

Agent-based Framework of Empirical Land Use/Cover Change Model

for Simulating Relationships between Land Degradation, Household Behavior and Policy Implementation in Northeast China

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1. Introduction (background 1/2)

➤ LUCC

- Change in a coupled human-environment system
- Fundamental process for better land management
- Complex process related to various disciplines

➤ Recent studies on LUCC

- Need of understanding people's decision-making
- Lack of spatial and interactive action among actors

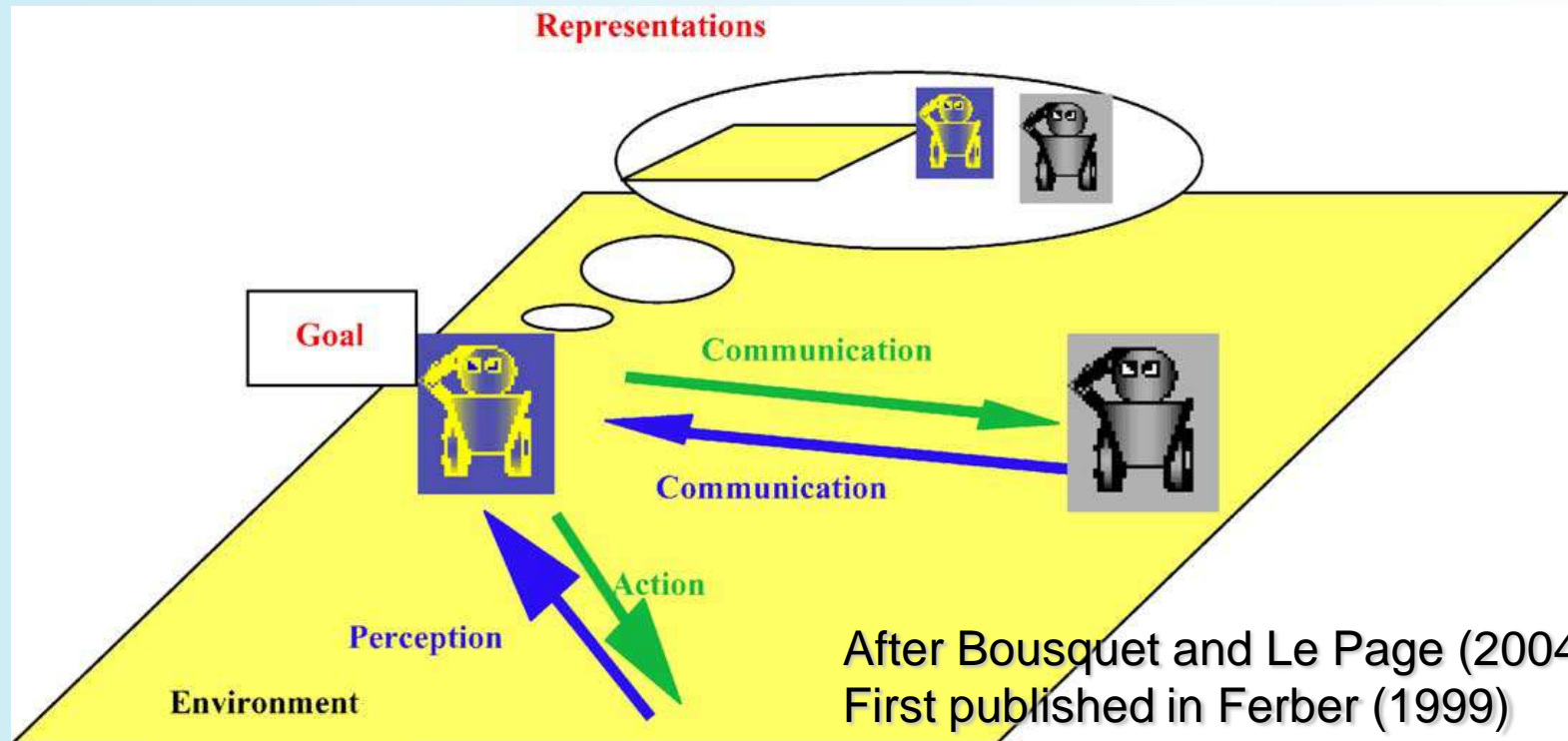
➤ Attention to MAS

- Modeling approach to meet the recent demands

What is MAS?

“A multi-agent system is a community of agents, situated in an environment”

(Benenson and Torrens, 2004)



After Bousquet and Le Page (2004)
First published in Ferber (1999)

1. Introduction (background 2/2)

- Issues on current MAS-LUCC models
 - Earlier hypothetical and experimental examples
 - Challenge to further develop empirical methods
- Desertification problem
 - Need for appropriate land use management
 - Much unknown knowledge to build LUCC models

Not only empirical data but also new findings need to be integrated in MAS-LUCC models

1. Introduction (objectives)

Final goal

Appropriate land use planning in desertified area

Approach

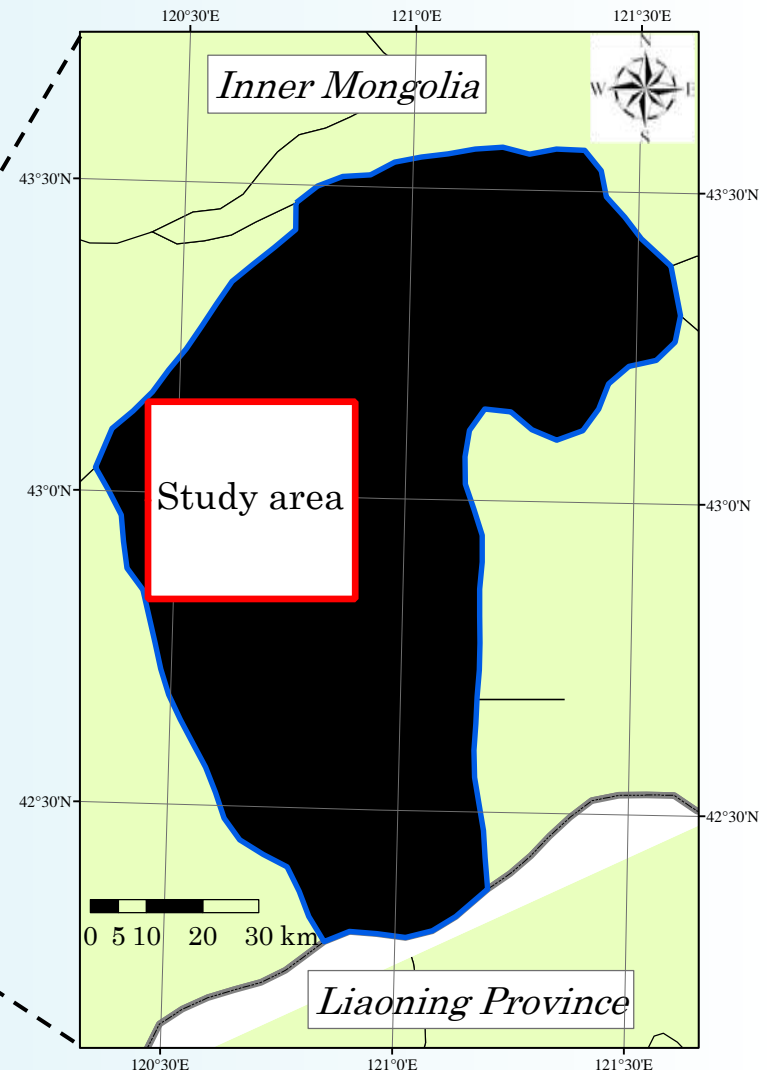
Construct an empirical MAS-LUCC model
&

Simulate dynamics between land degradation,
household behavior, and policy implementation

In this presentation, we show our conceptual MAS-LUCC model and our previous work to construct the model

2. Study area

- Daqintala Town, Inner Mongolia, China
- Mean annual precipitation and temperature: 366 mm and 6.8°C
- An agro-pastoral transition zone in NE China



3. Conceptual model

(Policy impact analysis)

Current and hypothetical desertification-related policies

Impact

Impact

Household state

Responses

Biophysical response sub model

Decision-making sub model

Tenure relations

Landscape state

Actions

(Household agent)

(Landscape agent)

Interactions between agents

(Household decision-making module)

(Landscape dynamics module)

4. Previous and ongoing work

4.1. Identification of typical land use types by interview

4.2., 4.3., and 4.4 → *Biophysical response sub model*

Ecological field surveys on land degradation and restoration according to the typical land use types

4.5. → *Landscape state*

Remote sensing analysis on the spatial distribution of the typical land use types

4.6. → *Policy impact analysis*

Interview survey on processes of policy implementation

4.7. → *Household state and Decision-making sub model*

Household survey and some analyses (ongoing)

4.1. Typical land use type



Maize cropland
on **lowland**



Maize cropland
on **flat sand land**



Bean-centered
cropland on
sand dunes



4.2. Land degradation patterns by typical cropland types

➤ Ecological field survey

- Changes in crop biomass, floristic composition, and soil properties according to the durations of cultivation in each typical cropland type

➤ Results

- Significantly different patterns of those temporal changes between the typical cropland types



4.3. Land degradation patterns by typical rangeland types

➤ Literature review

Studies on rangeland degradation in this area

➤ Results

No studies on temporal pattern of rangeland degradation, except for a grazing experiment

–Temporal changes in sheep liveweight under different grazing intensity

–Temporal changes in vegetation and soil conditions according to differences in topography



4.4. Land restoration patterns by key restoration measures

➤ Ecological field survey

- Temporal changes in floristic composition and soil properties by key restoration measures in this area, considering topographic types

➤ Results

- Progress of vegetation and soil restoration along a topographic gradient
- Significantly different speed of the restoration among the restoration measures



4.5. Spatial distribution of typical land use types

- **Satellite remote sensing analyses**
 - Land use/cover (LUC) classification by an object-oriented analysis
 - Generation of a digital surface model by photogrammetry
 - Landform classification using generated the surface model
- **Results**
 - Accurate LUC and landform classification maps
 - Regional extraction of the typical land use types



4.6. Social process of policy implementation

➤ Social field survey and GIS analysis

- Hierarchical interview with town government, village representatives and households
- Spatial heterogeneity of social conditions



➤ Results

- Process of policy implementation through mutual relationships between the three actors reflecting their hierarchical and spatial heterogeneity

4.6. Household agents representing reality (ongoing)

➤ Objectives

- Modeling households' decision-making mechanism
- Typology and spatial allocation of household agents



➤ Methods

- A few methodologies suggested and developed in recent studies
 - e.g. • Mathematical programming for the household model
 - Multivariate and Monte Carlo techniques for the typology and spatial allocation

5. Conclusion

- Our conceptual MAS-LUCC model
 - Household decision-making module

not only a meaningful example of few developed empirical MAS-LUCC models, but also a successful model case of effectively integrating studies of different disciplines

according to typical land use types

- Regional mapping the typical land use types
- Social processes of policy implementation
- Households' decision-making mechanisms and producing household agents