

# General Discussion

# **GUIDELINE FOR THE RESEARCH ON LAND USE/COVER CHANGE IN ASIAN COUNTRIES (FIRST DRAFT)<sup>1</sup>**

Land Use Subcommittee, Japan

## **1. Introduction**

Global environmental issues have been growing in scientific importance since the Stockholm Conference in 1972 and the UNCED in 1992. ICSU (International Council of Scientific Unions) and ISSC (International Social Science Council) are planning an international research project on global environmental issues cooperatively with IGBP and HDP. That project is approaching the working stage. IGBP and HDP jointly established CPPC-LUCC (Core Project Planning Committee-Land Use/Cover Change) in order to initiate a new core research project, i.e., LUCC/IGBP-HDP in 1995. It will be necessary for Japan to contribute in many ways to this international collaborative study.

To strengthen the research structure, Japan established a Land Use Subcommittee within the Japan National Committee for IGBP at the 15 team of the Science Council of Japan in October 1992. In the current 16th term, the Japan National Committee for Global Environmental Studies now includes a Japan National Committee for IGBP and another for HDP. It is also planned that these committees join to form a LUCC Subcommittee.

On the other hand, the National Institute for Environmental Studies (NIES) is devising a program for contributing to global environmental conservation in Asia under the Eco-Asia Plan. A part of that program will be a mechanism for cooperating with LUCC. Under such conditions, it is hoped that the LUCC Research Plan devised by NIES meets the purpose of the international LUCC research plan as much as possible. CPPC-LUCC submitted the third draft at a meeting in Moriama, Japan in June, 1994 and is now preparing the final draft. NIES held a LUCC Japan Workshop in Kyoto after the CPPC-LUCC Moriama meeting and previewed both the international LUCC research plan and the LUCC Japan research plan.

Based on these preparations, the following research plan is provided as a guideline for studying LUCC in Asia.

## **2. Objectives and Research Framework**

### **2.1. Objectives**

This study aims to address the following subjects concerning land use/cover change which promise to become the main focal points of global environmental issues in Asia.

- 1) To understand the actual conditions concerning land use/cover change and to construct a LUCC database;
- 2) To clarify the factors ( or driving forces) underlying land use/cover change as well as those affecting global environmental change;
- 3) To construct estimation models of land use/cover change; and

---

<sup>1</sup> This paper was prepared for the session of General Discussion to introduce a course of research of the Land Use Subcommittee of IGBP-Japan.

- 4) To construct policy models for resolving global environmental issues, particularly land use/cover change, and to suggest an improvement policy related to LUCC for solving global environmental issues.

## **2.2 Objective Areas**

This study covers the regions of TEA (Northeast Asian Region), SARCS (Southeast Asian Region) and SAS (South Asian Region) of IGBP START in Asia in cooperation with related Asian countries. Japanese research groups will begin the study centering on TEA and SARCS. (See Fig. 1)

## **2.3 Research Framework**

Our Asian research on LUCC should be arranged to facilitate cooperation with the LUCC/IGBP-HDP Research Plan, which is preparing by CPPC-LUCC/IGBP-HDP as much as possible. However, the LUCC/IGBP-HDP plan is at present divided into three foci (See Fig. 2), while this Japanese research plan is divided into four, as shown in Fig. 3. The main contents of each focus of the Japanese proposal are as follows.

### **Focus 1: Data Presentation/Regional Classification**

This Focus 1 includes the construction of a database in Focus 2 by CPPC-LUCC/IGBP-HDP (hereafter called "CPPC") : Land-Cover Change Patterns. This divides into 5 tasks to develop the study efficiently. Task 1.1 reviews units of various data, analyzes the hierarchical system of the region and defines data units which will contribute to the database. Then, biophysical (Task 1.2) and socioeconomic data (Task 1.3) are collected to construct each database. Through the practical use of such a database, the objective region is illustrated by each categorized data (Task 1.4) and analyzed for finding spatial type (Task 1.5). Based on the classification, case study areas for Focus 2 are selected.

### **Focus 2: Case Study**

This Focus is equivalent to Focus 1 by CPPC : Land-Use Change Processes (Situations). Focus 1 by CPPC inclines toward a socioeconomic case study, while ours is a comprehensive case study including biophysical case study. This divides into (X+1) Tasks; Task 2.1 to 2.X are case studies, while Task 2.(X+1) is a comparative study by region of these case studies.

Each case study sets some themes concerning global environmental conservation, such as the expansion of cultivated acreage upon an increase in population, decrease in agricultural land with growing urbanization, the decreasing fertility of agricultural land, etc. Each case study analyzes in detail the sequence of cause and effect involved in those issues. In this analysis, a region is divided into a variety of regional types and each theme is analyzed by individual regional type. Based on such an analysis of regional types, test models by regional type are created, and this supplies pertinent information for constructing comprehensive regional models (Focus 3).

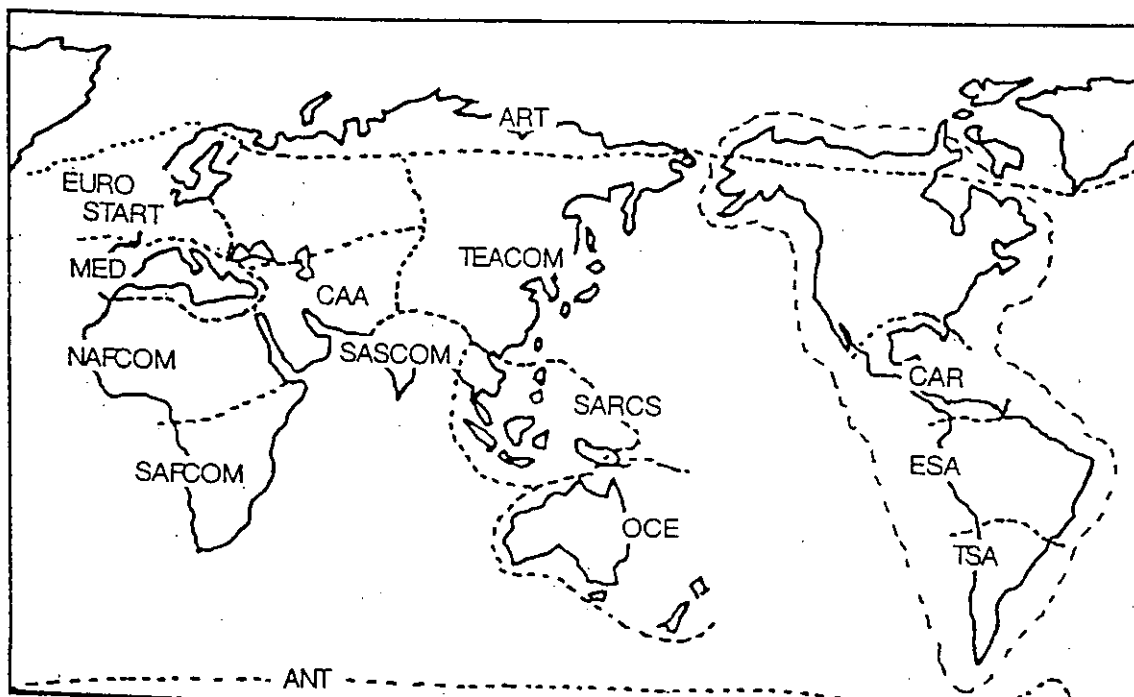
# GLOBAL CHANGE SYSTEM FOR ANALYSIS, RESEARCH AND TRAINING (START)

START	= System for Analysis, Research and Training = $\sum$ RRN
RRN	= a Regional Research Network = RRC + $\sum$ RRS
RRC	= the Regional Research Centre
RRS	= an affiliated Regional Research Site = (research institutions and stations).

IGBP

WCRP

HDP



ENRICH

APN

IAI

Fig.1 IGBP-START

# STRUCTURE OF LUCC SCIENCE PLAN

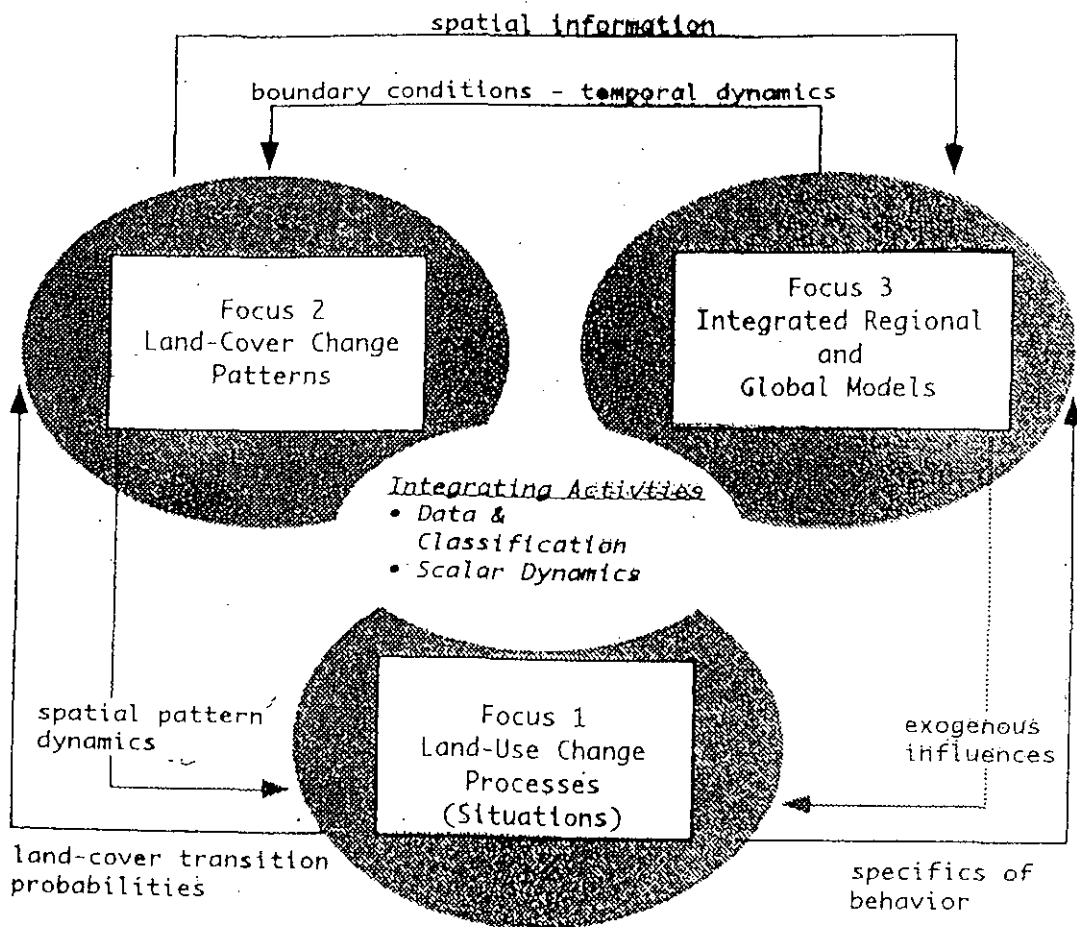


Fig.2 IGBP-LUCC Science Plan

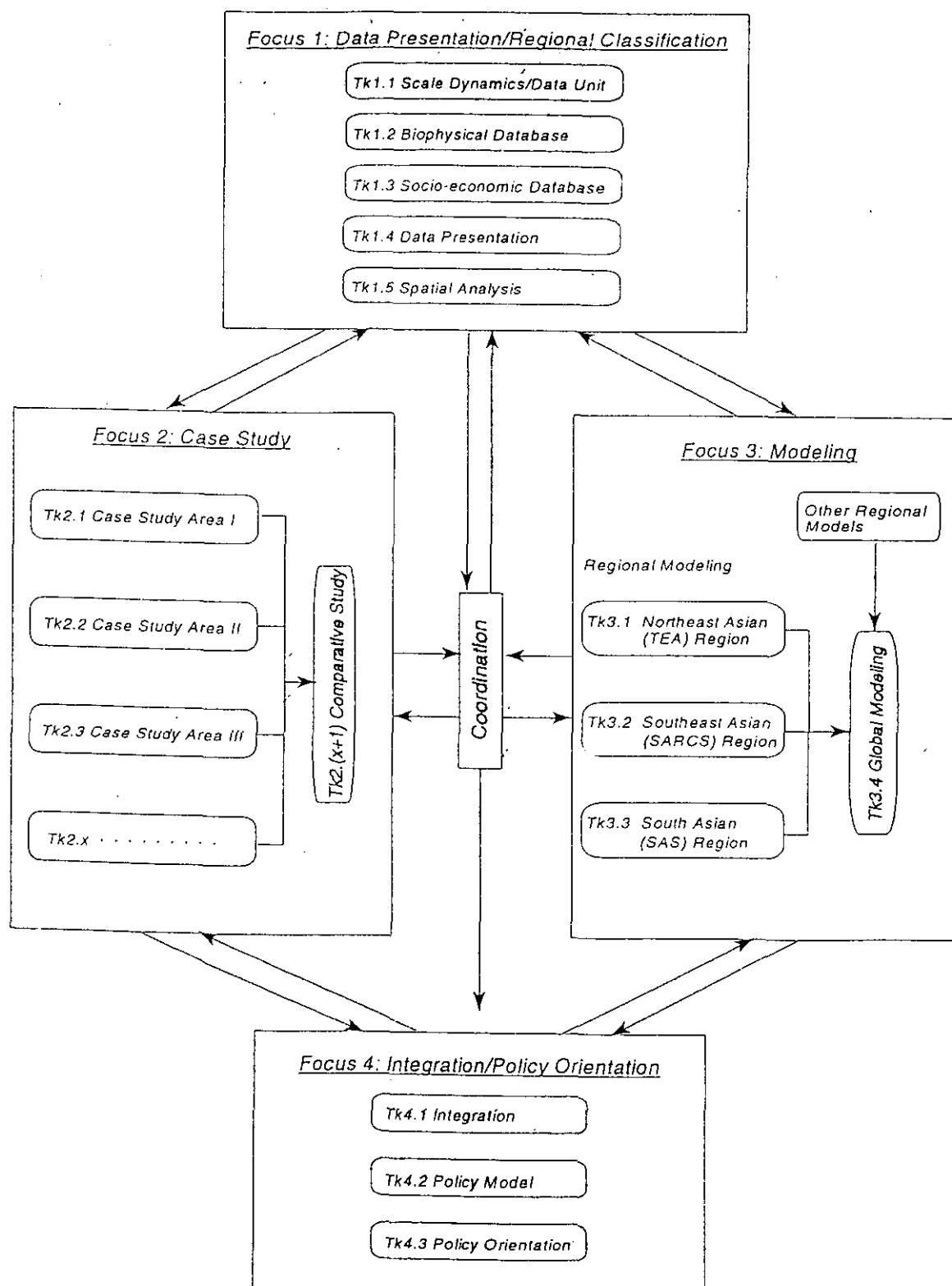


Fig.3 Research Structure

### **Focus 3: Modelling**

This Focus is nearly equivalent to Focus 3 by CPPC. Task 3.1 to 3.3 construct models of TEA, SARCS and SAS in the Asian region, and thus affords a base for global modelling. The global model is then studied together with information from other regions. Combined models are constructed from models by regional type, especially considering the mutual relation among the latter. Land use/cover change is estimated by models, and the factors of change are studied in order to establish a base for considering the policy proposals of Focus 4.

### **Focus 4: Integration and Policy**

The proposal of CPPC has no focus equivalent to this Focus 4, which integrates the previously mentioned Focus 1 to 3 and is responsible for making a policy proposal. Task 4.1 integrates Focus 1 to 3, then summarizes and estimates the study of land use/cover change. Task 4.2 pursues policy models for global environmental conservation, mainly taking account of solution in every target region obtained by the above analyses. Based on the results given by Task 4.2, a concrete policy proposal is made for global environmental conservation from the view point of land use/cover policy.

## **3. Theoretical Approach**

Several points are discussed here, in order to clarify the relationship between the study of land use/cover change and global environmental conservation.

### **3.1 Global Environmental Conservation**

This is a study of land use/cover change for global environmental conservation. The need is not for a vague appreciation of global environmental conservation, but for a precise grasp of the purpose of conservation and a consolidation of research subjects. Thus, it is necessary to propose a definite purpose for research implementation.

For example, the following are classifications of purpose awareness concerning global environmental conservation.

- 1) To purify the air of CFCs, CO<sub>2</sub>, NO<sub>x</sub> and to improve the atmospheric environment, etc.:  
Acid rain, earth warming, the change in land use under warming, expansion of the ozone hole, etc. are prevented. The LUCC study pursues the related mechanism between land use/cover change and the production of those gases.
- 2) To assure an adequate food supply:  
It is necessary to solve food shortages due to increases in population and the deterioration of agricultural land. It is indispensable for LUCC research to clarify the mechanism/control of population increase and the improvement policy /mechanism of the deterioration of agricultural land.
- 3) To supply safely living and industrial resource:  
It is necessary to assure a reliable living and industrial resources such as timber and energy. It is also necessary to examine how this is to be accomplished for each regional

type.

4) To stabilize the living environment:

Conservation of the eco system is more important than a matter of taste. It is to keep biological linkage system of natural environment which is impossible to change artificially. It is also necessary to preserve water and to stabilize elements of the environment directly linked to human survival, such as land use order.

In any event, it is necessary to make clear that the substantial purpose of global environmental conservation is to afford a base for clarifying subjects of each case study.

### **3.2 Regional Structure**

It is necessary for researchers to have a shared understanding about the macroscopic relationship among elements necessary for considering the relationship of human activities and global environment. However, such common understanding is produced in the course of research, and it is impossible to deal with it in the stage of research planning.

However it is indispensable for researchers in disparate fields to have some degree of common understanding, even though who and what to clarify in the research objects and what role to play. In these understanding, it is impossible to execute the totally unified research. One view of the regional structure is introduced to supply a framework for the total research effort. Regional structure as used here is the whole relation between nature and human beings made by modified global environment on the surface of earth, which is made by human activities.

The regional structure is roughly shown in Fig. 4. Human activities are divided into Production systems, Living systems and Public systems. It is understood that there exist, in support of mutual human activities, such as Society, Economy, Infrastructure, Space and Environment (in the narrower sense).

Land use, the use of space in a wider sense, is a reflection of human activities on the land, which produce relationships among society, economy, infrastructure and environment. Land cover is reflected on the surface of the earth as a consequence of land use.

In other words, human activities drawing resources from the environment constitute land use. However, such an approach is beyond the scope of this study. Thus, considering the modelling of the whole regional society, this study focuses human activities for land use. Such situations are shown in Fig. 5. In Fig. 5 urban activities in urban areas, agricultural and forestry activities in rural areas, and human activities in desert and wetland are grouped, but each activity consists of the three human activities, i.e. Production systems, Living systems and Public systems. Such activities produce resources from the environment and, as a result, are reflected in land use and cover.

### **3.3 Living Sphere and Regional Hierarchy**

Human beings generally limit their activities to a certain domain. This domain radiates outward from daily activities to monthly, tri-monthly and annual activities. A region of such human activities is called an Influential sphere or a Living sphere which hierarchically links the scale of



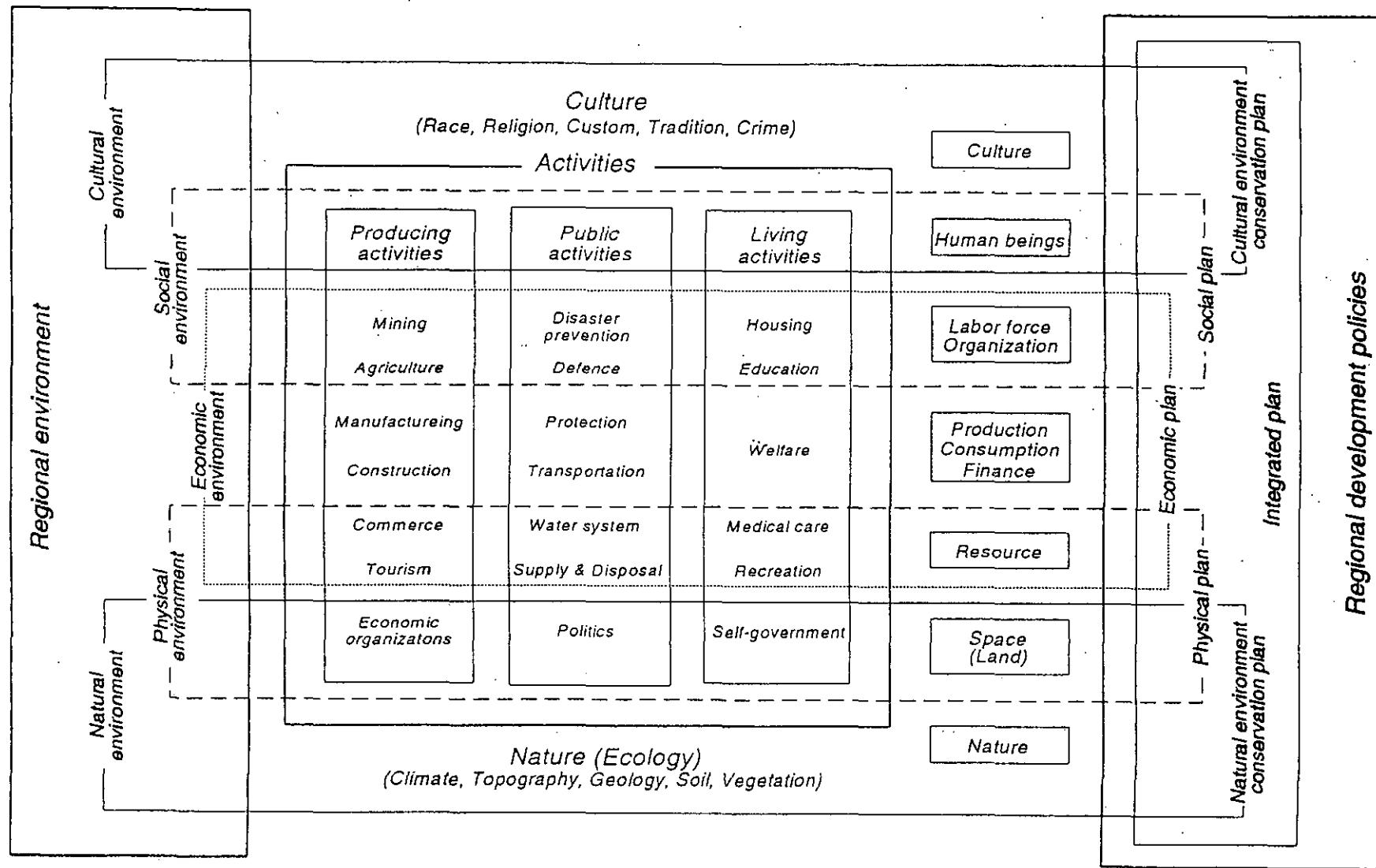
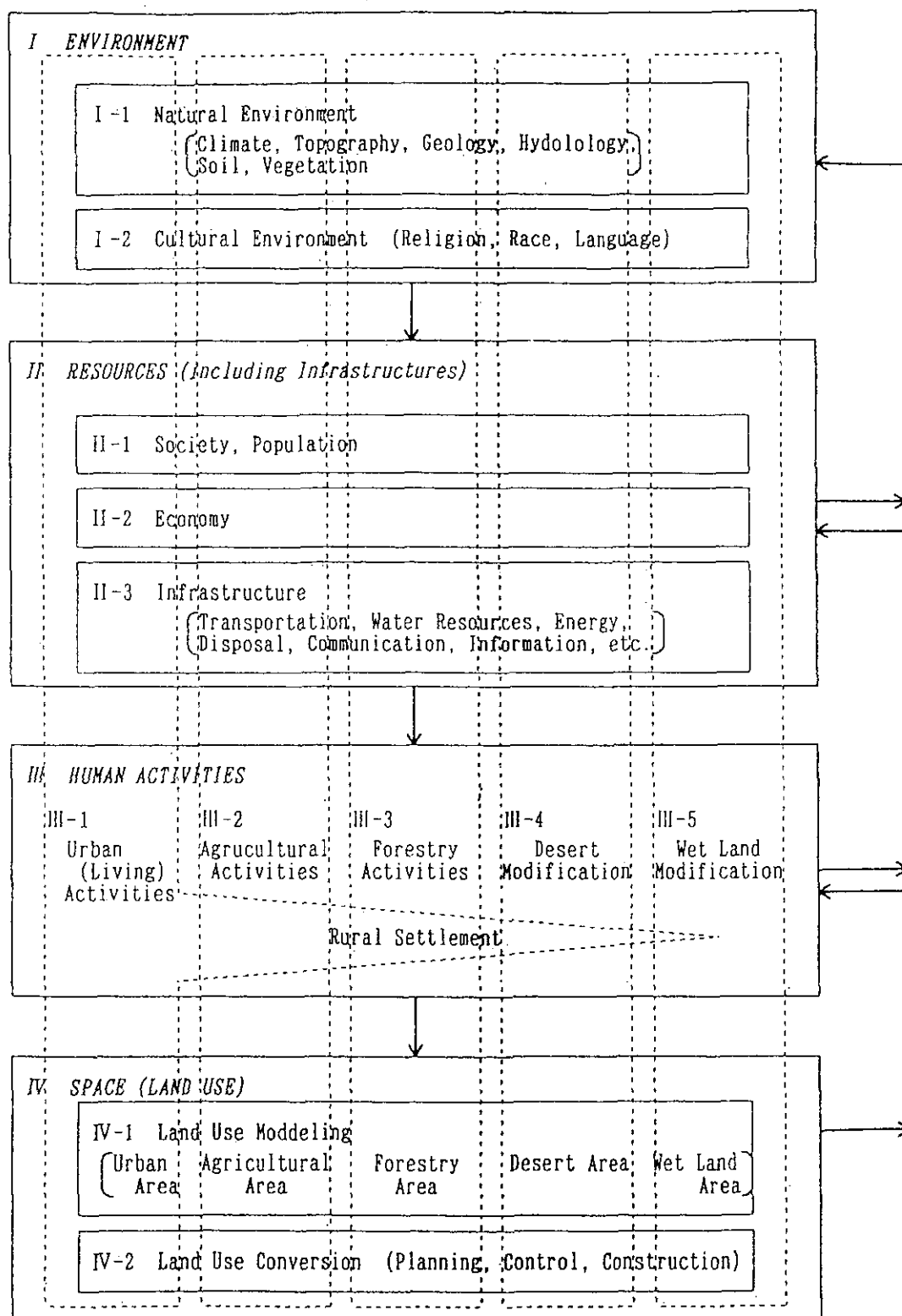


Fig.4 Concept of Regional Structure



**Fig.5 Regional Structure**  
(Environment, Resources, Human Activities, and LAND USE)

	Hierarchy	Area (km <sup>2</sup> ) and Radius* (km)	Examples of Area (km <sup>2</sup> )
Globe		A: 175,000,000 - 315,000,000 r: 7,463 - 10,013	Total land area (148,889,000)
Region		A: 25,000,000 - 45,000,000 r: 2,822 - 3,786	Asia (27,576,000) N A merica (24,249,000) S America (17,832,000)
Sub-region		A: 3,500,000 - 6,300,000 r: 1,055 - 1,416	SE Asia (4,243,000) Europe (4,973,000) U SA (9,373,000) Brazil (8,512,000)
Country		A: 500,000 - 900,000 r: 399 - 535	Japan (378,000) U K (244,000) France (547,000) Germany (357,000) Indonesia (1,905,000)
Province		A: 70,000 - 130,000 r: 149 - 203	Netherlands (41,000) Switzerland (41,000) A ustria (84,000) East Jawa (48,000) Kinki (27,300)
Prefecture		A: 10,000 - 18,000 r: 56 - 76	Kyoto Pref. (4,613)
County		A: 1,500 - 2,500 r: 22 - 28	Tango Dist. (840)
Municipality		A: 200 - 3500 r: 8 - 11	Kyoto City (611)

30 - 50 km<sup>2</sup> => Fundamental unit

Fig. 6 Hierarchy of Region

a region to the frequency of its human activities. This is called regional hierarchy. Such regional hierarchy is formed historically in each region, and remains reflected in administrative provinces, townships, etc, found in every country. Fig. 6 illustrates the hierarchy of a region. In cooperation with each country, it is necessary to examine the relation between the hierarchical system of the regions of each country and its administrative areas. Following that, socioeconomic data units should be determined.

### **3.4 Land Use and Cover**

The concept of land use and cover should be clarified. Ordinarily speaking, categories of land cover (distinctions within an agricultural area, settlement area, industrial area, etc.) can't be recognized on a map scaled below 1/10,000. Actually, we talk about kinds of land cover in a map on a smaller scale. For example, a paddy field area includes not only the paddy field, but different kinds of land cover like roads, settlements and rivers.

This study should review categories of land cover by regional scale and clarify how to recognize land cover on the scale of a map. On the other hand, it needs to clarify how to apprehend land use according to the scale. Related to this, of particular importance is how to recognize the subject body of land use.

### **3.5 Land Use/Cover Change Model**

The important point of this study is that the case study team of Focus 2 and the model team of Focus 3 are in agreement as much as possible about the overall structure of the land use/cover change model. The fundamental structure of land use/cover change, for which this study aims, should be made clear through an estimation model which is created by each regional type. Of course, some case studies will present issues that can't be estimated in such a simple manner. However, the first approach will be undertaken using such a simple model mentioned above. In any case, the fundamental structure of the model should be fully considered.

### **3.6 Global Environmental Conservation Policies**

The study of global environmental conservation is currently a mature discipline, but the pursuit of a substantial plan for global environmental conservation is still vague, random and disorganized. For solving global environment issues, it is necessary to implement global environmental conservation systematically and comprehensively region by region. It is also necessary to pursue how a strategic policy of global environmental conservation should be applied to each regional unit. From such considerations, it is necessary to propose region-based, synthesizing and systematic policies of global environmental conservation in order to successfully complete the study of land use/cover change.

## **4. Focus 1: Data Presentation and Regional Classification**

### **4.1 Scale of Region and Data Units**

It is important for this study to construct a combined database of biophysical and socioeconomic data. As socioeconomic data is currently available only from administrative units in every country, it is necessary to determine the appropriate administrative area based on the regional

hierarchy mentioned above, and then designating it as a unit of the proposed database.

It is indispensable to convert biophysical data into data based on the administrative data unit. The main form of biophysical data in the LUCC study is mesh data, which is derived from remote sensing data and maps. The area ratio of various biophysical data by each administrative data unit can be obtained from mesh data, with making mesh administrative area, while the area ratio of biophysical data by each data unit can be obtained from a map, by measuring items by planimeter and this area ratio is used with socioeconomic data.

## **4.2 Biophysical Database**

Biophysical data is, as mentioned above, mainly as follows:

- 1) Mesh-data
- 2) Map

Mesh-data is remote sensing data, etc.. There data should be converted to the area ratio of the administrative area, as mentioned above.

## **4.3 Socioeconomic Database**

Most socioeconomic data can be obtained by administrative areas as mentioned above. However, to make them the database of this study, they should be organized by data unit as determined in 4.1. If there is no data to match the data unit, it is necessary to make the database by incorporating data of lower administrative areas.

For both biophysical and socioeconomic data, it is indispensable to match various data with a corresponding unit of administrative area (data unit). Accordingly, the conversion method is quite simple, but making a database using specific units as administrative areas is essential.

## **4.4 Data Presentation**

The result of Focus 1 is a database presentation by data unit. Viewing the data presentation by administrative area, it becomes possible to determine the factors causing land use/cover change, etc. and to consider their mutual relationships.

## **4.5 Regional Classification**

The main factors for regional classification are derived from an analysis of the mutual relation between factors. Each region is classified using various classification methods, and a regional classification map is made. This map will be a fundamental source of information for selecting case study areas.

# **5. Focus 2: Case Studies**

## **5.1 Subjects of Case Studies and Selection of Case Study Areas**

Subjects for the study of land use/cover change in the light of global environmental issues are chosen, and case study areas suitable for such subjects are selected. Referring to the results of regional classification made in 4.5 for selecting case study areas, features of case study areas

are clarified and suitable areas for case study are selected.

The selection of case study subjects is the most important task of this study. When deciding on research strategy, it is necessary to present and discuss many research directions, eventually arriving at a common understanding among as many researchers as possible. Only examples of research subjects are given here, but further consideration is needed to arrive at a research plan for case studies.

Here are some examples of research subjects:

- 1) Expansion or decrease in agricultural area (deforestation for the use of agriculture, destruction of agricultural land due to urbanization, abandonment of cultivation)
- 2) Degrading the quality of agricultural land (excessive use of chemical fertilizer, salinization, soil erosion)
- 3) Deforestation for export and fuel
- 4) Overpasturage of livestock
- 5) Formation of urban slums (migration of farmers to cities)
- 6) Aggravation of urban environment
- 7) Influence on fisheries of land use change along shorelines
- 8) Changes in water usage
- 9) New land use/cover change by road construction

The selection of such research themes will clarify the factors for various investigations and research.

## **5.2 Framework of Investigation and Research**

Each researcher will take an individual approach to each case study, bringing personal views to bear on the new scientific research results. Accordingly, the case study method should take the individual researcher's approach into account.

On the other hand, research cooperation across a variety of disciplines will be important for producing research results. Particularly, in such a study of land use/cover change for global environmental conservation, it is indispensable for researchers to cooperate in gathering data for each case study area and to incorporate these data into one common database for the modeling of Focus 3 and for making the policy suggestions of Focus 4.

In general, data items to be collected are determined by consensus, and those data are collected in keeping with the minimum requirements for each case study. Besides, it is necessary for researchers to try each case study team.

## **5.3 Case Studies**

Case studies are conducted within the research study framework mentioned above. Case study areas are divided into several sub-regions which are classified into the following types, in order to grasp the characteristics of land use/cover change by regional types.

- a. Urban and industrial area
- b. Paddy area
- c. Upland area

- d. Pasture area
- e. Forested area
- f. Desert area
- g. Wetland area

## **5.4 Comparative Study**

This study analyzes the characteristics of land use/cover change by each regional type obtained in the study of 5.3, and comparatively reviews land use/cover change by such regional types. The results will become the information base for constructing models of land use/cover change.

## **6. Focus 3: Regional/Global Model**

### **6.1 Main Approach to Regional Model**

From case studies by regional types, models are derived from land use/cover change by typical regional types, even simple ones. Based on such models, regional models are constructed.

For constructing regional models, regional classification is reviewed again, and regional classification within a model of the target region is determined. Integrated regional models are then constructed applying model by regional types. As this is only a preliminary model, it is hoped that a more detailed model based on the preliminary model would be derived for each country.

### **6.2 Regional Model and Asian Model**

Regional models are constructed of TEA, SARCS and SAS as mentioned above. Based on the results of regional models, Asian models are conceived.

### **6.3 Contribution to Global Model**

In the same way as the construction of Asian models, global models are constructed based on the results of the LUCC study of other areas which will contribute some of the results to the total LUCC study.

## **7. Focus 4: Integration and Policies**

### **7.1 Method of Integration**

Comparing the results of Focus 2 with models obtained in Focus 3, this study reviews the availability of each model. In particular, target regions for global environmental conservation are selected.

### **7.2 Development of Policy Model**

In the target region obtained in 7.1, a global environmental conservation model which includes various policy variables is made based on land use/cover change policies. This model depends on the timing and choice of policies to be introduced, and on the ability to make target regions as

self-supporting as possible for sustainable development. With the construction of this model, the basic knowledge needed for making global environmental conservation policy becomes clear.

### **7.3 Guideline for Global Environmental Conservation Policy**

Based on the models of Focus 3 and the case studies of Focus 2, general policies are worked out, and specific policies for developing global environmental conservation are clarified through the policy models of 7.2.