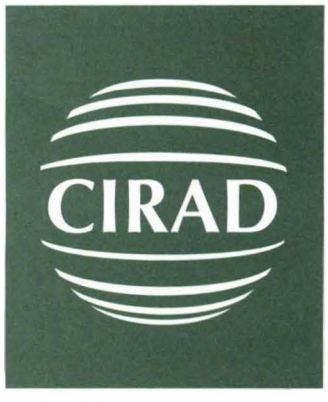

Département territoires, environnement et acteurs
Cirad-tera

Rapport N° 62/98

François Bousquet

Rapport de mission Thaïlande et Vietnam (19 Juin-26 Juin 1998) : participation à l'atelier sur

Les méthodes de transfert d'échelle dans les approches écorégionales de gestion des ressources naturelles.

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Les méthodes de transfert d'échelle dans les approches écorégionales de gestion des ressources naturelles.

Plan du rapport

Résumé

Du 22 au 24 Juin 1998, l'IRRI (International Rice Research Institute), le CAF (College of Agriculture and Forestry of the Vietnam National University) et le Sub-Niapp (Sub National Institute of Agriculture Planning and Projection) organisaient un atelier de travail intitulé «Scaling methodologies in eco-regional approaches for natural resource management : towards further research collaboration » à Ho Chi Minh Ville au Viet Nam. Dans le cadre de cette mission un séminaire a aussi été organisé par M. Guy Trébuil (Cirad-CA) au TEI (Thaïland Environmental Institute) à Bangkok pour y présenter nos recherches.

Mots Clés : Ecorégionalité, Transfert d'échelle

Du 22 au 24 Juin 1998, l'IRRI (International Rice Research Institute), le CAF (College of Agriculture and Forestry of the Vietnam National University) et le Sub-Niapp (Sub National Institute of Agriculture Planning and Projection) organisaient un atelier de travail intitulé «Scaling methodologies in eco-regional approaches for natural resource management : towards further research collaboration » à Ho Chi Minh Ville au Viet Nam. J'étais invité à présenter une contribution sur le thème des systèmes multi-agents et la gestion des ressources renouvelables. Cette mission fut financée par le ministère des Affaires Etrangères dans le cadre de l'appui à la contribution française à l'initiative écorégionale Asie humide EcorI (marché à bond de commande N° 96.31.109 « appui agronomique à la culture en écosystème montagnard humide »). Dans le cadre de cette mission un séminaire a aussi été organisé par M. Guy Trébuil (Cirad-CA) au TEI (Thaïland Environmental Institute) à Bangkok pour y présenter nos recherches.

Chronologie.

Vendredi 19 Juin. Arrivée à Bangkok. Séminaire au TEI l'après midi. Le TEI est un institut créé par l'ancien premier ministre Aronh Panyarachum. Il rassemble des technocrates de haut niveau et des jeunes chercheurs jouant un rôle de « club de pensée » influençant la politique environnementale du gouvernement. Son directeur participera à la mise en place de l'initiative écorégionale Ecor-I au centre Thaïlande.

Samedi 20 Juin. Visite en tant qu'invité par M. Manichon à la station expérimentale de Suivan du projet coton au centre Doras (Cirad-CA à l'Université Kosetsart) . Aperçu des travaux de Mrs D.Dessaw et A.Renou et de Mlle I. Dusselle.

Dimanche 21 Juin. Voyage Bangkok-Ho Chi Minh Ville.

Lundi 22 Juin- Mercredi 24 Juin : participation à l'atelier IRRI-CAF-SubNiapp.

Jeudi 25 Juin-Vendredi 26 Juin. Retour en France

Personnes rencontrées et organisation de l'atelier.

Personnes rencontrées

En Thaïlande : Dr. Sitanon Jesdapipat et son équipe responsable du département Ressources Naturelles du TEI et professeur à l'Université Chulalongkorn. Une dizaine de personnes sélectionnéesont assisté au séminaire durant lequel j'ai présenté les principes des simulations multi-agents et les applications que nous développons. Pour m'adapter à l'auditoire j'ai mis l'accent sur les applications forestières et économiques. Mes interlocuteurs ont paru satisfaits du séminaire et des suites sont envisagées, en terme de collaboration par l'encadrement de stagiaires thaïs et des formations en Thaïlande. Par la suite, Guy Trébuil a eu l'occasion de présenter nos travaux et de faire des démonstrations à l'Université de Chiang Maï, avec les mêmes conséquences : formations et encadrements communs. Des projets peuvent être montés avec le TEI et l'université Chiang Maï.

Au Vietnam. J'ai rencontré de nombreuses personnes provenant de divers groupes.

- Quelques chercheurs Français travaillant dans la région sur la gestion des ressources naturelles : J.-C. Castella (Orstom-Irri, basé aux Philippines), F.Molle (Orstom, Thaïlande), P.Bergeret (Gret, Vietnam-Nord), O. Husson (Cirad-CA, Vietnam Nord), R. Bourgeois et F. Jesus (Cirad-Amis, Indonésie). A divers degrés plusieurs personnes sont intéressées par les méthodes de simulation, intégrées avec des approches spatiales, que nous proposons. Ainsi, J.C. Castella présente les simulations comme l'outil pour

l'interdisciplinarité dans le projet qu'il mène. Une collaboration avec nous passera par le biais de l'interaction avec nos partenaires de l'Orstom à Orléans et à Bondy. R. Bourgeois et F. Jesus sont aussi intéressés par les travaux sur les simulations de filières.

- Quelques chercheurs asiatiques : Prof. Dr. Pham Van Cu, Directeur du centre de télédétection et géomatique à Hanoi, P.Teng, responsable du programme inter-écosystèmes à l'Irri, S.P. Kam responsable de l'information géographique à l'Irri, N.Binh et H. Cai du département de foresterie sociale du CAF à Ho Chi Minh Ville. Ces différentes personnes se sont montrées intéréssées par un transfert des méthodes que nous développons sous forme de formations.
- Quelques chercheurs d'instituts internationaux : U. Deichmann, de la division statistiques des Nation Unies, M. Hoosbeck et D. Jansen de l'Université de Wageningen spécialistes du transfert d'échelle en sciences du sol, D. Brennan qui travaille sur des simulations de la gestion de l'eau en Australie.

Organisation de l'atelier.

Après une introduction par P.Teng, le premier jour fut consacré à des présentations sur les techniques et outils (voir programme de l'atelier en annexe de ce rapport). Ainsi, entre autres, F.Borne (Cirad Amis) fit une présentation de méthodes développées et utilisées au Cirad en télédétection pour traiter les problèmes de changement d'échelle. Le deuxième jour fut consacré à des études de cas correspondant à l'initiative ecorégionale Ecor-I. On trouvera en annexe une fiche descriptive du reseau SystNet présenté par R.Roetter. Ce travail propose une aggrégation entre le niveau de l'exploitation et la région basée sur la programmation linéaire multi-objectifs. Le troisième jour fut consacré à un travail en sous groupes sur différents thèmes (Définitions, gestion, intégration, gestion des données, ...). J'ai participé aux travaux du sous groupe Intégration.

La conférence introductive de P.Teng qui présente un travail commun avec le Professeur R.Rabbinge (en annexe) ouvre sur les différents niveaux d'aggrégation en distinguant les niveaux de production écologique et les niveaux en socio-économie. Pour la partie écologique on passe de la feuille au champ puis à l'exploitation et à la région. Pour les auteurs cela n'a pas de sens de travailler avec des modèles détaillés de croissance pour explorer la dynamique au niveau du paysage. Pour la partie socio-économique, le niveau microscopique est l'exploitation. L'agrégation au niveau régional est difficile en raison de l'hétérogénéité au niveau micro, et des nouvelles forces au niveau macro. Il est donc conseillé de travailler sur des modèles d'interaction entre les deux niveaux.

Quelques éléments de réflexion.

Je consigne ici quelques remarques qui ont trait au thème de l'écorégionalité en relation avec les activités de recherche que nous menons et des orientations potentielles.

1. Tout d'abord une remarque de forme : dans cet atelier sur l'écorégionalité la plupart des chercheurs parlent plutôt de gestion des ressources naturelles que d'écorégionalité.
2. La gestion des ressources naturelles s'intéresse essentiellement aux ressources agricoles. Très peu de choses sont présentées sur l'existence de ressources renouvelables non agricoles si l'on excepte le problème de la disparition des forêts.
3. L'origine disciplinaire des chercheurs coïncide avec la remarque précédente : pédologues, agronomes et agro-économistes forment la grande majorité des participants, associés à des

spécialistes de différentes méthodes et outils tels la télédétection, les statistiques, la modélisation.

4. Les méthodes d'agrégation correspondent à cette origine disciplinaire: modélisation du choix individuel d'agriculteurs entre différentes alternatives.

En conséquence il me semble qu'une voie originale dans ce contexte pour aborder ces problèmes serait de s'attaquer aux problèmes de **gestion de ressources par de multiples usagers**. Les espaces envisagés comprennent aussi des ressources renouvelables telles la forêt, la faune sauvage. Il serait original de se focaliser sur les problèmes d'interaction entre les ressources et leurs usages. D'un point de vue social cela pourrait correspondre aux questions **d'appropriation et d'usages collectifs** des ressources, en articulation avec une rationalité qui peut conduire les choix de l'individu.

5. La question du transfert d'échelle est souvent abordée suivant une perception de l'emboîtement de niveaux tels un ensemble de poupées russes. Dés lors que l'on s'intéresse à des ressources multiples en interactions avec des niveaux d'organisation sociale, l'image des hiérarchies complexes enchevêtrées paraît mieux convenir. Cela pose des problèmes de pas de temps, de maille spatiales difficiles à aborder. L'approche en trois niveaux (parcelles,exploitation, région) me paraît difficile à soutenir dans tous les problèmes écorégionaux. Divers outils ont été présentés. Le Cirad a présenté séparément ses compétences dans le domaine de la télédétection et des simulations.

Dans le cadre de projets dans lequel le Cirad contribue à l'initiative écorégionale (Ecor-I, Amazonie), il serait très bénéfique que nous arrivions à présenter **l'articulation entre les différentes méthodes** que nous maîtrisons et développons dans le programme Ere et à la MTD: télédétection, Sig, analyse spatiale et simulations des comportements et stratégies d'acteurs.

En conséquence de ces quelques remarques, cet atelier a eu lieu à un moment de restructuration de nos activités de recherche. Pour mettre à profit notre originalité, nos compétences et se positionner en appui aux démarches écorégionales, il me paraîtrait intéressant de s'intéresser aux usages des ressources sur un espace en mettant l'accent sur leur multiplicité et leurs interactions. Cette dernière caractéristique implique de s'intéresser à l'articulation des processus individuels et collectifs pour la prise de décision. Pour cela il est nécessaire de développer des méthodes qui spécifient l'usage et la complémentarité des différents outils que nous proposons.

Conclusions et Perspectives

Suite à cet atelier les perspectives sont de trois ordres :

-L'une a trait aux **nombreuses demandes en formation sur les simulations multi-agents**. Il est nécessaire de la préparer, en anglais, avec un travail sur les supports de cours. Il est nécessaire de présenter et de mettre à disposition nos outils, c'est à dire mettre l'accent sur une documentation. Des formations sont envisageables dès à présent et demandées en Thaïlande, au Vietnam et en Indonésie.

-L'autre a trait aux opérations de modélisation sur laquelles des appuis sont demandés. Un travail commence sous l'égide de Guy Trebuil à partir de ses travaux inter-disciplinaires et

multi-échelles sur la gestion conservatoire des sols et la diversification agricole marchande conduits au Nord-Thaïlande en collaboration avec l'Irri, l'Université KU_Leuven et les universités régionales de Chiang-Maï (maîtrise internationale sur les systèmes agricoles) et de Mae Jo. Ce travail pourra permettre d'amorcer la formation de partenaires nationaux (CMU, TEI, etc)

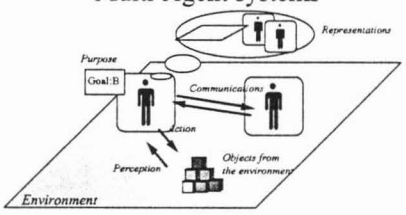
-Enfin, d'un point de vue méthodologique, il est nécessaire de continuer les problématiques de modélisation d'entités spatiales telles que commencées avec les collègues de l'Inra Sad, qui a servi de base à la présentation faite à l'atelier. Ces travaux s'intéressent à la modélisation de dynamiques spatiales sur différentes échelles. On représente les connaissances soit à l'échelle de la maille spatiale, soit à l'échelle d'une entité englobante (ex: la forêt), soit à l'échelle du paysage. Les organisateurs ont sélectionné notre présentation pour un des articles d'un ouvrage qui sera publié par l'Irri .

Les transparents de l'exposé présenté à Ho Chi Minh Ville

- Context
- Multi-agent system methodology and Cormas tool
- MAS and organisation levels : a landscape dynamics example.
- MAS and socio-economic analysis
  - Industry and economic management tools
  - Irrigated system viability

Le but de cette présentation était donc de discuter l'usage des Sma pour le transfert d'échelles.
La méthode a été présentée ainsi que deux exemples, l'un ayant trait au spatial, l'autre au social.

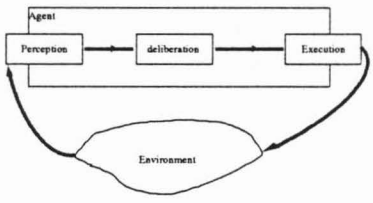
Multi-Agent systems



Agent interacting with its environment and other agents (from Ferber, 1995)

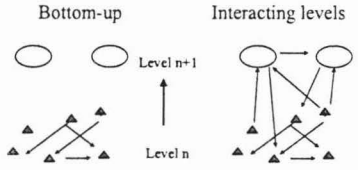
Quelques explications sur la méthode des systèmes multi-agents. Un agent est dans un environnement qu'il perçoit et surlequel il agit, il se fait des représentations et communique

Cycle perception / action of an agent



Représentation d'un agent

Multi-agents and scales



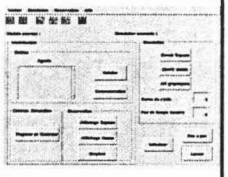
L'approche ascendante classique et l'approche plus complexe avec des interactions de niveaux différents

Context

- Interactions between renewable resources dynamics and social dynamics
- From field studies (hunting, agroforestry, irrigated system, livestocks) to a simulation tool

L'outil de simulation que nous avons développé au Cirad.

Principles of Cormas



- Agents and interactions
  - space
  - messages
- Control of the dynamics
- The observer 's viewpoint

Organization levels

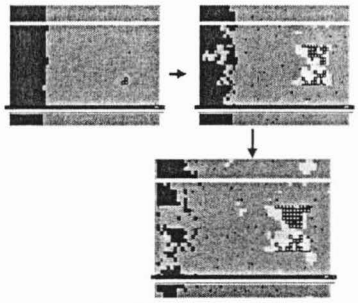
- Population growth and landscape dynamics
- Version 1 : peasant and cattle agents
- Version 2 : spatial entities as agents

Premier exemple de travail sur le transfert d'échelles : un exercice sur la dynamique du paysage. Un village grossit, augmente ses champs, la savane gagne sur la forêt. Dans la version 1 du modèle on considère les actions des paysans et des troupeaux. Dans la version 2 des entités géographiques sont considérées comme agents

Peasant and cattle agents

- Rules of the peasant agents : move randomly in the savana until three crops in the savana, come back to the village, create a new peasant agent.
- Rules of the cattle agents : move randomly on the savana or the forest, transform the forest into savana

Version avec des agents paysans et troupeaux

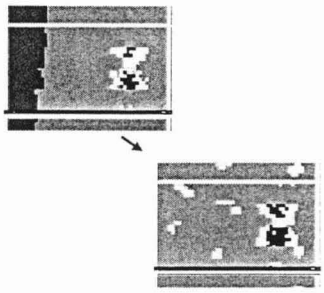


On voit ici trois images prises à des pas de temps différents. En bleu le village, jaune les champs, vert la savane, vert foncé la forêt. Les points blancs sont les paysans, noirs les troupeaux

Spatial entities

- The agents : savana, forest, village, crop
- Each controls a part of the space (cells).
- Agents communicate to echange parts of the cells.
- Ex: Village agent send a message to savana agent, savana send neighbouting cells to the plot and send a message to the forest

Vesrion 2 : La dynamique est gérée par des échanges d'espace entre les quatre agents : village, champs, savane, forêt

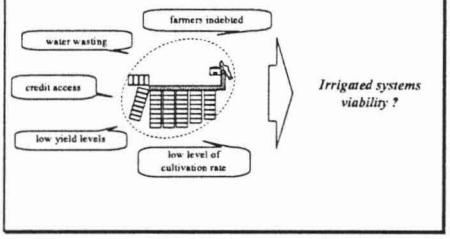


Irrigated system viability

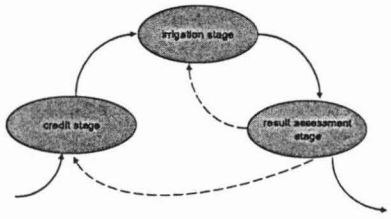
- Knowledge representation
- The social model : two levels, the individual and the group
- Simulations : co-adaptation between individual rules and collective rules

Un exemple de travail sur plusieurs niveaux d'organisation.
Pour simuler le fonctionnement d'un périmètre irrigué on représente le comportement des groupes et des individus

An example: irrigated systems management



Stages represented



Le modèle représentera trois étapes d'une saison, l'accès au intrants et au crédit, l'irrigation, l'évaluation des résultats de la campagne.
Chacune de ces phases implique des dynamiques au niveau des groupes et au niveau des individus

collective rules and individual behaviors: examples

- Pumping station management
  - rule for starting pumping station
  - rule for authorizing farmers to take part in the cropping season
- Individual behaviors
  - goal for cultivating his plot
  - rule for lending money to other farmers

Des exemples de règles pour le groupe qui gère la station de pompage, et pour les individus qui irriguent.

Example of viable scenarios

- Has 21
  - start pumps when enough farmers are ready, authorize farmers to take part in the cropping season if they have paid individually their irrigation fee
  - most farmers have a goal of production and lend only symbolic amount to other farmers
- Has 62
  - start pumps at a fixed date, authorize farmers to take part in the cropping season if they have paid collectively their irrigation fee
  - most farmers have not a goal of production and lend whole amount they are asked to other farmers

En conclusion, il est montré que la viabilité réside dans la cohérence entre les règles de différents niveaux plus que dans la qualité des règles elles-mêmes. Ici deux exemples de couples viables

Perspectives

- The Group agent
- Linking Cormas and GIS
- How to use MAS in a decision-making process?

D'un point de vue méthode , la progression pour travailler le problème du transfert d'échelle passe par le développement de l'agent Groupe, que ce soit pour des dimensions spatiales ou sociales.

Workshop on Scaling Methodologies in Eco-regional Approaches for Natural Resource Management: Towards further research collaboration

22-24 June 1998

Venue:
College of Agriculture and Forestry (CAF)
Vietnam National University
Ho Chi Minh City, Vietnam

Jointly organized by:

- **International Rice Research Institute (IRRI)**
- **College of Agriculture and Forestry (CAF) Vietnam National University - Ho Chi Minh City**
- **Sub National Institute of Agriculture Planning and Projection (Sub-NIAPP)**

IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE

CAF

Sub-NIAPP
Sub-National Institute for Agricultural Planning & Projection in South VN

Sponsored by:
The International Rice Research Institute
The SYSNET Project under the Ecoregional Fund
The C.T. DeWit Graduate School of Production Ecology

Objectives

1. To sensitize researchers on the importance and relevance of scale in studying agro-ecological processes and in analysis of production systems.
2. To examine recent research efforts and accomplishments in the development of scaling methodology relevant for agro-ecological characterization and NRM for sustainable agricultural production.
3. To identify research opportunities and develop research agenda for collaborative projects among Agricultural Research Organizations (AROs), International Agricultural Research Centers (IARCs) and National AgriculTural Research Systems (NARS) to strengthen on-going research on agro-ecological characterization and NRM, with emphasis on scale integration and scale transfer.

Expected outputs

1. Researchers sensitized to the importance and relevance of scale in NRM research and informed about concepts, approaches, methodologies and techniques addressing the issue of scale in related disciplines.
2. Case studies presented as possible candidates for strengthening scale-dependent approaches.
3. Proposals identified and a work plan formulated to pursue joint collaborative research efforts in developing scaling methodologies in agro-ecological and NRM research.

Background and Rationale

The eco-regional approach focuses on development of strategies and techniques for Natural Resource Management (NRM) at the regional (sub-national and higher) level for sustainable agricultural production. It requires that we look beyond individual crops and beyond the plant, field and farm level where the science of crop production has largely concentrated on. NRM requires rational decisions to be made, supported by relevant and reliable information. There is a need to translate and transfer information about natural resource characteristics as well as models of agro-ecological processes across different spatial and temporal scales to build the body of knowledge that can support sound NRM decisions. Just as it is useful to "scale-up" our understanding of bio-physical processes from plant, field and farm studies to the level at which regional planning and public policy is formulated, it is equally useful to be able to disaggregate and deduce processes and information from a coarser level, i.e. "scaling down." In recent years, active research is being carried out to develop methodologies and techniques for scale transfer and integration in a broad range of disciplines, both in the biophysical as well as the socio-economic sciences. This indicates an increasing recognition of the relevance of the scale issue. It is opportune at this point that IRRI is coordinating the eco-regional initiative for the humid and sub-humid tropics and sub-tropics, to bring together the experts and researchers in a workshop which specifically addresses scaling methodology for NRM research at the regional level.

Program

21 June 1998
Arrival of workshop participants to Ho Chi Minh City
Registration upon check-in at hotel.

Day 1: 22 June 1998

8:30-9:00 Registration (continued)

9:00-9:30 Opening remarks
- Vice-President of the Vietnam National University, Ho Chi Minh city
- Dr. Paul Teng, Cross-Ecosystems Program Leader, IRRI

Group photograph taking

9:30-9:45 Tea

9:45-10:45 Chair: *L.T. Hieu*
Keynote address by Prof. R. Rabbinge: Relevance of scale-dependent approaches in ecoregional research for natural resource management

10:45-11:45 **Session A: Scale issues and techniques: implications for survey, data collection and management for NRM**
Chair: *U. Deichmann*
Rapporteur: *O. Husson*

1. Sampling strategies and sample representation at different spatial and temporal scales — *M. Hoosbeek*
2. Scale-dependent approaches in land use cartography using remote sensing data — *A. Begue & F. Borne*

11:45-1300 Lunch

13:00-15:00 **Session B: Scale issues and techniques in data processing, analysis and modeling**
B1. *Issues and techniques for up- and down-scaling agro-ecological characteristics and for land evaluation*
Chair: *H. Manichon*
Rapporteur: *A. Laborte*

1. Scaling and spatial synchronization of climate and agricultural data for agroecological characterisation - case study for Eastern India — *A.S.R.A.S. Sastri & V.P. Singh*
2. Up- and down-scaling of agroecological stresses — *J. Ingram*
3. Scale issues in land suitability modelling in a deltaic context: A case study of Tien Hai area in the Red River Delta, Vietnam — *P.V. Cu*
4. Using decision tree as an expert support system for land evaluation study at the farm scale as compared with regional and district scale — *L.Q. Tri, M.E.F. van Mensvoort & J. Bouma*

Changed

15:00-15:15 Tea

15:15-17:15 **Session B: Scale issues and techniques in data processing, analysis and modeling**
B2. *Issues and techniques for up- and down-scaling human/behavioral characteristics and for integrating biophysical and socio-economic analysis*
Chair: *G. Trebuil*
Rapporteur: *C. Edmonds*

1. Spatial scale and resolution in the analysis of socio-economic and demographic data — *U. Deichmann*

2. Modeling the management of river resources: A case study of the Murray River in Australia — *D. Brennan*
3. Multi-agent systems and renewable resource management management — *O. Barreteau & F. Bousquet*
4. Can scaling methodologies ignore stakeholders analysis? — *P. Bergeret*

Evening: Official dinner

Day 2: 23 June 1998

8:00-10:00 **Session B: Scale issues and techniques in data processing, analysis and modeling**
B3, *Issues and techniques for modeling and linking agro-ecological processes at different scales*
Chair: *H. van Keulen*
Rapporteur: *P.K. Aggarwal*

1. Crop yield estimation at different scales — *R. Roetter*
2. Modeling and linking hydrological processes at different scales — *J.P. Bricquet, F.P. de Vries & C. Niamskul*
3. Scale issues in the analysis of nitrate pollution in the upper groundwater in the Netherlands — *D. Jansen*
4. *Scale issues in Integrated Pest Management* — *P. Teng/J. Waage*

10:00-10:15 Tea

10:15-11:45 **Session B: Scale issues and techniques in data processing, analysis and modeling**
B4. *Scale issues pertaining to natural resources management in Vietnam*
Chair: *N.V. Nhan*
Rapporteur: *L.Q. Tri*

1. Ecoregional approaches for natural resources management in the Mekong Delta: A case study in the Plain of Reeds - The IAS/FOS Project — *O. Husson, M.T. Phung and J. Bouma*
2. Agricultural ecological zoning in Vietnam — *T.A. Phong, N.V. Pho & N.V. Tien*
3. Information requirements for establishing a forestry management plan — *Ngo An*

11:45-13:00 Lunch

13:00-15:00 **Session C: Scale issues in addressing NRM research under the Ecoregional Initiative**
Chair: *D. Brennan*
Rapporteur: *P.M. Bolink*

1. Exploring agricultural land use options for Haryana: Scaling issues — *P.K. Aggarwal*
2. Scale issues in land evaluation: the Ilocos Norte Case Study — *A. Laborte*
3. Scaling issues in methodology development for land use planning and policy formulation: the Kedah-Perlis case study — *Ismail A. B.*
4. Scale issues in irrigation management: the gap between theoretical and real management - the case of the Chao Phraya Delta, Thailand — *F. Molle & C. Chompadist*

15:00-15:15 Tea

15:15-17:00 **Session C: Scale issues in addressing NRM research under the Ecoregional Initiative**
Chair: *P.V. Cu*
Rapporteur: *C.T. Hoanh*

1. Between micro and macro-level studies, the quest for a meso-level for effective community-based natural resources management in Vietnam uplands. — *J.C. Castella*
2. ~~The Vietnam SYSNET Project~~ — ~~*N.X. Lai*~~
3. GIS databases for participatory natural management in the uplands: lessons and challenges for a new research agenda — *N.D. Binh & H.H. Cai*

Evening: Free

Day 3: 24 June 1998

8:00-10:00 **Session D: Towards collaborative approaches to address scale issues**
Moderator: *J.K. Ladha*
Rapporteur: *J.C. Castella*

8:00-9:00 Summary of research issues and techniques in scale integration and scale transfer — *H. van Keulen*

9:00-9:15 Emerging scale-related issues in NRM under EcoR initiative - a synthesis — *S. Kam*

9:15-9:45 Plenary: Research issue identification

9:45-10:00 Tea

Program

10:00-11:45	**Session D: Towards collaborative approaches to address scale issues** Moderator: *P. Teng* Rapporteur: *G. van Laar* Discussion groups: Case study development
11:45-13:00	Lunch
13:00-15:00	**Session D** (continued) Plenary: Case study presentation Discussion: Formulating research agenda and proposals
15:00-15:15	Tea
15:15-16:30	**Session E: Conclusion and next steps** Chair: *T.P. Tuong* Rapporteur: *R. Roetter* Workshop conclusion and action plan Closing

Workshop Venue

Venue for the Opening day will be held at the College of Agriculture and Forestry, Vietnam National University, Ho Chi Minh City. The campus is 20 km from the hotel (about 45 min. drive). The local host institution will organize buses to transport participants to and from the hotel.

Conference sessions for the second and third days (23-24 June 1998) will be held at Conferece Room of Ministry of Education and Training (Ho Chi Minh City Office).

General Information

ACCOMMODATION

Foreign participants:

Victory Hotel (Vietnamese name: Khach San Thang Loi)
14 Vo Van Tan, Dist 3, Ho Chi Minh City
Tel.: 8294989
Fax: 8299604.

Room rate: 30 US$ at single occupancy per night per person inclusive of breakfast.

Local participants will be notified by the host institution regarding their accommodation arrangement.

COMMUNICATIONS

Personal use of phone, fax, and telex will be charged to personal accounts of participants.

BANKING SERVICES AND CREDIT CARDS

Major foreign currencies can be freely converted into Vietnam Dong at the hotel's cashier counter or local banks. Traveler cheques are difficult to cash in Vietnam.

Major credit cards are accepted in big hotels and shopping centers only.

SECRETARIAT

You may contact the secretariat for your queries: review of slides and overheads, duplication of papers, accommodation problems, reconfirmation of tickets, transportation from and to airport, field trip, etc..

TELEPHONE CONTACTS

Day 1 of the Workshop

Prof. Dr. Luu Trong Hieu
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Days 2 and 3 of the Workshop

Mr. Vu Manh Tien
Tel: 84-8 8291 244

SCALE PROBLEMS IN AGROECOLOGICAL STUDIES TENSION BETWEEN AGGREGATION LEVELS

R. Rabbinge and P. S. Teng

Ladies and gentleman, you're all very welcome at this workshop sponsored by IRRI and the C. T. de Wit Graduate School of Production Ecology. As Chairman of the Board of Trustees of IRRI and Scientific Director of the Graduate School, I like to express my appreciation to the organizers of this meeting. I hope and expect a useful and productive workshop. I'm very sorry that I can't attend this meeting and would to thank Dr. P.S. Teng for his willingness to take my position. I wish you all a good workshop.

INTRODUCTION

The increased interest in ecoregional programs and projects is in line with the evolution of the research agenda in national and international agricultural research. This workshop is timely and needed as it addresses some problems that are crucial importance in ecoregional studies. Ecoregional studies are the fifth phase of international agricultural research that we've witnessed during the last few decades. In the first phase development of new varieties was the major issue and the international centers were at that time basically breeding institutes. It became already rapidly clear that the new varieties could only perform when the appropriate agrotechnologies were used and thus we see in the second phase more interest in irrigation, soil fertility, crop protection and various other agronomical activities. In the third phase of development of the international agricultural research agenda, in the early seventies, it become clear that the socio-economic characteristics of the farming systems in which is evolved should be taken into account in order to fine tune technologies and interventions to their specific needs Farming systems research and participatory research became the buzz words. After that phase it was more and more felt necessary to expand the aims of goals of agricultural research. Productivity alone is no longer sufficient and objectives such as resource are efficiency became major issues. Natural resource management became more and more the second pillow of international agricultural research. Now at the end of the twentieth century that may be very difficult for different areas and regions. Biophysical and socioeconomic conditions may be very different in various regions and so the ecoregional approaches that accounts for such differences is becoming more and more adopted. However the methodologies to do such research are poorly developed and it is for that particular reason that various projects meant at a better development of such methodologies were initiated in the nineties. Sysnet is one of them. In these projects problems of Scale and Aggregation and Disaggregation are major issues. That is the subject of this workshop and I'm glad that I may give some introduction remarks on that issue.

TENSION BETWEEN AGGREGATION LEVELS

Tension between aggregation levels and also between disciplines occurs frequently and is partly due to misunderstanding, improper definitions and the absence of well-defined aims of a study. In this introductions definitions of concepts are given and different objectives of land use studies are discussed in an analysis of real and apparent conflicts between disciplines and aggregation levels.

All ecoregional studies consider systems, at a high aggregation level. Crops, or cropping systems, are building blocks in land use studies for farming systems or systems at regional level. Systems are limited parts of reality with well-defined boundaries. The boundaries are selected on the basis of the objectives of the study.

In ecoregional studies, agricultural and other land use systems have to be well-defined. The definition comprises three sets of classification criteria: time, space and the influence of man. The last criterium requires an appropriate description of objectives of a study. Roughly three types of studies with different objectives may be distinguished: (i) descriptive and comparative studies, (ii) explorative studies, and (iii) planning studies.

In descriptive, comparative land use studies, the functioning of the system (e.g. the farm household or a region) is investigated. By analyzing the various descriptions of the system it is possible to explain the current situation and to gain insight in its limitations. By means of descriptive, comparative system analysis it may be possible to tell something about the near future. In this type of study the influence of man is a very important driving variable in the system analysis.

Another group of land use studies aims at exploring possibilities and potentials for a particular farm or area in the long run. This can be done from a biophysical and technical point of view or in such a way that socio-economic factors are also involved. In studies meant to investigate the biophysical potentials of a particular area, the way man manages the system at present is excluded. The potentials in land use of the area are dictated by the soil, the climate and the characteristics of a crop. In explorative studies, concepts like best technical means and best ecological means are used rather than best practical means. In such studies the potentials cannot be translated into consequences for the farming system, or in the day-to-day management of a cropping system or crop. In explorative studies in which socio-economic factors are also taken into account, assumption on farm management have to be introduced. These studies explore which land use changes can take place, taking into account socio-economic factors also. Management decisions are very often determined by socio-economic objectives and constraints rather than production-ecological possibilities. Land use studies that are meant to identify and explore technical possibilities and limitations are usually relatively narrow and need mainly biophysical knowledge and insight, whereas explorative land use studies in which socio-economic objectives and constraints are included need a much wider interdisciplinary approach.

After certain land use options for the future have been chosen, studies for planning and management become important. The question of how the land use options that have been chosen can actually be achieved is crucial. Policy instruments play an important role in it. Predictive models at various aggregation levels may be very useful. They may help in strategic and tactical planning. At various levels of aggregation other models are needed.

It is vital for any study to identify the appropriate level of aggregation, i.e. the level that corresponds with the objectives of the valuation. Studies on possibilities at farm level have a different character to those at a regional level. It is important to choose the appropriate aggregation level in relation to the objective of the study and to be explicit about the aggregation level of the study.

Production-ecological and socio-economic aggregation levels may be distinguished and possible reasons for tension and conflicts between aggregation levels and disciplines will be identified. An interface between the farm and regional level and various disciplines is needed. Possible rules and recommendations to prevent tensions and conflicts maybe suggested. It may also be useful to screen the various case studies on land use against these guidelines.

AGGREGATION LEVELS IN PRODUCTION-ECOLOGICAL TERMS

The basis of all primary and secondary production in agro-ecosystems is the photosynthesis of plants. Individual leaves intercept the radiation of the sun and use its energy for the production of sugars by means of a reaction between carbon dioxide and water. The underlying diffusion of CO_2 and photochemical and biochemical processes can be quantified, thus enabling us to compute the sugar yield from the number of CO_2 and H_2O molecules involved. The sugars are used for the construction of all types of structural components. This construction requires energy that is obtained through combustion of sugar-the so-called 'growth respiration'. Together with the photosynthesis and the growth respiration, the maintenance respiration closes the C-balance at leaf level. Insight in the physical, chemical and physiological processes involved in photosynthesis of leaves and respiration forms the basis of production ecology.

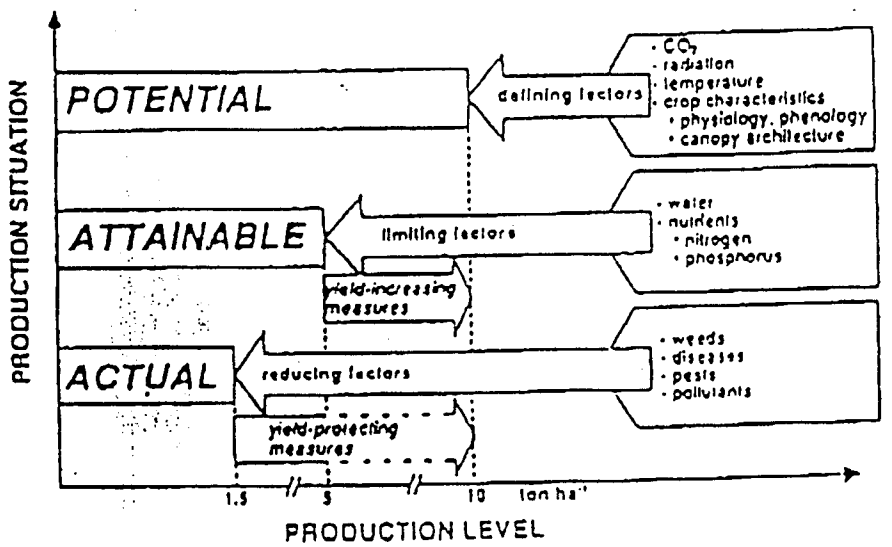

Figure 3.1 Schematic overview of different types of production factors and their corresponding production levels (Reproduced from Rabbinge, 1993, by permission of the Ciba Foundation)

Integration of leaf photosynthesis to crop level (De Wit, 1965) enables the quantification of crop performance under various circumstances. Dynamic simulation models are used for that purpose. At the crop level, various growth factors can be distinguished; the growth-defining, limiting and reducing factors (Figure 3.1). From a plant's point of view, the potential production is dictated by the growth-defining factors climate and characteristics of the crop. The attainable and actual production are determined by production-limiting and production-reducing factors.

A crop is part of cropping system, and a cropping system is part of land use on the farm and in the region. In land use studies at the farm or regional level, production-ecological concepts and insights may be used to explore the system. The biophysical potentials of land units within a system can be investigated using crop growth simulation models. The production-ecological concepts and insights are used in this case only for the exploration of land use potentials and not for prediction, explanation and management support. The latter objectives would require completely different approaches and models.

In a system analysis, the level of detail of each of the underlying levels is dictated by the questions posed at the higher level. The more accuracy or the more quantitative aspects needed at the higher level, the more detail at the underlying level is necessary. In dynamic simulation studies, e.g. crop-growth simulation studies, this is made explicit by using the concept of aggregation level and the spatio-temporal characteristics, scale and time coefficients. Many production-ecological studies, e.g. leaf photosynthesis or

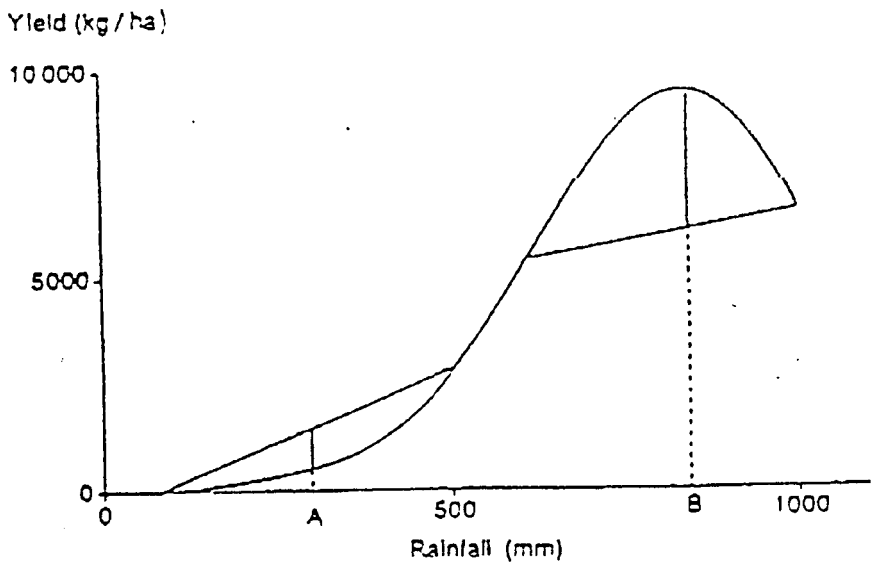

Figure 3.2 The influence of averaging rainfall on its calculated yield response. The yield is underestimated by averaging in the lower rainfall region (A) and overestimated in the higher rainfall region (B). Source: De Wit and Van Keulen (1987) (Reproduced by permission of Elsevier Science Publishers BV)

crop growth analysis, aim at understanding and explanation, and in these studies a detailed crop-growth simulation model is required. However, it does not make much sense to work with a detailed crop-growth simulator in explorative land use studies. The results of detailed crop-growth simulators are very plot-specific and cannot be used for the objective of quantifying

(quesstimate) various yield levels in different land evaluation units. Land use studies need crop-growth simulators of a low level of complexity. They should be adequate for the determination of a first estimate of potential and attainable yield for homogeneous units on the soil and climate map. Time coefficients are then normally big and the land units for which yield is estimated are of a considerable size.

Aggregating information from a lower to a higher aggregating level is dangerous when homogeneity at the lower level is absent. Two examples of possible consequences of aggregation in land use studies are given in Figures 3.2 and 3.3. The first concerns heterogeneity in rainfall, which affects the results of a quantitative land evaluation (figure 3.2). Because of the curvilinear relation between rainfall and yield, the yields are underestimated in the lower rainfall region and overestimated in the higher rainfall region by using average rainfall figures. The second example shows a possible consequence of aggregating land units or sub-regions in a land use study using linear programming (Figure 3.3). By aggregating heterogeneous land evaluation units or sub-regions and averaging the corresponding input-output data of the different units or sub-regions, the extremes in the original input-output data level off. When these aggregated data are used in an LP model the results of an optimisation may be less extreme than when non-aggregated data are used. Suppose a particular region consists of four land evaluation units of 1000 ha each. The wheat yields with a certain production technique in these regions are supposed to be 8, 6, 4 and 2 ton/ha for units 1, 2, 3 and 4, respectively. The objective of the optimisation in this example is to minimize the area in the region required to produce 10,000 ton wheat. In Figure 3.3 the effect of aggregating units 1 and 2 and units 3 and 4 is shown. Without aggregation, the minimum area is 1333 ha (1000 ha in unit 1 with 8 ton/ha and 333 ha in unit 2 with 6 ton/ha) whereas after aggregation the minimum area is

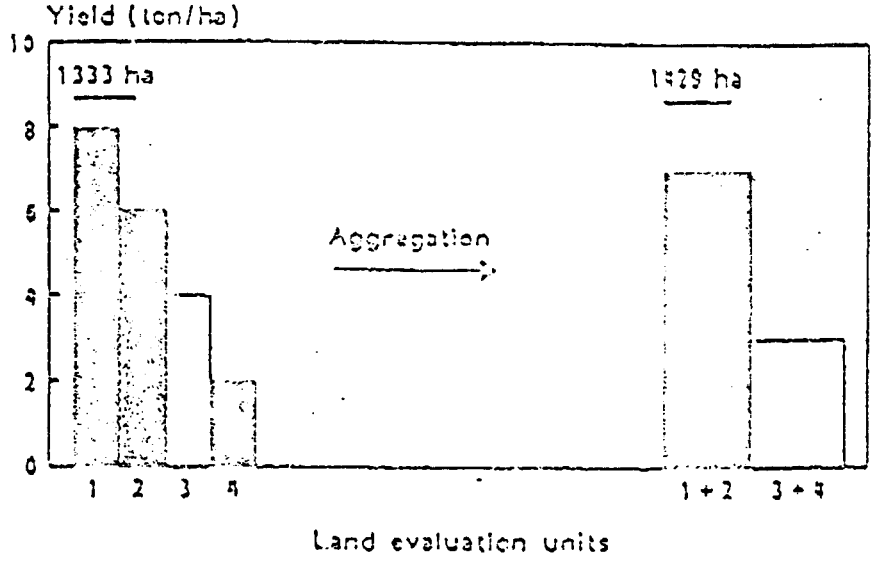

Figure 3.3 The effect of aggregation of four land evaluation units of 1000 ha each to two units of 2000 ha each on the minimum agricultural area required to produce 10 000 ton wheat in the region (4000 ha total). The average wheat yields in units 1, 2, 3 and 4 are 8, 6, 4 and 2 ton/ha, respectively. The average yields in the aggregated units 1 + 2 and 3 + 4 are 7 and 3 ton/ha, respectively. The minimum area in the non-aggregated problem is 1333 ha, wheras after aggregation the minimum area is 1429 ha. Source: unpublished data of R. J. Hijmans and M. K. van Ittersum

1429 ha (1429 ha in unit 1+2 with an average yield of 7 ton/ha). In the aggregated model the minimum agricultural area is larger than in the non-aggregated model.

Heterogeneity in time and space should be handled with care. In land use studies the credo 'first calculate, then average' is valid. Heterogeneity and curvilinearity in input relations should be retained as along as possible and their consequences should be included in the evaluation studies.

AGGREGATION LEVELS IN SOCIO-ECONOMIC TERMS

Many land use studies in socio-economic terms described the functioning of farm households at micro-level. By analysing the various descriptions at this level it is possible to explore options for change and to get a better insight into limitations. These limitations may be biophysical but are often institutional. They comprise limitations due to shortage of labour, capital, knowledge, infrastructure or policy. Solutions to eliminate such limitations may be described when the functioning of the farm systems is better understood. Lower levels of aggregation than the farm are usually not considered in socio-economic terms. The farm is the basic unit.

Studies on a regional level may be based on the aggregation of studies on a farm level. However, that creates many difficulties as there is variation between individual farms, and limitations at regional level may differ from those at farm level. The 'bottom-up' approach has, therefore, its limitations; aggregating farm level to regional level will lead to ambiguous results. On the other hand, it is very hard to draw conclusions from regional studies about decisions to be made at the farm level. An interactive approach between the regional and the farm level seems a more apt approach, but before substantiating that for explorative studies, we will deal with the tension between the different types of land use studies and disciplines.

TENSION AND CONFLICTS BETWEEN AGGREGATION LEVELS AND DISCIPLINES

The presence of various aggregation levels and many disciplines in land use studies may easily lead to misunderstanding, polarisation and finally absence of any communication. The conflicts and tension often arise from differences in objectives or unclear objectives of a study.

Many studies are concerned with a static description of the present situation and do not take into account the dynamics of systems. On the basis of static observations of present land use, conclusions on the possibilities in the future are possible only up to a certain extent. In the short term, insight into possibilities for change can be given but it is virtually impossible to explore long-term options. In those cases, the future is an extrapolation of past and present, and discontinuities in trends are absent. The future is regarded as restricted by the past and shows no unexpected possibilities. In many socio-economic studies for the short term this type of extrapolation makes sense. Deterministic, descriptive studies are then sufficient.

New results are possible when the past is not used as a measure for the future but when political or societal desires are combined with technical possibilities. This means explorative instead of predictive studies, which use plausibility and predictive value as the criteria for measuring the quality. In explorative technical studies plausibility is not important but consistency, completeness and scientific soundness of the technical possibilities are the most important criteria for measuring the quality of long-term studies. In explorative studies for land use the relations are not described but based on insight into the input-output relations. In studies that describe the present situation, correlation between various variables and characteristics are used. Causal relations based on an understanding of basic process are then absent. For explorative studies, a good understanding of the input-output relations is necessary. This may lead to the definition of techniques that are not yet widely used in practice. The feasibility of various options is not based on their relation to the present status, but on the biophysical and technical limitations and possibilities that determine the potential.

Often, in land use studies the behaviour of actors is incorporated and send as an integral part of land use. In descriptive analytic studies this approach is necessary as actors form part of the way the present situation may be explained from developments in the past. However, in explorative land use studies behaviour of actors should be explicit and choices should be transparent. This may help in the judgement of a priori assumptions, expectations and objectives.

Production-ecological studies are in most cases explorative and deterministic, using explanatory models that are integrated in multiple goal explorative models. Socio-economic studies are in most cases predictive, using descriptive input-output relations based on the past.

POSSIBLE INTERFACE BETWEEN VARIOUS AGGREGATION LEVELS AND DISCIPLINES

In explorative land use studies at the regional level, technical information about land use is confronted with different objective functions in an interactive multiple-goal linear programming model. The technical information can be derived from crop-growth simulation models, literature and expert knowledge, and the objective functions can be distilled from the different policy views in the region. The time horizon (e.g. 25 years) of these studies is far enough away to limit its effect. In this way, different land use options can be generated which represent the different policy views in the system; they demonstrate the extremes in land use from a technical point of view for the long run.

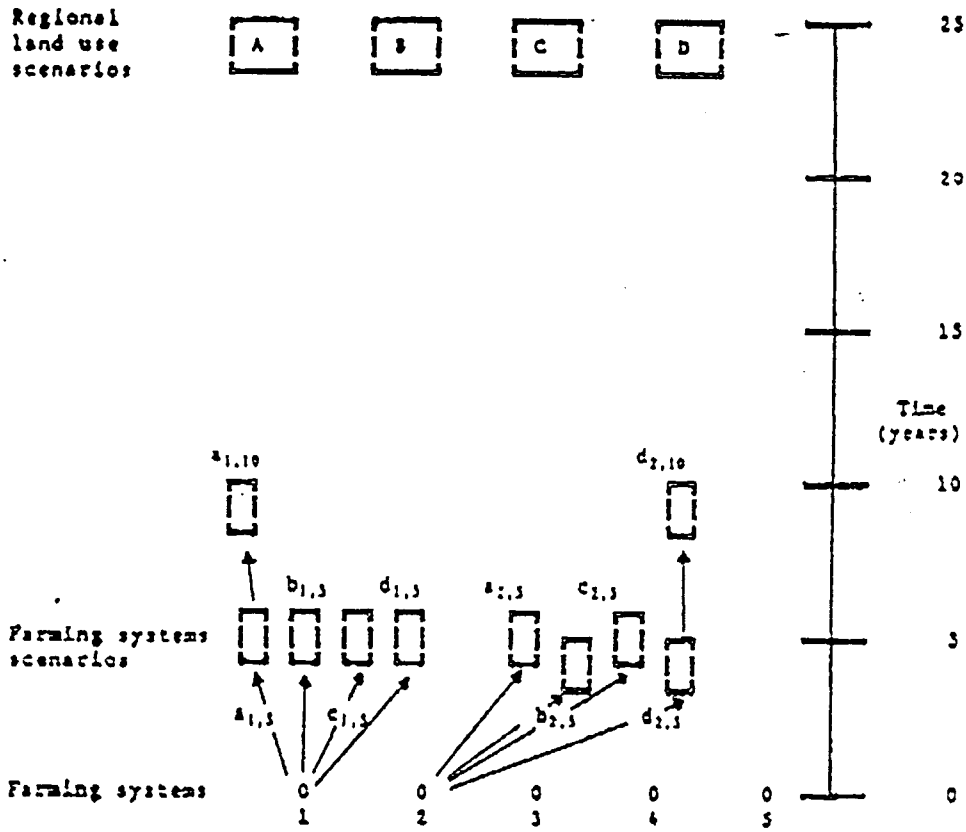

Figure 3.4 Interface between an explorative land use study at the regional level and explorative land use studies at the farming system level within the region. A, B, C and D are regional scenarios representing different policy views. $a_{1,5}$: Scenario a (priority of different objectives similar to those in Scenario A for the region) for farming system 1 in year 5; $d_{2,10}$: Scenario d (priority of different objectives similar to those in Scenario D for the region) for farming system 2 in year 10

However, these studies do not show the consequences for the individual farms within the region. The relation with the actual situation and short-term options is absent but may be achieved with a procedure explained in Figure 3.4

The regional land use options set the scene for more detailed studies at farm level. This can be done in an interactive way. Different farming systems in the region can be distinguished. For each of these farming systems explorative studies can be carried out with much shorter time steps (e.g. 5 years) by confronting technical information about land use on the farm with the objectives of the farmer and those of the region in LP models. Different scenarios for each of the farming systems can be generated by putting different weights to the objectives of the region. For the first time interval, the land use activities that are offered to the linear programming model are more closely related to the current land use activities, whereas for later intervals they are more closely related to possible future land use activities. From these explorative farm studies an answer to the question of whether individual farms (farming systems) may be capable of reaching the land use patterns found in the regional study might be obtained. Often structural

changes in size and structure are necessary. Exploration with studies at farm level may help to gain insight into the way transfer can take place. These studies should demonstrate whether institutional, socio-economical or cultural factors limit the attainable changes in the near future. Such studies require detailed economic and social analysis of the present situation. The connection with explorative studies for the long term may take place from both sides, from the present and from the potential future. When necessary the regional studies may be made more dynamic by the introduction of various time horizons (Spharim et al., 1992).

Both in the regional and farm studies the definition of the boundaries of a system, the elements of the system and the influences of the environment are very important. At the farm level the 'farm gate' it the appropriate boundary; however, it should be clear whether income generated outside the farm but used for investment in the farm is taken into account. At a regional level, for instance, it is important to be explicit about possible imports and exports of products; in other words, to distinguish between policies aiming at self-sufficiency for agricultural products or those aiming at free market and free trade.

GUIDELINES

To prevent misunderstanding and lack of communication between disciplines and aggregation levels, some guidelines have been formulated:

1. Describe the objectives of land use studies explicitly. The objectives of the study determine the size of the system, its boundaries and the environment. The objectives may vary from an investigation of the short-term perspectives of an individual farm to an exploration of possible land use in a region.

2. Define the system and its boundaries in time, space and influence of man. Systems as a limited part of reality are not a construct but are quantifiable and identifiable phenomena. Models are simplified representations of systems.

3. Described the next lower level and next higher level of aggregation. The definition of the system and boundaries enables a clear description in general terms of the next lower and next higher levels of aggregation. The relation between aggregation levels can be identified in that case. It is impossible to consider at once (for example, in one model) more than three aggregation levels. It will lead to unreliable results or to unjustified conclusions.

4. Identify the external influences and constraints. Their influence in terms of driving force (e.g. as an effect on the demand for agricultural products in the system) and constraints that dictate the ultimate limits (technical limits, e.g. maximum yields or water availability, and normative limits, e.g. a minimum employment rate) should be defined.

5. Determine the internal variable (activities) related to land use, their interaction and their relation with the environment. The objectives and size of the system dictate these variables. A minimal number of variables is as a preferable strategy.

6. Make explicit the necessary technical information and the various policy issues. In regional land use studies an indication of various techniques and their organisation is sufficient, whereas studies on a household level require much more detail in the way of labour organisation, income generation, etc. Depending on the objectives and limits of the system, other technical information (e.g. consumption level, imports and exports) is needed.

7. If explanation is the aim, distinguish clearly between levels. Systems behaviour is explained from the underlying process level. Quantification of explicit relations at a process level form the backbone of the explanation and understanding of systems behaviour.

8. If prediction is the aim, be sure of the reliability of the models. Models that are used for predictions should be validated and their sensitivity for changes in inputs and input relations should be tested. Their robustness or fragility should be quantified and considered in the predictions.

9. If exploration is the aim, do not pretend to predict. Often explorative studies are interpreted as predictions. If plausibility and not consistency or technical possibility is considered as a criterion for the value of an explorative study, this may lead to the wrong type of discussion.

10. If decision-making is the aim, determine exactly the appropriate decision variables. Decision-making, be it strategic, tactical or operational, requires proper identification of the decision variables. Description of the ultimate decision variable and consequences of change should be quantified. In this way, decision-making is supported by land use studies.

11. Aggregate or average as late as possible. Aggregation or averaging input date may lead to the wrong results. First compute/calculate and then average should be the credo. Another order leads to the wrong results in cases of curvilinear input relations or in cases of much variation due to stochasticity of input data.

12. Never disaggregate in order to derive guidelines for management decisions at a lower aggregation level. The relation between micro, meso and macro level in socio-economic studies is a critical one. The same holds for aggregation levels in production-ecological studies. It is dangerous to draw conclusions from studies on meso or macro level for individual situations at micro levels. The study at the meso or macro level shows the ultimate consequences of the choices of policy-makers at that level. They do not indicate what decisions have to be made at the micro level.

The guidelines and suggestions described above may be used as a checklist in the evaluation of case studies on land use. Awareness of these guidelines may increase the quality of these studies and indicate what may be expected and for what purpose the studies may be used.

In the present workshop we may see how various ecoregional studies are done at various aggregation levels and it may illustrate the difficulties which we see when we're not aware of the various time and spatial scales. It is for that reason that this workshop may be so helpful to develop common ground for various studies in the future.

I wish you all a useful and fruitful workshop.

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Spharim, I., Spharim, R. and De Wit, C. t., 1992. Modelling agricultural development strategy. In: Alberda, T., Van Keulen, H., Seligman, N.G. and De Wit, C. T. (eds), Food from Dry Lands, pp. 159-192. Kluwer Academic, Dordrecht.

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SysNet

A Systems Research Network for Ecoregional Land Use Planning in Tropical Asia

R Roetter, CT Hoanh, JMCA Cabrera, A Laborte and B Nuñez

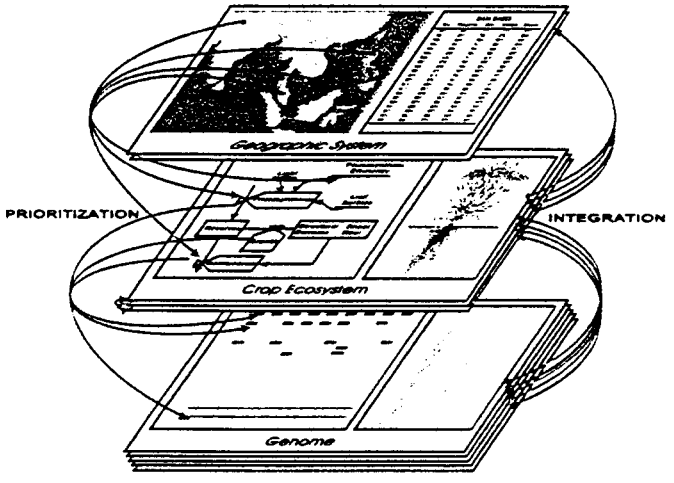
Objectives:

1. To develop scientific-technical methodology to explore land use options using models and expert systems at sub-national level.
2. To develop operational methodology that will support the cooperation needed in a network to address issues at multiple sites.

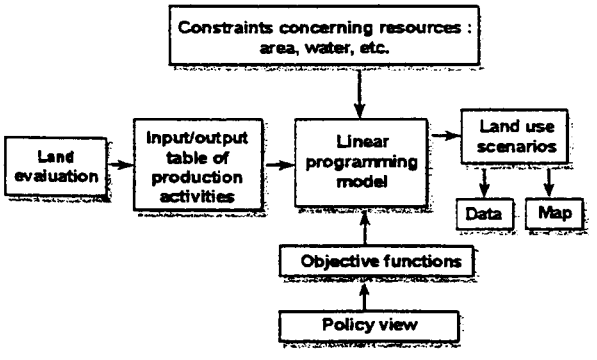
Expected outputs:

1. Models and expert systems identified/developed and evaluated for estimating yield and environmental effects at different scales.
2. Options for agricultural land use explored at four representative domains in tropical Asia.
3. Teams of trained scientists who can apply systems analysis techniques at the regional level to identify development potential and opportunities.

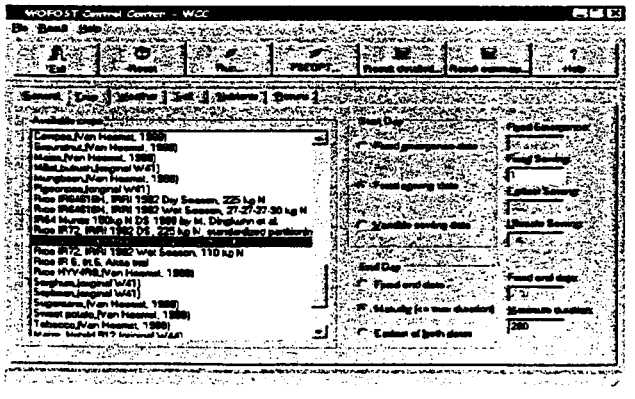
Ecoregional Approach: Integration from Genome to Region



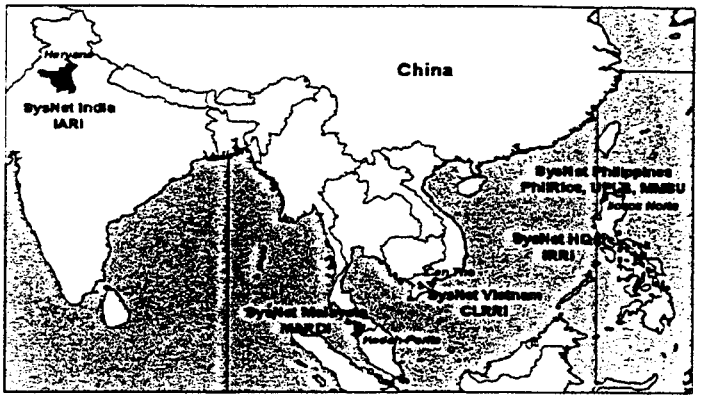
Interactive Multiple Goal Linear Programming (IMGLP) for land use planning



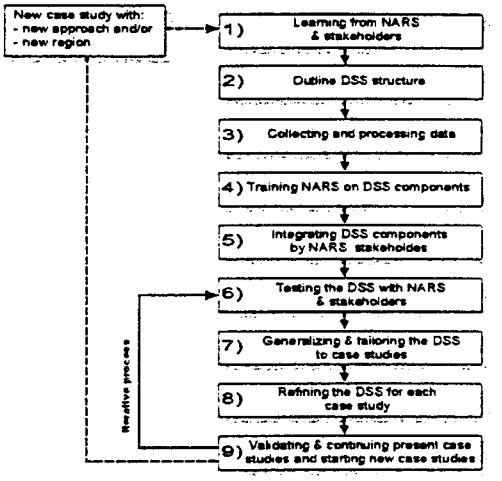
WOFOST Control Center for crop modelling



SysNet Project : Partners and Study Regions



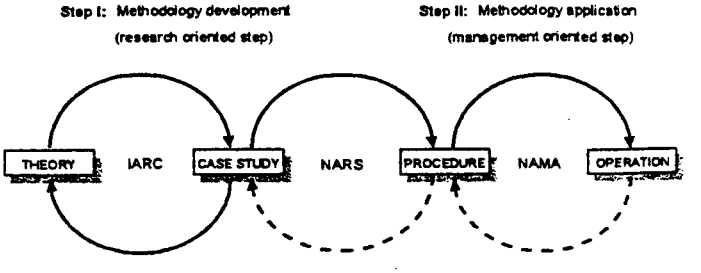
SysNet experience: Nine steps in developing Decision Support System (DSS) for land use planning



Achievements to date (April 98):

1. Established "Systems Research Network" for developing methodologies to address natural resource management issues and set up case studies at subnational level: Haryana, India; Kedah-Perlis, Malaysia; Ilocos Norte, Philippines; Can Tho Province, Vietnam.
2. Developed and applied operational methodology including consultative stakeholders' meetings, five training workshops on crop modeling and linear programming and several attachment trainings (GIS) at NARS partner institutions and at IRRI; and provided adapted tools (crop models, optimization software).
3. Designed decision support system, agreed on general methodology and applied this in prototype models for the four case study regions; conducted interactive (stakeholder-scientist) workshops resulting in revised "optimum land use allocation" models for Ilocos Norte, Can Tho and Haryana.

Sharing research between IARC, NARS and NAMA



IARC: International Agricultural Research Centers
NARS: National Agricultural Research Systems
NAMA: National Agricultural Management Agencies