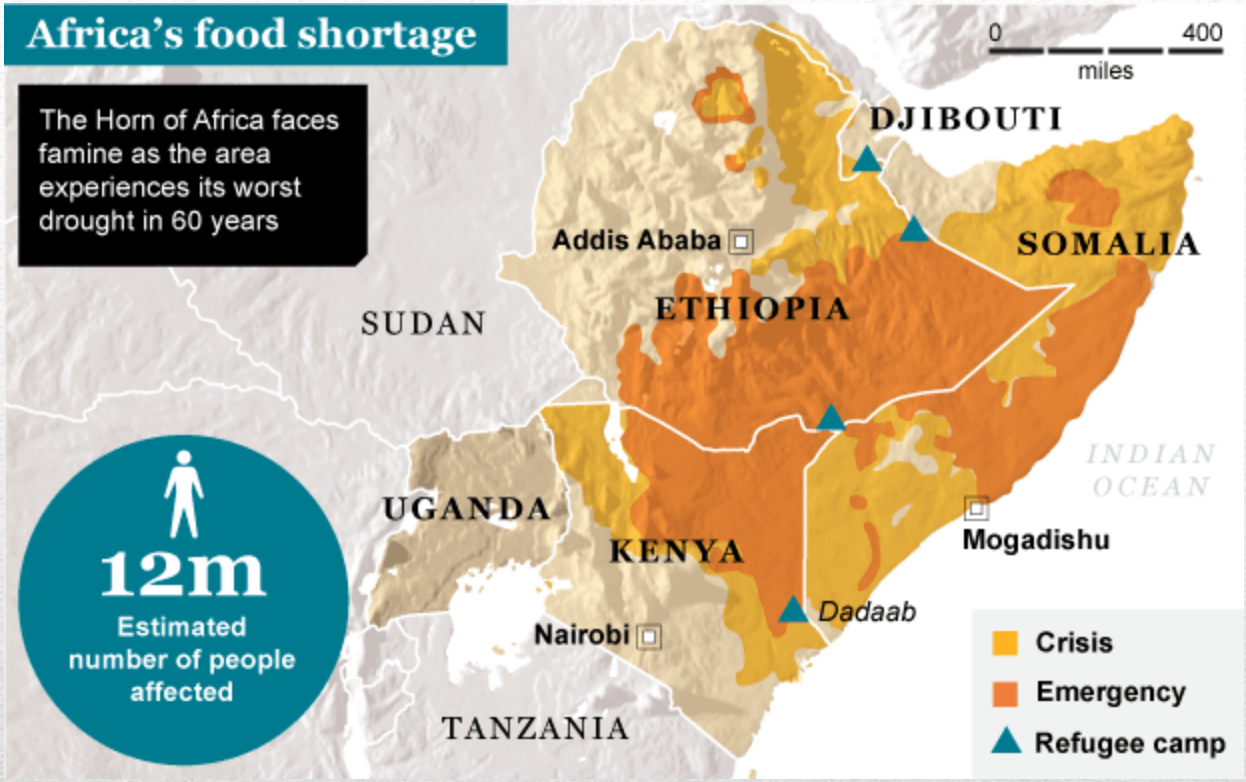
www.merriam-webster.com

Outline

Drought

- Simple Definition: a period of water shortage
  - Crop and livestock damage
  - Water supply shortages
- Severity depends on:
  - Duration
  - Degree of moisture deficiency
  - Size/location of affected area

Source: UN OCHA Crisis in the Horn of Africa

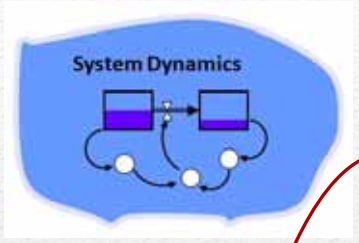


http://humanitarian.worldconcern.org/tag/horn-of-africa/page/2/

Build a **system-based tool** to support policies to mitigate drought impacts

Research Objective

TOOLs for System Modeling and Analysis

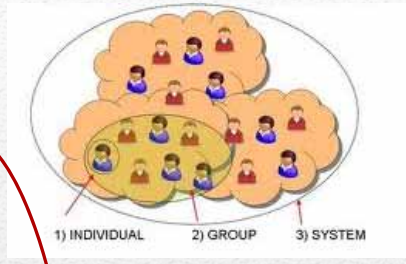


System Dynamics

Biological, physical, and engineered systems

Agent-Based Model

Behaviors of actors and social systems

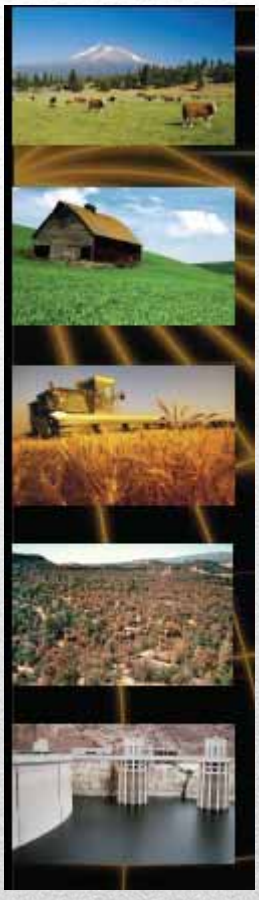


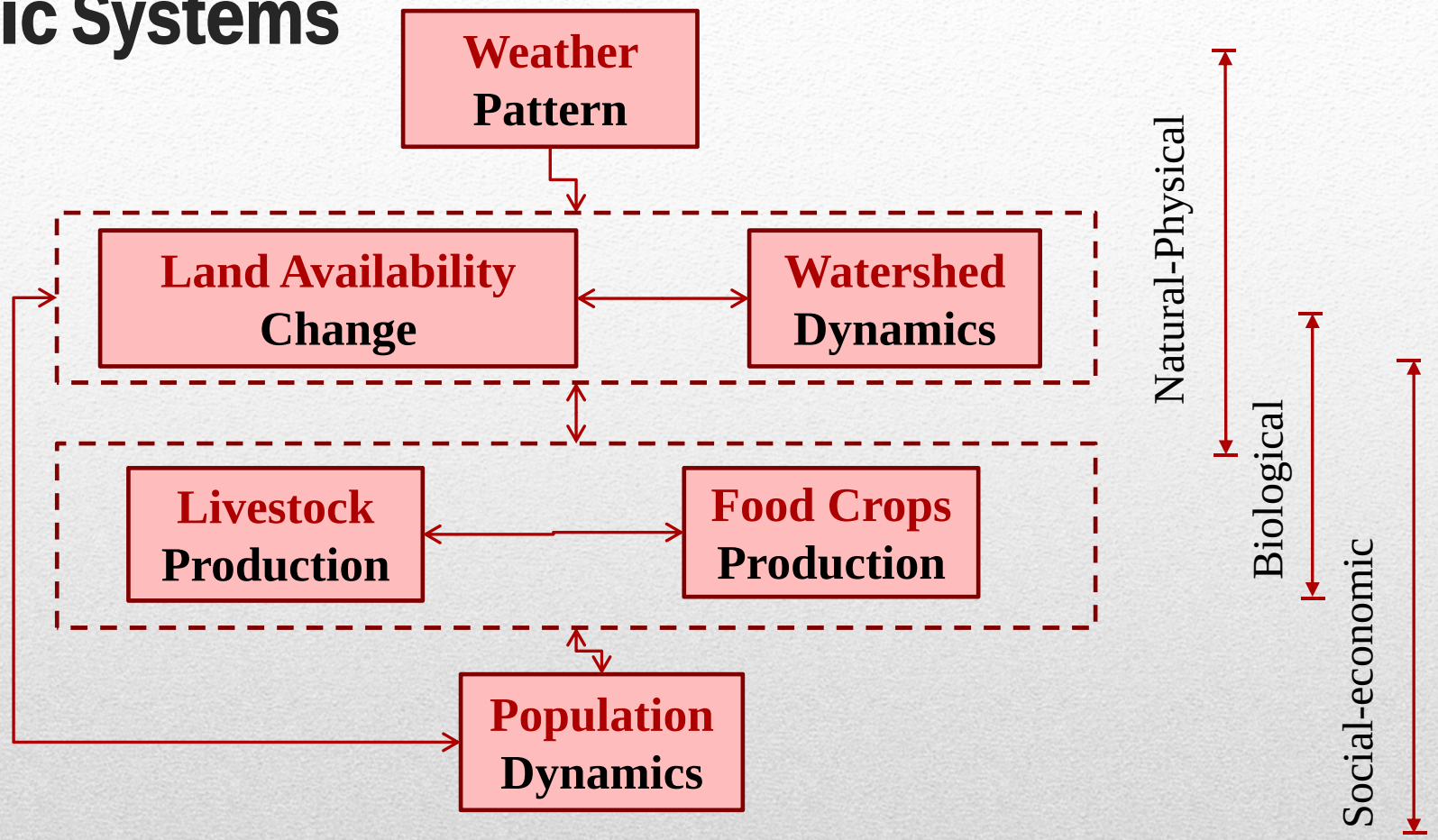
Gaming and Simulation

Conflict resolution and management

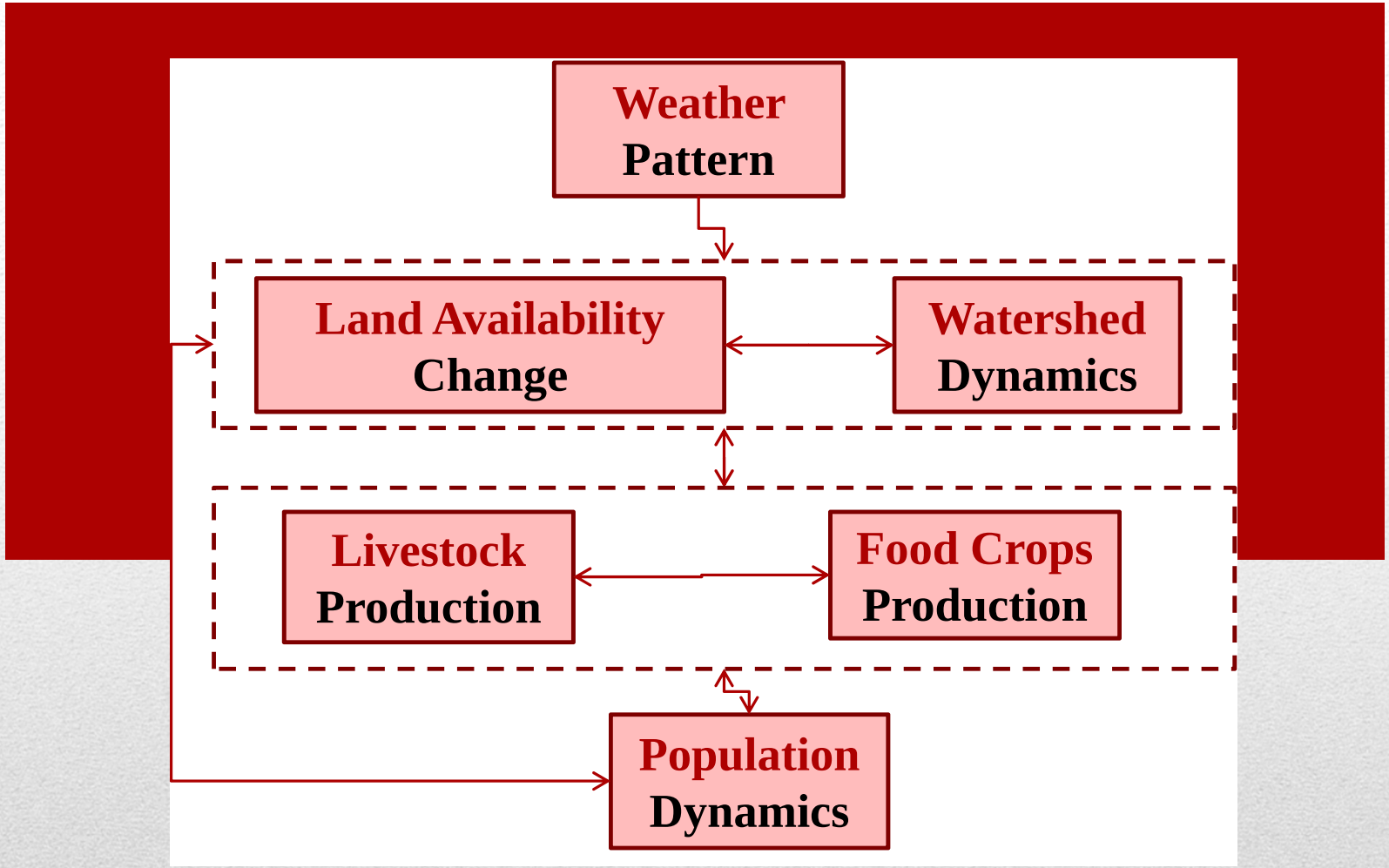
Policy Evaluation

Dynamic Systems

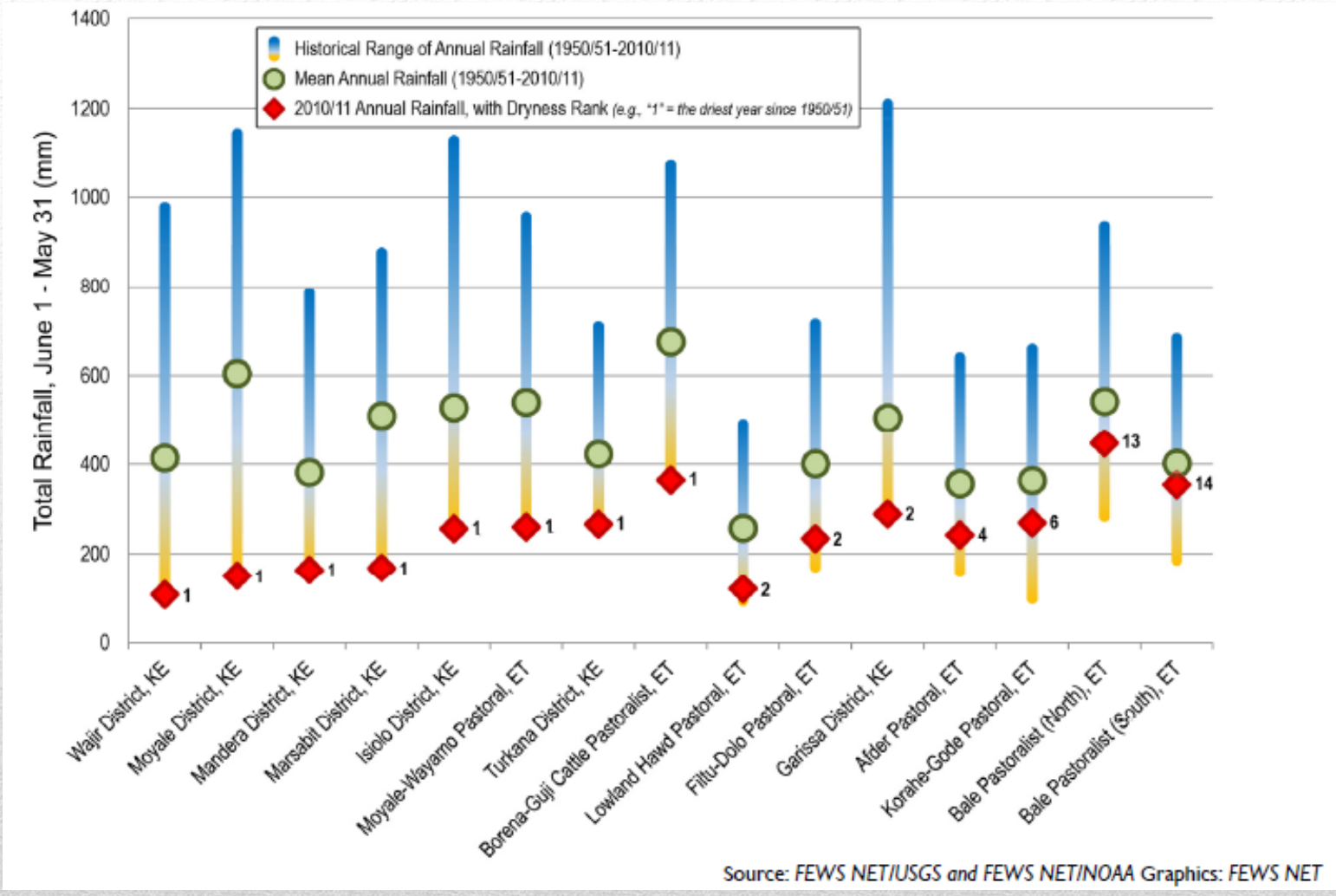




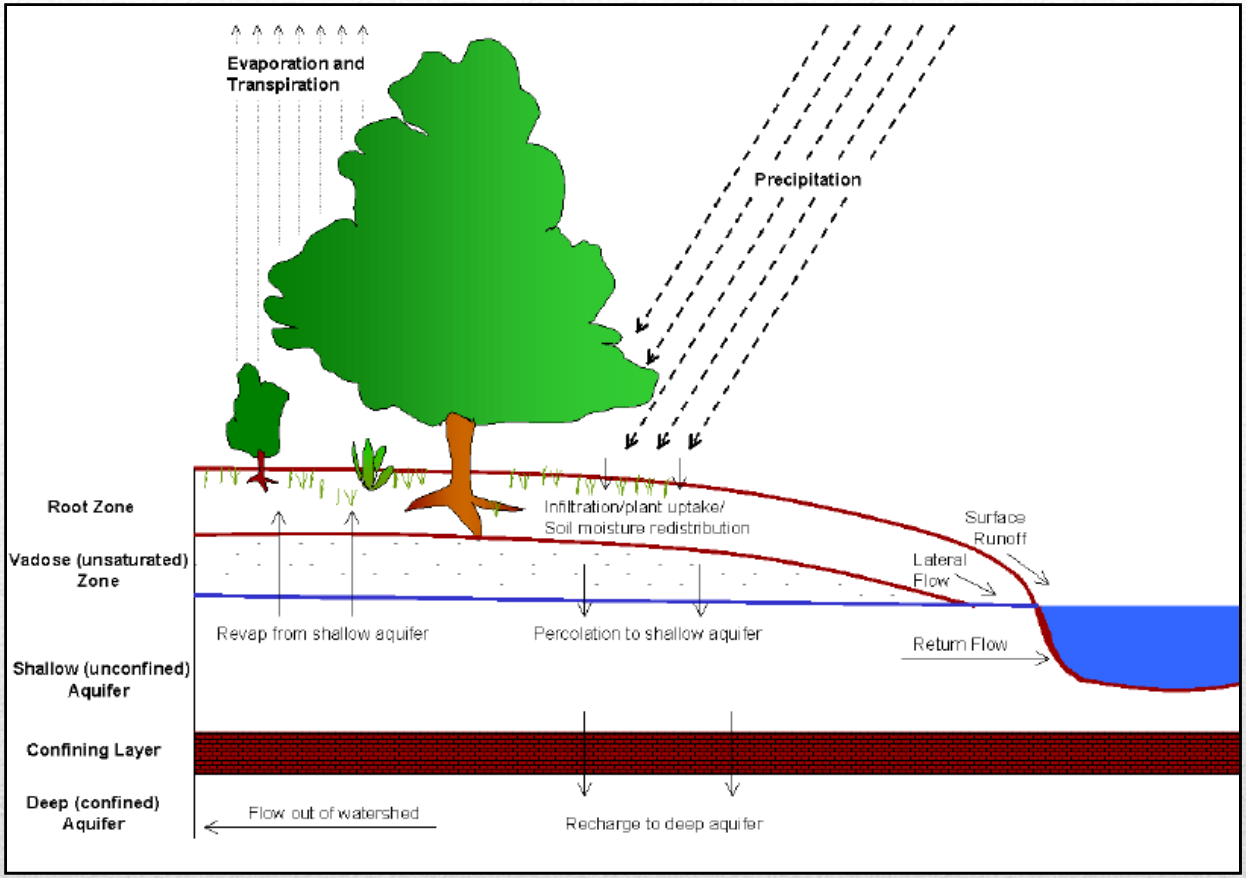
- **Understand** fundamental **causes, process, interdependencies,** and impacts of drought
- **Build** a representative **systems model**



SYSTEM ELEMENTS



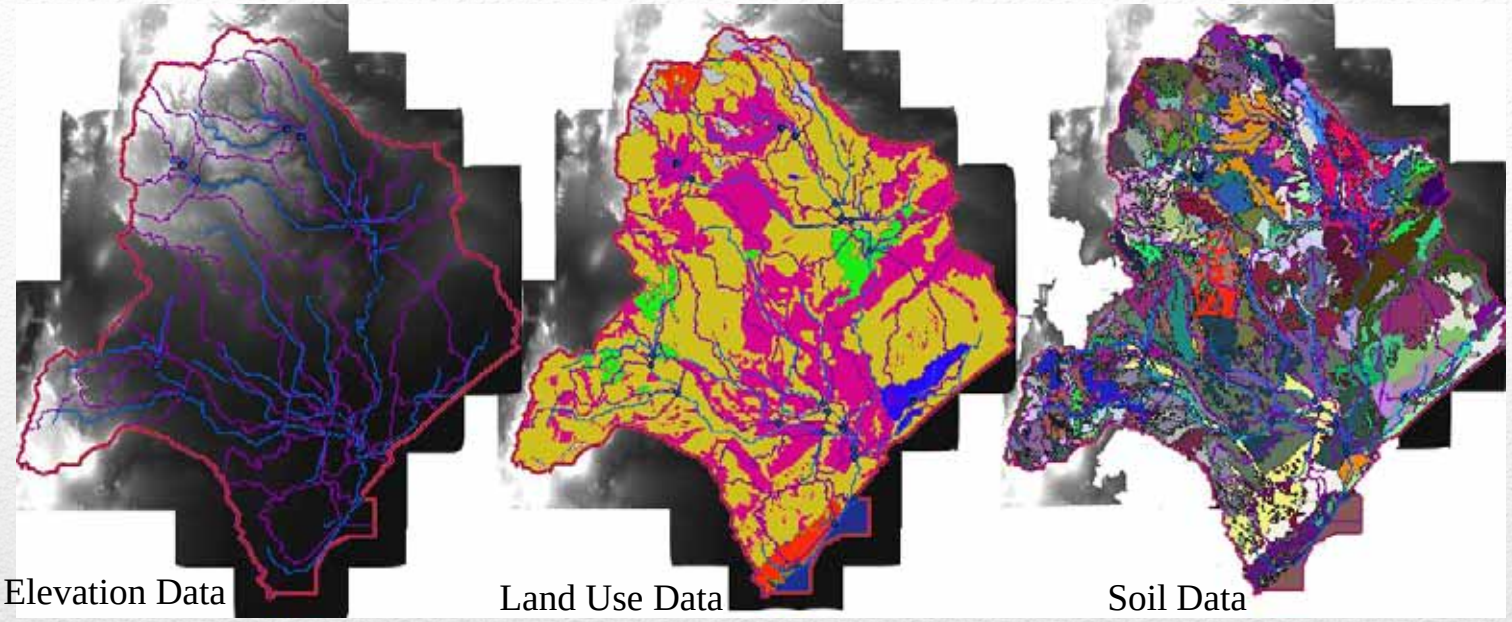
Weather Pattern: Rain Fall



SWAT2009 Theoretical Documentation

- Soil & Water Assessment Tool (SWAT) Model
  - Simulates hydrologic cycle based on water balance

Watershed System Model

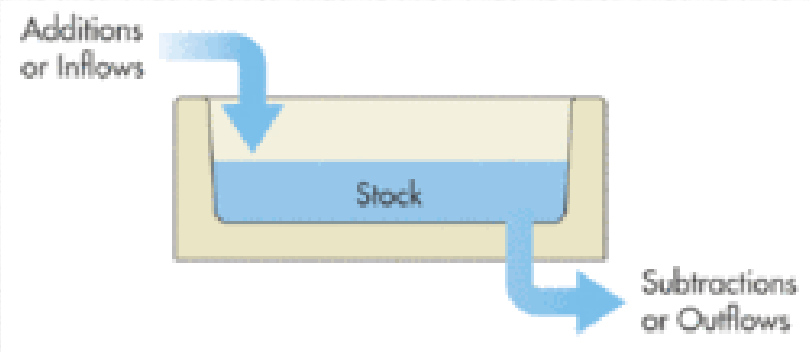


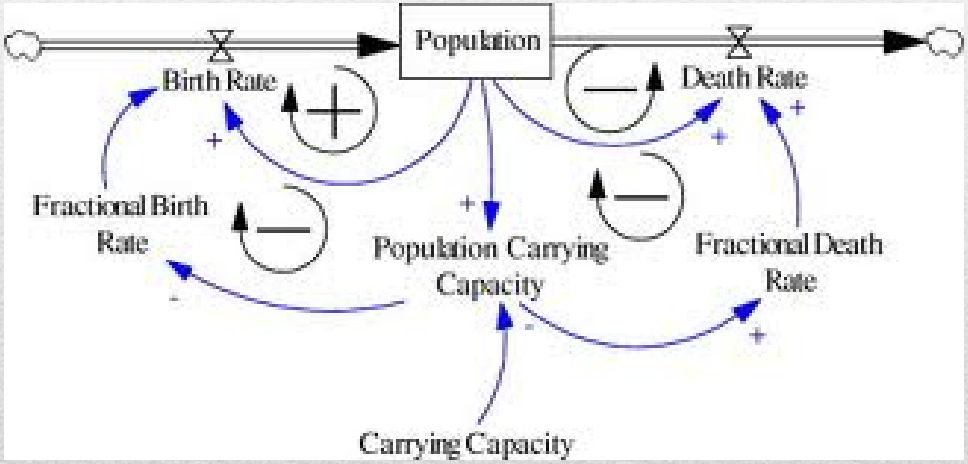
- Physically based model
  - Requires weather, soil, topography, vegetation, and land management data
- Hydrologic Response Units (HRUs)
  - Lumped land areas within a subbasin based on unique land cover, soil, and management combinations

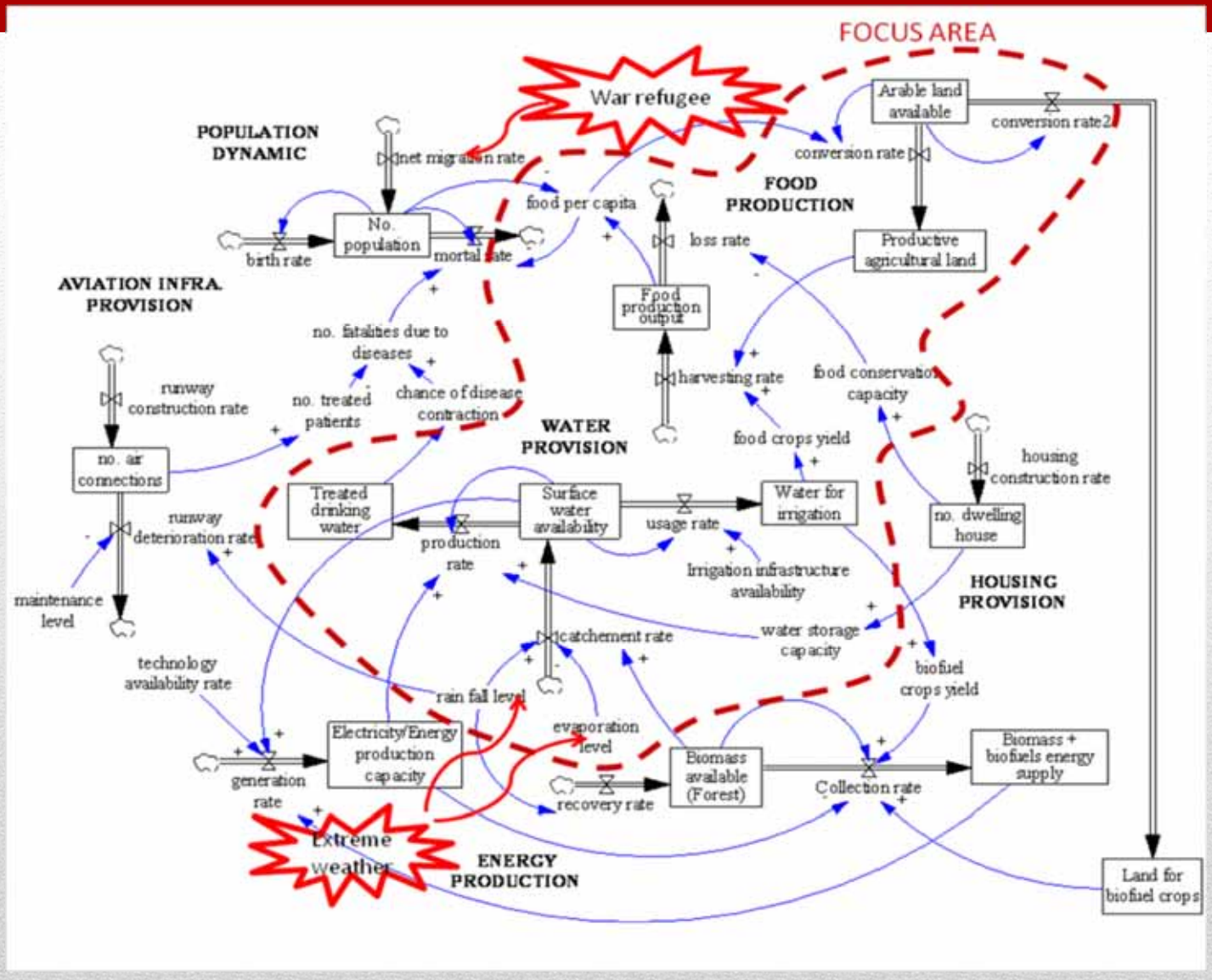
SWAT Model

System dynamics model (1)

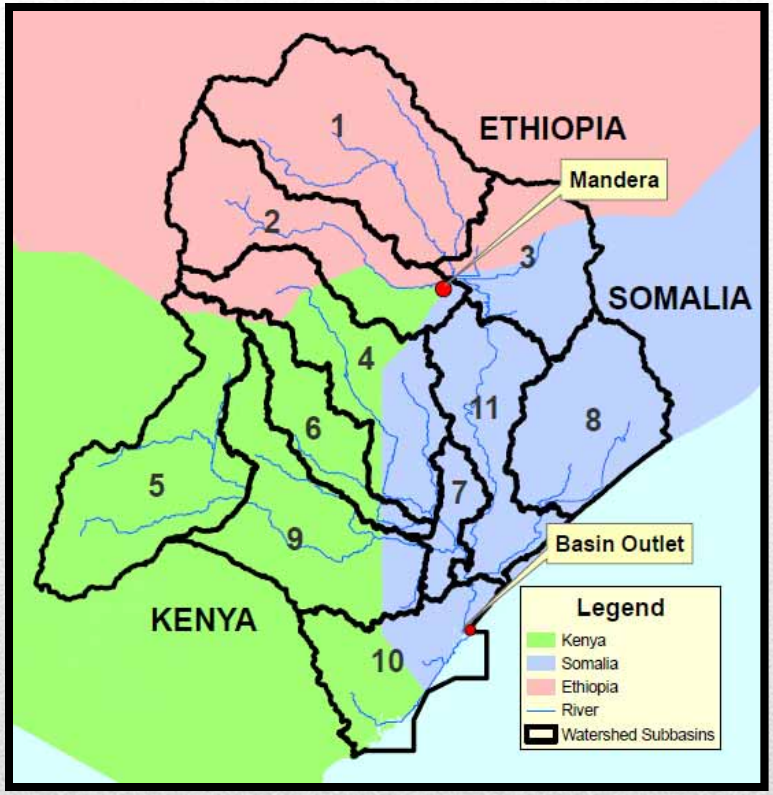
- Basic representation: **stock and flow** diagram

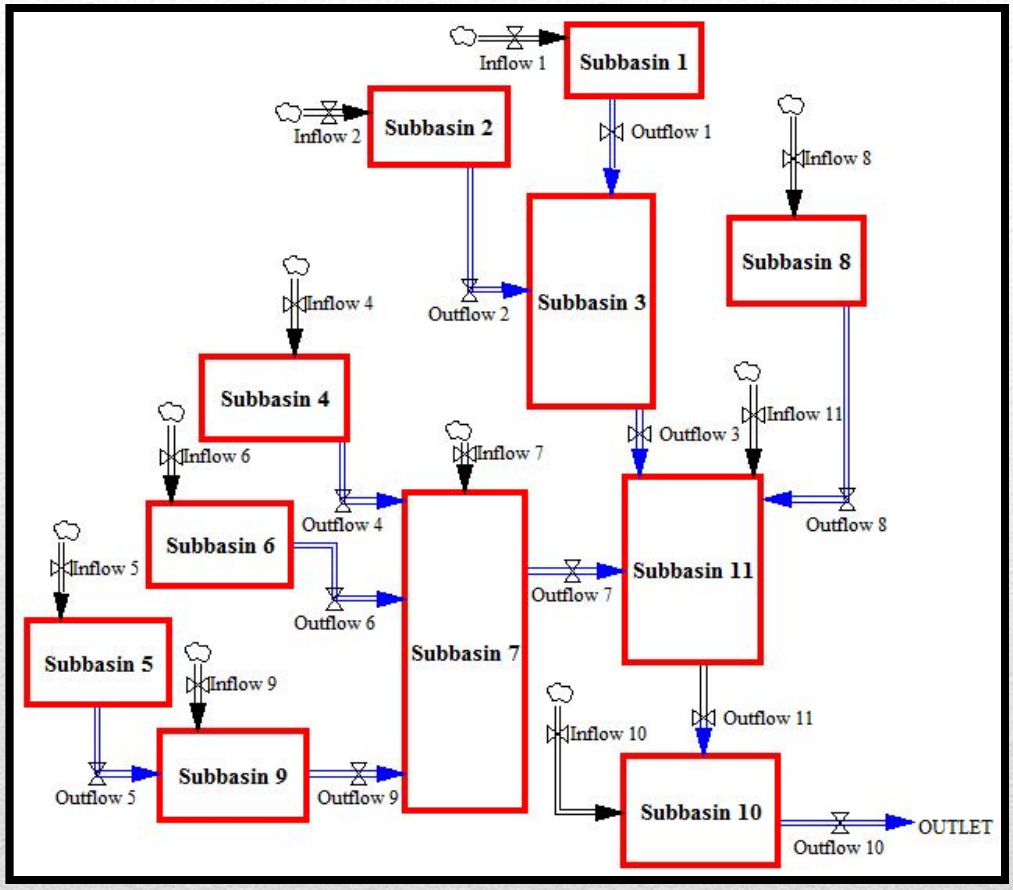






System Dynamics Modeling



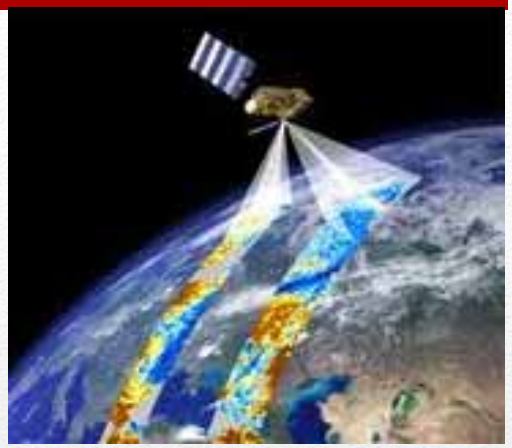


- Sub-basin Model

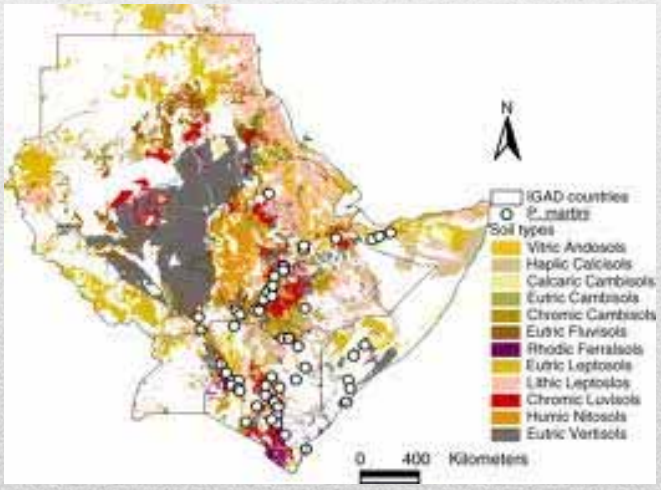
Watershed System Scope

Land availability dynamics

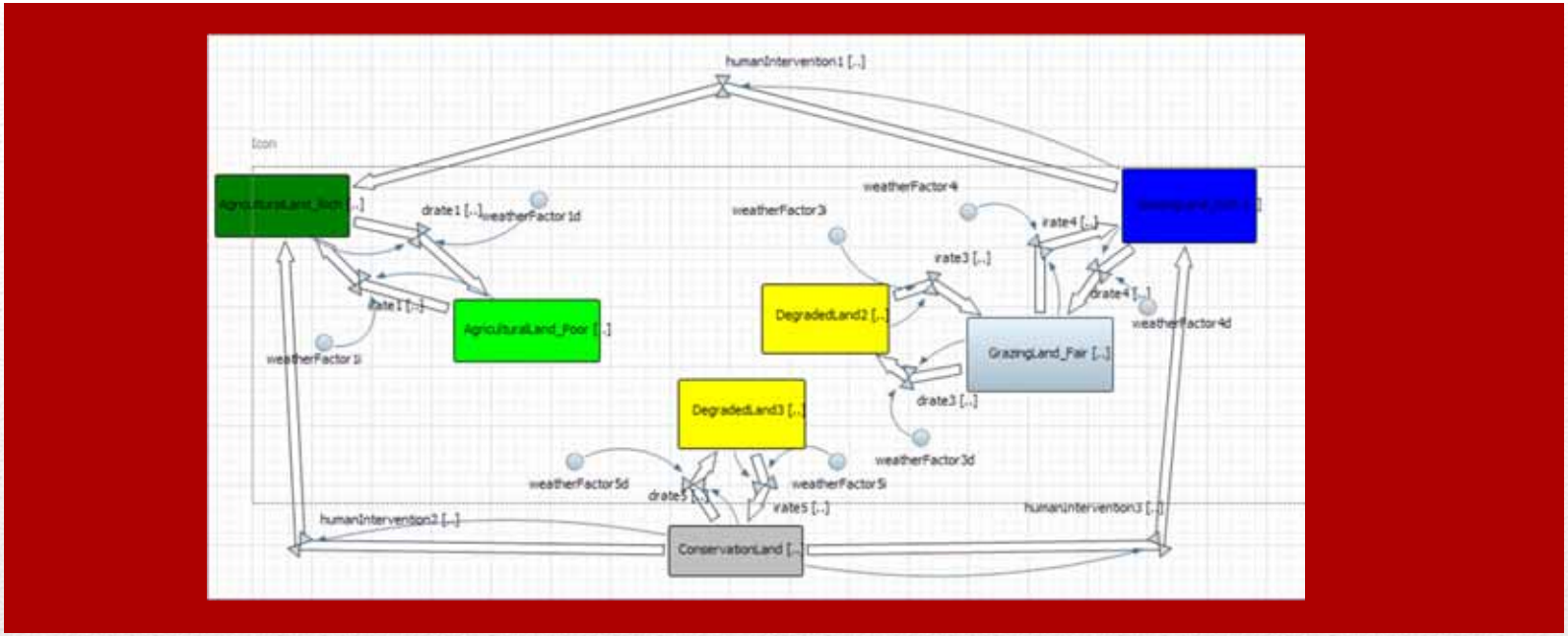
- Data: Remote Sensing (NDVI), Human Settlement, and Soil
- Four types of land:
  - Rich and Poor **Agriculture Land**
    - 25 miles of human settlements
  - Rich and Poor **Grazing Land**
    - Grazing areas for Pastoralist
  - **Degraded Land**
  - **Conservation Land**



waterresources.at



Acta Tropica Volume 90, Issue 1, March 2004, Pages 73–86



DEMO: SYSTEM TOOL

Land Change Dynamics

- Dry land agriculture

- Three types of crops:
  - Corn
  - Sorghum
  - Drybean

Maize: $Y = 6.7761+0.\ 008.5(X)$; (Hollinger and Changnon, 1993);
Dry beans: $Y = 0.389(X)-13.765$; (Padilla-Ramírez J.S. *et al*, 2003);
Sorghum: $Y = 1.27 + 0.002(X)$; (Rowhani et al 2011);

Y: yield (tons/ha), X: annual precipitation (mm)

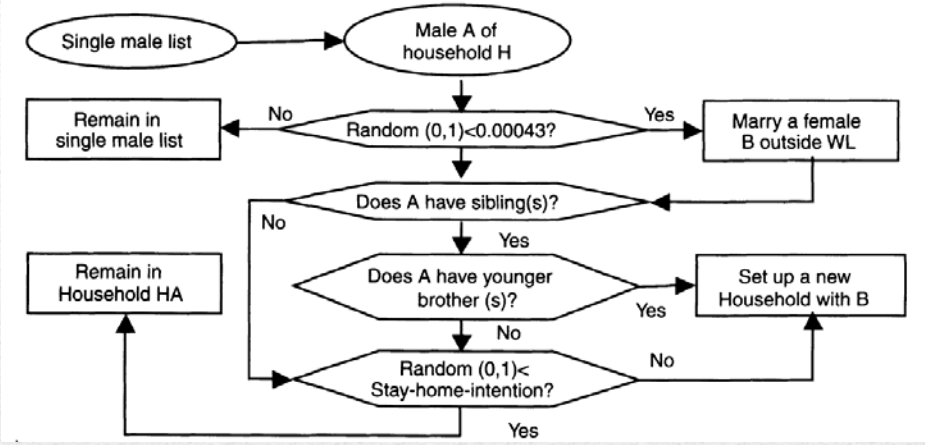
Food production dynamics

Population Dynamics

- Effects on birth and death rate
- Migration induced by drought
- Decisions are captured in a set of **decision rules**.
- Implemented in Agent-based Model

- Major issue: Influx of Internally displaced people (IDP)

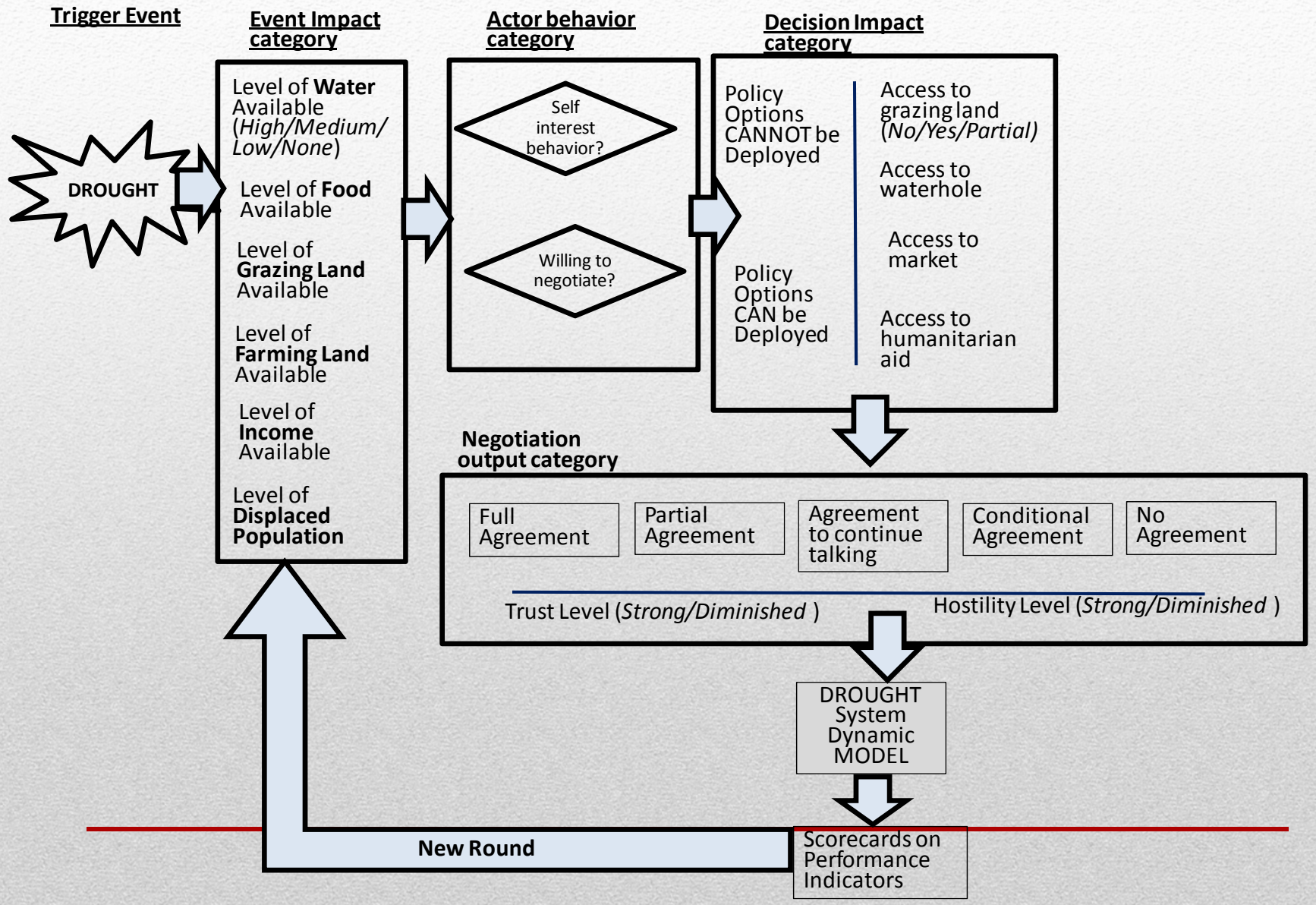
Actors' decision rules



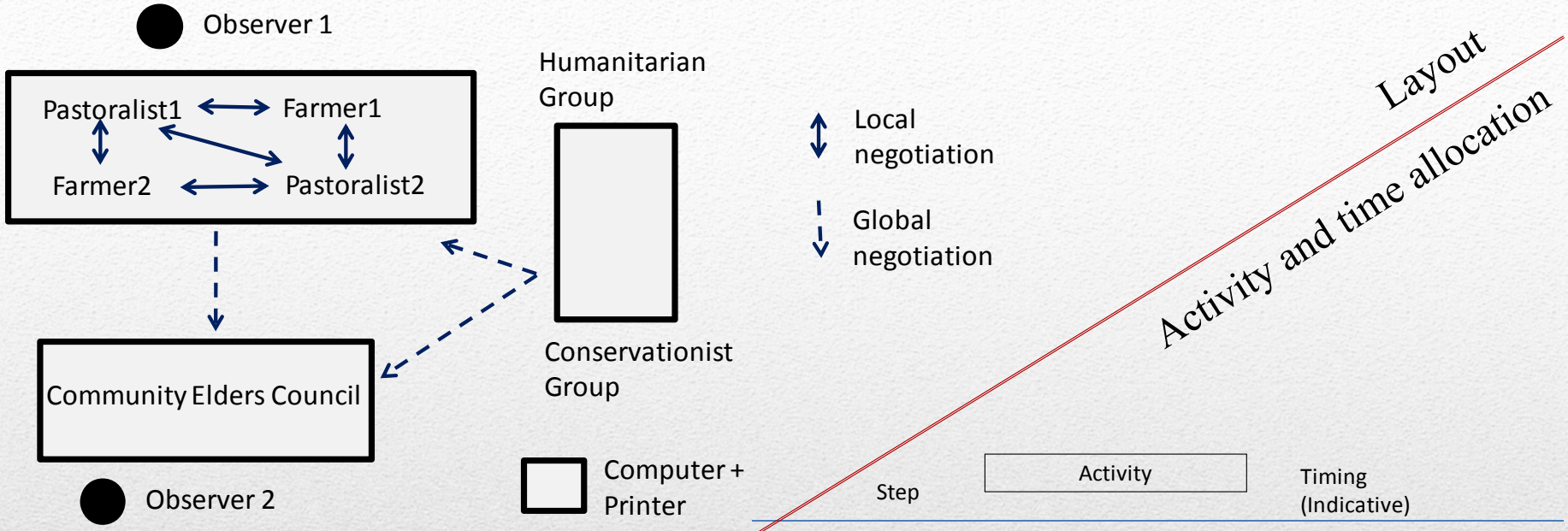
http://iheardthecry.com/

Role-playing Game-Simulation for Conflict Resolution

Role-Playing Game-Simulation Design



RPG Set-up

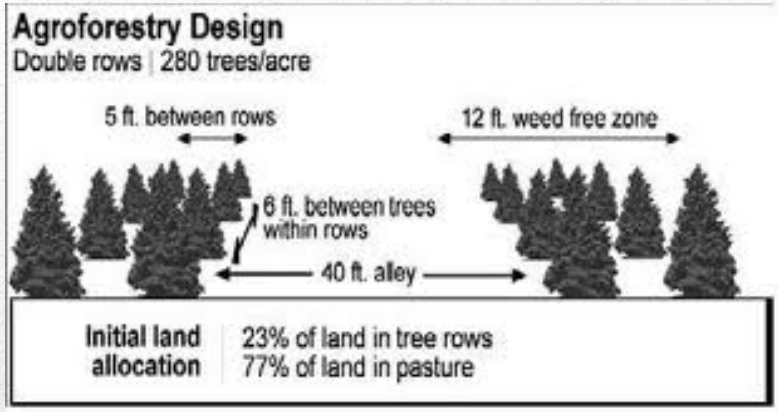


- Use African Study Class for try-out

POLICY DESCRIPTION

Agroforestry

- Combining trees and shrubs with crops and/or livestock
- Potential benefits:
  - Stabilize erosion
  - Improve water and soil quality
  - Improve crop yield by 98 %



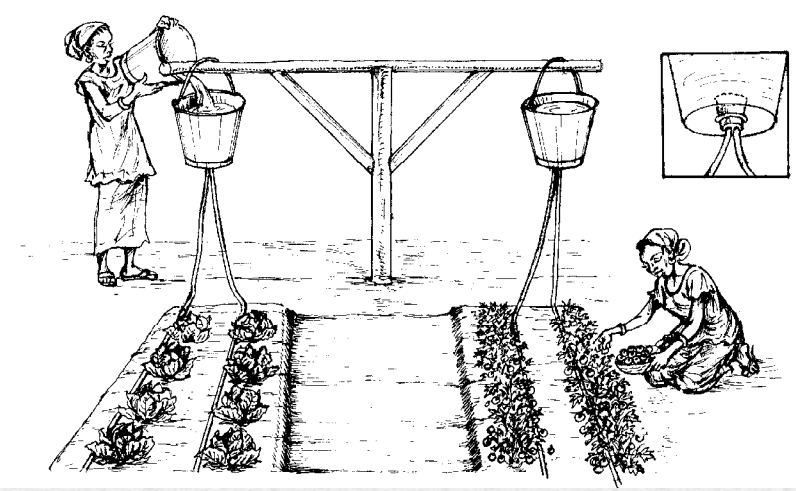
Source: smallfarms.oregonstate.edu

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

Drip Irrigation

- Drip irrigation is a unique method suitable for use as “supplementary irrigation”
- Enable farmers to grow high value crops, hence increase incomes
- The introduction of fertilizers through the drip irrigation system: **fertigation**

- Crop yield improvement up to 98%
- Water saving up to 79%



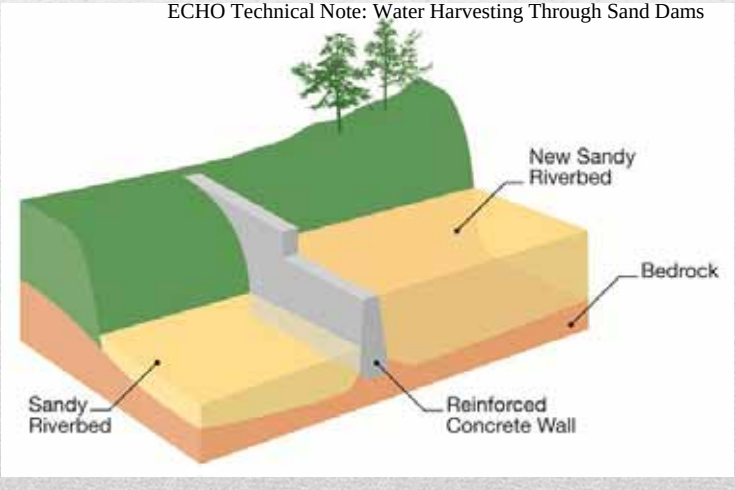
http://www.developmentart.com/alin.htm

Doubleharvest.org

Hydrological Policies (1)

- 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

Hydrological Policies (2)

- Rainwater harvesting (RWH)
  - Rooftop tanks store rainwater collected from impermeable surfaces for use at later times
  - Ponds/Pans are strategically dug to collect runoff, evaporation and siltation are key issues
- Wells
  - Hand dug wells require little technical skills and are inexpensive but can dry up during droughts
  - Deep (Boreholes) are reliable during times of drought but are costly, require high technical skills, knowledge of surrounding subsurface hydrology, and encourage settlement

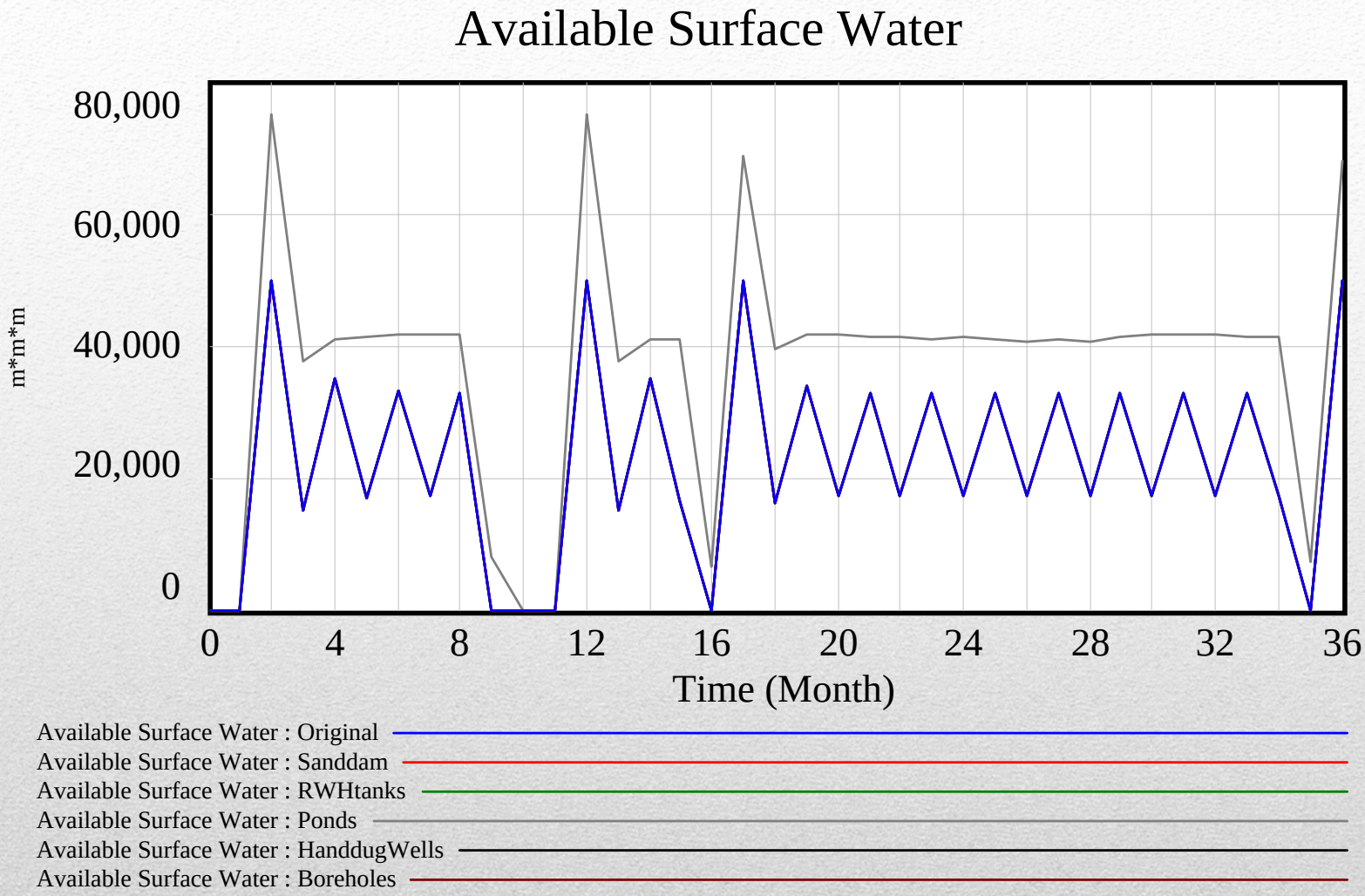
Worldagroforestry.org

Pond

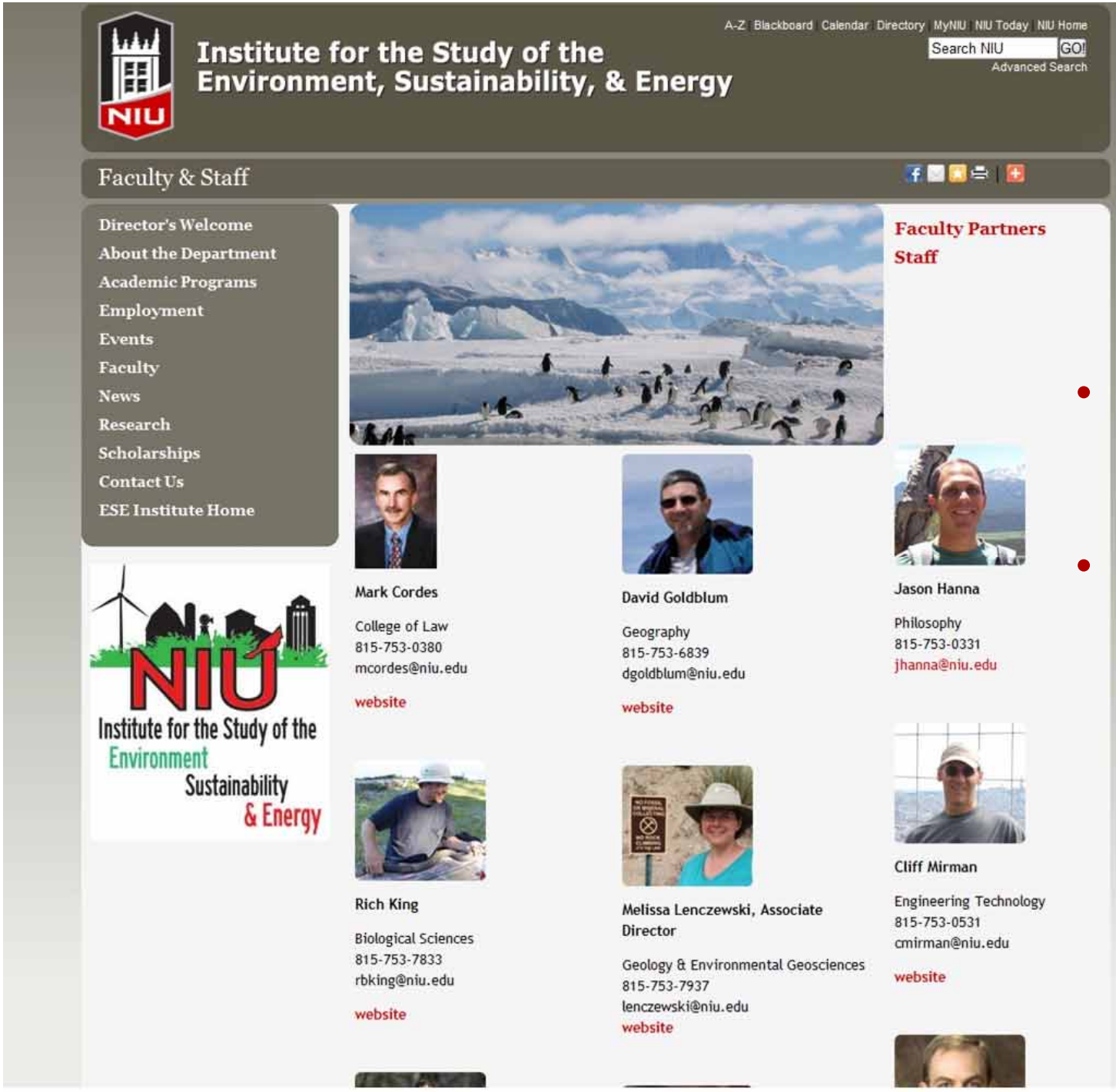
FAOSWALIM.org

Borehole

Unicef.org



Policy Evaluation Tool



- >15 faculty from 13 different departments
- A broad range of global and regional research activities and expertise

NIU Environmental Studies

- Biodiversity & Environmental Restoration
- Energy Studies
- Human Experience
- Environmental Policy
- Non-Governmental Organizations
- Water Studies

Samantha Melton (ENVS student) conducting stream monitoring for the Illinois EPA and presenting her research on snake reproductive ecology and conservation

Thank You!

Source: africa.theworldatlas.net

Lessons Learned?

www.merriam-webster.com