Trade-off analysis of land use change, livelihood and environmental services:

prospecting land use options for the Upper Konto catchment using the FALLOW model

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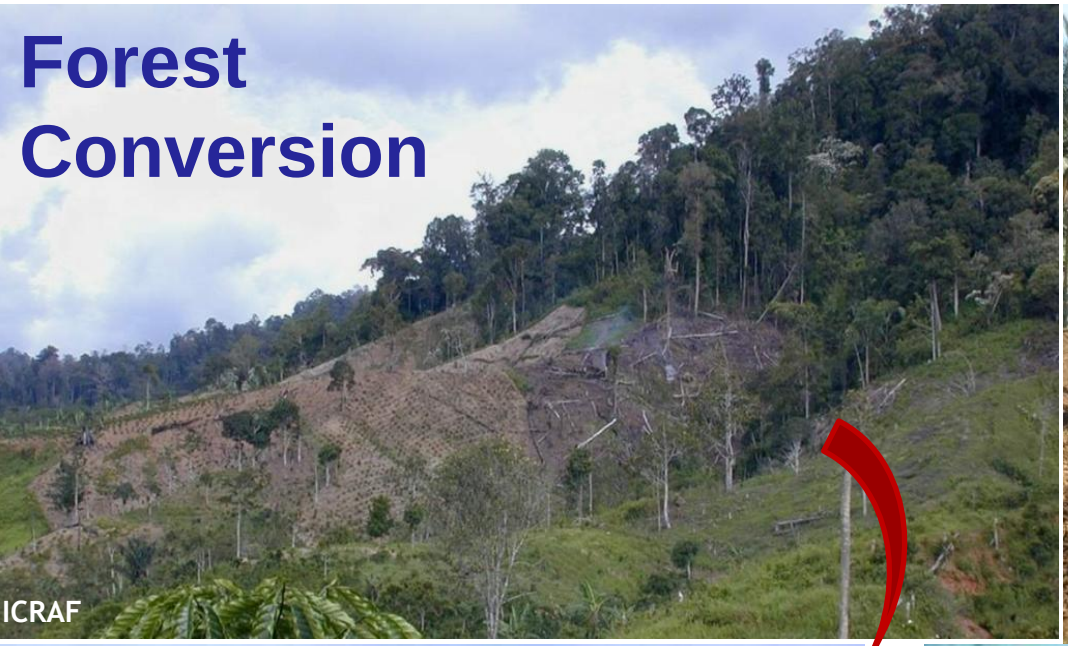
World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

Research Background



Agro-ecosystems management involves tradeoffs between multiple functions

Model simulation and scenario analysis could be efficient tools for natural resource managers to assess tradeoffs of various plausible options

Challenges

- Can simulation models and scenario analysis help decision makers and natural resource managers to assess trade-offs and explore plausible options effectively and efficiently ?

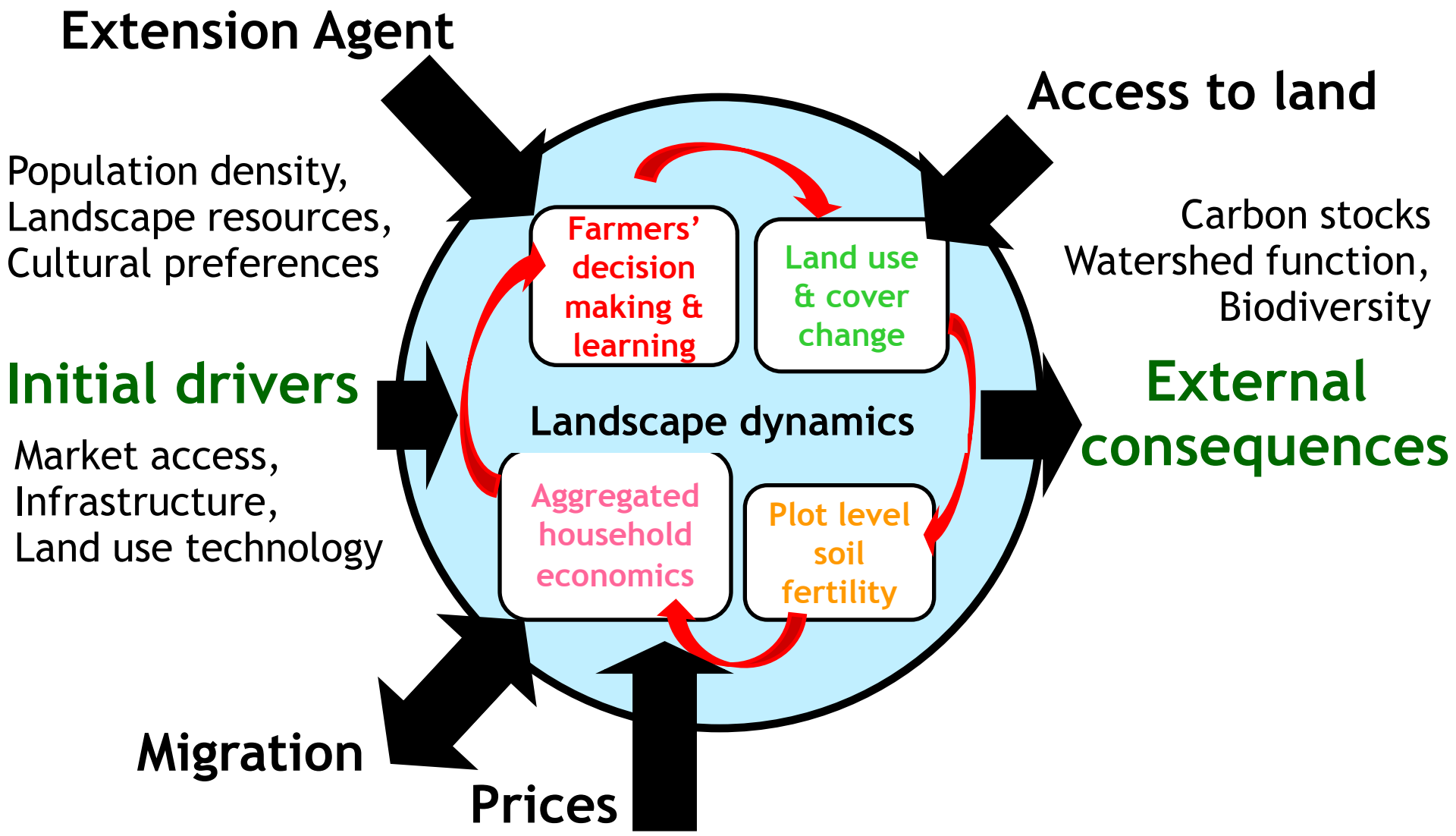
- What are the essential factors for simulation models or model results to be valuable for decision making in natural resource management?

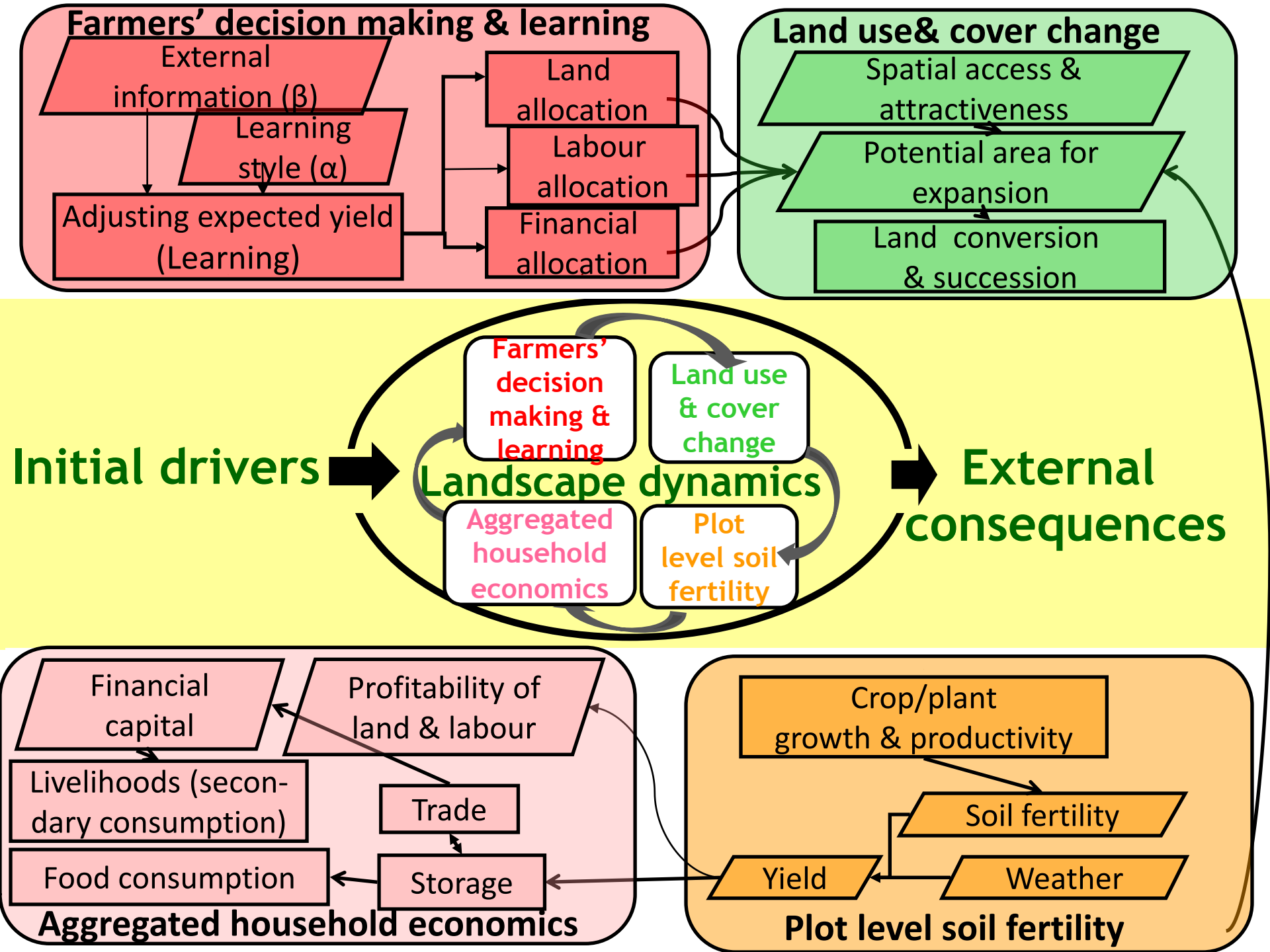
FALLOW Model

- Spatially explicit model developed in PC-Raster; agent-based learning and decision making.
- Integrating socio-economic and biophysical processes
- Time step: annual
- Spatial unit: ha of land (default)

van Noordwijk, M. 2002. Ecological Modelling, 149: 113-126

MODEL OVERVIEW




Farmers' decision making & learning
External information (β)
Learning style (α)
Adjusting expected yield (Learning)
Land allocation
Labour allocation
Financial allocation
Land use& cover change
Spatial access & attractiveness
Potential area for expansion
Land conversion & succession
Initial drivers
Farmers' decision making & learning
Land use & cover change
Landscape dynamics
Aggregated household economics
Plot level soil fertility
External consequences
Financial capital
Profitability of land & labour
Livelihoods (secon-dary consumption)
Trade
Food consumption
Storage
Aggregated household economics
Crop/plant growth & productivity
Soil fertility
Yield
Weather
Plot level soil fertility

Scale of processes in FALLOW Model

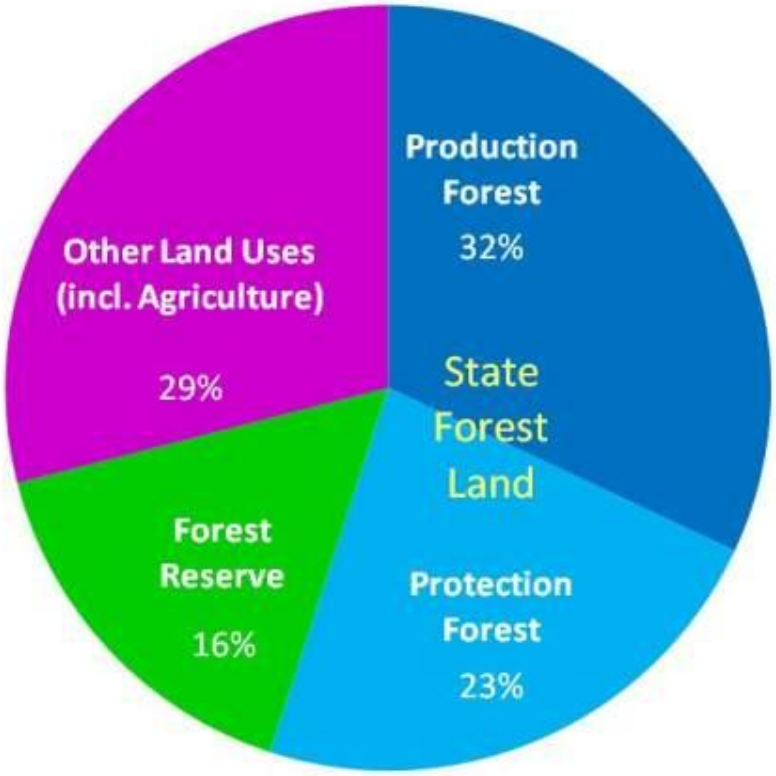
Process	Level	Agent
Decision making • what livelihood options? • how many plots to open and where?	• community (off-farm) • plot (default 1 ha)	• average farmers, can be differentiated by ability to adopt and learn • extension agent (implicit)
Biophysical processes • yield, • soil fertility dynamics, • land use succession, • aboveground biomass	plot	-
Institutional (access to land, new infrastructures)	watershed (study area level)	-

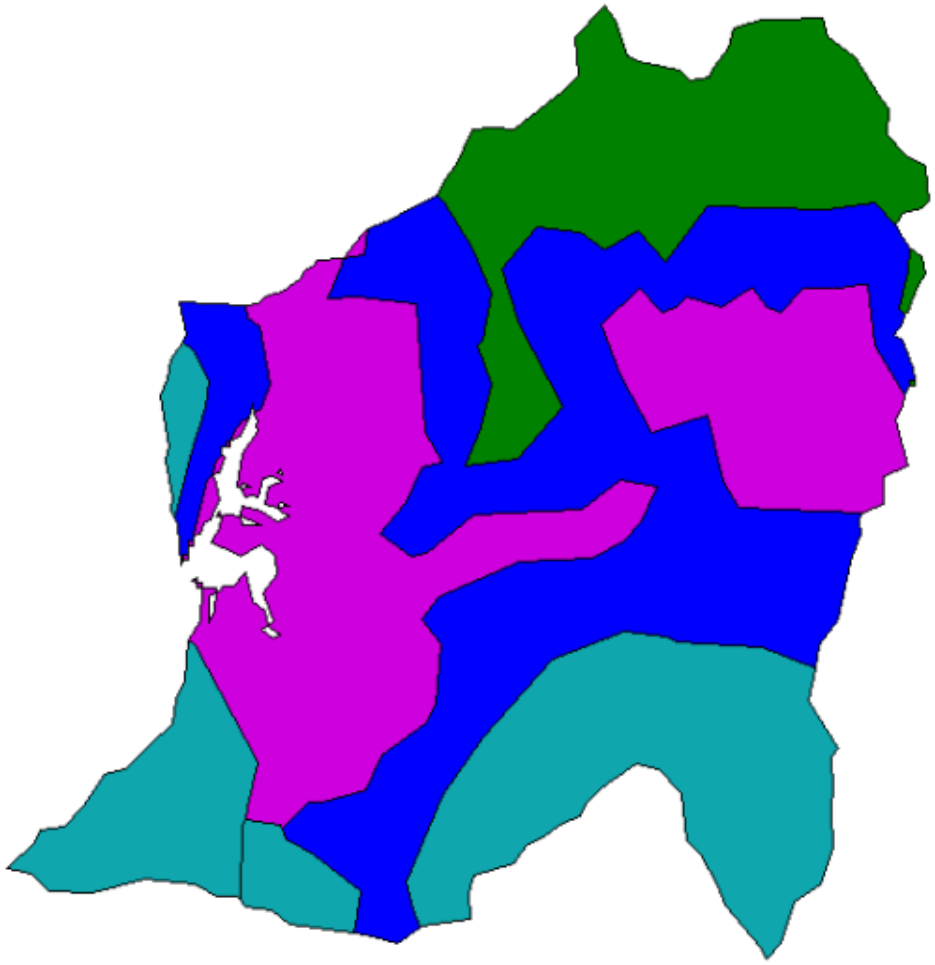
Research Location

- **Upper Konto catchment, East Java, Indonesia.**
- **Area of 233 km^2 of State Forest Land (tree plantation), remnant forest (degraded), agricultural land**

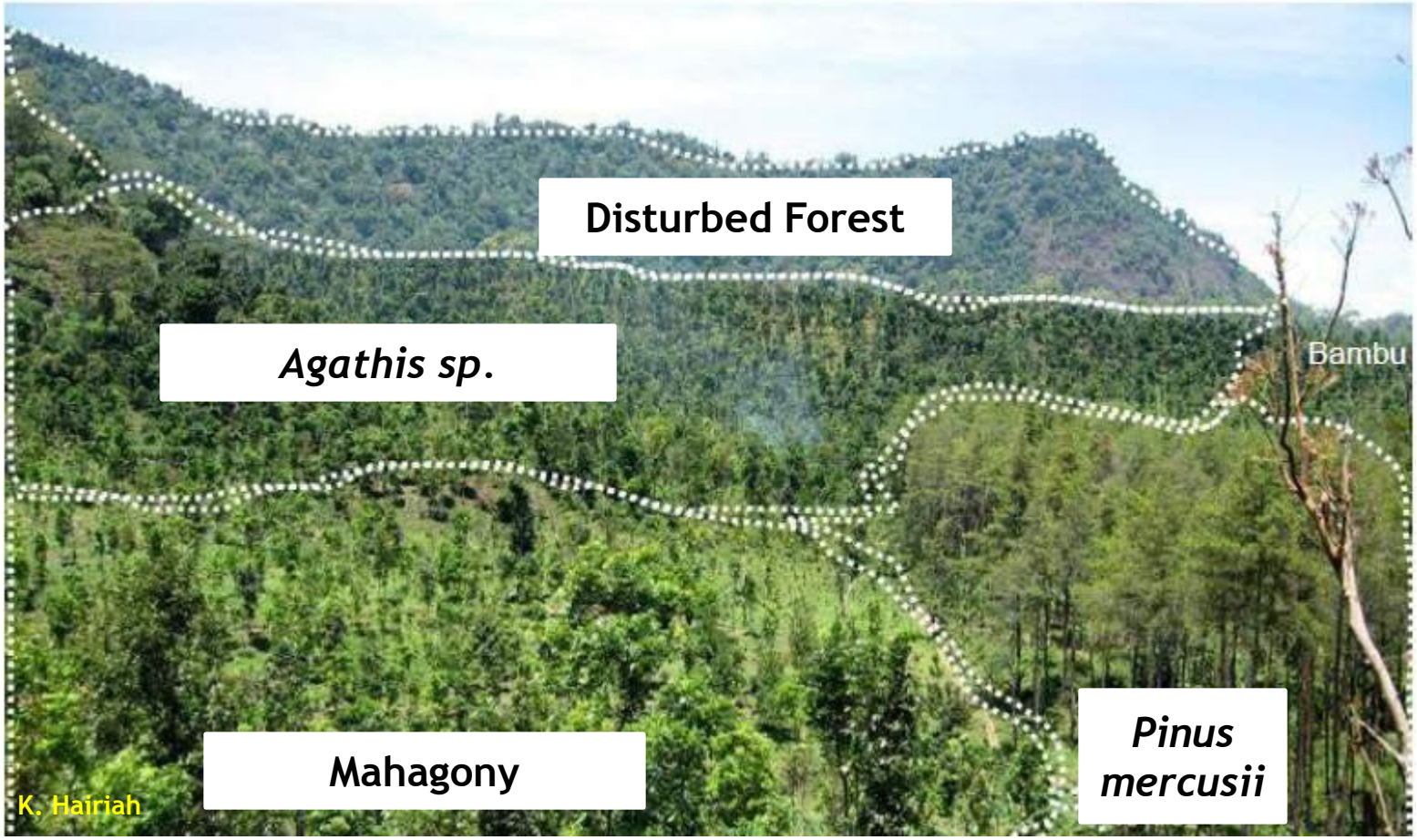
Landscape issues and concerns

Designated land use in Upper Konto catchment





Only 29% area is accessible and can be owned


Disturbed Forest
Agathis sp.
Bambu
Mahagony
Pinus mercusii
K. Hairiah

Landscape issues and concerns

Conversion of State Forest Land into agricultural land - 1999

Community Forest Based Management - 2002

Planting crops in between ‘forest’ trees.

Landscape issues and concerns

Conversion of State Forest Land into agricultural land - 1999

Community Forest Based Management - 2002

Planting crops in betwe rest' tr

Not successful !!!

Landscape issues and concerns

Examples of existing systems in State Forest areas (early 80's)

Coffee in Forest Production area.

Multistrata systems in Forest Protection area

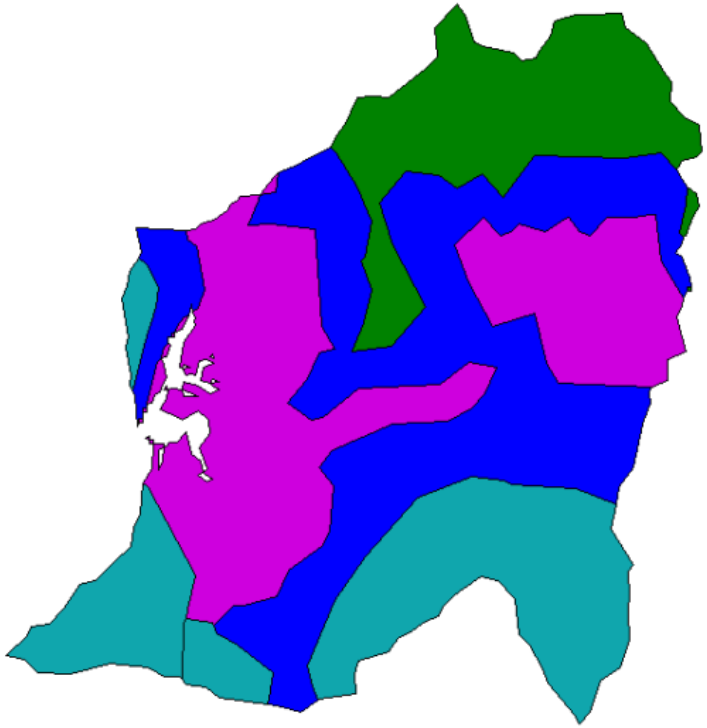
Modelling objectives

To assess plausible land use policy options that can be beneficial for community and State Forest Company,

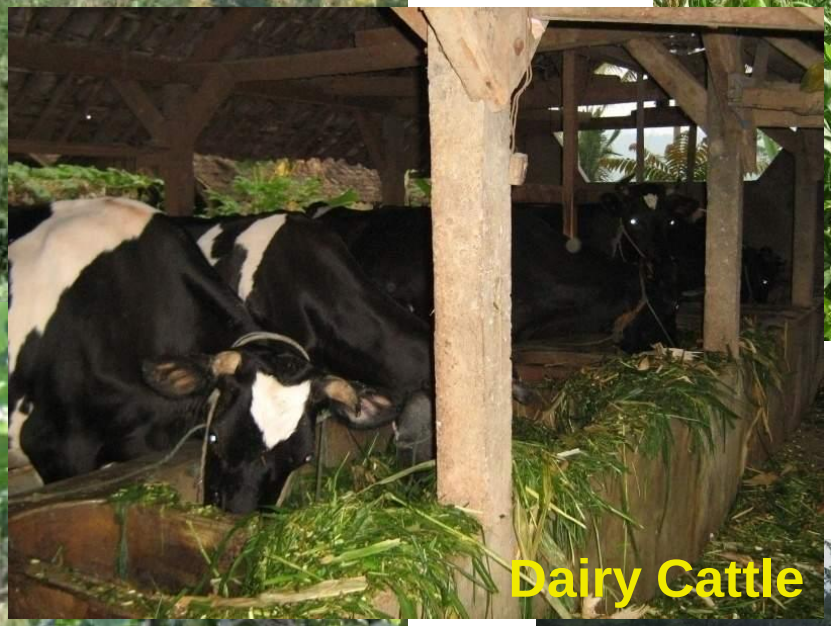
with aboveground carbon stocks (environmental services) and secondary consumption/welfare as indicators

Scenarios

0. Full access to land (Baseline)
1. Conserving **Forest Reserve**
2. Conserving **Forest Reserve** and **Protection Forest**
3. Similar to (2) with limited access to **Production Forest** (only tree-based systems allowed to grow)



Livelihood options

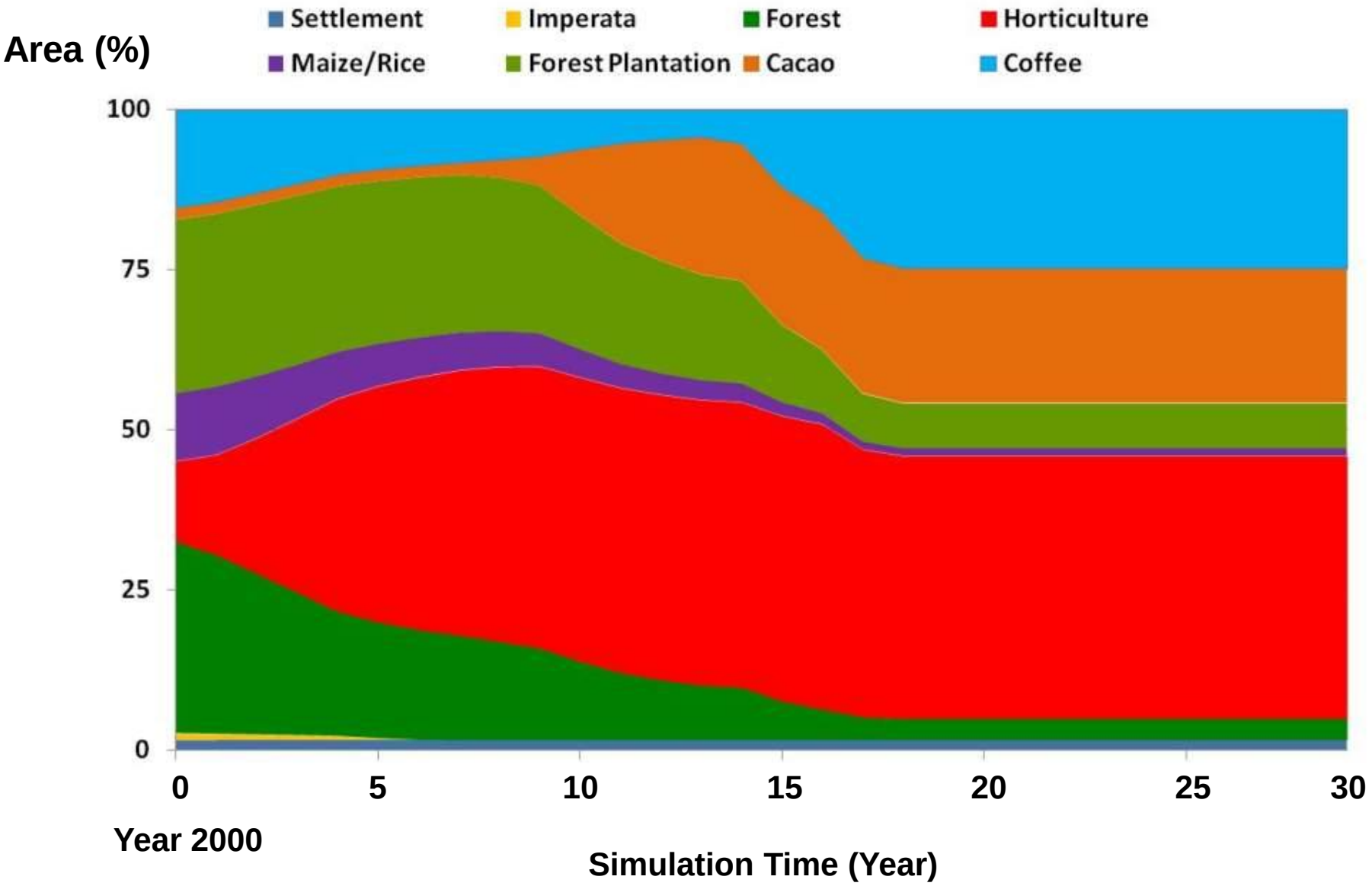


Payoff to labour and payoff to land

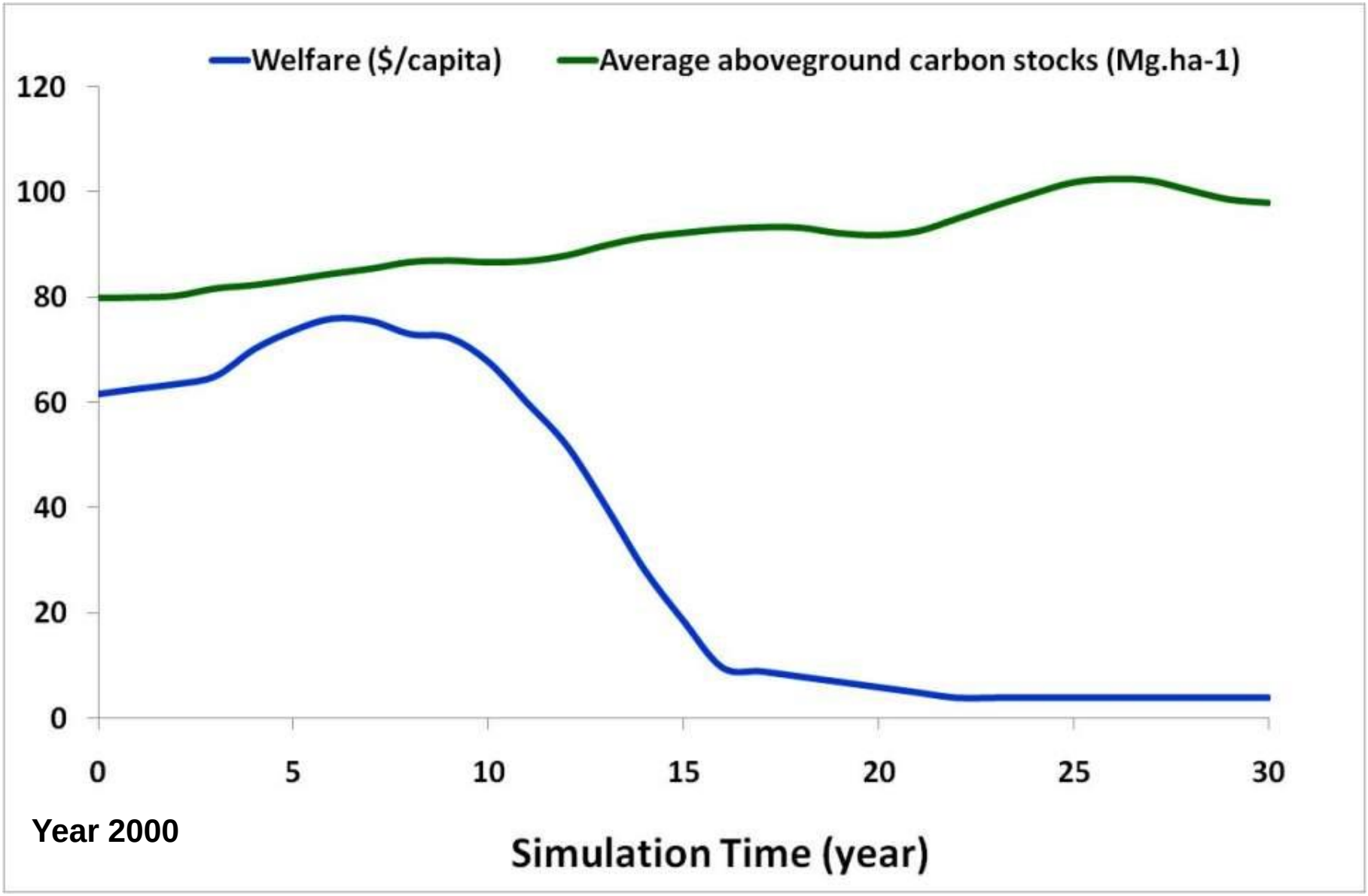
Livelihood options	Return to labour * (US$.persondayˉ¹)	Return to land* (US$.haˉ¹)
Maize/rice	2,30	450,00
Horticulture	9,50	2100,00
Coffee systems¤	5,00	900,00
Cacao systems¤	7,50	1390,00
Dairy cattle	5,50	not applicable

Preliminary Results

Landscape dynamics – baseline condition

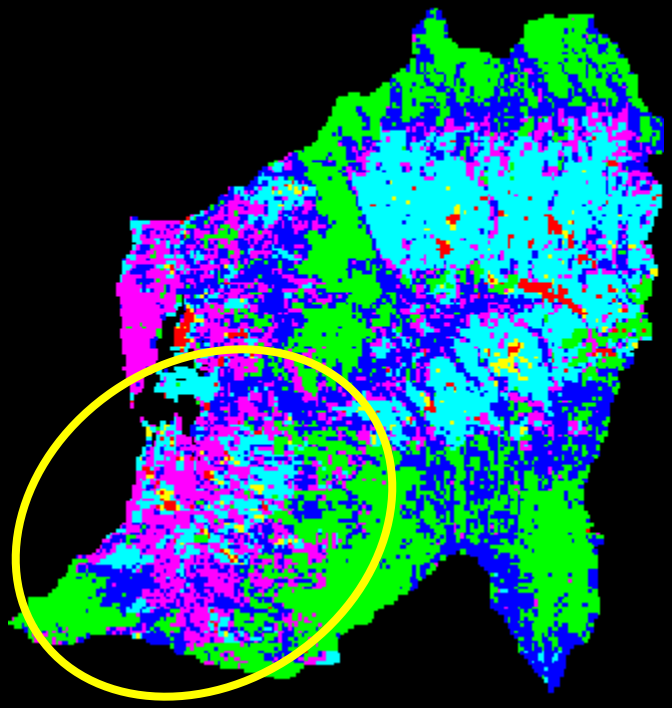


Welfare and carbon stocks dynamics

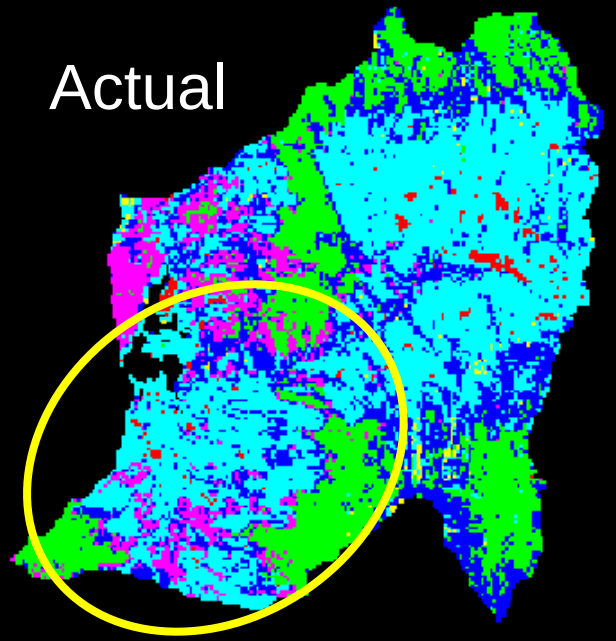


Model Performance

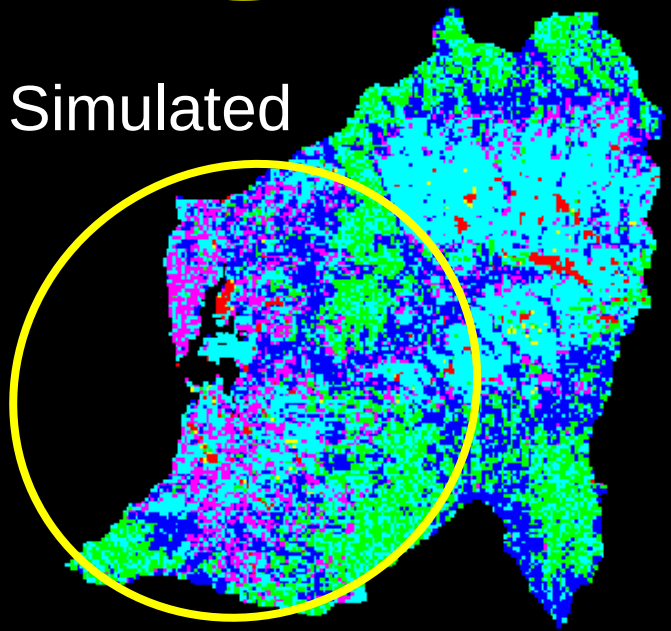
2000



2006 Actual

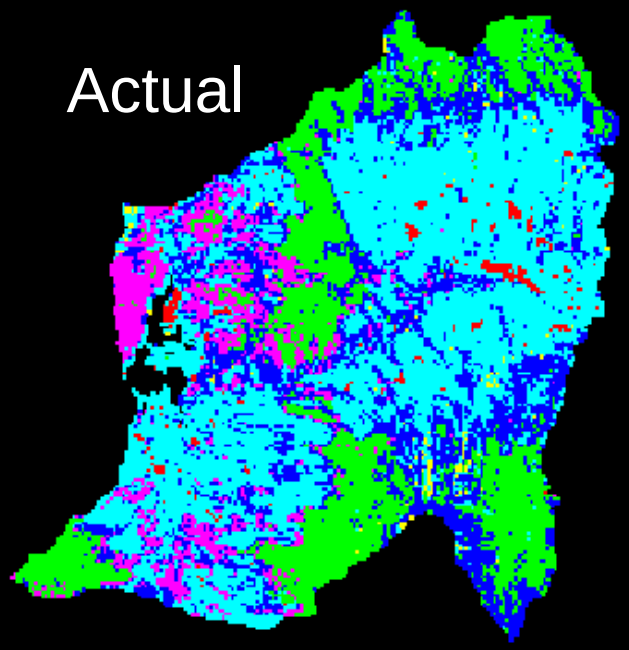


Simulated

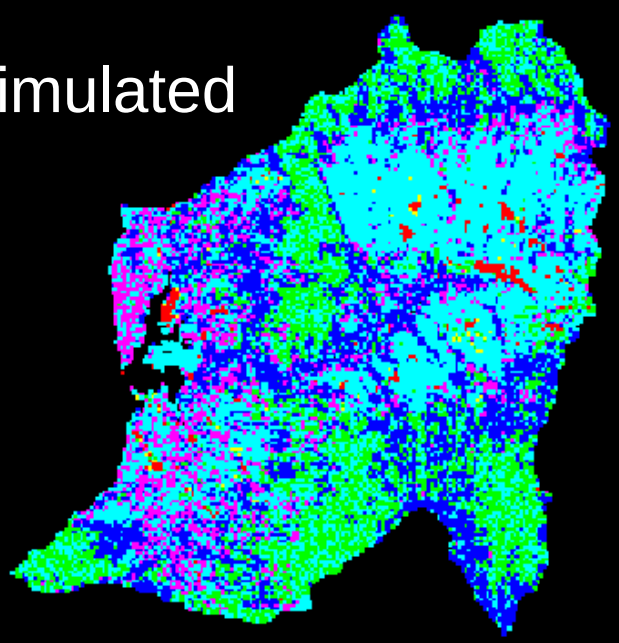


Settlement
Bush fallow
Forest
Agriculture
Forest Plantation/State Forest
Agroforestry

Model Performance



2006



Land cover	Area (km^2)		Spatial accuracy (%)	Relative area difference (%)
	Actual	Simulated		
Agriculture	102	101	52	-1
Agroforestry	20	26	25	22
Forest Plantation	53	59	80	10
Forest	51	42	49	-25

Scenarios

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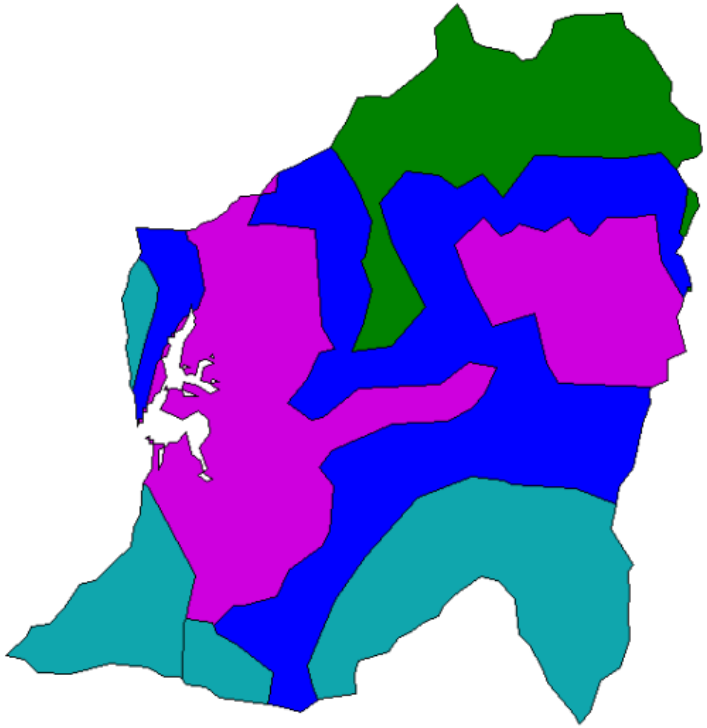
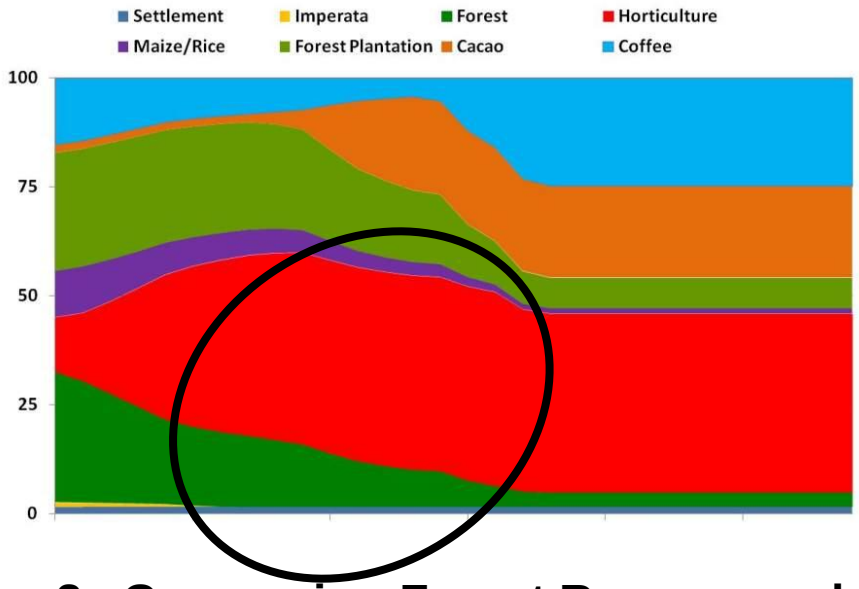
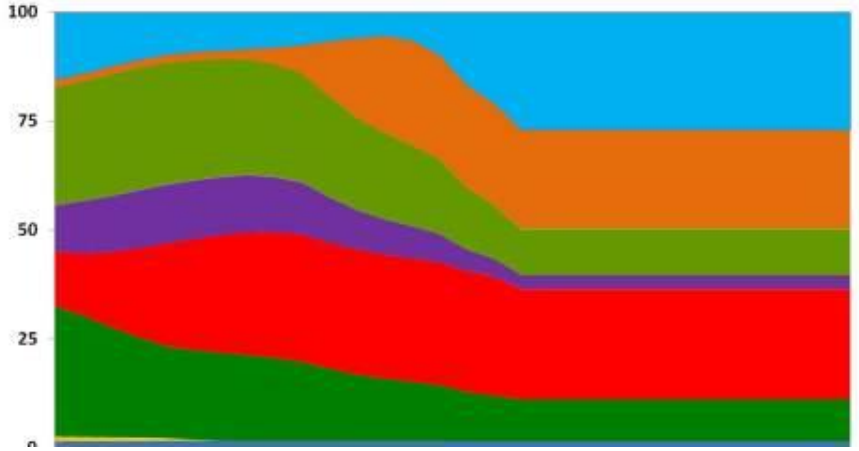


Model results – Landscape dynamics

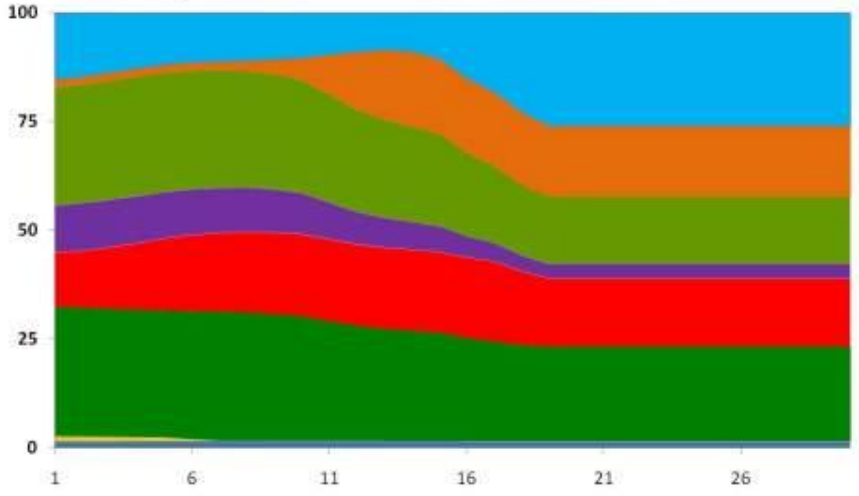
0. Baseline



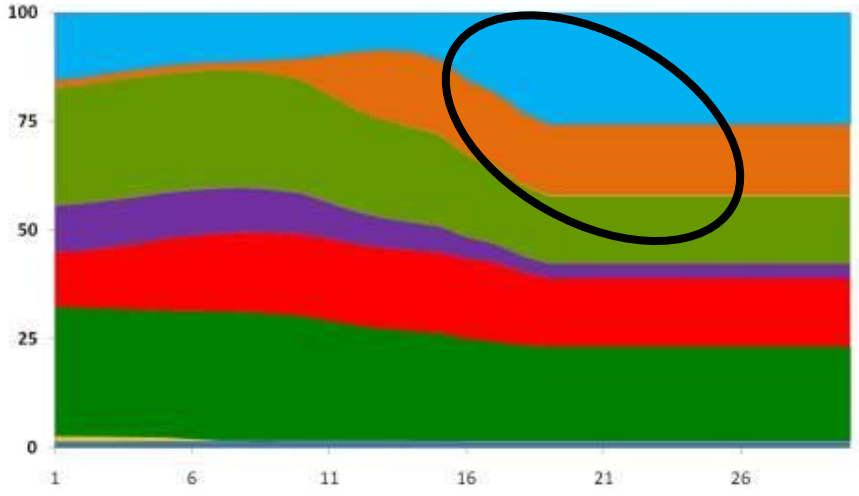
1. Conserving Forest Reserve



2. Conserving Forest Reserve and Protection Forest

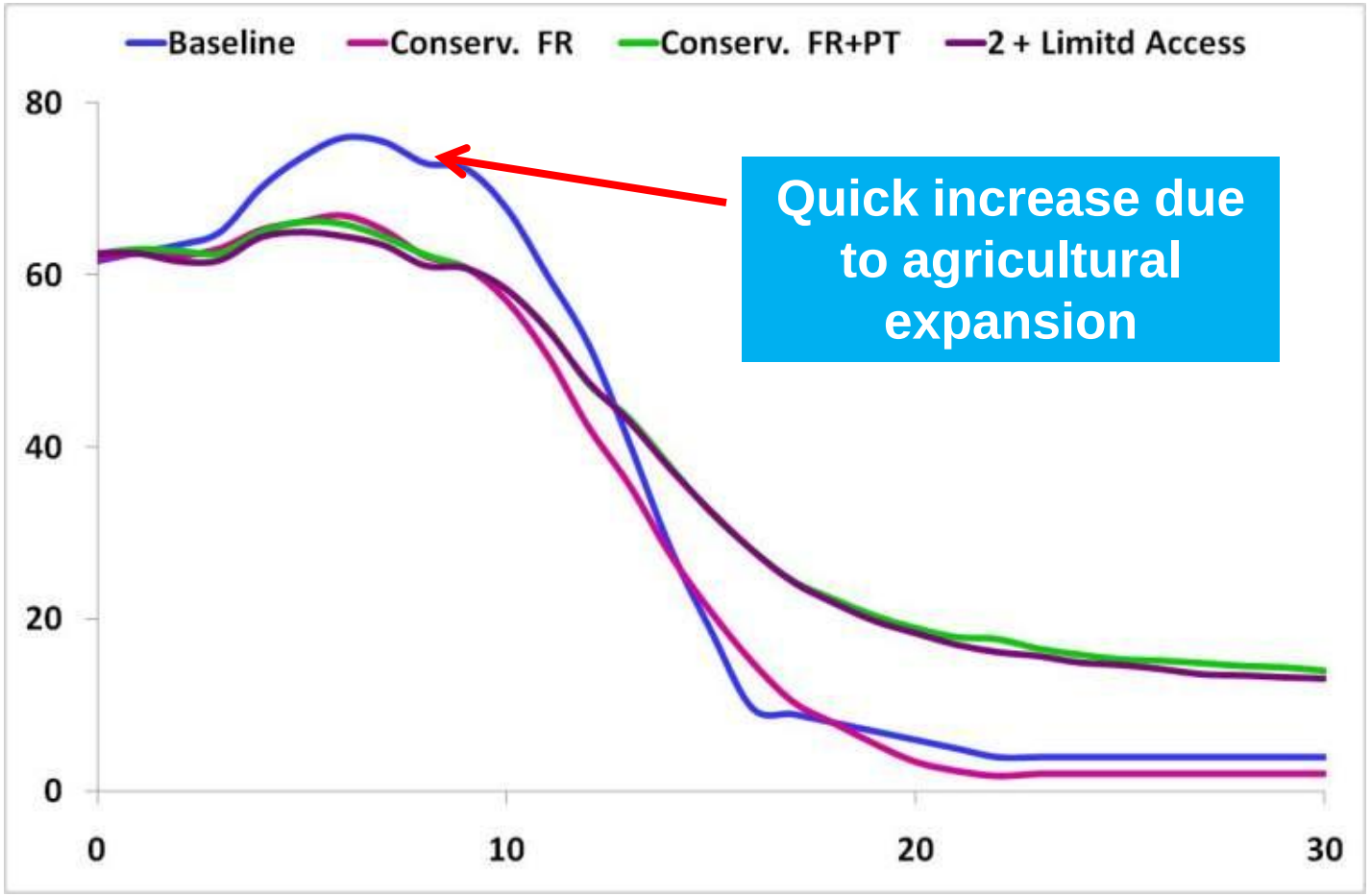


3. Conservation and limited access to Production Forest



Model results

Welfare ($/capita)

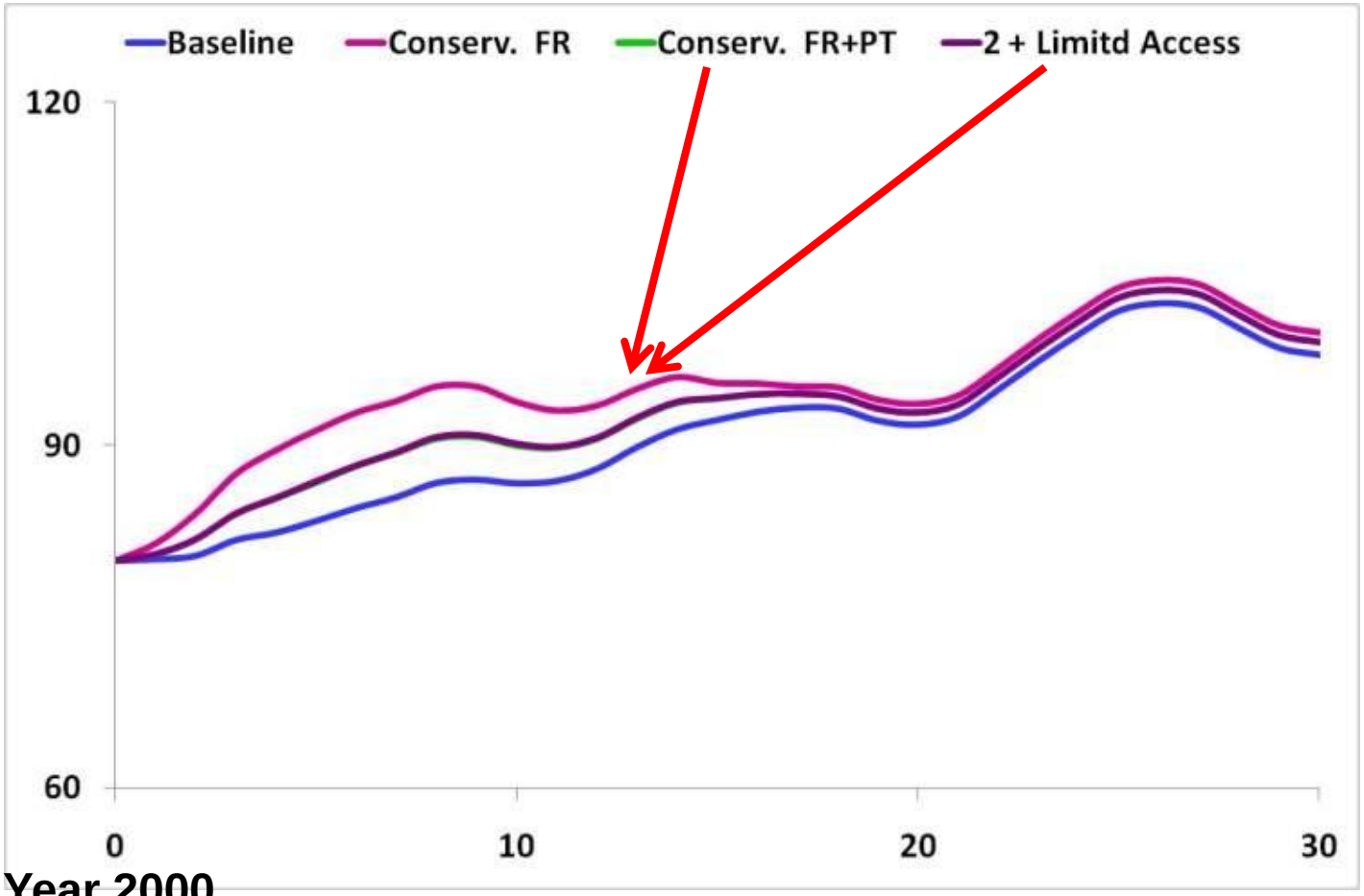


Year 2000

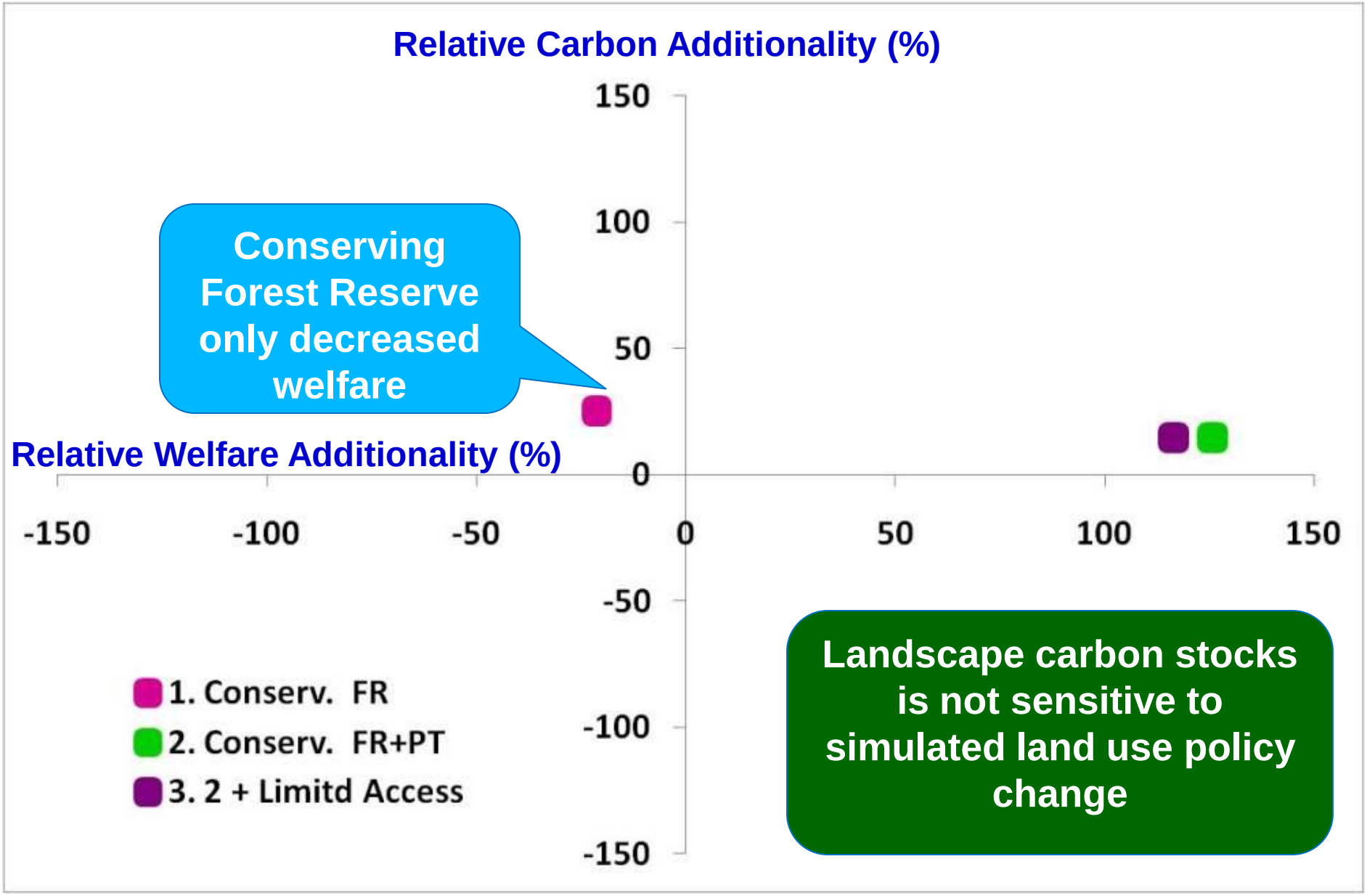
Simulation time (year)

Model results

Average aboveground carbon stocks (Mg ha-1)



Model results – Trade-offs



Findings suggests ....

- Conserving Forest Reserve will reduce welfare, also need to conserve Protection Forest
- Current land use policy scenarios does not increase overall landscape carbon
- Improve spatial accuracy of FALLOW (algorithm for new-plot)

Next steps ....

Present findings to stakeholders (eg. State Forest Company) to obtain feedback

→ Model validation by users!

Salience: is it relevant?

Credibility: is it ‘true’ - accepted?

Legitimacy: does it includes stakeholders’ interests

Model use in decision making as a culture ....

... and use of model/model results as part ‘negotiations support systems’ ...

Thank you

Merci

Vielen Dank

Terima kasih

Federal Ministry
for Economic Cooperation
and Development

gtz