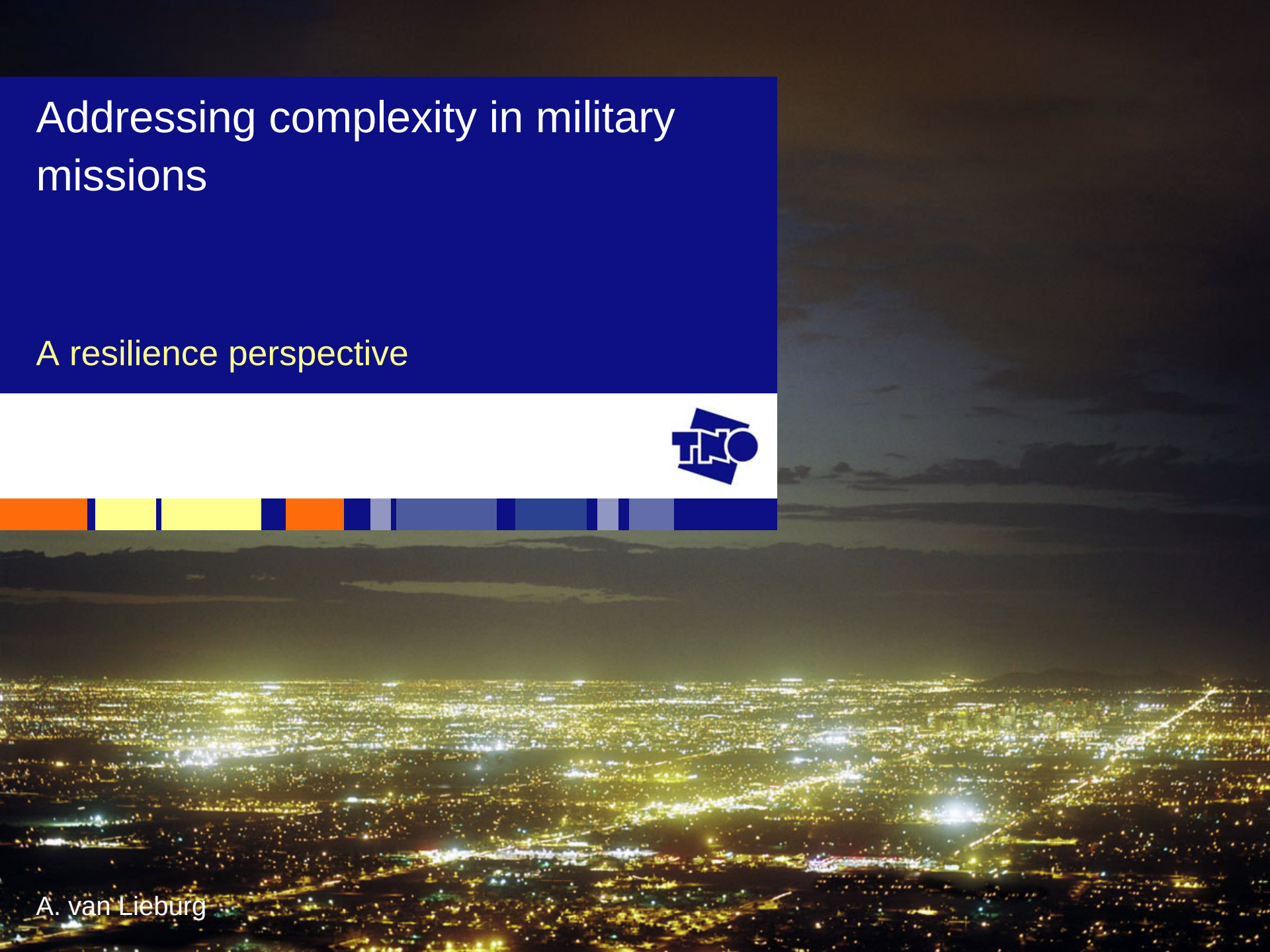
Addressing complexity in military missions

A resilience perspective



A. van Lieburg

Agenda

- Introduction
  - Background and aim
  - Complex adaptive systems
  - Resilience as perspective
- Assessing resilience
  - A methodological approach
  - Afghanistan as case study
- Role of Modeling and Simulation
  - Agent based models
  - Some examples
- Concluding remarks

Introduction

- Military (and humanitarian) mission are confronted with an increasing complexity
- Dealing with complexity is hard because these are large, open and often very dynamic
- Many sources of complexity
  - Defense organisation as a complex system and an increasing involvement of non-military actors, ngo, etc.
  - the shift towards a population oriented approach
- In this study we focus on the latter

Complex adaptive systems

Theme is the understanding of complex adaptive systems

Complex: many interacting actors, non-linear dynamics

Adaptive: system evolves and has emergent properties

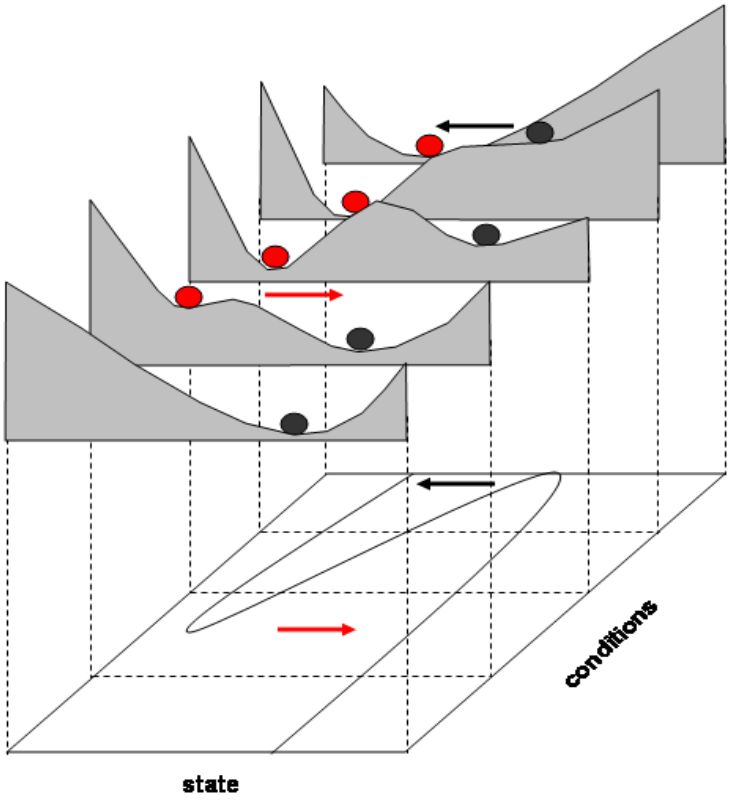
Difficulty in predicting and controlling the behavior of these systems

This study

- How to support an improved understanding of these systems from a military perspective
- Approach
  - Adopt and develop methodologies to study complex systems
  - Develop tooling, in particular we looked at the role of agent based modeling and simulation

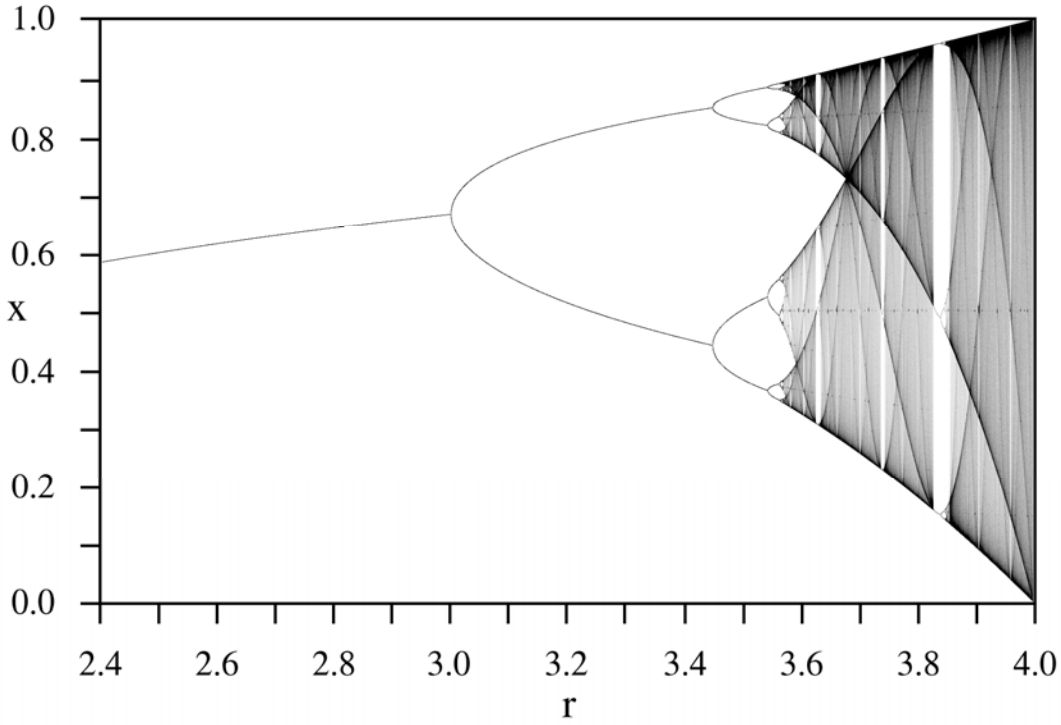
Resilience and the dynamics of complex systems

- Resilience: Ability of a complex system to recover from shocks and disturbances
  - Interesting from a transformation perspective – undermining the resilience of a system
  - Interesting from a conservational point of view – maintain desired configurations of a system

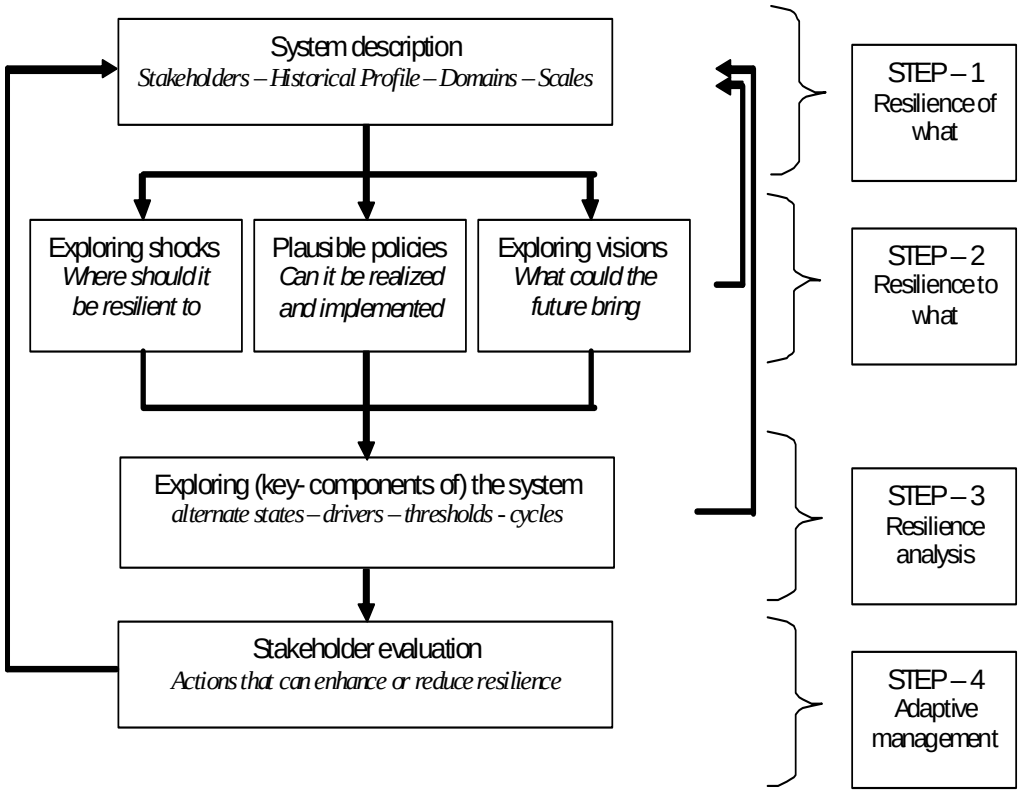


Passing beyond thresholds

- The dynamics of of complex system may change sudden when passing critical thresholds
- Major source of non-linearity in these systems which contribute to it's unpredictability



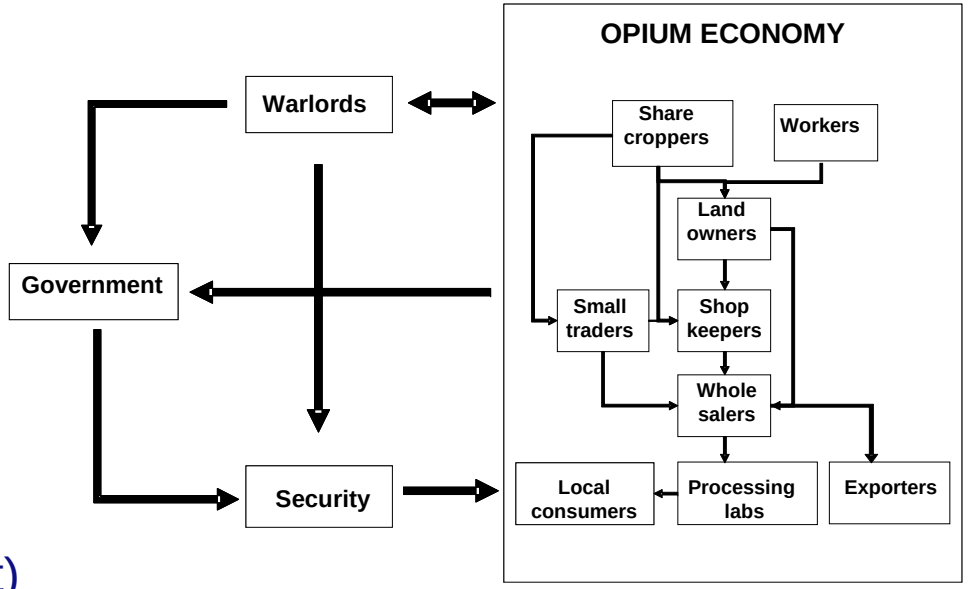
Assessing resilience



- Understand where the system is right now
- Understand where we want the system to move to
- Explore what drives the system
- Identify actions
- …and go back to the first step to re-asses your understanding

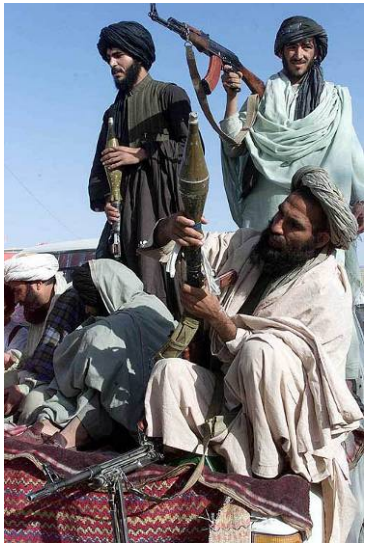
Key aspects of our exploration

- Used Afghanistan as example of military relevant complex system
- The observation and description the system
- The analysis of thresholds and transitions
- Some preliminiary views on adaptive management
- The development of some (agent) models to support above steps and evaluate the use of these models.



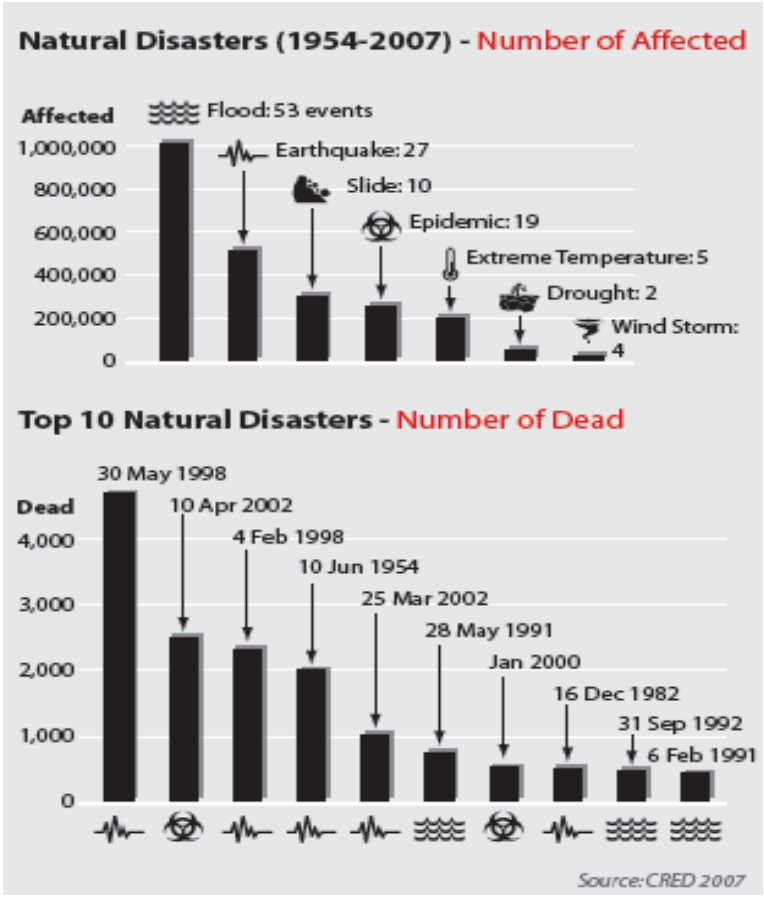
Step-1: Observing and describing the current system

- Bounding the system - scales
  - Spatial scales = Villages - Baluchi Valley - Uruzghan – Nation
  - Social scales = household – community – population
  - Temporal scales = seasonal nature (farming subsidence)
- Identifying key actors
  - warlords, government, land owner and poor farmers, traders, insurgents
- Identifying key drivers
  - debt, power, public opinion and attitude
- Historical profile
  - Characterized by several wars, tribal conflict and climate extremes

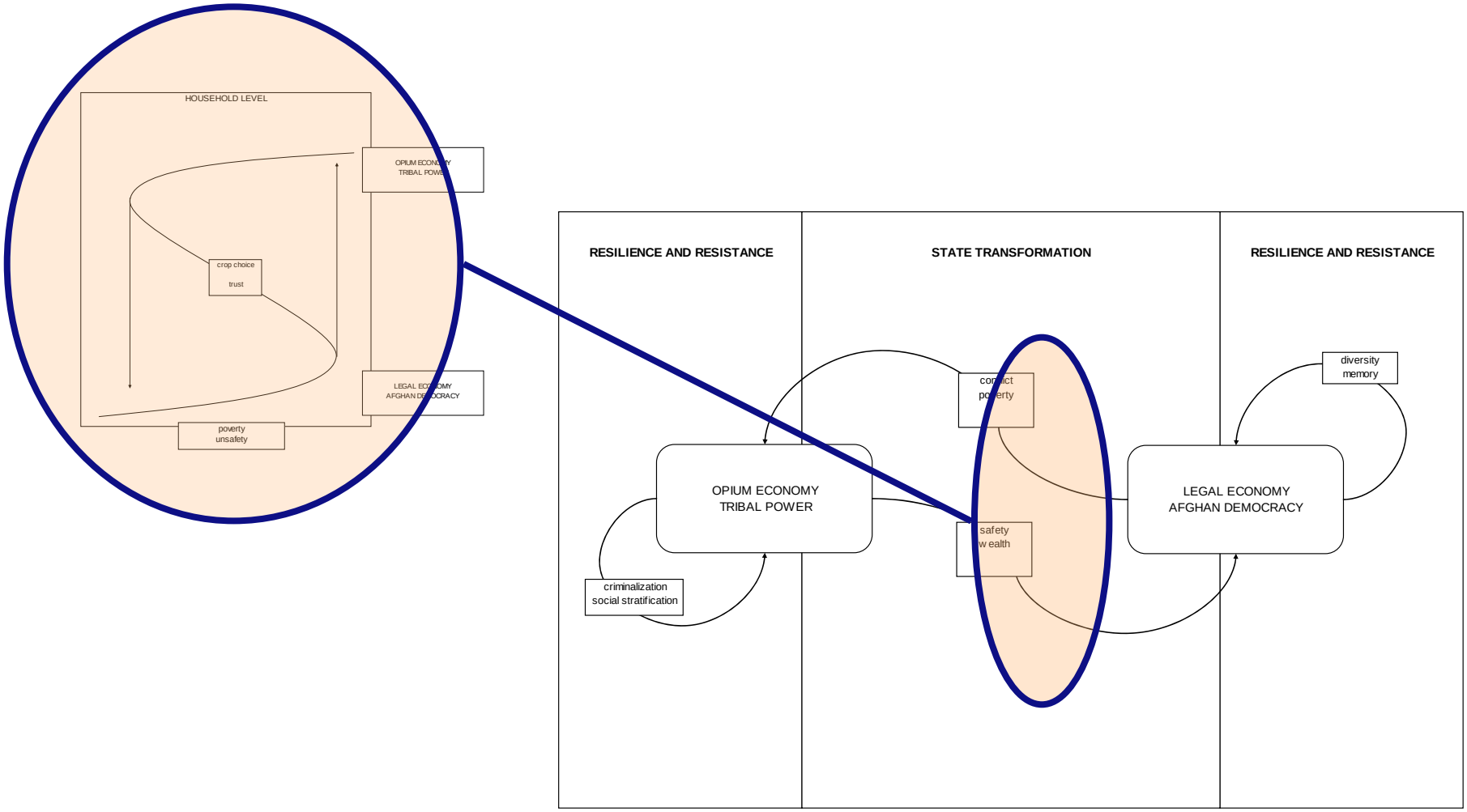


Step-2: Exploring the future

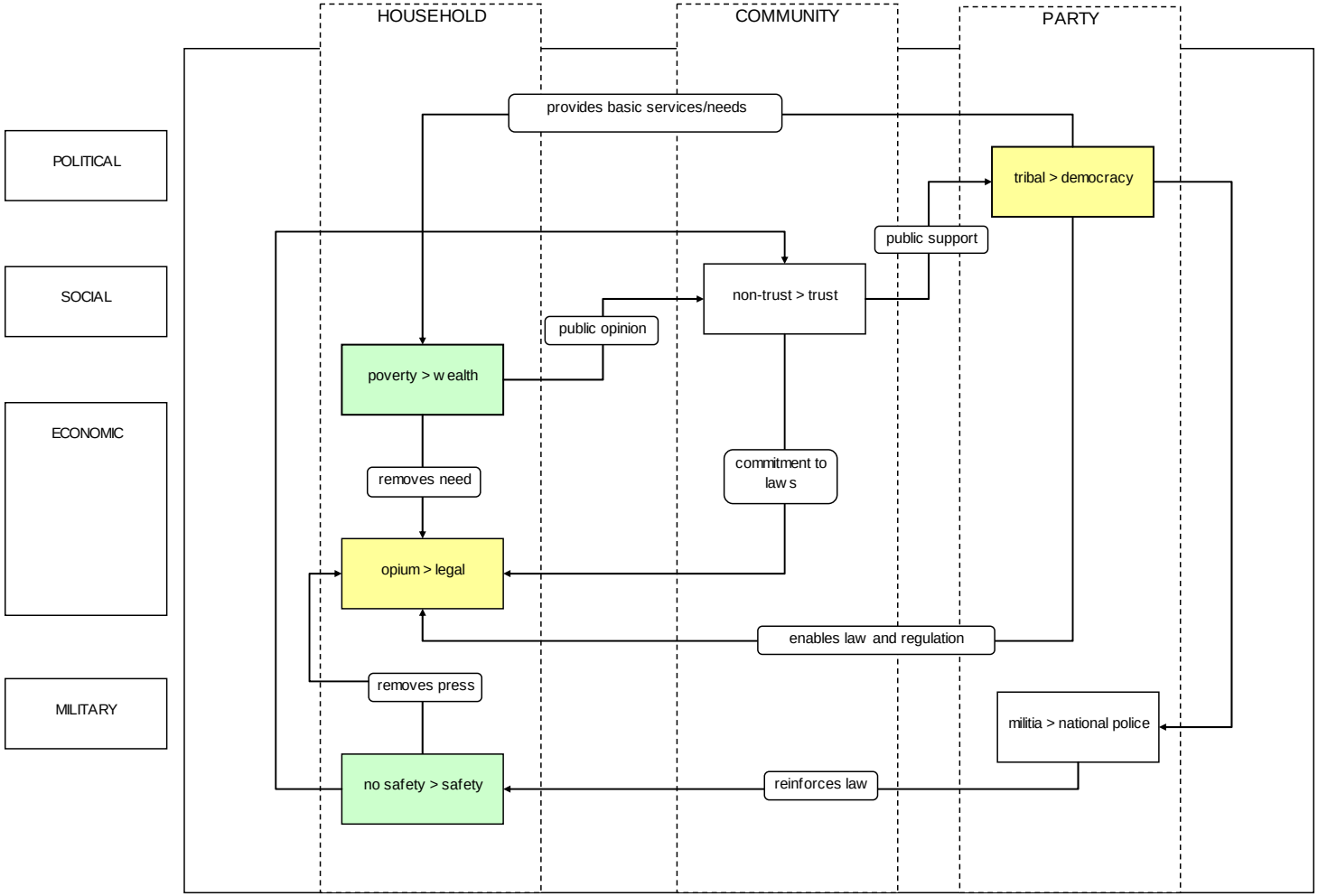
- Resilient to what - (identify and characterize shocks and disturbances)
- Plausible future configurations (develop scenarios)



Step-3: Thresholds and transitions

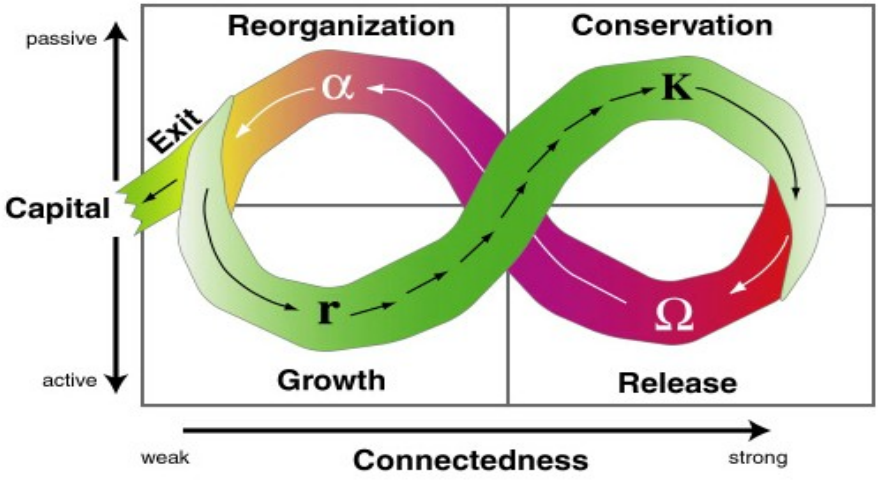


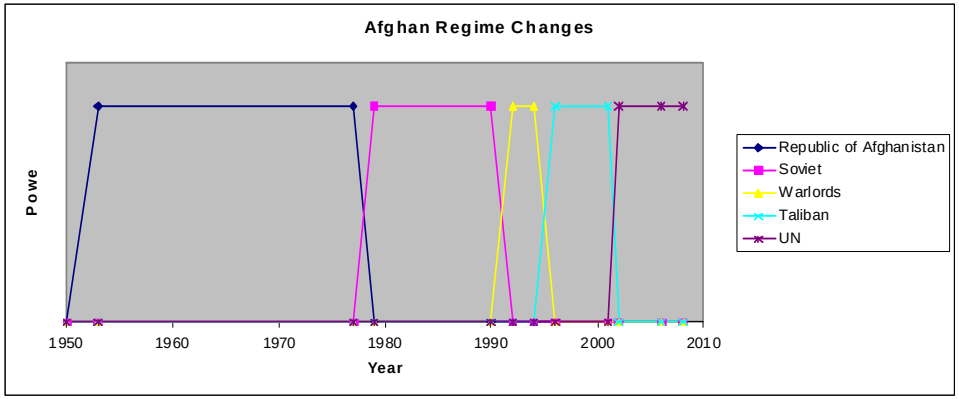
Step-3: *Cross-scale interactions*



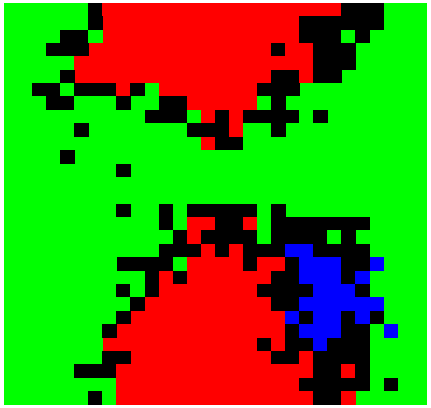
Step-4: Adaptive management

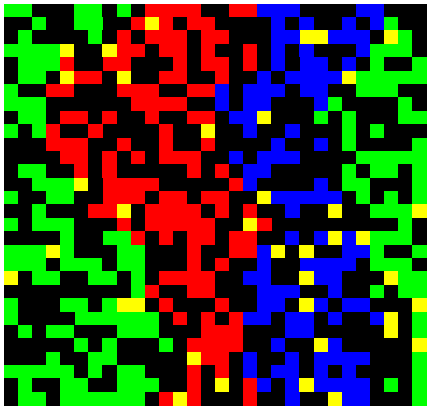
- Thresholds are the main target for actions
- Identification of (adaptive) cycles
- Resilience enhancing and/or reducing actions like those affecting response diversity and social memory.
- Search for windows of opportunity – i.e. benefit from cycles in the dynamics of system.





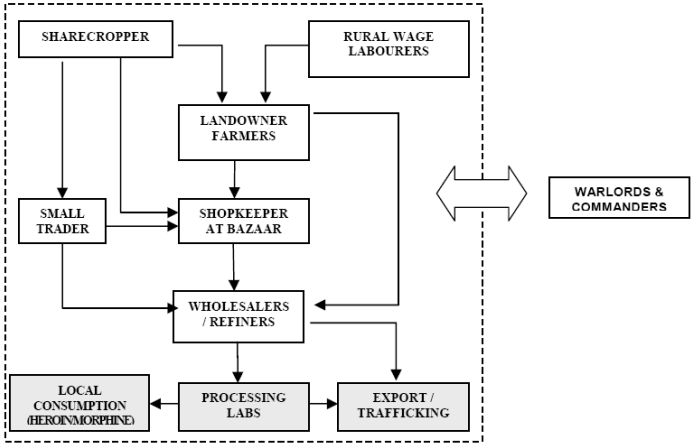
Role of modelling and simulation: agent based approaches

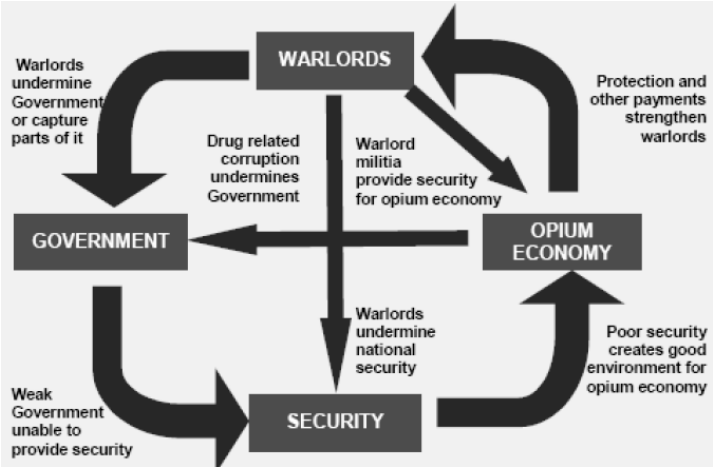




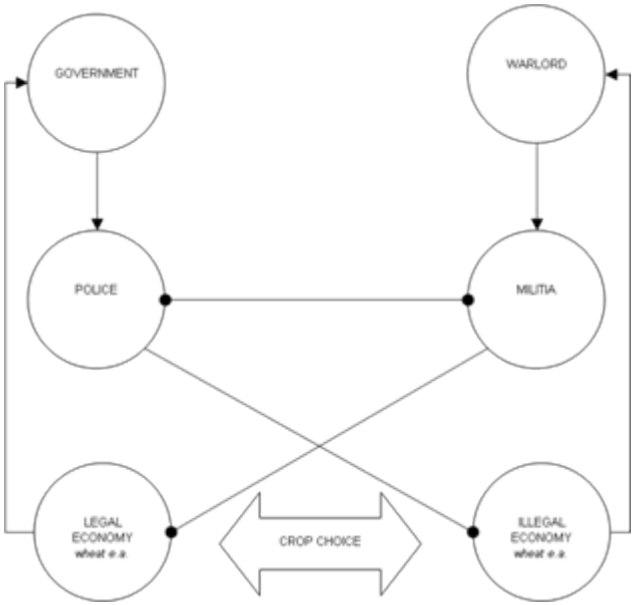
- Why agents
  - allow to express ideas about adaptation and emergence
  - Aligns well with many concepts of complexity
- Usage:
  - “Capturing” the knowledge about the dynamics of the system.
  - Develop general understanding of the impact (importance) of the different variables and parameters.
  - Better understanding of complex dynamics of these system (non-linearity, adaptation, spatial effects)

Model overview

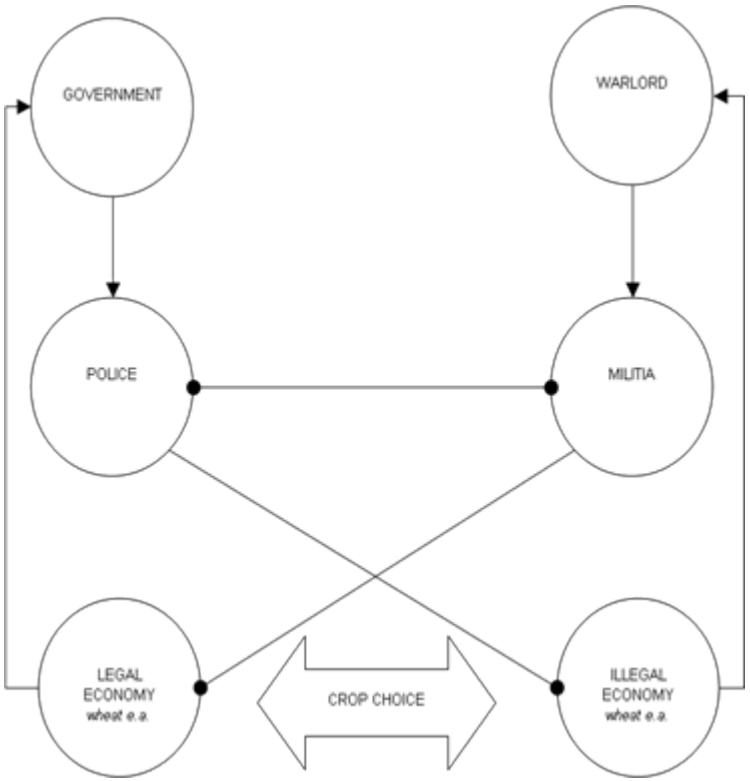




- Constructed an agent model to explore concepts of transformation and resilience
- Simple model of the afghan opium supply chain and warlord influence

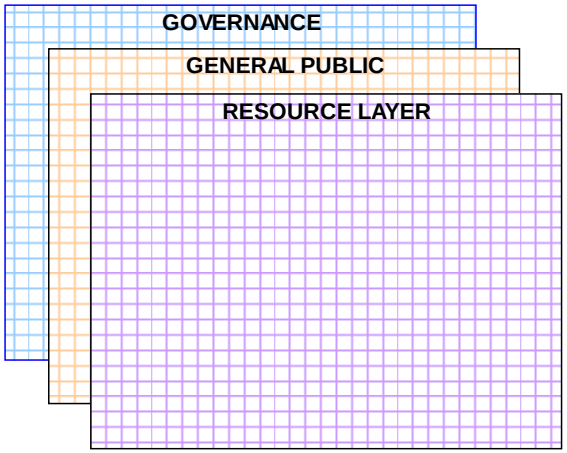


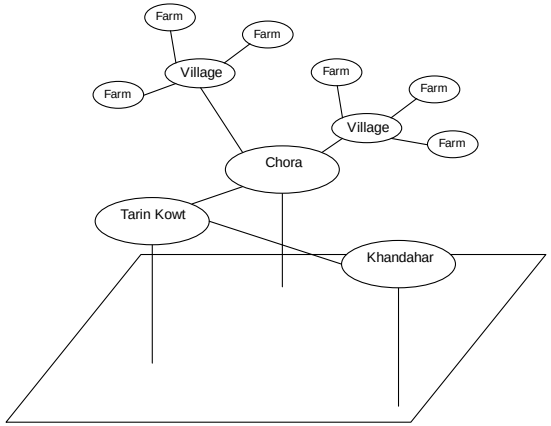
Model outline



- Segregation (Schellingen) – agent have a preference for areas with agents like them
- Rebellion (Epstein) -agent's combine hardship, legitimacy and retaliation risk into their decision to rebel or not
- Power – depending on their strength, rebellions may take over the current regime by capturing "political space".
- Hardship – agents may perceive economic hardship by their gains (or losses) in wealth. Wealth can be gained from collecting resources.

Model implementation

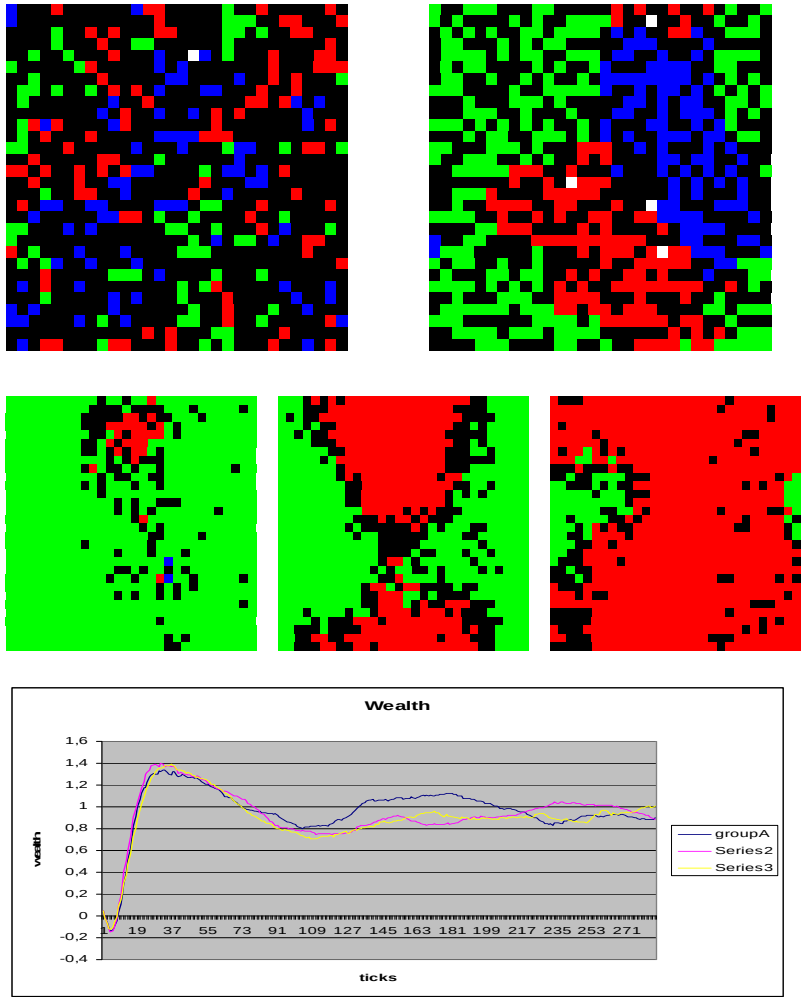




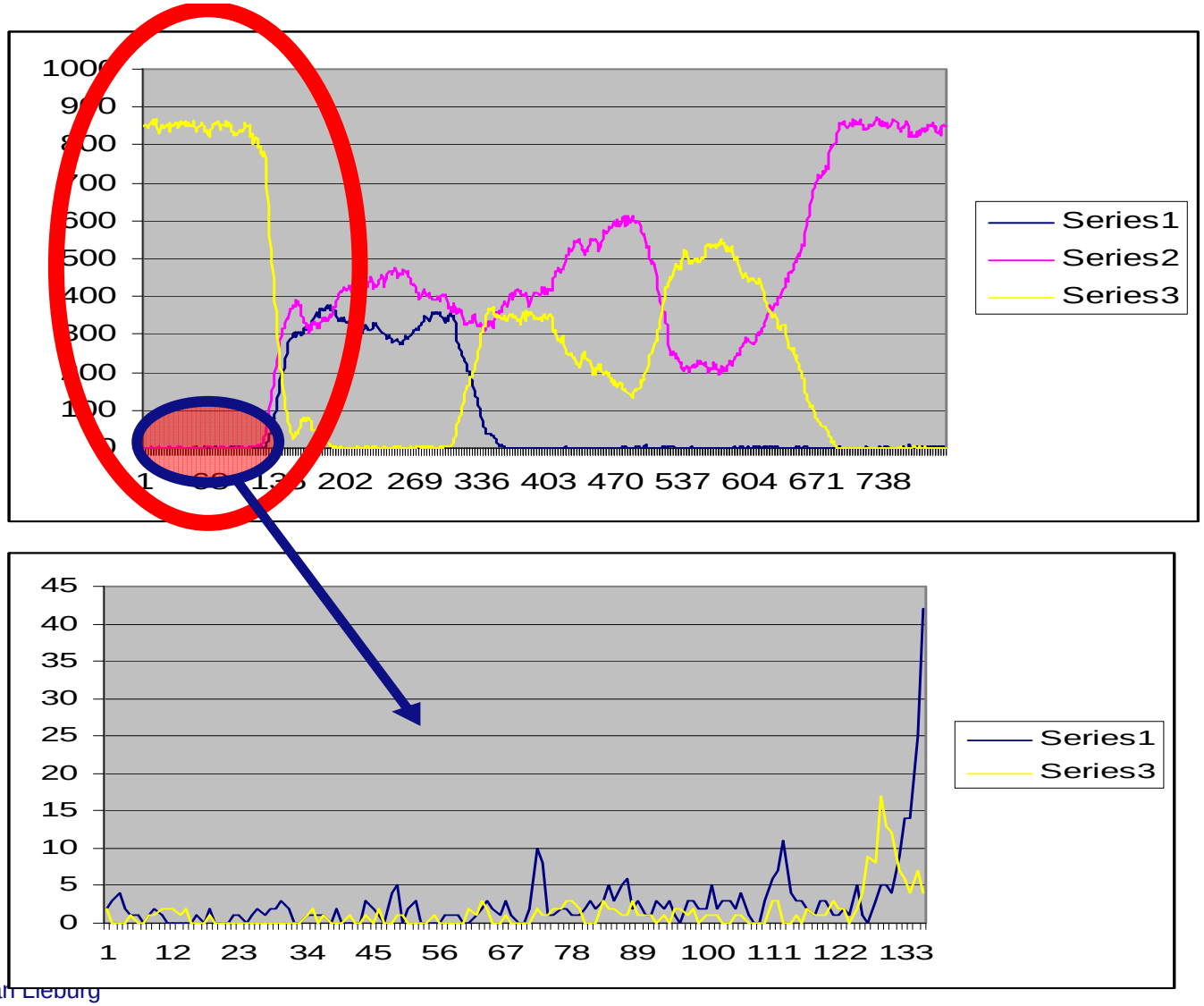
- Entities in the model (general public and governmental) are represented as agents
- Cellular automaton approach – three layered structure (resource, general public and power layers)
- Resource layer provides income to the public
- Public collect resources and may rebel against (and take over) the government
- Governmental entities compete for dominance and may assert control over the public and resources

Model dynamics

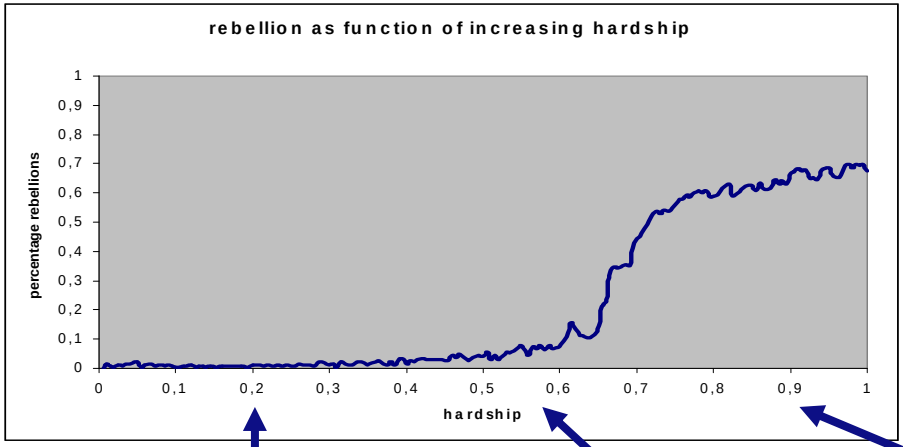
- Region with three distinct groups. These groups differ regarding political and cultural characteristics.
- These differences determine the legitimacy for a candidate ruler for each group. If a group with little legitimacy tries to gain power others may respond with rebellion and eventually a take over.
- Besides these power aspects, members of each group take part in a economic system in which they consume resources.

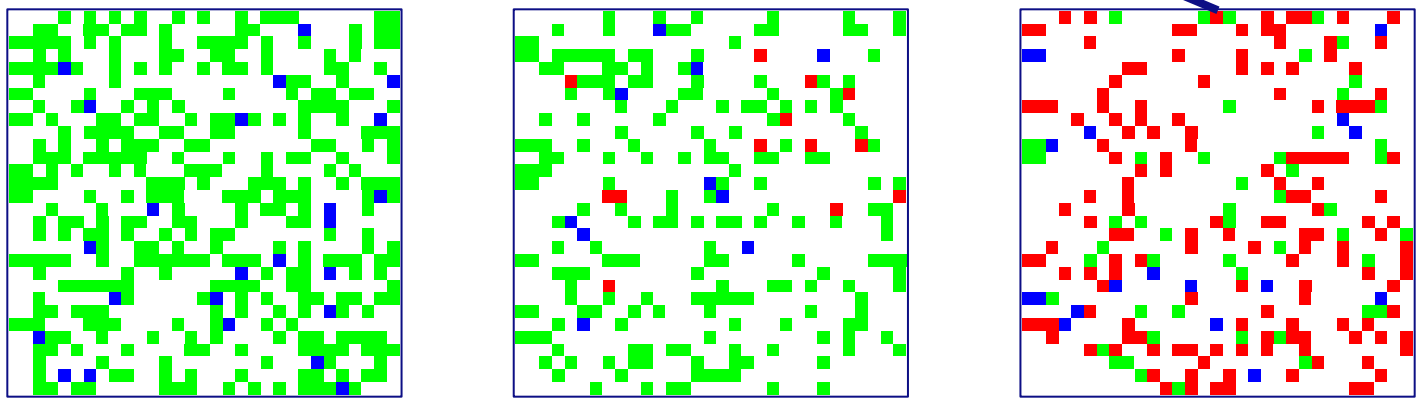


Simulation – regime changes



Simulation - exploring threshold dynamics

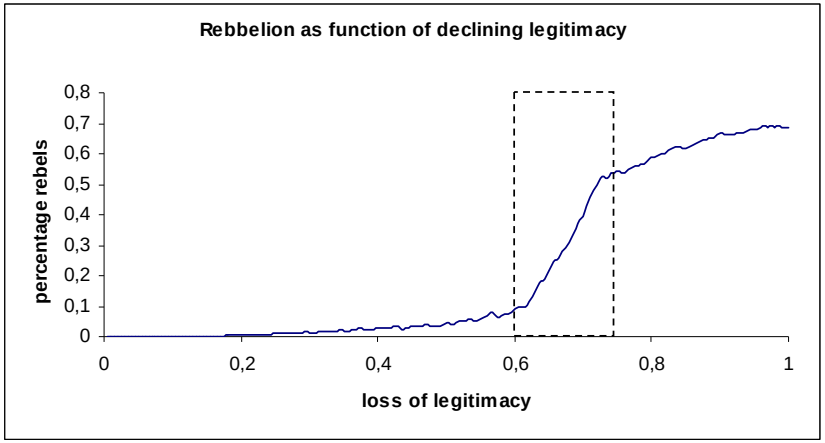


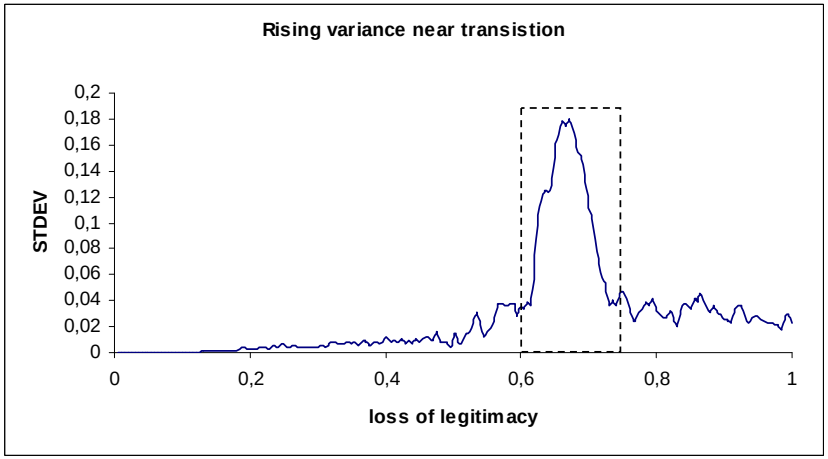


- Increasing hardship (or decreasing legitimacy) may cause local outbreaks of rebellion which eventually become widespread and persistent

Near threshold phenomena

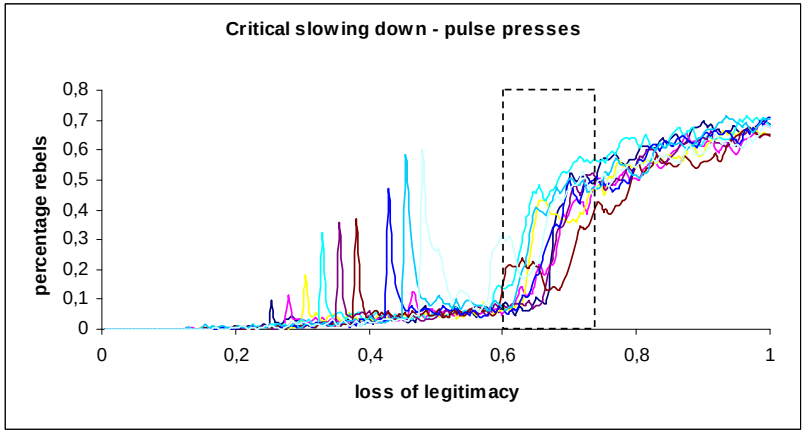
- Rising variance as indicator for sudden change
- Dynamics of the system becomes more volatile near thresholds
- *But, not generic*

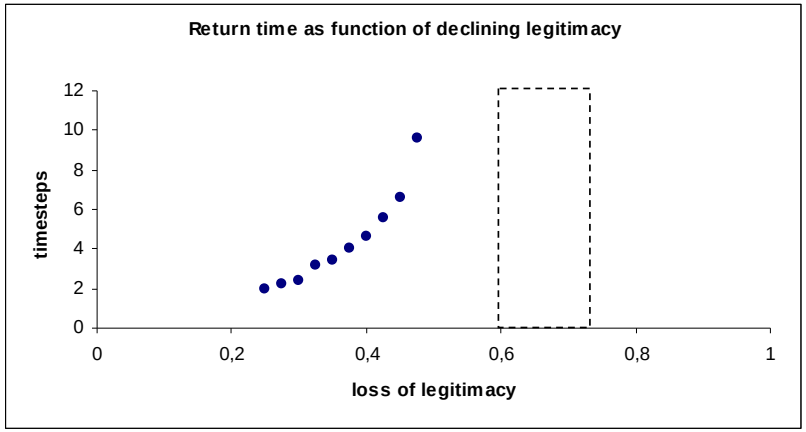




Near threshold phenomena

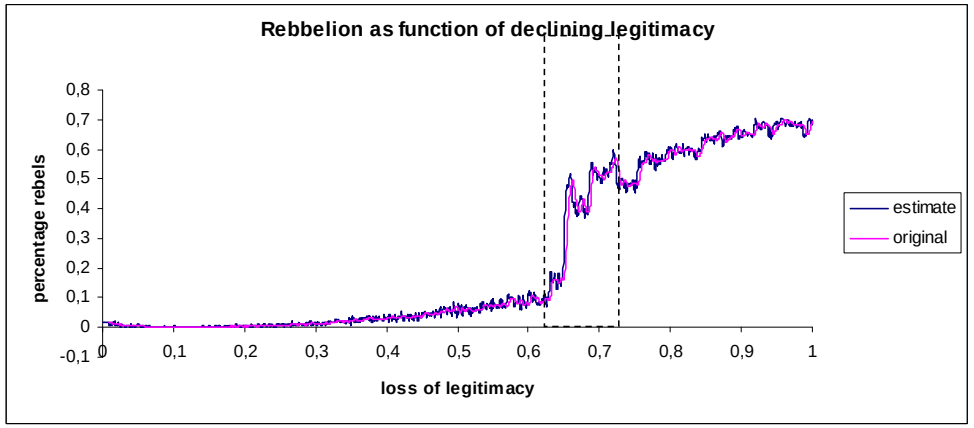
- Critical slowing down near threshold as measure for declining resilience
- Basic idea is that the “return time” of a systems increases when approaching a transition.
- *Drawback is the need for intervention and fine grained data*

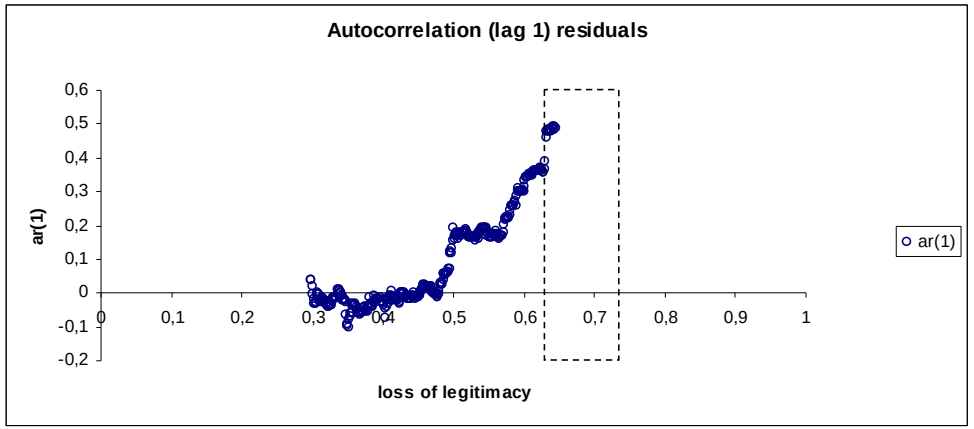




A first step towards the real world - autocorrelation

- Measuring critical slowing down requires active intervention
- Using autocorrelation one can circumvent this requirement





Discussion

- Thresholds are important
  - For understanding system dynamics
  - As candidates for intervention
- Recognizing them is challenging
  - Thresholds themselves often complex and entangled across scales and domains
  - Precise measurement challenging, if not impossible
- Rising variance and critical slowing down are potential indicators
  - Do not exactly tell “when” or “what”
  - But, at least indicate “that” something “large” is going to happen.
- Models useful for in-silico experimentation and may provide clues for the next steps – collecting and looking at the real data

Questions