Simulating Impacts of Local Forest Policies on Forest Ecosystem Services

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Outline

Backgrounds & Objectives

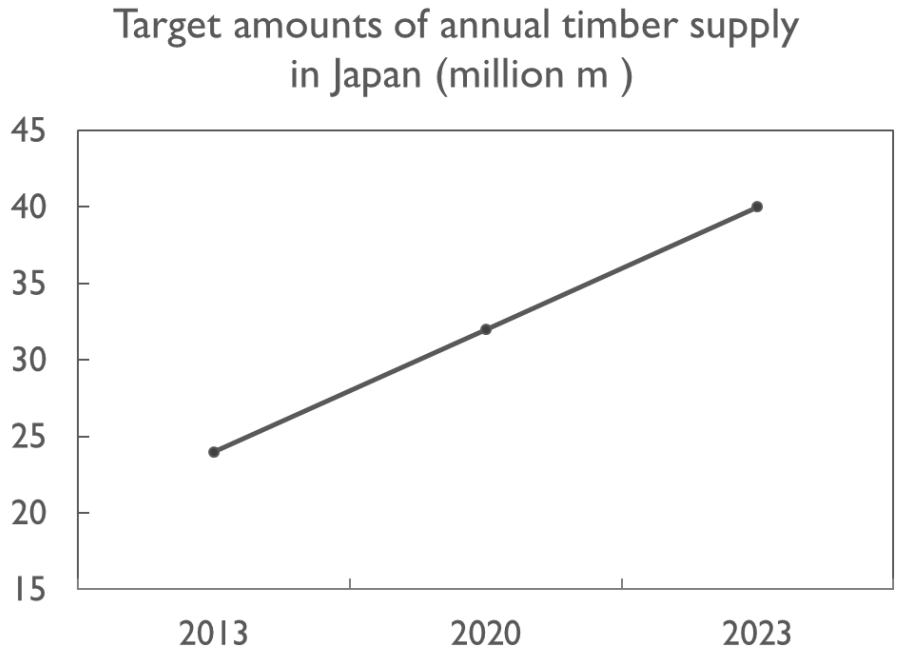
Methods

- Study area
- DSA : Stochastic simulation models
- DSA : Evaluation models for forest functions

Results of applying the DSA

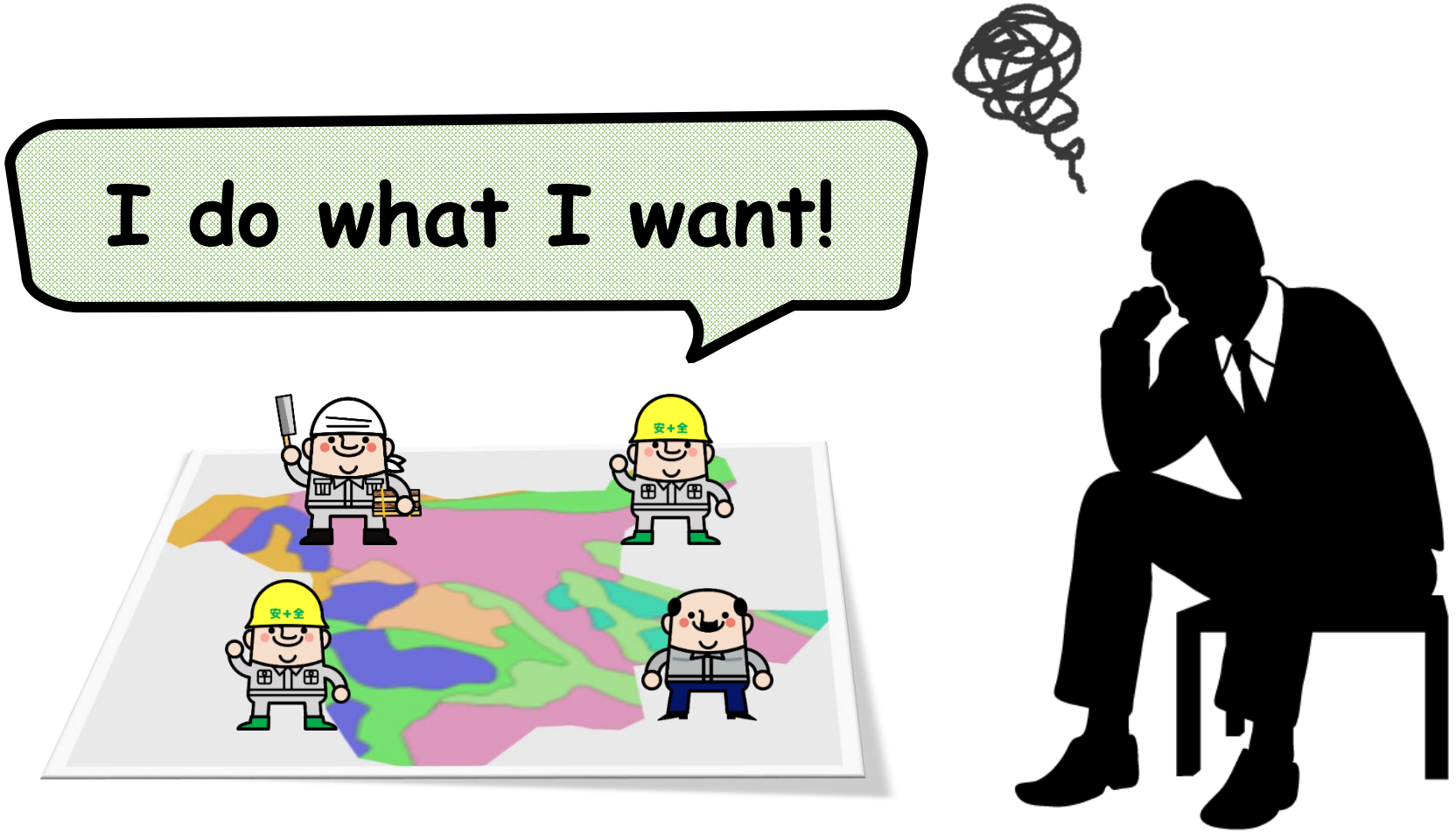
Summary

The role of local forest policy



To supply ecosystem services sustainably.

Challenges of local forest policy



Considering multiple decision makers.

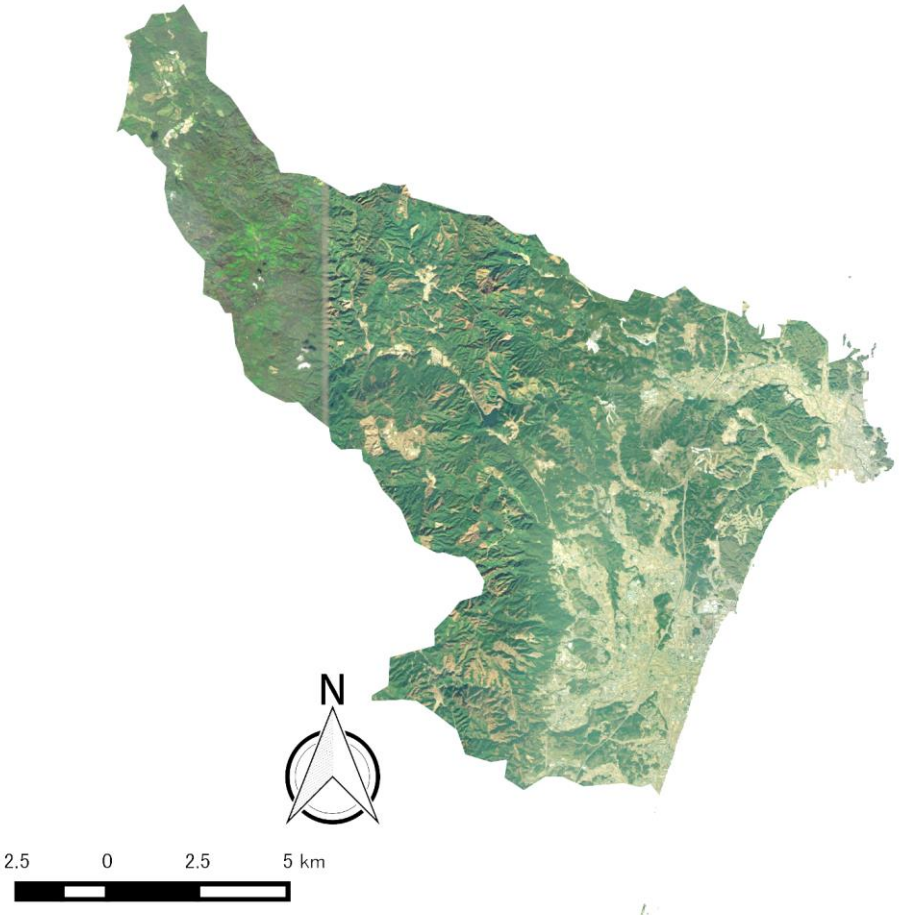
Objectives: Developing a DSA that

- Estimates impacts of policies to enhance wood production, and
- Suggests policies that alleviate the impacts

By a simulation model considering multiple decision makers.

Decision Support Approach

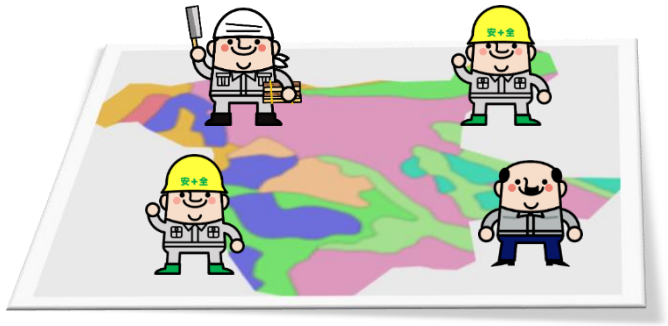
Study area : Kitaibaraki, Japan



- Plans to increase timber production.
- Preserve forest functions for local residents.

To estimate impacts the DSA contains:

- Stochastic simulation models, and



- Evaluation models for forest functions.

Stochastic Simulation

Alternative A

10 years later

Alternative B

10 years later

Alternative C

10 years later

Evaluation models

Wood production

Biodiversity

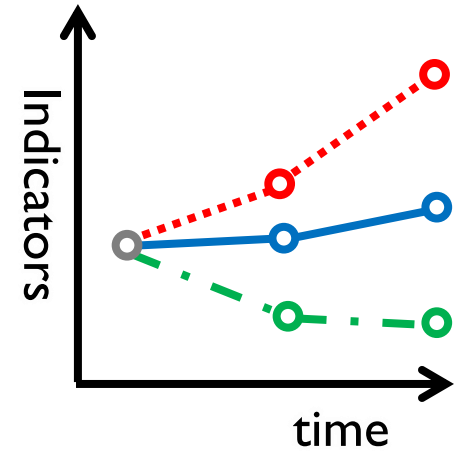
Soil erosion

Landslide

Carbon

Recreation

The changes of indicators in different alternatives



Alternatives

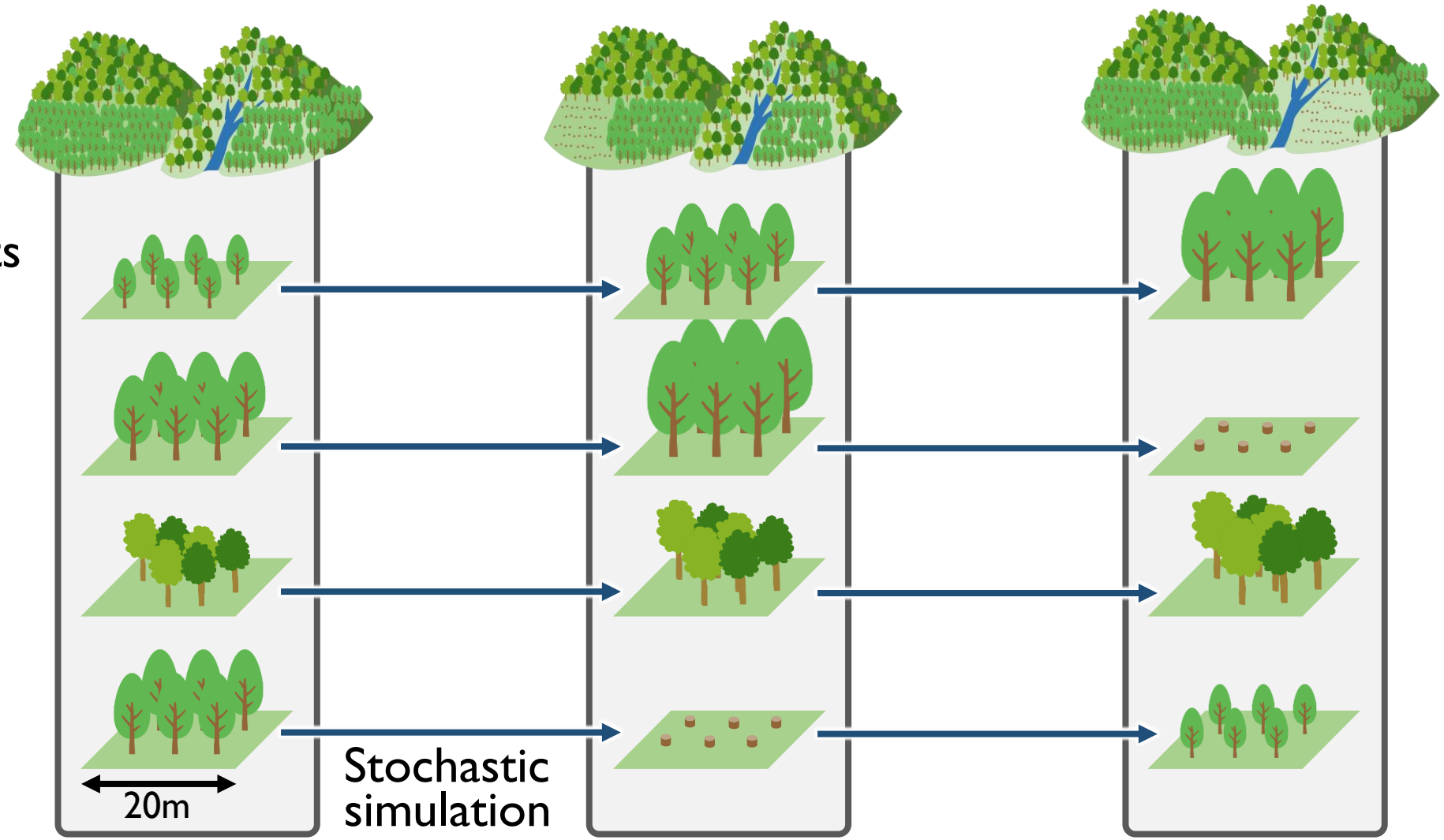
A

B

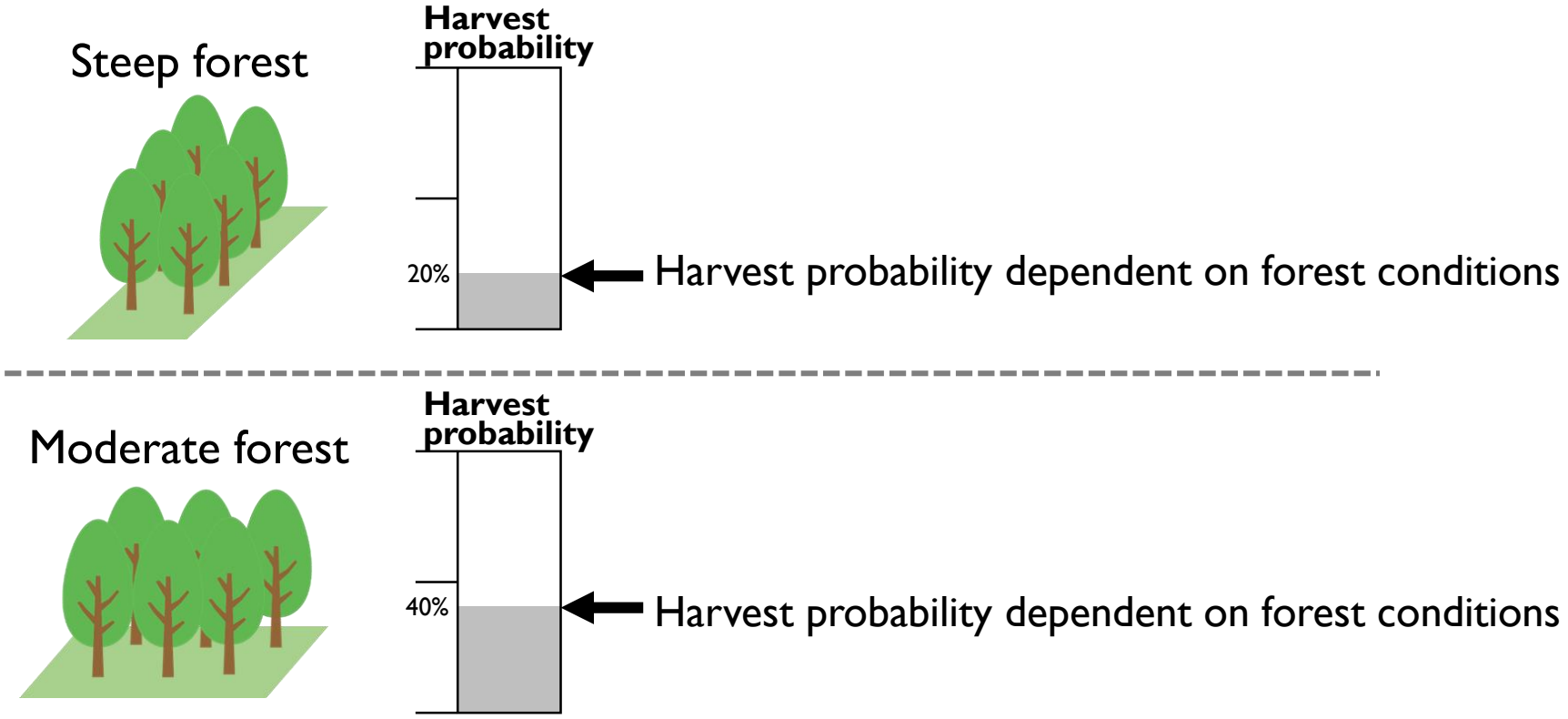
C

Microsimulation: simulating each forest separately

Dividing forests into 20m cells

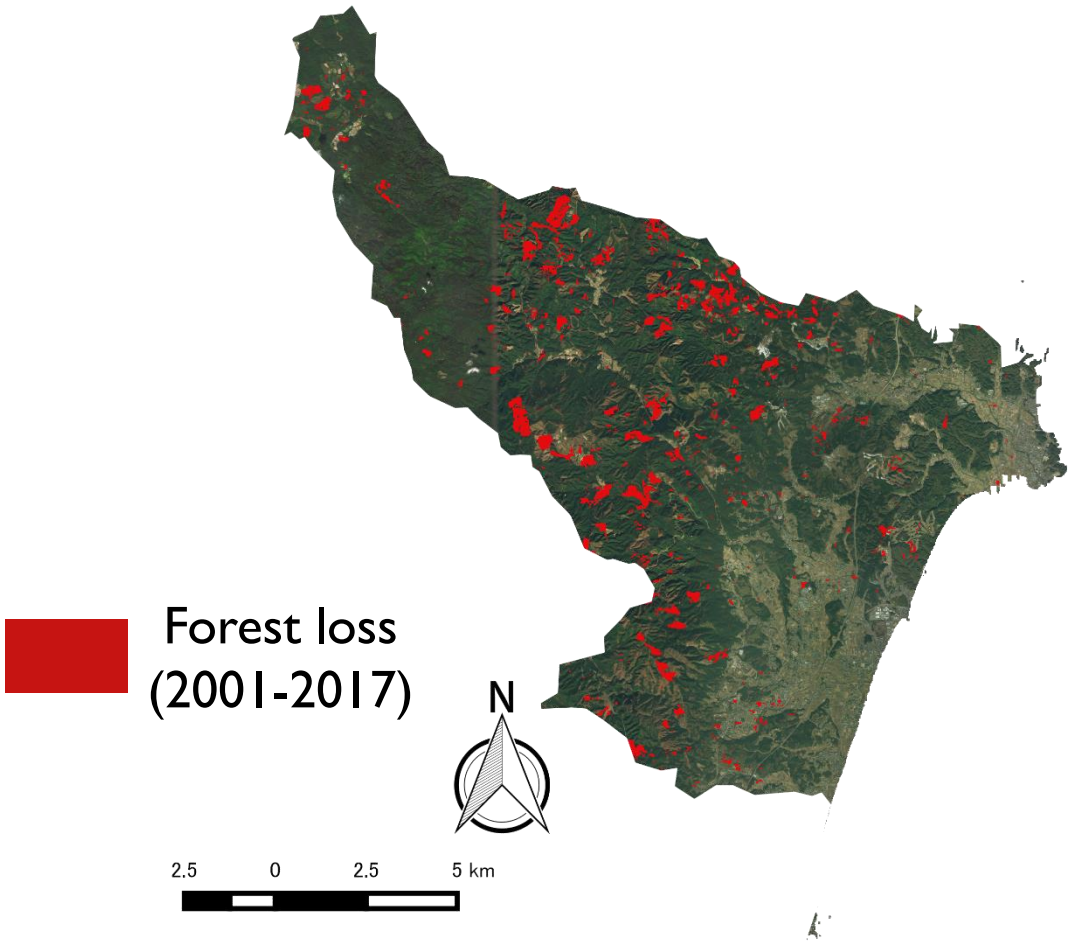


Microsimulation: simulating each forest separately



Harvest probabilities depend on forest conditions.

Harvest probabilities: estimated from data



Extracting harvested forest from
"Forest loss" map (Hansen et al., *Science* 2013)

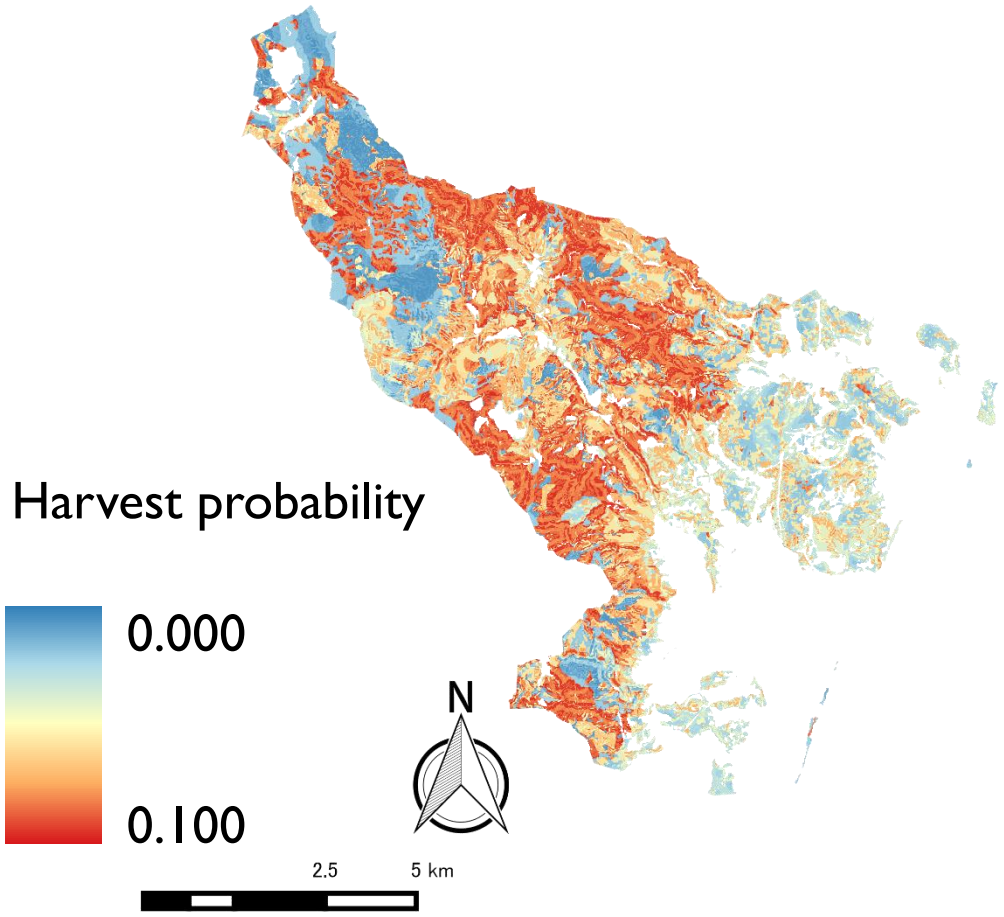
Analyzing conditions of harvested forest and estimate harvest probabilities

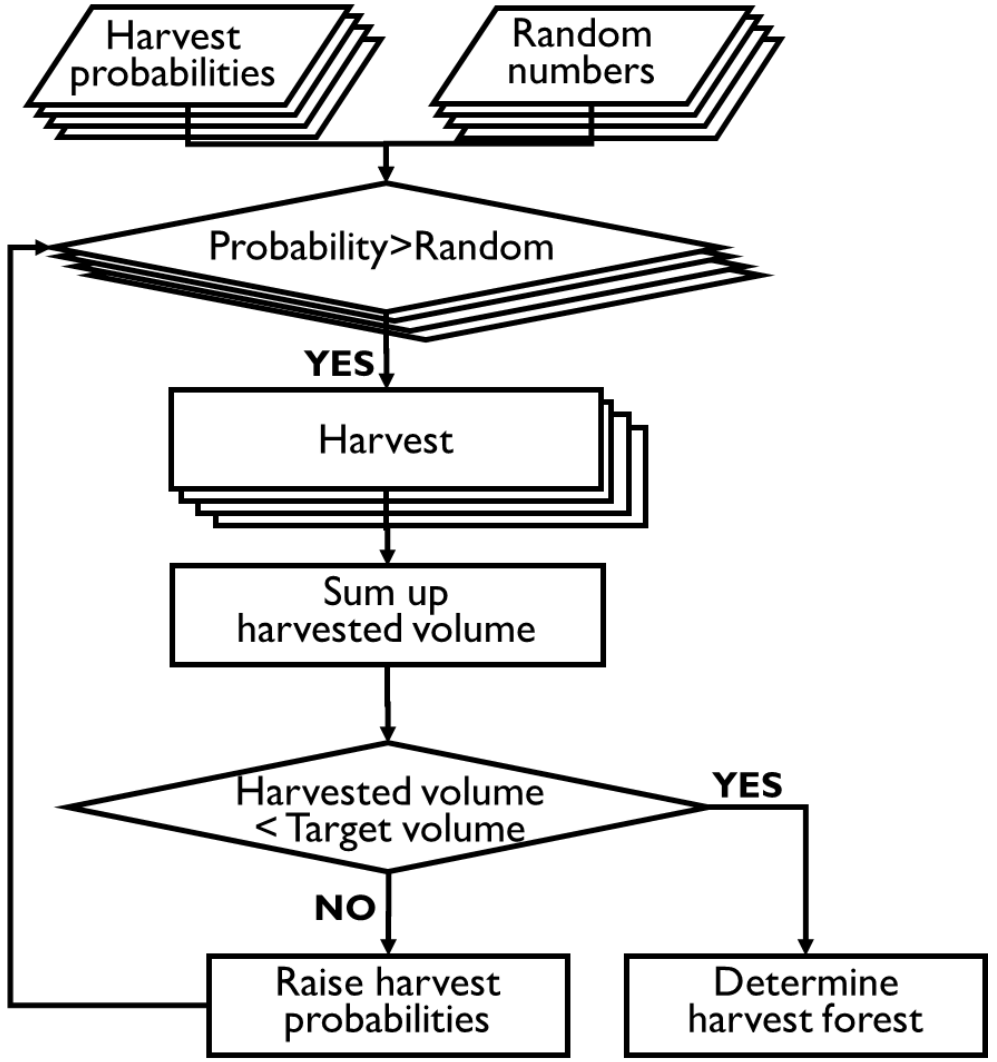
Private forest	or	National forest
Planted forest	or	Natural forest

Slope angle (0-, 15-, 30-, 35-)

Distance from road (0-, 100-, 200-, 300-)

Harvest probabilities: estimated from data





Stochastic Simulation

Alternative A

10 years later

Alternative B

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10 years later

Evaluation models

Wood production

Biodiversity

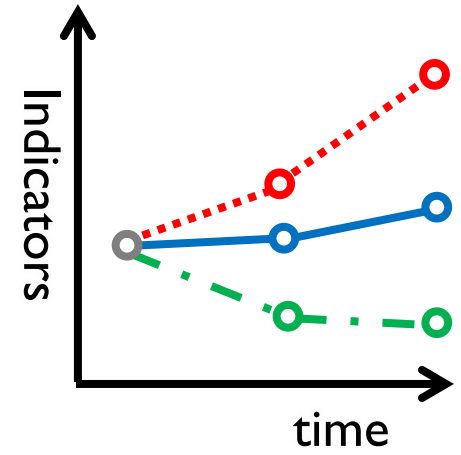
Soil erosion

Landslide

Carbon

Recreation

The changes of indicators in different alternatives



Alternatives

A

B

C

Functions	Indicator	Reference
Forestry	Indicator for forestry profitability	Yamizo Taga Regional Forest Plan
Biodiversity	Estimated density of large diameter trees, BA.	Yamaura et al. (2019)
Soil erosion	Amounts of eroded soil estimated by RUSLE method.	Renard et al. (1997)
Landslide	Ratio of forest area with high risk of landslides.	Forestry agency (2006)
Carbon	Carbon pools above and belowground parts in the area.	IPCC (2006)
Recreation	Indicator for accessibility and amenity	FFPRI(1995), Sugimura (2001), Takayama (2012)

Stochastic Simulation

Alternative A

10 years later

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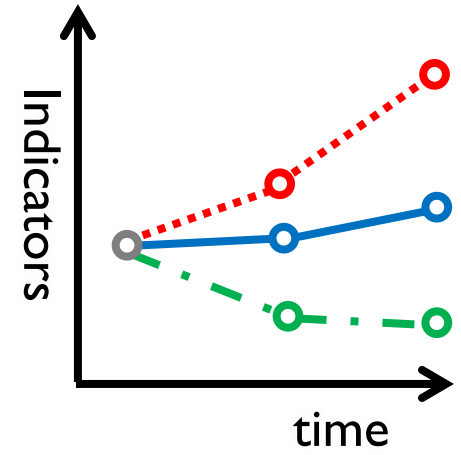

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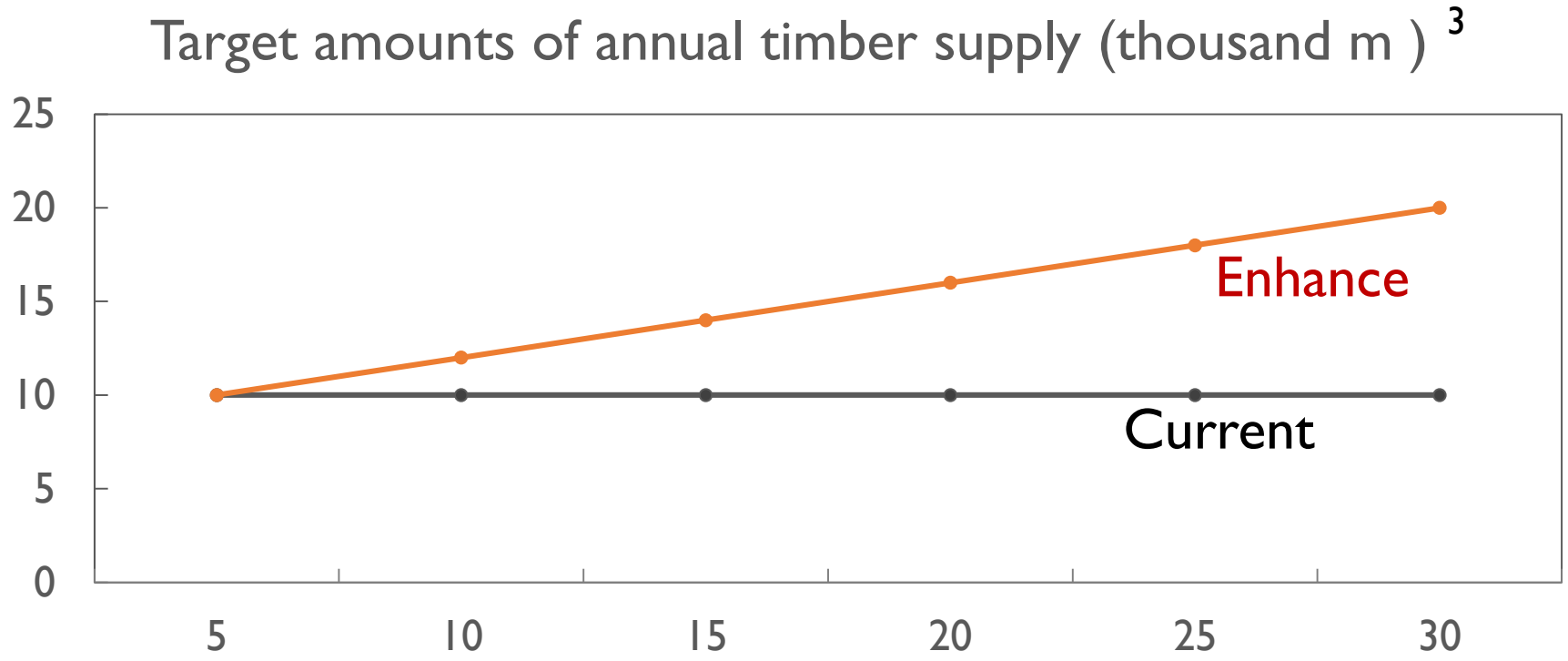


Policies	Current		Alternatives
Minimum harvest **age**	40	60	80
Obligating **reforestation**	<100m from road	<200m	<400m
Enhancing harvest inside **zone** (<100m from road)	Harvest probability 1time	1.5 times	2 times

Results

Forestry

Biodiversity

Soil erosion

Landslide

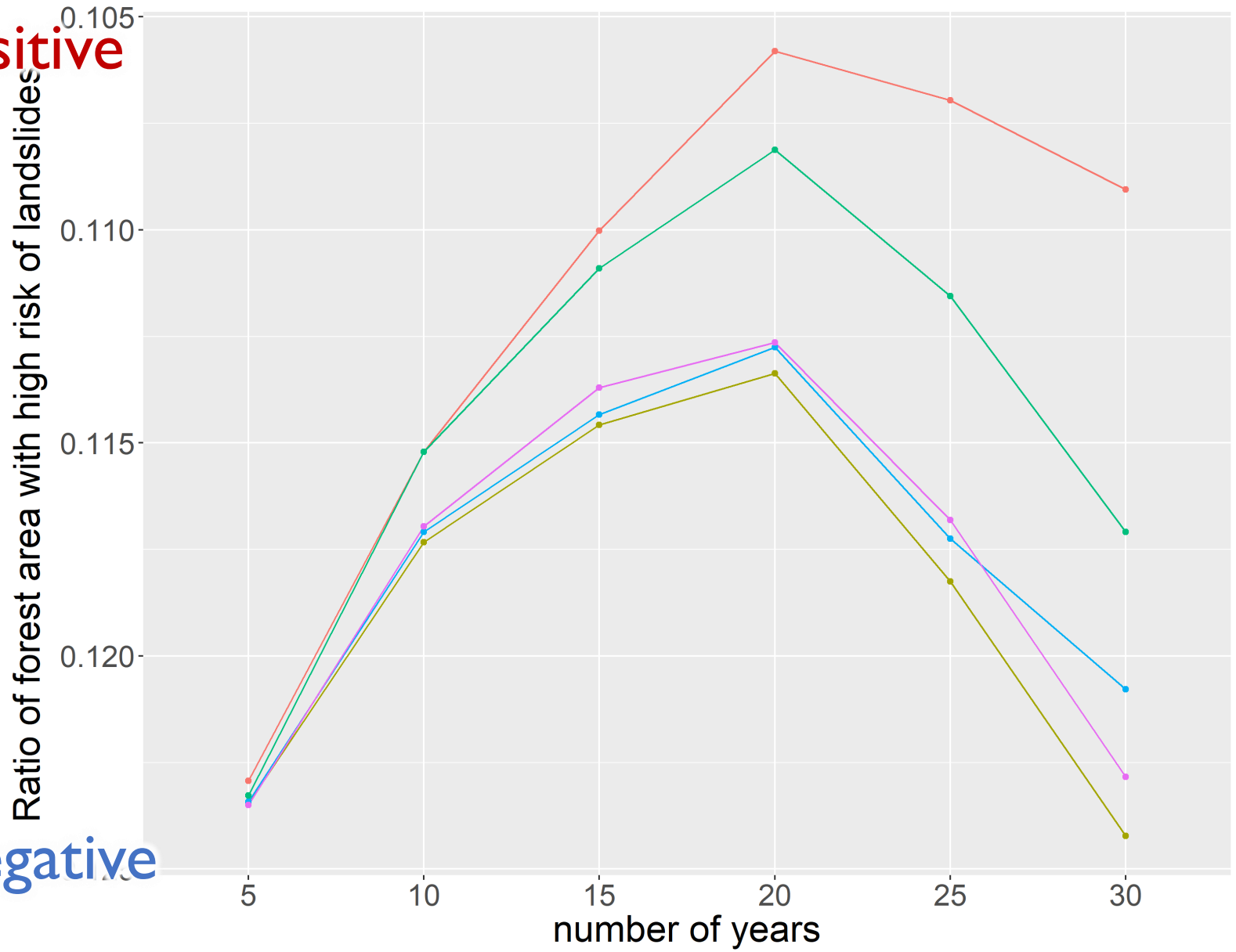
Carbon

Recreation

Landslides

Positive

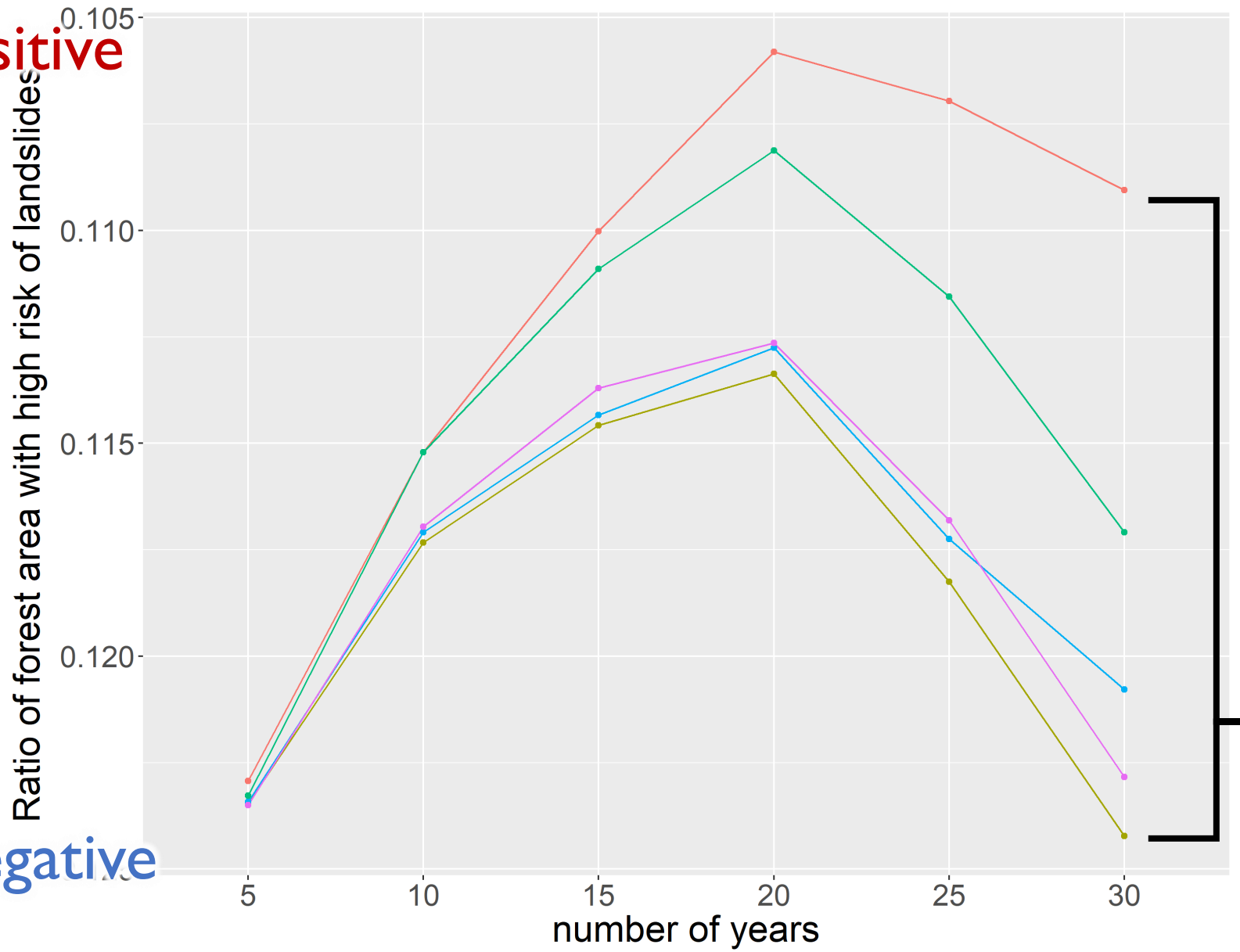
Negative



Landslides

Positive

Negative

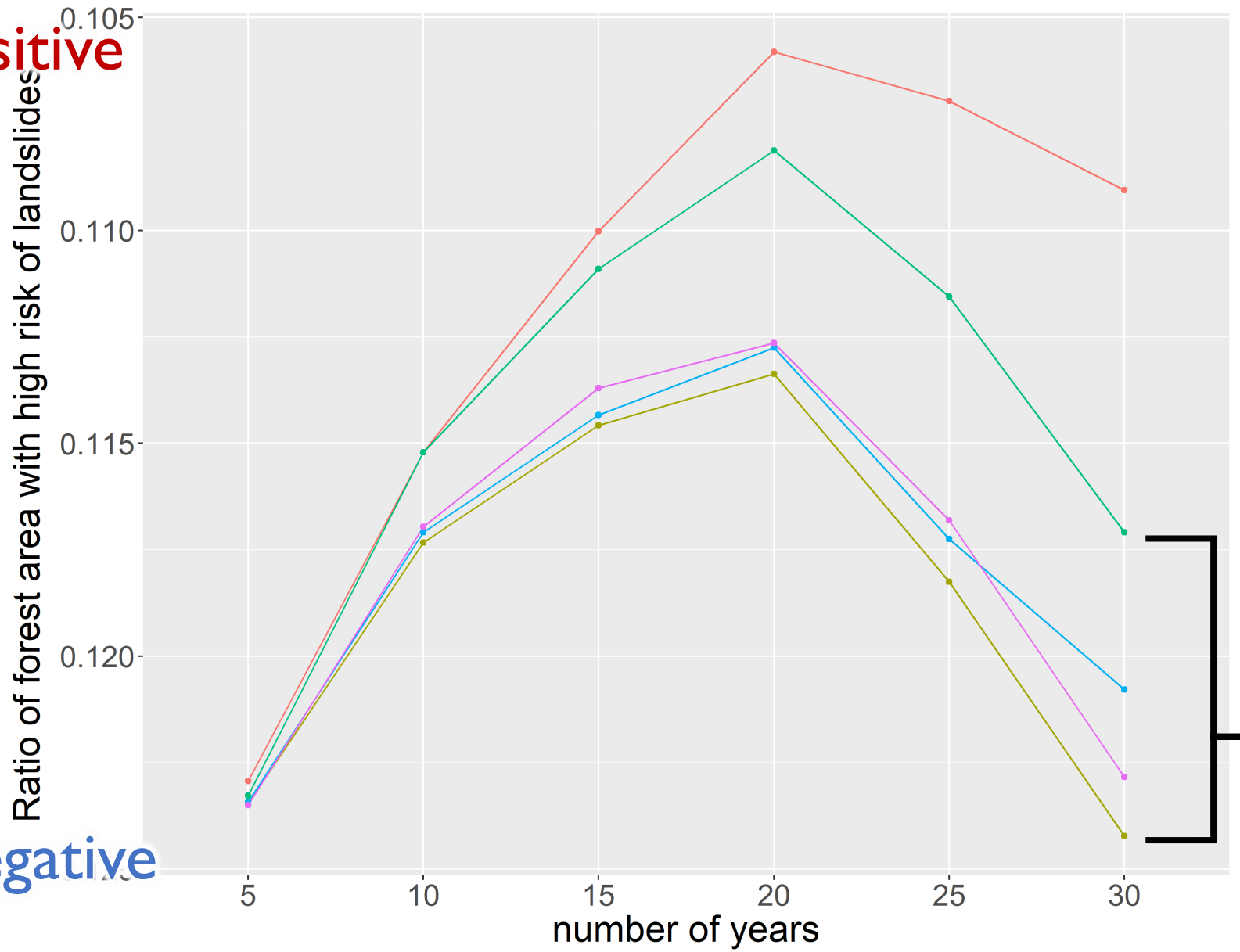


Impact of increasing production

Landslides

Positive

Negative



Forestry

Biodiversity

Soil erosion

Landslide

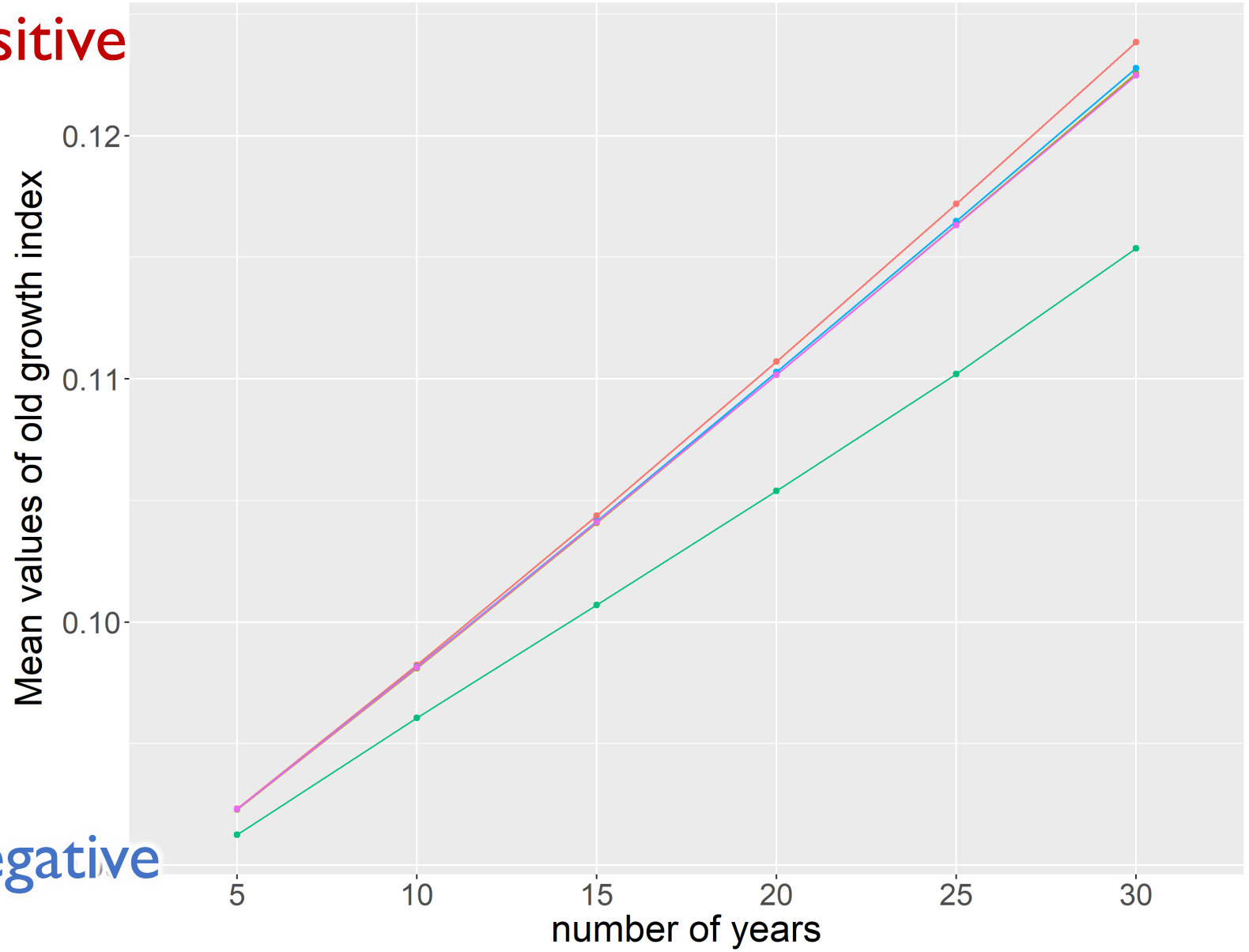
Carbon

Recreation

Biodiversity

Positive

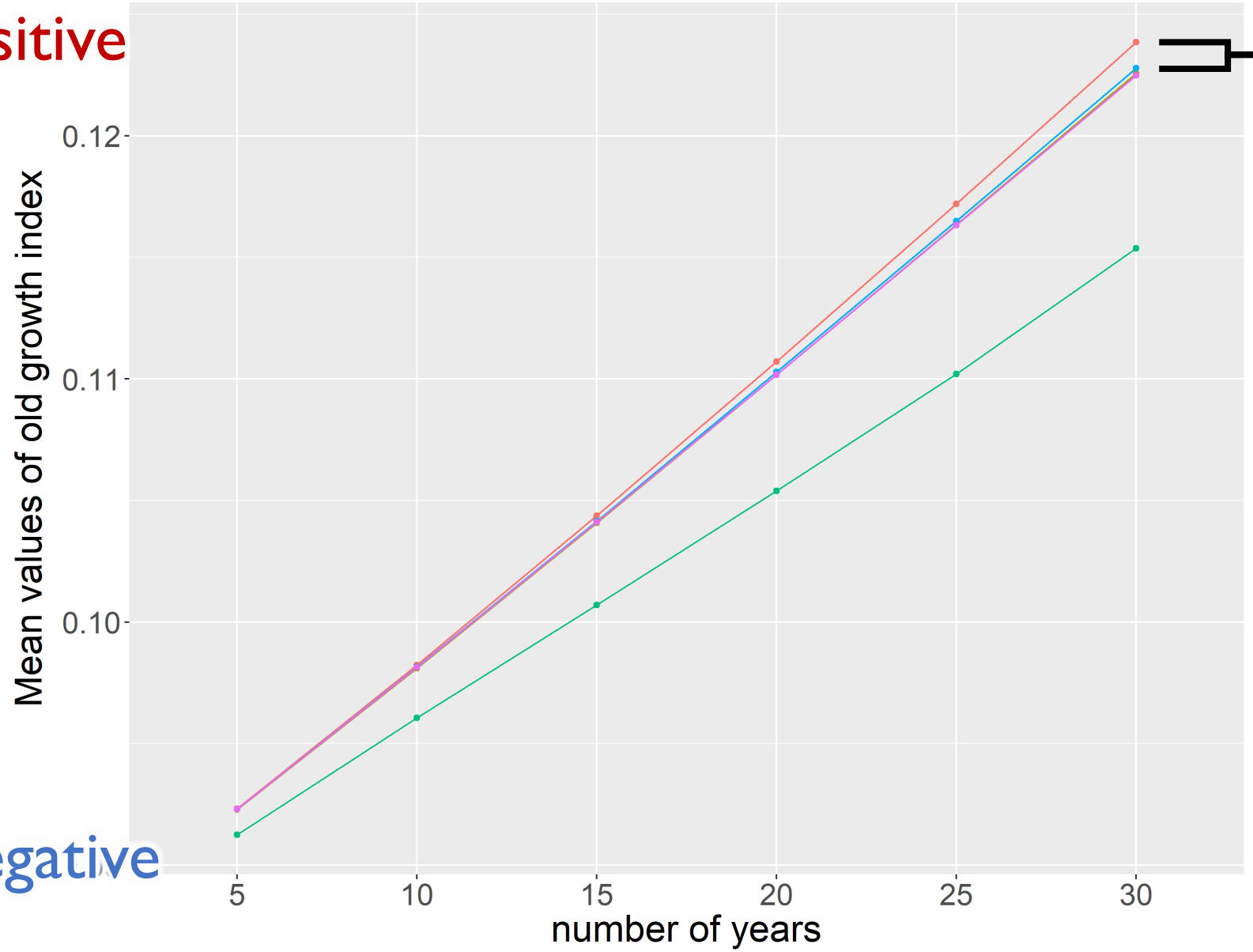
Negative



Biodiversity

Positive

Negative



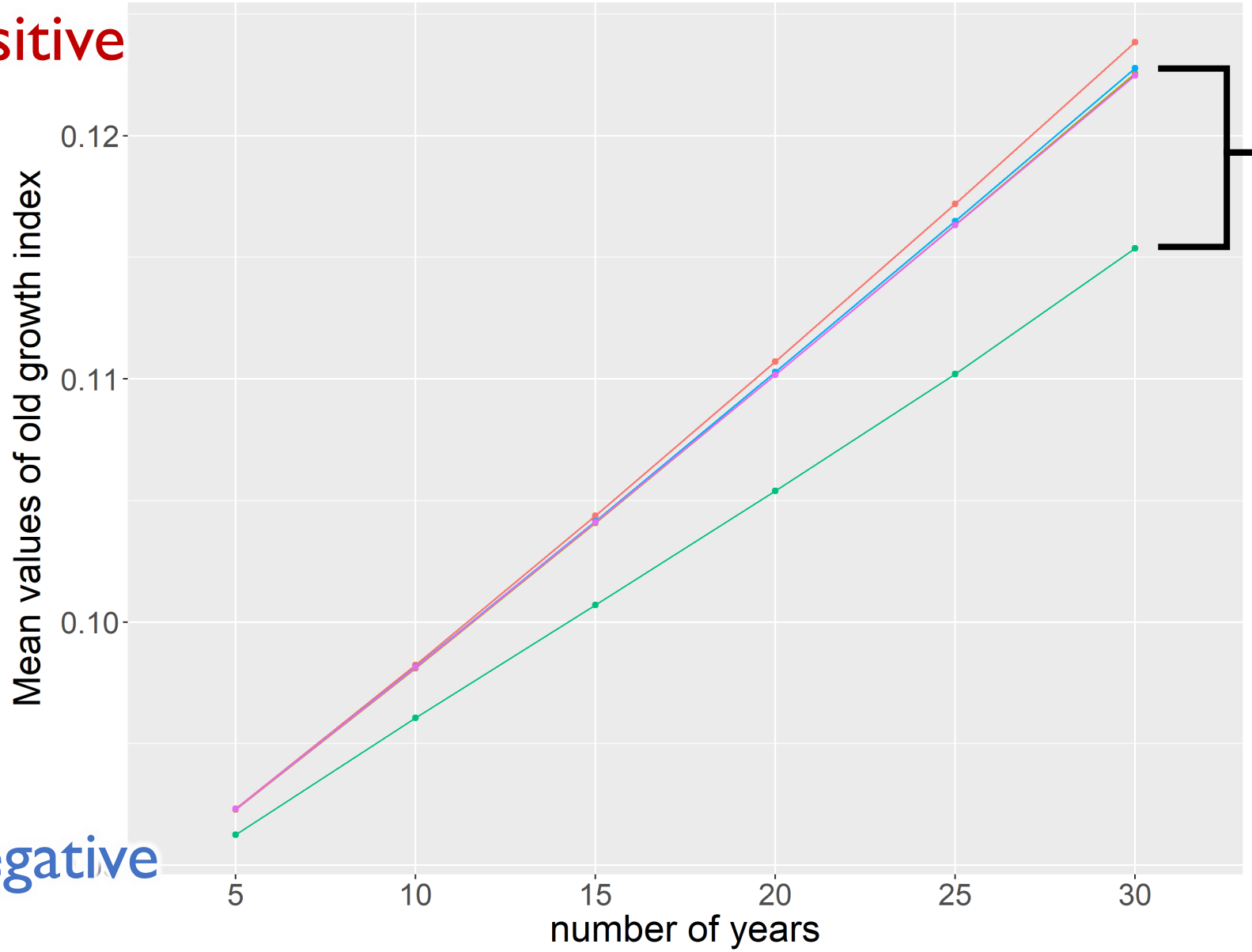
Impact of increasing production

policy
current
enhance
enhance+age
enhance+reforest
enhance+zone

Biodiversity

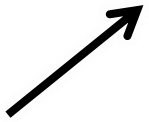
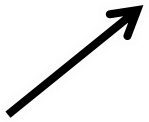
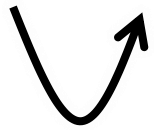
Positive

Negative



Damage
by the policy

policy
current
enhance
enhance+age
enhance+reforest
enhance+zone

Functions	Trends	Enhance	Harvest age	Reforestation	Zone
Forestry		−	+		
Biodiversity		−	− −		
Soil erosion		−	+	+ +	+
Landslide		−	+ +	+	+
Carbon		−		+	+
Recreation		−	−		− −

Functions	Trends	Enhance	Harvest age	Reforestation	Zone
Forestry	↗	−	+		
Biodiversity	↗	−	− −		
Soil erosion	↘↗	−			
Landslide	↗↘	−	− −	+	+
Carbon	↗	−		+	+
Recreation	↗	−	−		− −

Enhancing wood production harm forest functions.

Functions	Trends	Enhance	Harvest age	Reforestation	Zone
Forestry	↗	−	+		
Biodi			− −		
Soil e			+	+ +	+
Landslide	∩	−	+ +	+	+
Carbon	↗	−		+	+
Recreation	↗	−	−		− −

Alleviation policies have positive effects.

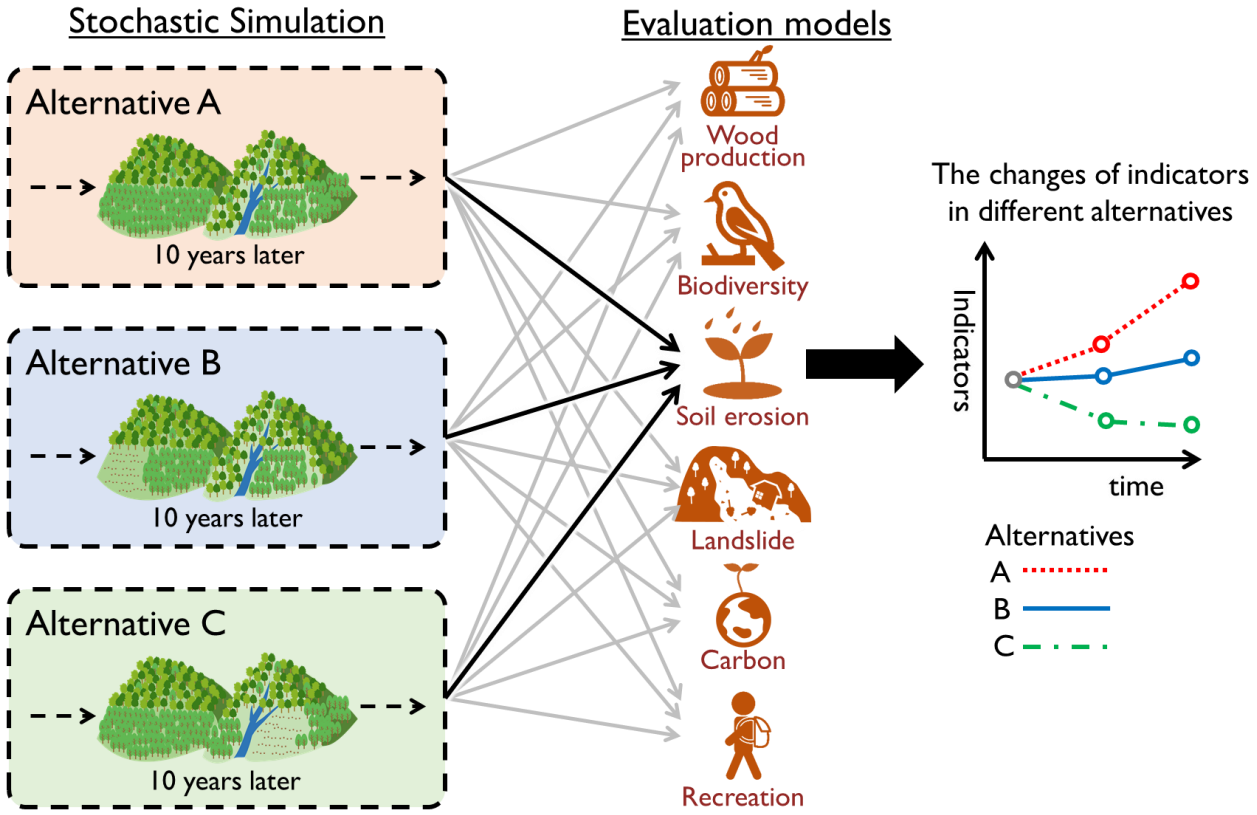
Functions	Trends	Enhance	Harvest age	Reforestation	Zone
Forestry	↗	−	+		
Biodiversity	↗	−	− −		
Soil erosi			+	+ +	+
Landslide			+ +	+	+
Carbon	↗	−		+	+
Recreation	↗	−	−		− −

Alleviation policies might be negative.

Functions	Trends	Enhance	Harvest age	Reforestation	Zone
Forestry	↗				
Biodiversity	↗	−	− −		
Soil erosion	↗	−	+	+ +	+
Landslide	↗	−	+ +	+	+
Carbon	↗	−		+	+
Recreation	↗	−	−		− −

Combining policies is a key for SFM.

Summary: We developed a DSA for regional forest management.



- Policies have both positive and negative effects.
- Combining different policies is important for SFM.

Conclusion:

- A stochastic simulation offers suggestive information.
- Policy makings should be with comprehensive view points.

The DSA can be a useful tool for regional SFM.

Further study would be:

- Verifying and improving accuracies of the simulation
- Organizing the approach to be a decision support system.

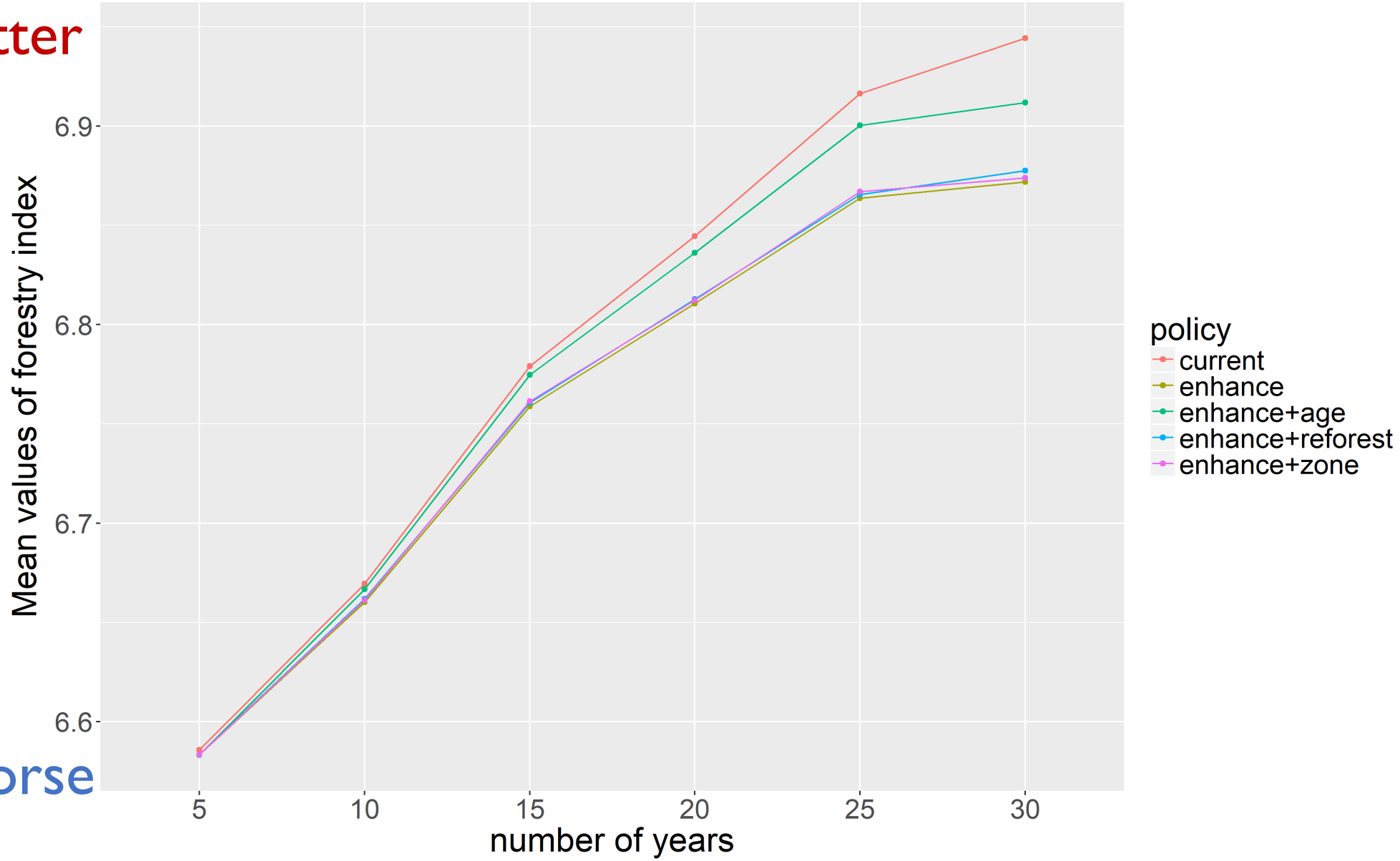
Obrigado!

Functions	Indicator	Factors
Forestry	Indicator for forestry profitability	Timber volume, slope, distance from road
Biodiversity	Estimated density of large diameter trees, BA.	Dominant species, age, topography, climate
Soil erosion	Amounts of eroded soil estimated by RUSLE method.	Dominant species, age, slope, precipitation, soil type
Landslide	Ratio of forest area with high risk of landslides.	Dominant species, age, slope, topography, soil type
Carbon	Carbon pools above and belowground parts in the area.	Dominant species, age, soil type
Recreation	Indicator for accessibility and amenity	Forest type, age, slope, distance from road

Forestry

Better

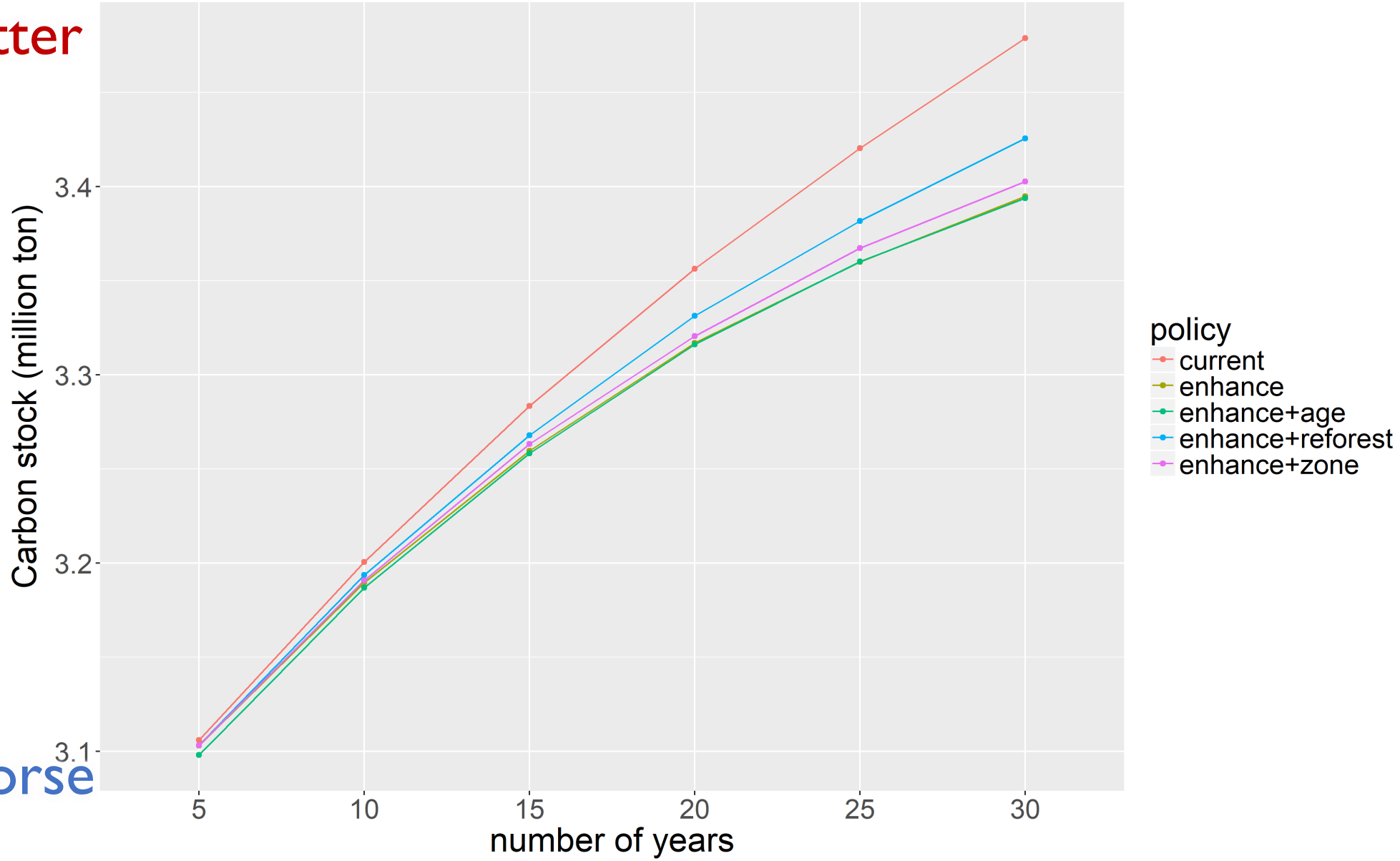
Worse



Carbon

Better

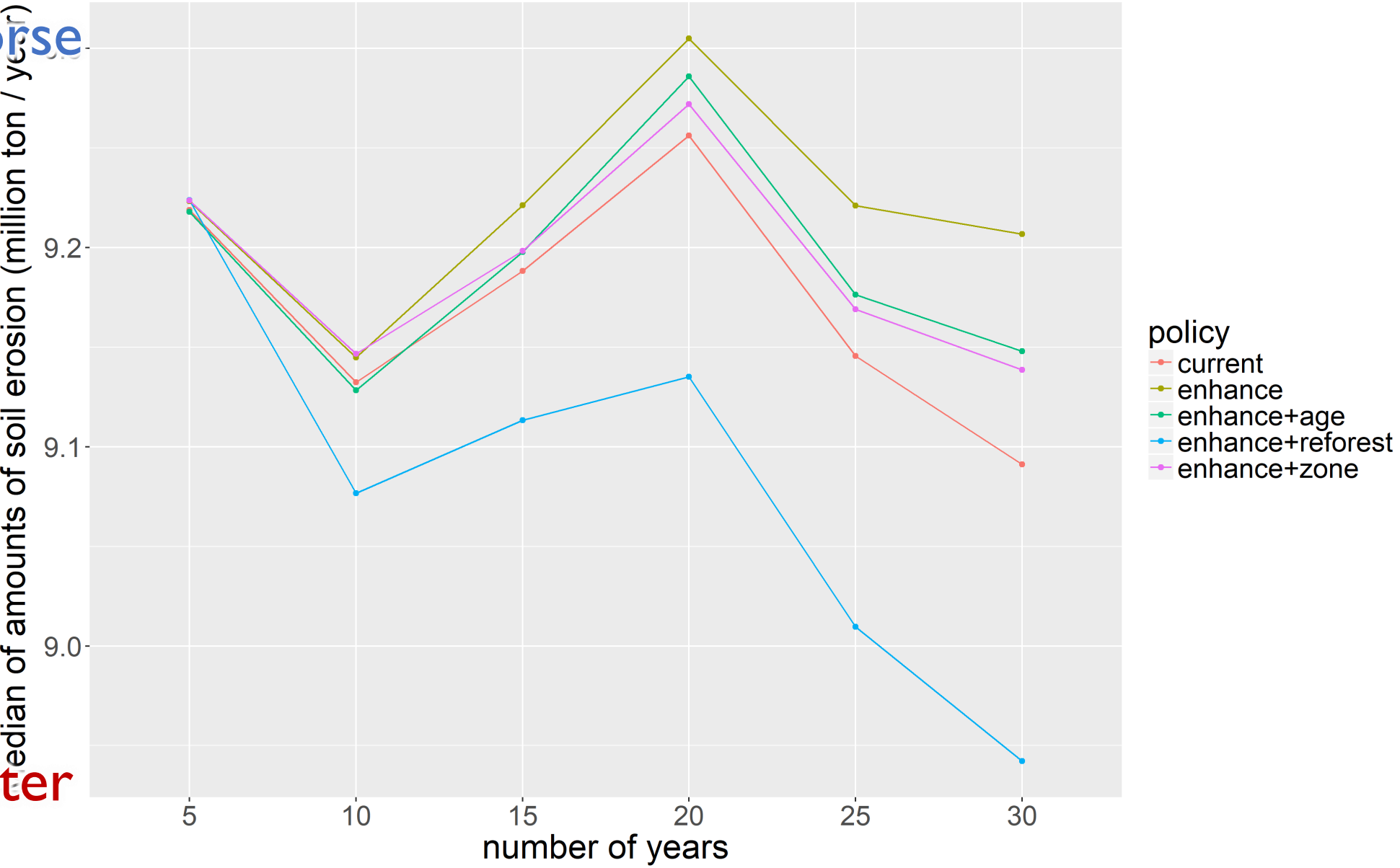
Worse



Soil erosion

Worse

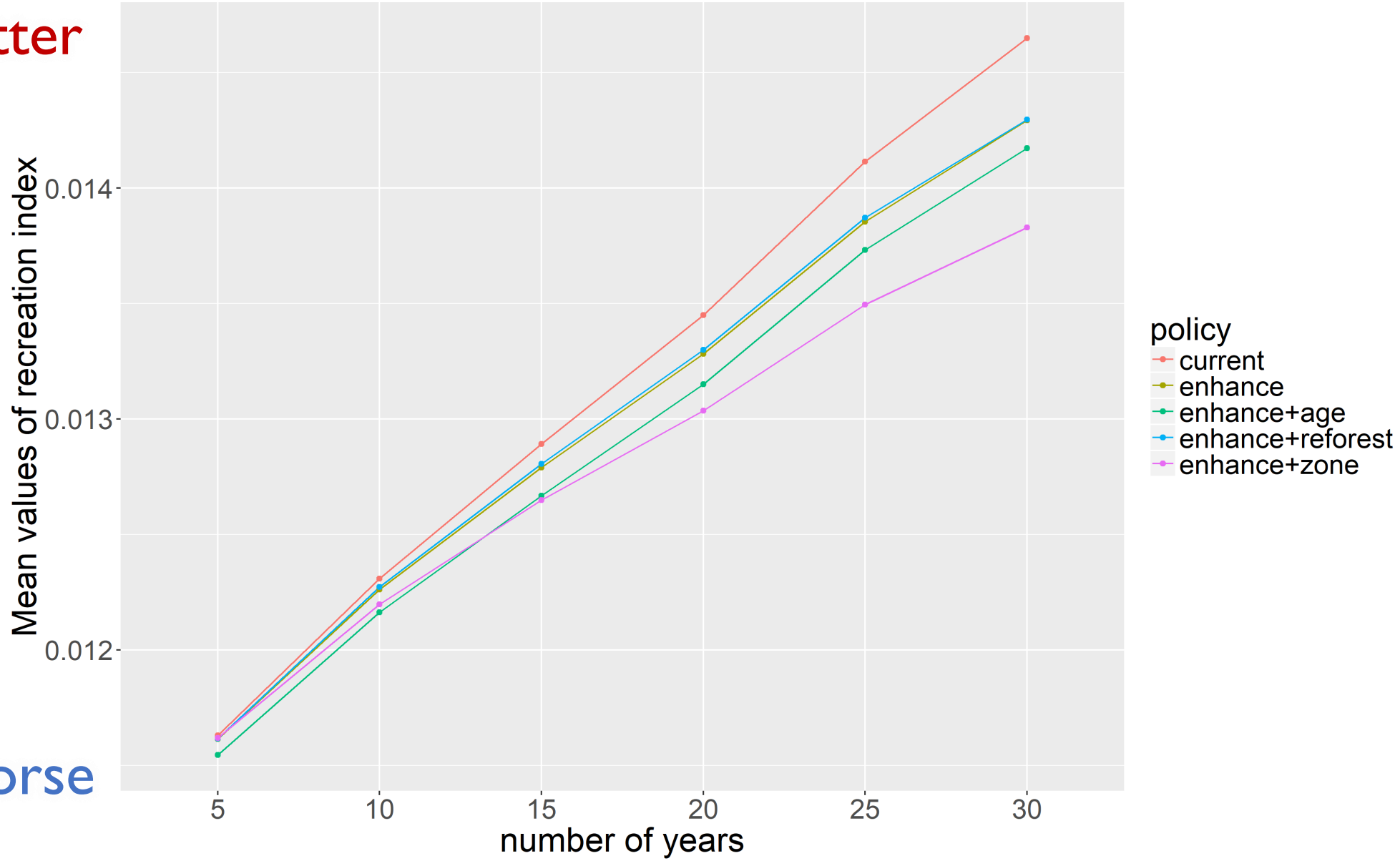
Better



Recreation

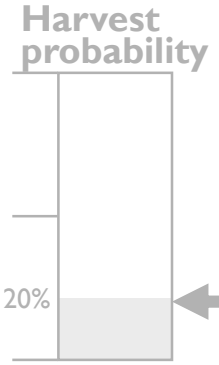
Better

Worse



Local policies aim to enhance or regulate harvest probabilities.

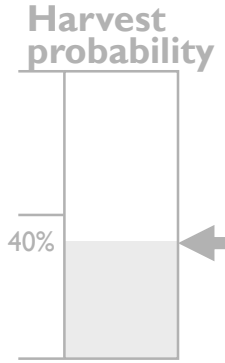
Steep forest



Harvest probability dependent on forest conditions

不要？

Moderate forest



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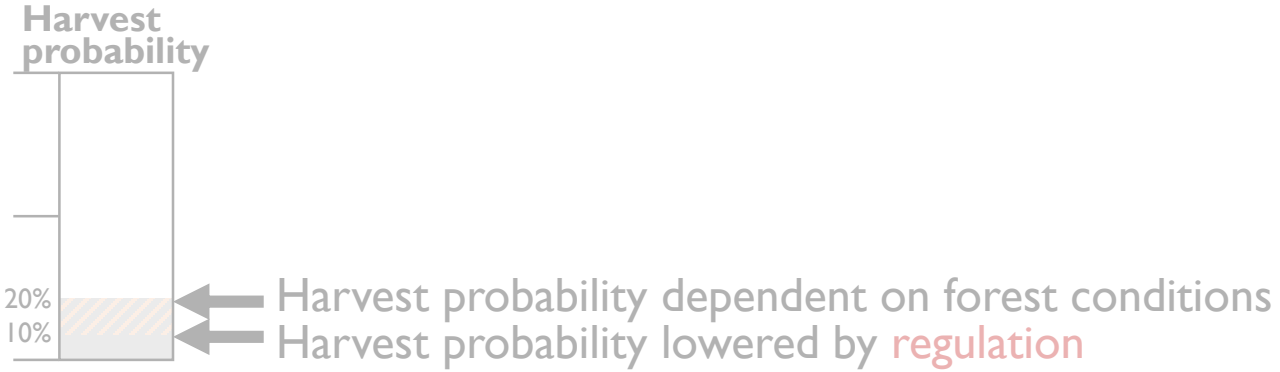

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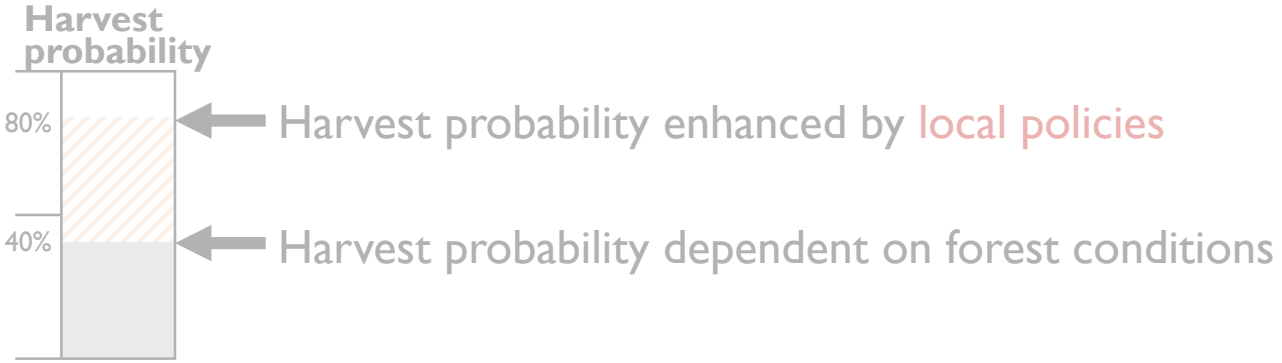
Moderate forest