

Modeling Sustainability Scenarios of Renewable Natural Resources and Economic Growth

Mihir Mathur & Kabir Sharma

2nd Asia Pacific System Dynamics
Conference, 21st FEB 2017

NUS, Singapore

Introduction and Rationale



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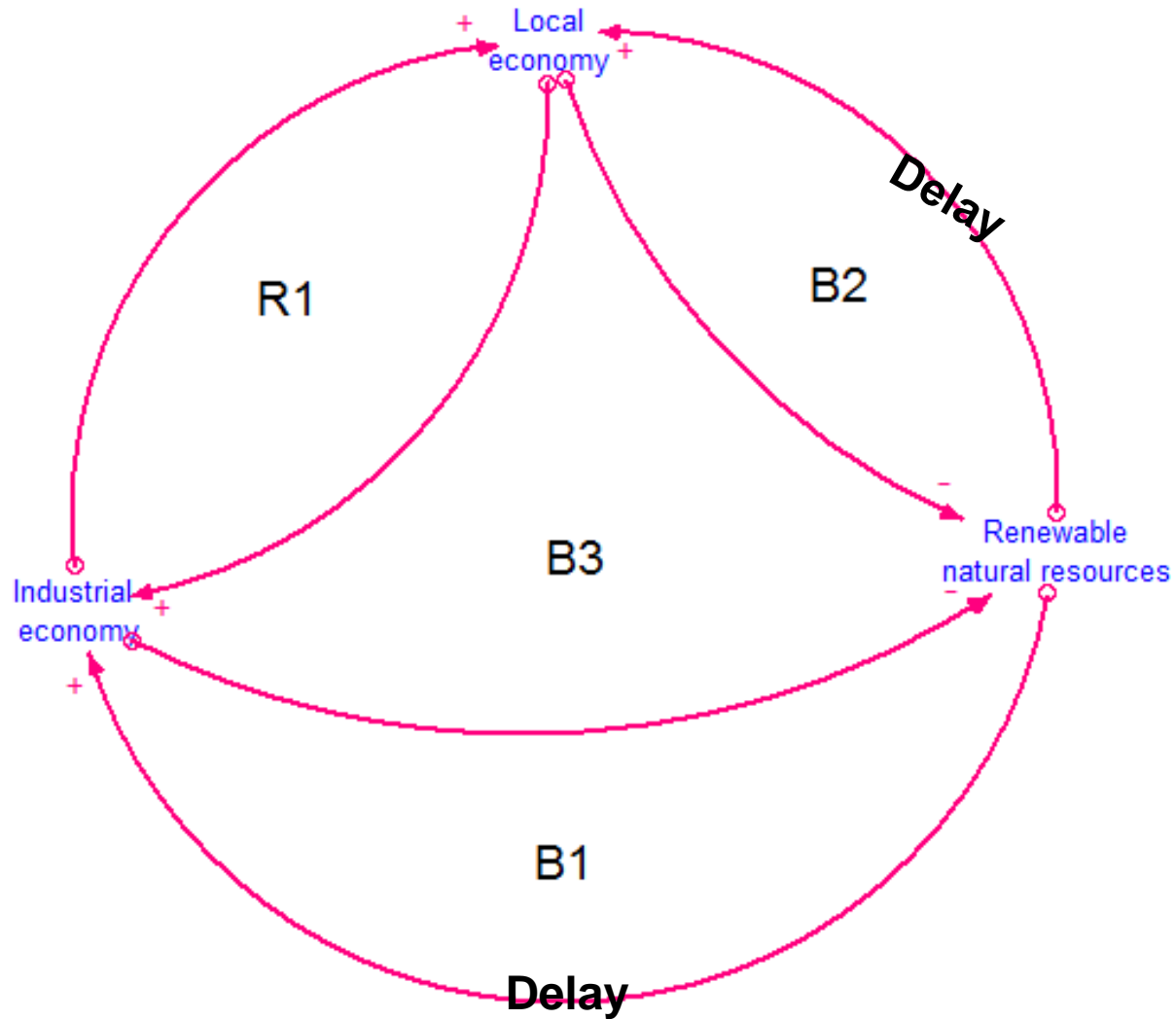
- Economic Growth has come at the cost of Environment Degradation
- Pressure on Renewable Natural Resources because rate of consumption is often above regeneration
- Potential of Irreversible loss of Ecological Diversity and Resources
- Threat to sustenance of humankind and economy
- What policies are most effective to achieve a balance between resources and economy?

- A theoretical model of the relationship between RNR, local economy and industrial economy
- The model tests the impact of three policy interventions
 - 1) **Resource efficiency**
 - 2) **Resource efficiency and green growth**
 - 3) **Localization of economies**
- System Dynamics Modeling

Dynamic Hypothesis



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The model consists of three sectors,

1) Industrial economy

It represents industrialized form of production of goods. Its growth rate follows a bell-shaped curve over the simulation time

2) Local economy

The local economy is conceptualized as a smaller, traditional economy and are assumed to be inherently slower in growth due to their dependence on local forms of livelihood

3) Renewable Natural resources

The renewable natural resource stock is taken as a reservoir of open access renewable resources (eg. forests, groundwater, fisheries etc.). It has a tipping point (assumed 25% of Initial Stock)

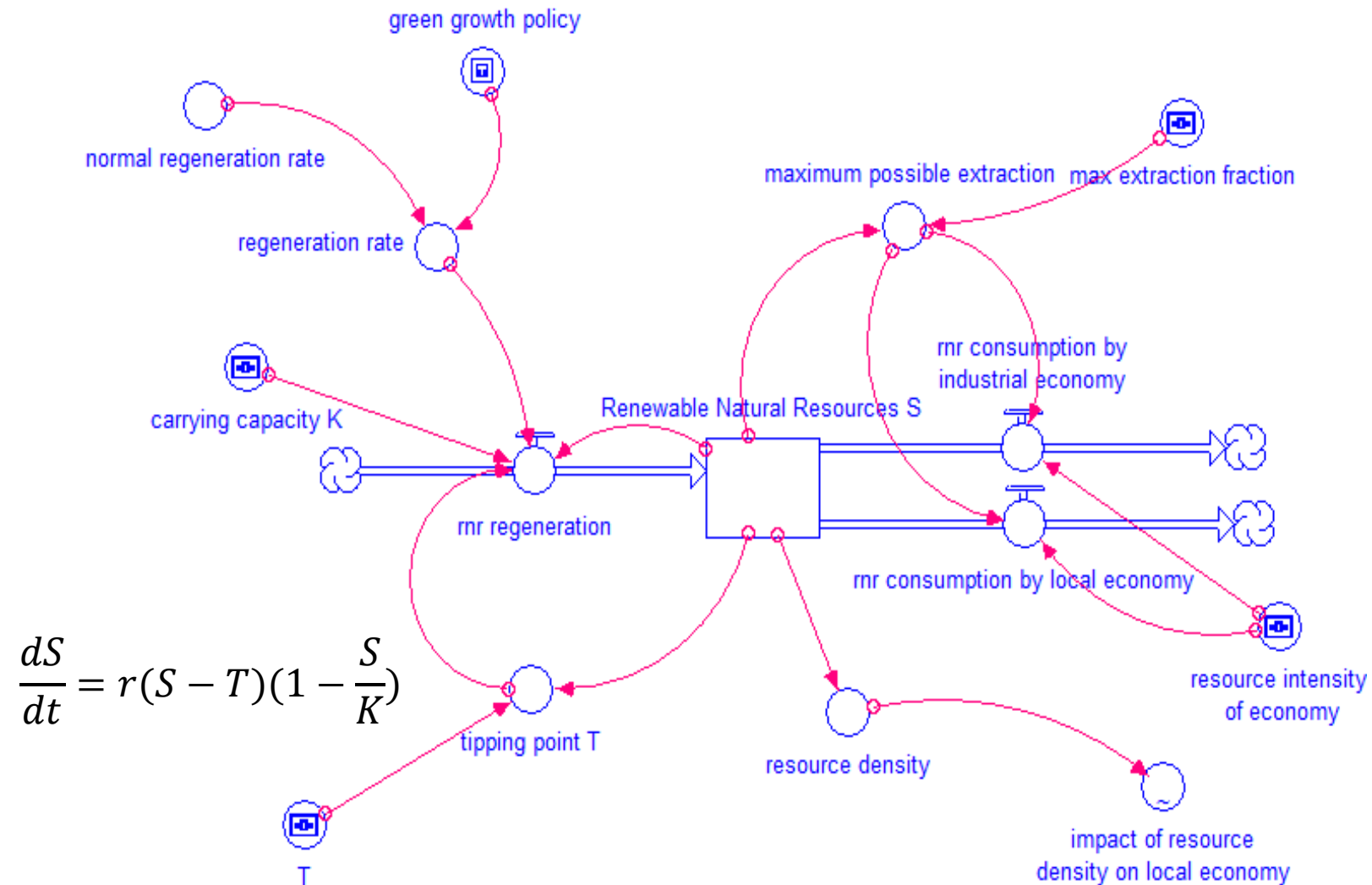
Model Description (contd.)



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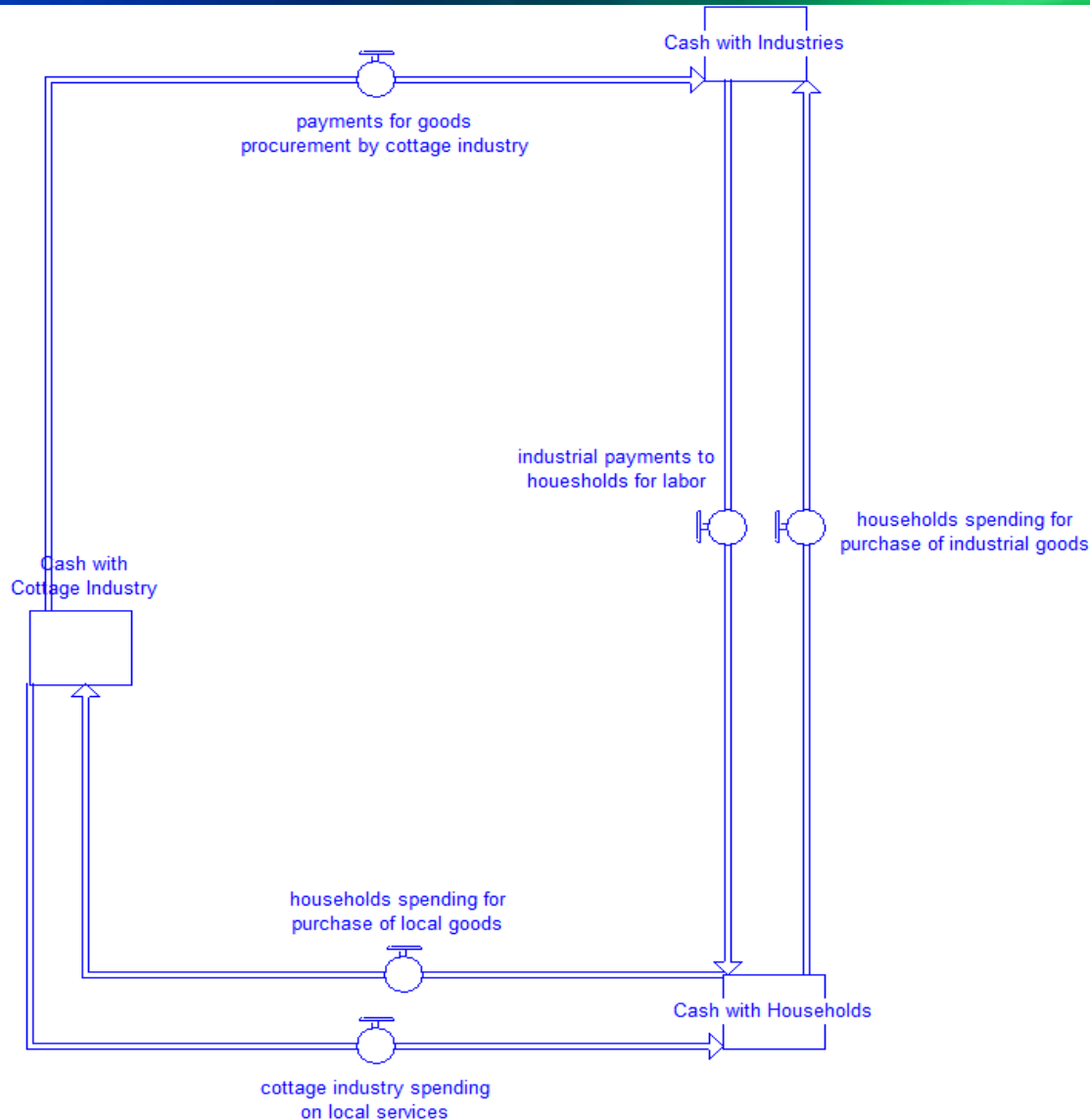
- Simulation time of 300 years to capture the delays in feedback from RNR to economy
- The economies (industrial and local) are considered to be a closed system, similar to the world economy
- The dynamics of money creation is considered outside the scope of the model
- Non Renewable Resources are not included
- The model structure and parameters are intended to test policy assumptions and not real world case study

Stock Flow Diagram - RNR



Stock Flow Diagram - Economy

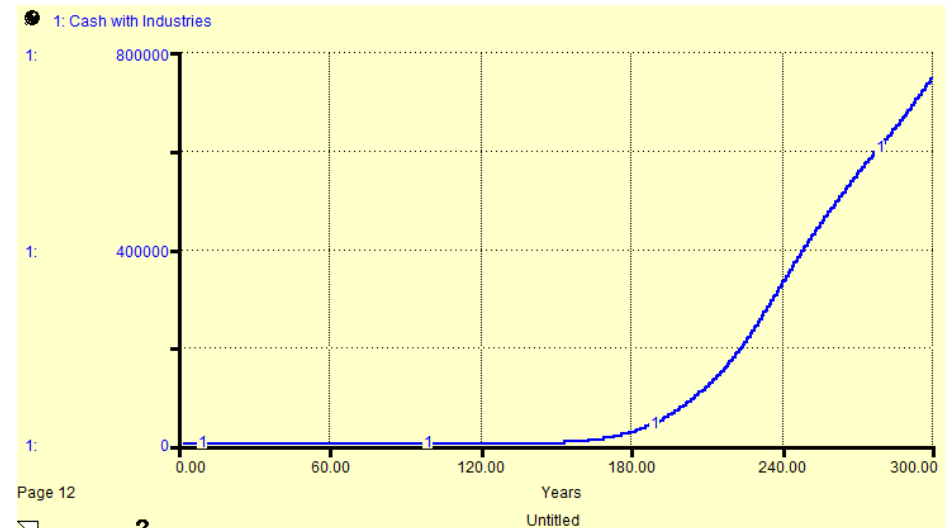
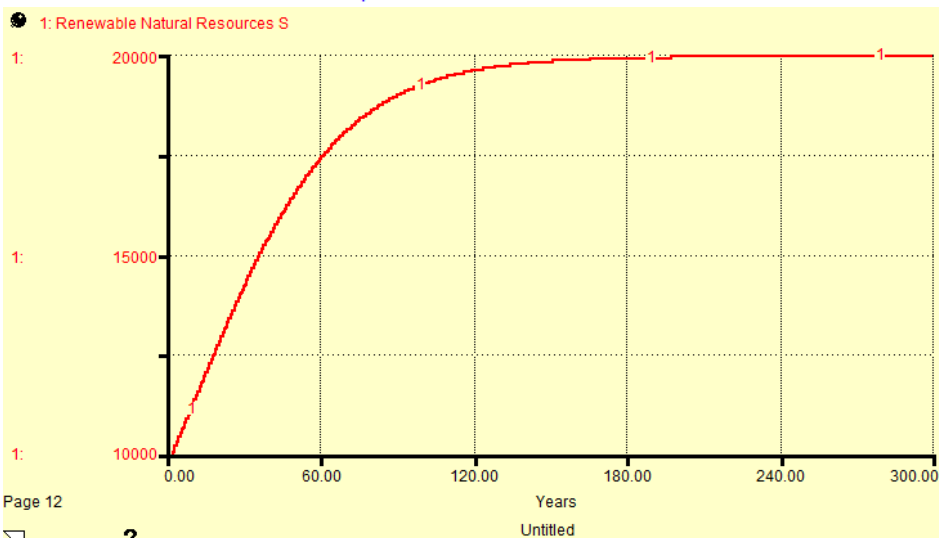
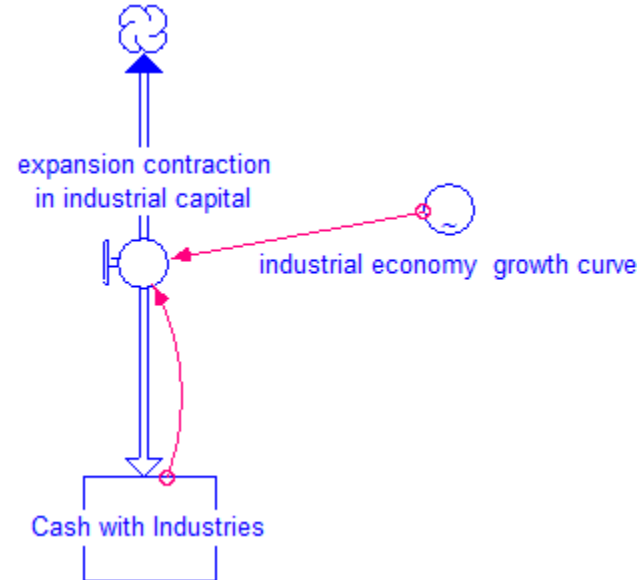
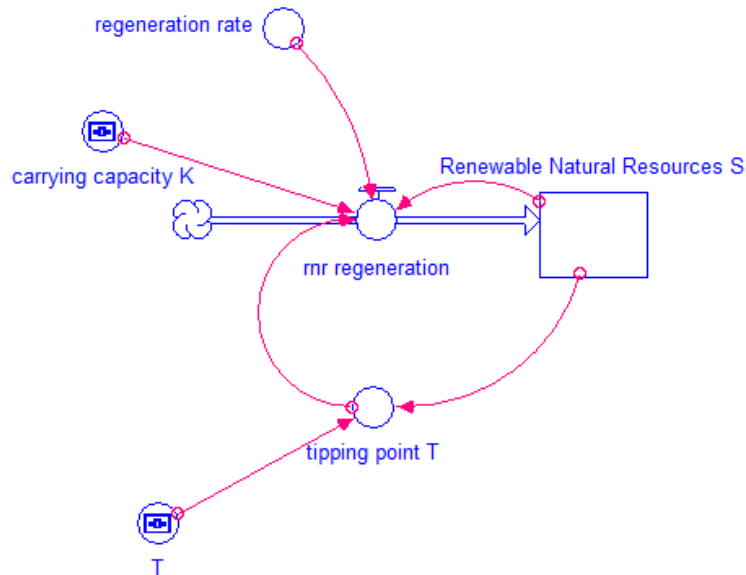
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Comparing Resource Growth and Economy Growth



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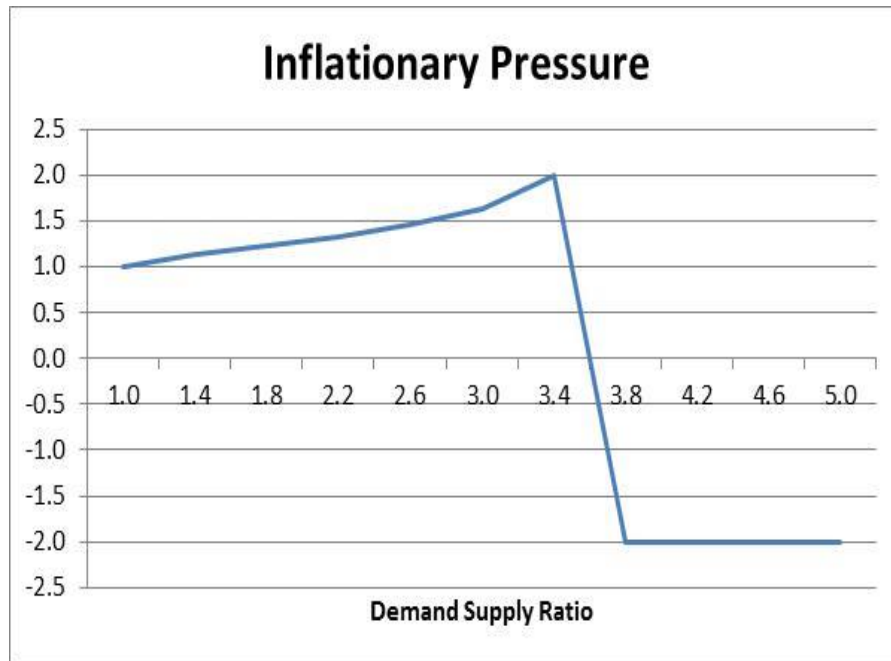


Feedback Dynamics



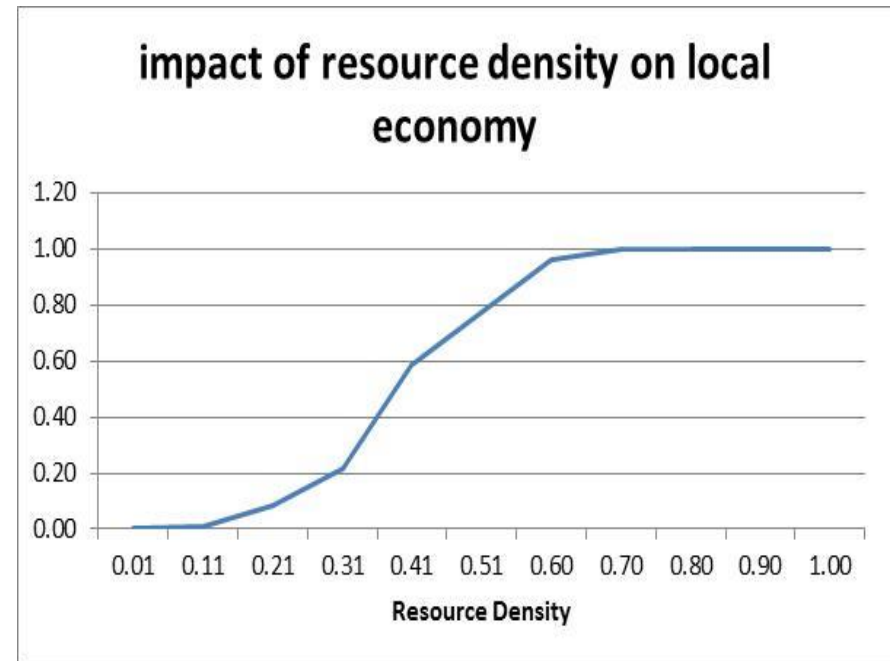
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Industrial Economy



This is modelled as a feedback from the ratio of demand to supply of resources which impacts the inflation.

Local Economy



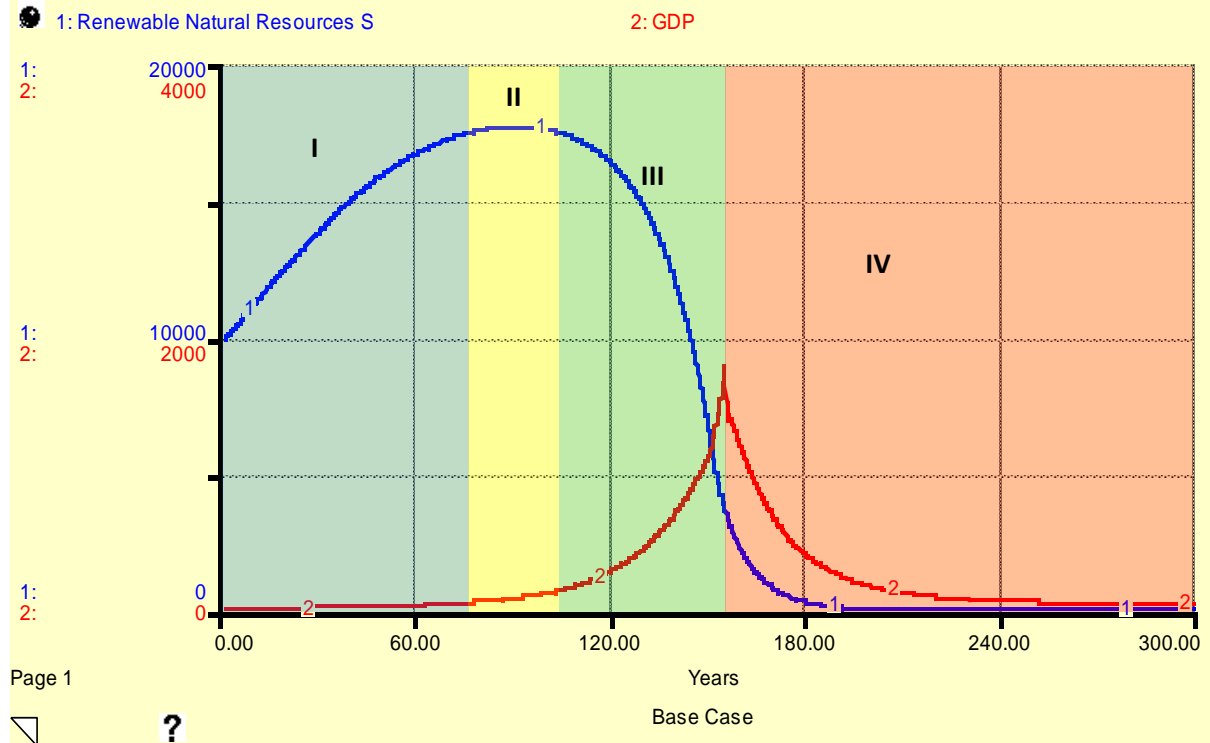
This is modelled as a feedback from the level of stock of renewable natural resources to the local spending fraction.

Base Case Simulation



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Parameter	Value
Initial renewable natural resources	10,000 kg
Natural resources' regeneration rate	4%
Resource intensity of the economy	1 kg/INR
Local economy's growth rate	2%
Industrial economy's growth rate	1-7%
Initial Wealth with households	INR 10
Initial Local cottage industry capital	INR 10
Initial Industrial economy capital	INR 10

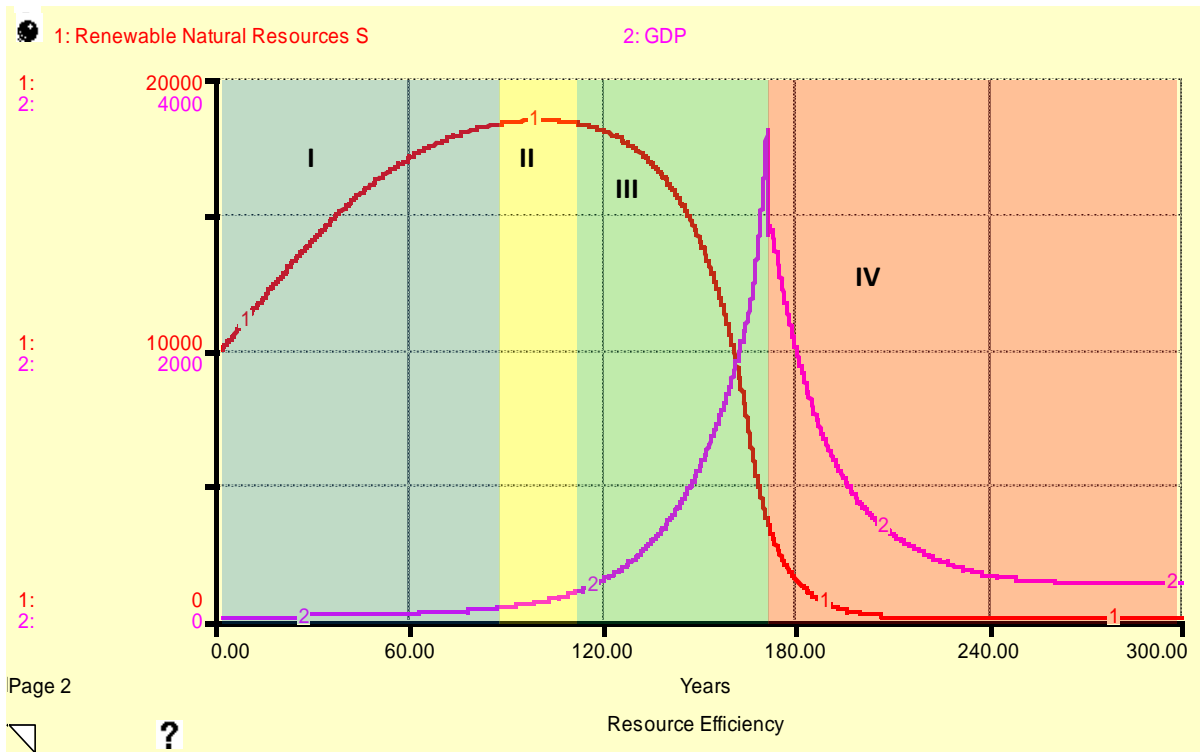


Resource Efficiency: Reducing Resource Intensity of Economy



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Parameter	Value
Initial renewable natural resources	10,000 kg
Natural resources' regeneration rate	4%
Resource intensity of the economy	0.5 kg/INR
Local economy's growth rate	2%
Industrial economy's growth rate	1-7%
Initial Wealth with households	INR 10
Initial Local cottage industry capital	INR 10
Initial Industrial economy capital	INR 10

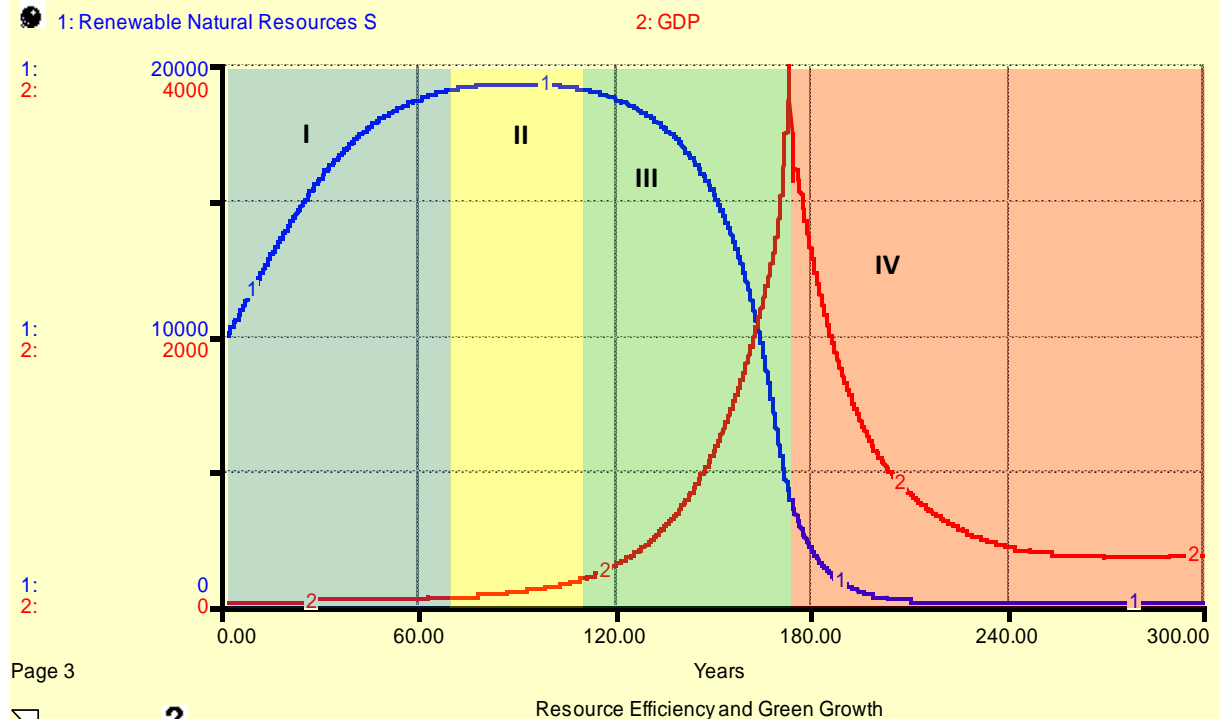


Green Growth: Increasing Resource Regeneration



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Parameter	Value
Initial renewable natural resources	10,000 kg
Natural resources' regeneration rate	6%
Resource intensity of the economy	0.5 kg/INR
Local economy's growth rate	2%
Industrial economy's growth rate	1-7%
Initial Wealth with households	INR 10
Initial Local cottage industry capital	INR 10
Initial Industrial economy capital	INR 10

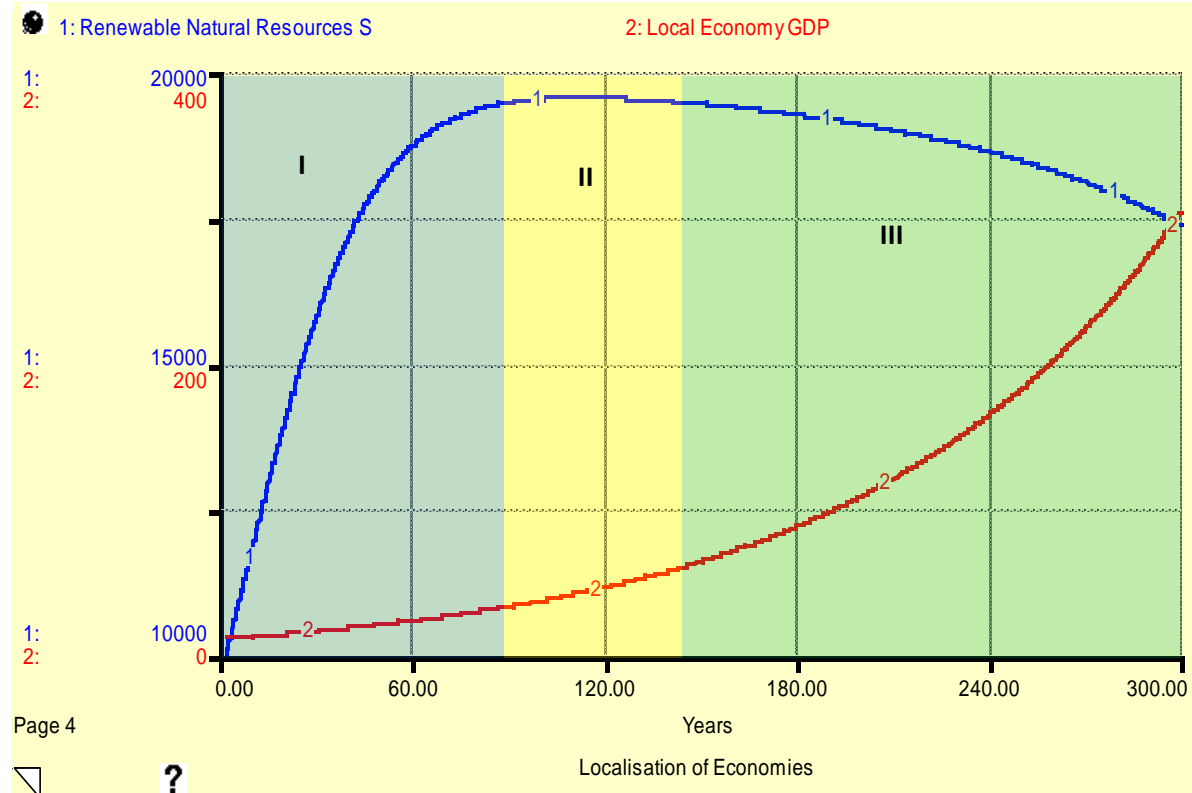


Localization: Local Economy Relying on Only Local Goods and Services



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Parameter	Value
Initial renewable natural resources	10,000 kg
Natural resources' regeneration rate	4%
Resource intensity of the economy	1 kg/INR
Local economy's growth rate	2%
Industrial economy's growth rate	1-7%
Initial Wealth with households	INR 10
Initial Local cottage industry capital	INR 10
Initial Industrial economy capital	INR 10
Local Spending fraction	0.99



Localisation: Extended Time Frame Scenario

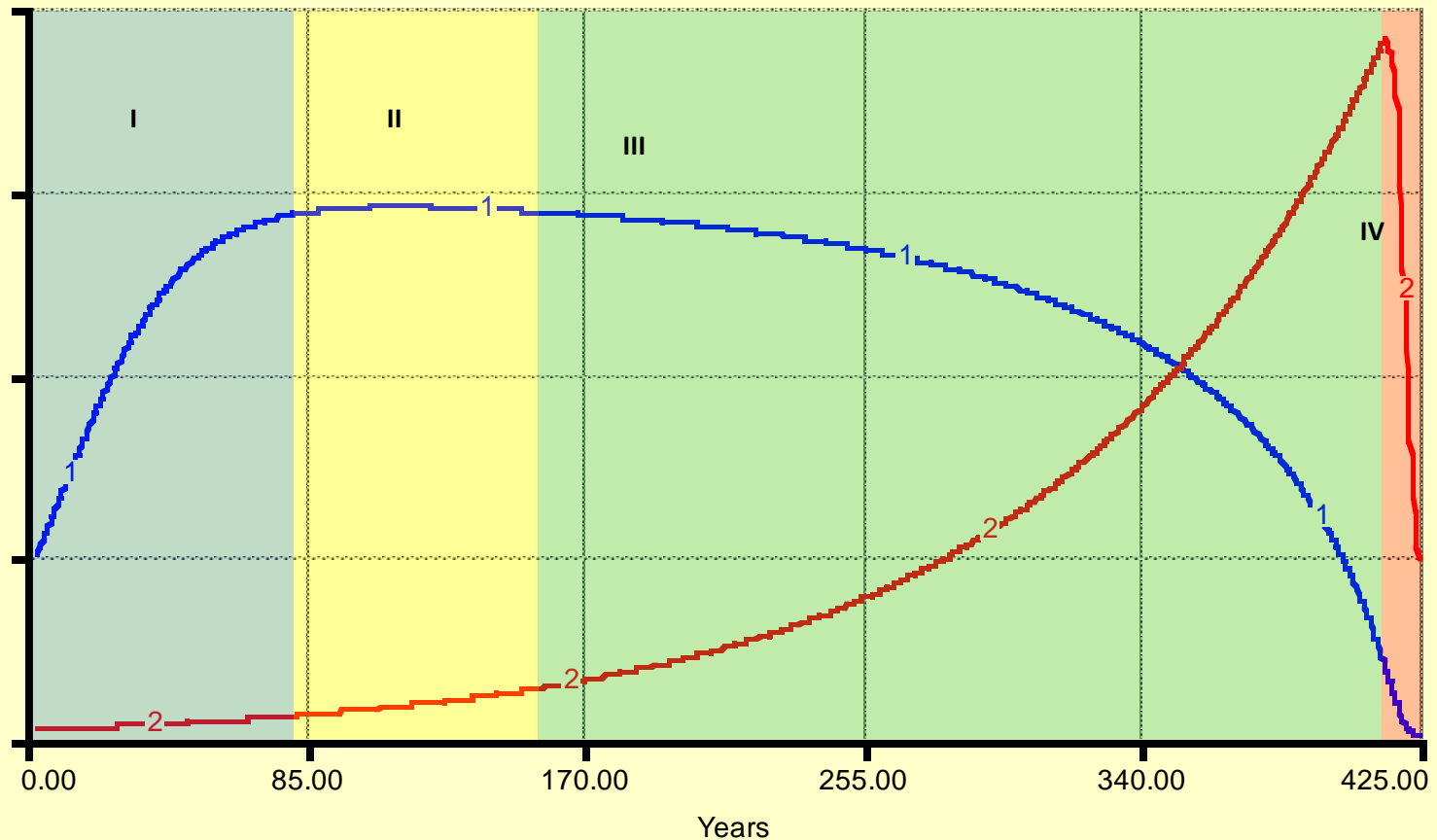


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1: Renewable Natural Resources

2: Local GDP



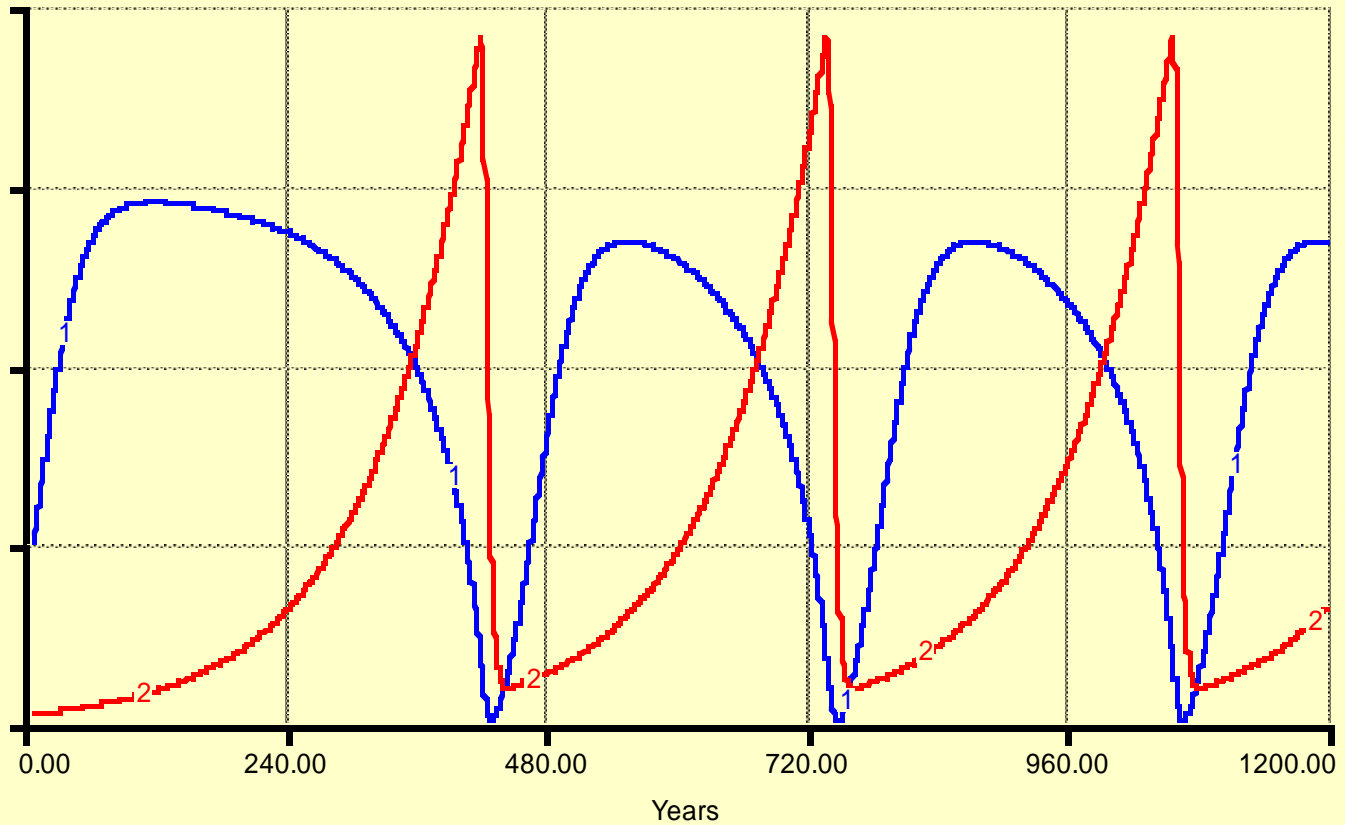
Long Cycles in Localized Economy



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1: Renewable Natural Resources

2: Local GDP



Analysis and Discussion



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- All four stages of growth and collapse occur in resource efficiency and green growth policies
- Localisation is able to avoid the collapse but correction still happens
- Flow based feedback (industrial economy) against Stock based feedback (local economy) and slow growth rate of local economy are the key factors
- These feedback dynamics make localisation more proactive towards the state of RNR thereby avoiding crossing of tipping points

Insights and Learning



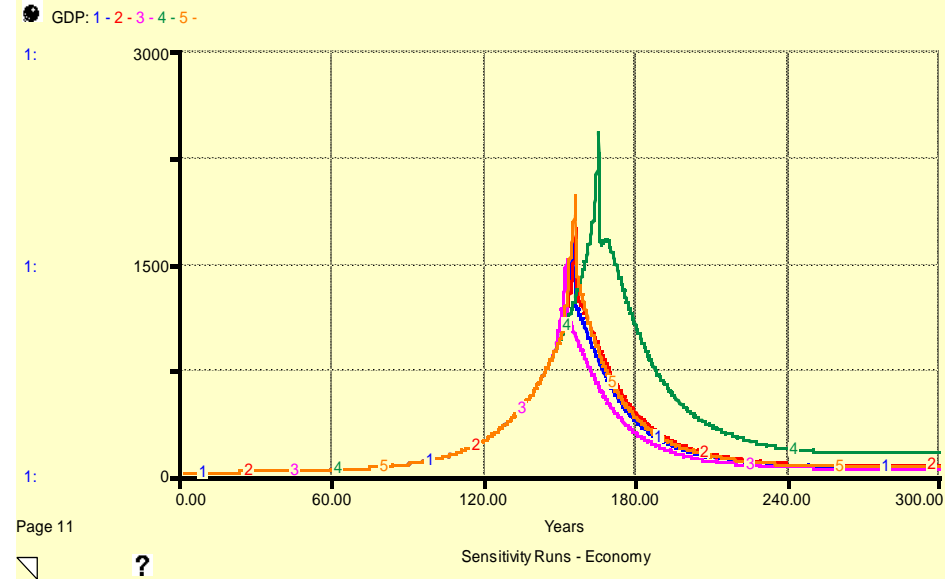
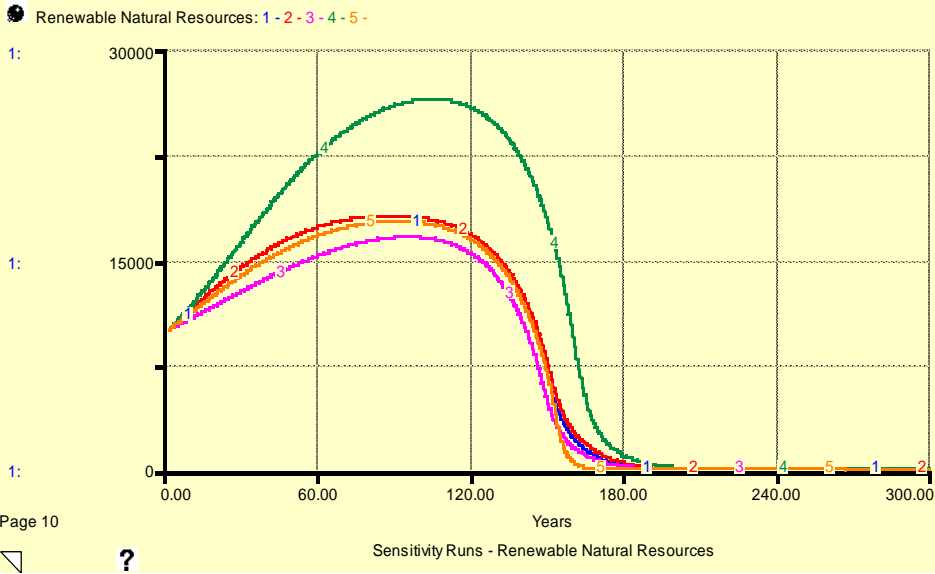
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- The stock of resources has a maximum carrying capacity beyond which it cannot grow while there is no endogenous carrying capacity (other than due to external resource constraints) for the economy to stop its growth.
- As long as the growth in the size of economy is not controlled it would neutralize efficiency and conservation/restoration gains ultimately failing to reach desired goals.
- Once the economy has grown for too long, a zero growth policy may fail to sustain the resources due to the continuation of large consumption flows coming from large scale economic activities.

Sensitivity Runs



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1. Base Run
2. Late Resource Tipping Point
3. Early Resource Tipping Point
4. Carrying capacity doubled
5. Maximum extraction fraction doubled

Questions for Further Research



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- What size of economy is desirable to maintain sustainable ecology of resources?
- What forms of livelihoods would work when the economy undergoes correction?
- What are the enabling conditions to reduce economic growth and move towards sustainable economies?
- How could (automated) fast feedback mechanisms from resources (stock) to economy be built to make economy proactively responsive towards the state of resources?

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Thank You!

Avoid the Unmanageable: Mitigate
Manage the Unavoidable: Adapt

Contact: mihir.mathur@teri.res.in, kabir.sharma@teri.res.in

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