Modelling Coupled Human-Natural Systems in Banni Grassland, India using Participatory System Dynamics

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Background
- Banni grassland: 2500 sq. km in Kachchh, Gujarat
- Low rainfall (Avg. 340 mm)
- Once Asia’s largest tropical grassland
- Traditionally, home to several semi-nomadic pastoral communities, Malharis.
- Grassland productivity reduced significantly since 1960s due to invasion by Prosopis juliflora (PJ) planted to stop Rann ingression.
- PJ today > 50% of Banni’s vegetation cover
- Pastoralist economy affected by shrinking grassland but alternate livelihoods now possible (sale of wood, charcoal, etc.)
- Many other changes: a) continued ambiguity since independence about ownership of land; b) the filing for Forest Rights to the Banni by resident pastoralists under the Forest Rights Act of 2006; and c) recent increased integration with the market.

Objective
- To make an ‘insight-building’ decision support system (DSS);
- To facilitate its use by Banni’s stakeholders (local communities, forest & revenue departments)
- To test outcomes of policy options in Banni under different scenarios (Grassland Restoration, Community Forest Rights, Climate Change)

Methodology
- Participatory System Dynamics: Eliciting information, trends, stories, model structures, and mental models using Systems Thinking Tools and simulation modelling in workshops with researchers & Malharis
- Malharis: 2 workshops (One with youth, One with elders) using adapted Ice Berg Tree Model
- Researchers: 3 workshops- (Ice Berg, Stock-Flow Mapping, Causal Loop Diagrams(CL): Simulation)

Workshop outputs
- Synthesis
  - A higher-order CLD emerged from the models made with the research team and communities.
  - Reinforcing loops that are responsible for continued growth of Banni’s economy and livestock are currently dominant
  - Balancing loops maintaining herd size currently dormant.
  - Purple Loops: Indirect Balancing Loops which are dormant
  - Blue lines: impact of external interventions, supporting the reinforcing processes and growth of the economy.
  - Other forms of income: charcoal and wood from PJ biomass, tourism, etc.) aiding livestock economy.
  - Aspirations also changing with changes in livelihoods.
  - Rainfall variability due to climate change may become increasingly important

Simulation Model
- CLD Converted to Simulation Model for 2010-2050: 4 Modules-Land-PJ Biomass, Grassland Biomass, Livestock, Economics
- Land-PJ Biomass Module Depicted:
  - Area Dynamics: 2 Stock System, Conversion of Grassland to PJ through Livestock-Enhanced PJ spread, Conversion back to Grassland through PJ Uprooting,

Some Results & Ongoing Work
- Current runs of Land-PJ Biomass Module Show:
  - Reference Scenario: PJ area increases by ~30% between 2010 and 2050, grassland area falls accordingly. PJ growth shows increase & saturation.
  - Grassland Restoration Scenario: 30% annual rate of biomass removal of all stages of PJ (2020 onward) -> ~90% reduction in PJ area by 2050.
  - Biophysical parameters from related study comprising PJ- uprooting, PJ-lopping, and PJ control treatments to understand rates of regeneration of PJ, regrowth of lopped PJ & estimate standing biomass & productivity.
  - Socio-economic and governance shifts in Banni captured through qualitative models are being integrated with biophysical model using ‘Switches’ for ‘What-If’ conditions.
  - A user-friendly interface for the model is now being developed in the form of an interactive App for users to explore potential scenarios.
  - Workshops planned with Banni stakeholders (Malharis, Forest Deptt) and researchers using the App, for policy testing and completing the ‘loop’.

References

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