A model for forest cover change interpreting the impacts of institutions and polices

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Choice of land use is determined by

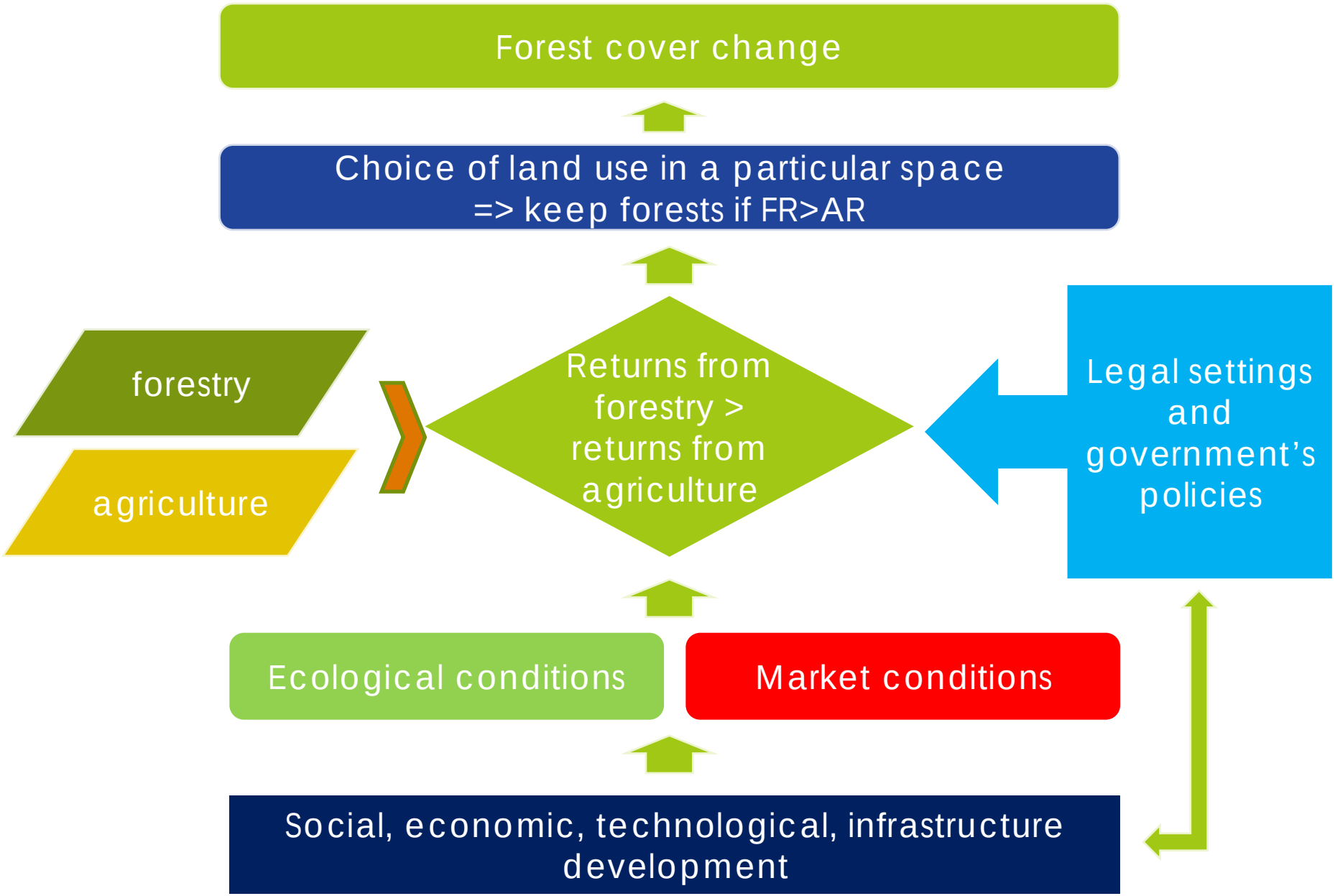
- The land owner or occupant ("owner").
- The returns of benefits to the "owner" from land use depends on the yield and price of the product or services.
- To keep a parcel of land as forest, the returns should be larger than the opportunity costs (OC), i.e. the value to be foregone in order to keep it as forest.

△forest cover = f (OC of keeping forest)

- The Factors listed below determines OC:
  - **Legal settings** (including land/tree property rights, land use restrictions, international conventions and agreements)
  - **Social development** such as population density and social capital (measured in terms of transparency)
  - **Economic development** such as GDP per capita, the public's concerns of environmental quality (literary rate) and infrastructure development
  - **Technological development** such as agricultural productivity increase and ICT advancement
  - **Ecological factors** such as land productivity, climate change
  - **Market conditions** (prices of forest products, shadow price of ecosystems services, agricultural crops, energy, and capital)

forest cover = f (OC of keeping forest)

- Government's policies (including trade restriction, subsidies, taxes, energy supply, control of foreign investment, etc.) influence the factors above.


Forest cover change
Choice of land use in a particular space
=> keep forests if FR>AR
forestry
agriculture
Returns from forestry > returns from agriculture
Legal settings and government's policies
Ecological conditions
Market conditions
Social, economic, technological, infrastructure development

Institutions and governance

- A forest policy can be effective not only when the social and economic environments are favorable, but also when institutions can support the policy.
- Therefore, “Policy integration” should be based on institutions for forest governance.
- A policy can be integrated horizontally and vertically.
- To design policy interventions geared for forest transition, we have to understand the society in terms of social, economic, ecological, cultural and spiritual context.

Vietnam

- Forest cover change = f(x)
- X is composed of :
  - Property right arrangement
  - Financial arrangement (loans for planting trees)
  - Timber demand (prices)
  - Agricultural productivity
  - PES for forest conservation
  - Law enforcement for forest protection

India

- Forest cover change = f(x)
- X is composed of :
  - Agricultural productivity
  - Timber demand supporting timber price
  - Timber tenure arrangement supporting people's participation in forest management
  - Non-timber value of forest increased
  - Economic growth
  - Trade policy liberalizing timber import

Malaysia

- Forest cover change = f(x)
- X is composed of :
  - Economic development (GDP per capita)
  - Population growth
  - Demand for timber from overseas
  - Agriculture expansion (export of palm oil)

Japan

- Forest cover change = f(x)
- X is composed of :
  - Property right (privatization of national forests)
  - Population growth, aging population
  - Economic development (GDP per capita)
  - Agricultural productivity
  - Urbanization
  - Timber trade liberalizing import
  - Energy substitution
  - Non-timber value of forest increased

Laos

- Forest cover change = f(x)
- X is composed of :
  - Economic development (GDP per capita)
  - Weak law enforcement - Illegal logging
  - Industrial plantations – rubber
  - Infrastructure development
  - Foreign investment (esp. from China)
  - Shifting cultivation

Indonesia

- Forest cover change = f(x)
- X is composed of :
  - investment policy (Logging timber)
  - Population
  - Transition to regional autonomy, Decentralization
  - Timber production and logging concession
  - Agricultural area expansion (rubber, oil palm plantation)
  - Migration
  - Shifting cultivation and forest fire
  - Illegal logging
  - Government polity or movement

Philippines

- Forest cover change = f(x)
- X is composed of :
  - Logging
  - Shifting cultivation
  - Fuel wood consumption
  - Population growth
  - Poverty
  - Corruption
  - Weak law enforcement
  - Unstable policy
  - Land tenure

China

- Forest cover change = f(x)
- X is composed of :
  - Agriculture expansion
  - Fuel wood consumption
  - Afforestation and deforestation
  - Forest tenure
  - Strict law enforcement
  - Forest ownership reform
  - Government investment in forestry
  - Natural forest protection program
  - Urban and rural population
  - Economic development, Per capita income increase
  - Globalization and Timber trade
  - International environmental agreement of institution

Korea (South)

- Forest cover change = f(x)
- X is composed of :
  - Economic development
  - Policy integration (fuel wood, Community movement...)
  - Population migration
  - Public participation
  - Agriculture expansion
  - Agricultural productivity
  - Political leadership
  - Environmental concerns

How can we measure the impacts of policy variables on forest cover change ?

- The returns of agriculture and forestry can depend on:
  - Technology development (crop yield/ha)
  - Wage rate (GDP per capita)
  - Crop/timber (stumpage) prices
  - Compensation for ecosystems services/ subsidies for social functions (of agriculture)
  - Infrastructure development (road density)
  - Trade policy (trade restriction)
  - Private property rights including land tenure
  - Social capital (Corruption)

macro-economics	GDP
	interest rate
	investment
	saving
	inflation rate
	import-export
	growth rate
	income distrebution
world external factor	global timber price
	oil price
	convention
	agreement
social & demograghic factor	population
	population distribution
	population growth rate
	urbanization
	age structure
	migration rate
	literacy
	population density
	infrastucture

Technological development	Agricultural productivity
	Forestry productivity
government policies	Land / forest tenure
	forest conservation
	afforestation & forest plantation
	watershed conservasion
	timber import/export
	notifiesd forest land
	land change restriction
	forest administration
	energy use
	domestic timber production
	biodiversity conservation

country	Private owners	Pop growth	Law & social capital	Environ mental concern	GDP per capita	Road density	Crop yield	Timber scarcity	Government policies
China	timber tenure	low	Law enforced	high	Fast grow	high	high	yes	PES, trade liberalization
India	timber tenure	middle	Law enforced	high	Fast grow	?	High	yes	Trade liberalization
Japan	privatization	low	Law enforced	high	Fast grow	high	High	yes	trade liberalization
Korea	privatization	low	Law enforced	high	Fast grow	High	High	yes	trade liberalization
Vietnam	timber tenure	?	Law enforced	?	Fast grow	high	High	yes	trade liberalization
Indonesia	?	high	weak	?	Low grow	increased	Low	no	migration
Laos	?	high	weak	?	Low grow	?	Low	No	Foreign investment
Malaysia	?	high	Weak ?	?	Fast grow	increased	?	no	Log export ban
Philippines	?	high	weak	?	Low grow	high	?	yes	Logging ban
DPRK									

country	Private owners	Pop growth	Law & social capital	Environ mental concern	GDP per capita	Road density	Crop yield	Timber scarcity	Government policies
China	1	0	1	1	1	1	1	1	1
India	1	0	1	1	1	?	1	1	1
Japan	0	0	1	1	1	1	1	1	1
Korea	0	0	1	1	1	1	1	1	1
Vietnam	1	?	1	?	1	1	1	1	1
Indonesia	?	1	0	?	0	0	0	0	0
Laos	?	1	0	?	0	?	0	0	0
Malaysia	?	1	?	?	1	0	?	0	1
Philippines	?	1	0	?	0	?	?	1	1
DPRK									

Research Questions on Forest Policy Design for Forest Transition

1. Which factors are essential for FT occurrence in a country or region?
2. Which factors are factors hindering FT occurrence ?
3. Which factors are common factors for the cases of FT occurrence?
4. Which factors are common factors for the cases of not-yet FT occurrence ?

A **Boolean algebra** is a six-tuple consisting of a set A, equipped with two binary operations $\wedge$ (called "meet" or "and"), $\vee$ (called "join" or "or"), a unary operation $\neg$ (called "complement" or "not") and two elements 0 and 1 (called "bottom" and "top", or "least" and "greatest" element, also denoted by the symbols $\bot$ and $\top$, respectively), such that for all elements a, b and c of A, the following axioms hold:

A Boolean algebra with only one element is called a **trivial Boolean algebra** or a **degenerate Boolean algebra**.

It follows from the last three pairs of axioms above (identity, distributivity and complements) that

$$a = b \wedge a \quad \text{if and only if} \quad a \vee b = b.$$

The relation $\leq$ defined by $a \leq b$ if these equivalent conditions hold, is a partial order with least element 0 and greatest element 1. The meet $a \wedge b$ and the join $a \vee b$ of two elements coincide with their infimum and supremum, respectively, with respect to $\leq$.

The first four pairs of axioms constitute a definition of a bounded lattice.
It follows from the first five pairs of axioms that any complement is unique.

The set of axioms is self-dual in the sense that if one exchanges $\vee$ with $\wedge$ and 0 with 1 in an axiom, the result is again an axiom.

Therefore by applying this operation to a Boolean algebra (or Boolean lattice), one obtains another Boolean algebra with the same elements; it is called its **dual**.

$a \vee (b \vee c) = (a \vee b) \vee c$	$a \wedge (b \wedge c) = (a \wedge b) \wedge c$	associativity
$a \vee b = b \vee a$	$a \wedge b = b \wedge a$	commutativity
$a \vee (a \wedge b) = a$	$a \wedge (a \vee b) = a$	absorption
$a \vee 0 = a$	$a \wedge 1 = a$	identity
$a \vee (b \wedge c) = (a \vee b) \wedge (a \vee c)$	$a \wedge (b \vee c) = (a \wedge b) \vee (a \wedge c)$	distributivity
$a \vee \neg a = 1$	$a \wedge \neg a = 0$	complements