Implementing the ecoregional approach in the Red River Basin uplands (Vietnam) Mountain Agricultural Systems (SAM) Project*

J.C. Castella[1], O. Husson[2], Le Quoc Doanh[3]
and Ha Dinh Tuan[3]
[1]International Rice Research Institute, P.O. Box 933,
Manila 1099, Philippines and ORSTOM, Paris, France
[2]CIRAD- CA / VASI, Van Dien, Thanh Tri,
Hanoi, Vietnam
[3]Vietnam Agricultural Sciences Institute (VASI),
Van Dien, Thanh Tri, Hanoi, Vietnam

Introduction: Problem setting

From development issues to scientific challenges

The main driving forces of the rapid and profound land use changes which have been occurring in Vietnam since the late 1980s are privatization of the economy, land redistribution and political reforms. Technical, economic and social transformations affect land use dynamics, agricultural production and natural resources management. Fragile upland ecosystems are endangered by the regression of forested areas and the development of non sustainable agricultural practices. On the other hand, sloping land redistribution increases farmers' differentiation and creates social tensions between people relying on the same natural resource base. Unfortunately, these land use transformations are often happening without any knowledge or prediction about their medium and long- term ecological, agronomic and social impact.

Many authors have described the general features of the northern Vietnam uplands and have emphasized the difficulties of breaking the vicious circle of increasing population pressure, environmental stress, impoverishment and marginality (Dao The Anh & Jesus, 1995; Eeuwes, 1995; Kerkvliet & Porter, 1995; Le Trong Cuc & Tran Duc Vien, 1995; Rambo et al., 1995; Rossi, 1995; Bal et al., 1997; FARM, 1997). A recent

* SAM is the French acronym for 'Systemes Agraires de Montagne'

contribution of Donovan et al. (1997) to the understanding of development trends in the northern Vietnam highlands classified problems of the highland regions into seven categories, namely:

- Physical constraints (e.g. broken terrain and steep slopes, low accessibility, poor acid soils, heavy rainfall, uneven rainfall distribution in time and space, etc.);

- Environmental constraints (e.g. deforestation, erosion, flooding, etc.);

- Infrastructural constraints (e.g. poorly developed systems of communication and transportation);

- Economic constraints (e.g. subsistence oriented agriculture, poor access to market);

- Population pressure (e.g. rapid growth rate, migrations, high level of unemployment);

- Cultural constraints (e.g. low level of education, different dialects, conflicting relations between ethnic groups); and

- Intellectual constraints (e.g. inadequate scientific knowledge of the highlands, belief in a single uniform development plan for the uplands).

This latter problem is identified as a major one constraining the development of a common vision for natural resource management (NRM). Attempts to apply a single uniform model, originally designed for the rather homogeneous lowlands, have proven to be disastrous most of the time in the highly diverse socio- economic systems of the uplands.

Methodological and conceptual problems are superimposed on the first six development issues (see above) when addressing specific upland environments. Research programmes are confronted by three major obstacles that make traditional approaches irrelevant.

Firstly, the extreme diversity, both ecological and social, is a major constraint to the generalization of local studies to higher integration levels. The main development trends are expressed in many different ways at farm or village level depending on local circumstances. This high diversity creates a very complex picture where nothing exists like a typical district, village or even household. The high heterogeneity raises major methodological problems for sampling procedures, data collection, and extrapolation of locally obtained results. Under these circumstances 'no single development plan can be broadly applicable, and no single model will prove to be successful everywhere' (Rambo, 1997).

Secondly, the very rapid pace of change in the region, especially since privatization of the economy, land redistribution, and political reforms of the late 1980s profoundly modified the relationships of people with their environment and also the interactions between stakeholders; regarding with such rapid changes, research results may be obsolete and/or useless before they can be released if methodologies cannot adapt continuously to this very dynamic environment. Keeping pace with the rapid agro- ecological and socio- economic changes is thus a major challenge for research programmes in order to maintain their relevance to development issues.

Thirdly, external driving forces play a major role in the transformation of mountainous areas of the Red River Basin. Studies focusing on development trends in the uplands cannot ignore external influences such as national policies, attraction of Chinese or western markets, etc., without the danger of becoming irrelevant. Locally rooted research needs to integrate broader perspectives when weighting relative advantages and constraints of proposed technological or institutional changes, as trade- offs often appear between different space- time scales. As a consequence, despite the will expressed by each NRM project in the Red River Basin (RRB) uplands to go towards an understanding of agricultural and forestry dynamics at regional level, research works often fail to go beyond local scales. This situation is mainly due to methodological problems (to cope with the high diversity and rapid pace of change) and to the lack of relevant institutional frameworks to develop such integrative activities. The challenge of research on NRM in the northern Vietnam mountains is to develop such methods and to facilitate the process of collective learning and to support mechanisms of negotiation among local people, so that they find their own way towards sustainable development.

The need for paradigm shifts

Heterogeneity as a source of information

Cartesian scientists reduce reality to its elementary parts to which the assumption of homogeneity (*ceteris paribus*) can be applied, as uniform environments are easier to deal with. But they need then to reconstruct the whole picture to find applications for their results. As the picture is becoming rapidly complex, the easy solution to extend the domain of application of their research is to make their environment become more uniform, which has proven to give disastrous consequences (Giampietro, 1997). For these scientists, the factors that cause undesired variation are regarded as disturbances that adversely affect the analysis of field experiments.

However, some authors re- interpret variation, giving it a totally new meaning and explicitly positive connotation (De Steenhuijsen Piters, 1995). Bio- and socio- diversity are now rehabilitated by the scientific community as they have proven very valuable to adapt to an uncertain and rapidly changing environment (Altieri, 1993). However, efforts to identify and define the factors that cause variation remain fragmented. Because of the focus on experimental research and of the inherent multidimensionality of the problem which, therefore, means that many disciplines are involved, an integrated approach for its analysis is lacking. Priority should be given to the development of such an approach, and variation should be treated as an object of research instead of as a statistical residue, in order to determine its objective importance and to derive essential information from it (De Steenhuijsen Piters, 1995).

Systems approaches provide key methods, concepts and tools to *reconstruct the picture*, to deal with hierarchies and systems characterized by a high level of diversity. They can help take advantage of the high spatial heterogeneity of northern mountain environments.

Creating a bridge between 'hard science' and 'soft systems'

The issue of sustainability concerns the evolution of ecosystems in interaction with societies that rely on them for their development. When dealing with long term evolution, one implicitly enlarges the space- time scale to encompass larger areas, with various sectors of activity and groups within society, future generations, and other societies and ecosystems distant in space but interacting through trade and communications (Giampietro & Pastore, 1997). As the aggregation level at which environmental problems occur moves upward, systems of regulation have to be created at the appropriate level that are compatible with lower and higher levels. For example, increased use of limited natural resources pushes social interdependence up to the ecoregional level, which leads to conflicts and to the need for negotiation about shared resources at this level. The scientific challenge becomes then to integrate multiple perspectives to accommodate conflicting interests and to reach agreement with regard to the use of natural sources at complementary levels: from the field to the ecoregion[1]. Beyond

1 An **ecoregion** is defined by the convergence of constraints and objectives of people living in a given geographic area and managing its natural resources: 'an area containing human societies, whose activities result from (*i*) their own objectives and needs, (*ii*) the resources (especially natural resources) that they can mobilize to this end, (*iii*) their mutual relations (exchange, competition, etc.), and (*iv*) the rules governing these relations' (Manichon, 1998).

the question of how people interact with their environment, the question of how they interact together about their environment is thus becoming increasingly important.

Unfortunately, so-called 'hard sciences' or natural sciences cannot answer the latter question (Röling, 1994) despite the major breakthroughs in agricultural development that they have allowed in the past. Hard sciences are based on the assumption that systems, defined unambiguously by their boundaries, operate on the basis of natural laws (Rabbinge et al., 1994). Under this paradigm, the role of researchers is to discover the truth and to unravel nature's secrets. Simulation models explore the future states of the system under different human objectives (De Wit et al., 1988; Rabbinge & Van Latesteijn, 1992; Van Keulen, 1993). People are supposed to maximize utility functions and researchers indicate the best technical means to achieve their goal. This type of reasoning has worked well from a productivity-driven perspective, under linear knowledge transfer from researchers to extensionists and down to the end- users. However, it shows its limits when upscaled to the ecoregional level for NRM. Hard sciences can show that an ecosystem is endangered but cannot impose 'ready- to- use' solutions or policies on stakeholders. People have to interact at the relevant aggregation level to find their way towards more sustainable management of natural resources.

The type of research needed to facilitate negotiations among stakeholders relies on a different paradigm than the one of hard sciences. Soft systems (Checkland, 1981; Röling, 1994) are based on the assumption that people construct their own realities through learning in social processes. Knowledge produced by human actors transforms the perceptions, and thereafter the actions, of other people in the society. Sustainability is thus closely linked to the perceptions that people have of their environment, and whether they can create platforms of interaction among them for concerted decision making about their environment (Dent et al., 1994; Darré, 1996; Röling, 1996). The role of research is then to make the problems become visible, and to provide information that facilitates the emergence of platforms of negotiation at the relevant aggregation level (e.g. problems diagnosed at farm level that must be solved at watershed level).

The two approaches presented here are not mutually exclusive, they are complementary (Figure 1).

Natural sciences paradigm	⇔	Social sciences paradigm
Epistemology		
Positivism (reality exists independenly of the observer)	⇔	Constructivism (reality is constructed by the observer)
Hard platform (De Wit, Rabbinge, Van Keulen, etc.)	⇔	Soft platform (Checkland, Darré, Röling, etc.)
Tools and simulation models		
Explorative models (technical / repeatable systems)	⇔	Heuristic models (agro- eco- socio / unique models)
Evolution from crop models to prototyping for vanguard farms	⇔	Evolution from farmer's decision making supports to virtual laboratories for socio- economic experiments
Main characteristics		
Generic models → universal	⇔	Negotiation support systems → Location specific
Long life span	⇔	Evolving: obsolete as soon as presented to stakeholders for validation
Linear knowledge transfer from scientists to extentionists to farmers	⇔	Iterative, interactive process facilitation of community learning
Scientist driven innovations	⇔	Stakeholders' interactions
Scientific rigor	⇔	Relevance for development

Figure 1. Complementarity of natural and social sciences paradigms for sustainable NRM.

Sustainability is an emerging property of this coupled system (Röling, 1994). Natural and social scientists should thus work together to develop new methods to make things visible from the complex ecoregional picture (Rabbinge, 1995; Dent, 1996; Manichon, 1998). However, the picture cannot be simplified by removing the actors. It would lead to scenarios delivered to decision makers without the keys to implement them. Social and cultural dimensions of sustainability are determinants not only of decision- making, the last step of the collective learning process, but also of the first stage of problem formulation (i.e. description of the system, spatial and temporal boundaries, actors perceptions of the problem, etc.). The different stakeholders, including scientists, should work out in an interactive fashion a common vision on NRM at the ecoregional level that would lead to new indicators, shared monitoring procedures, information systems, and concrete alternatives for action.

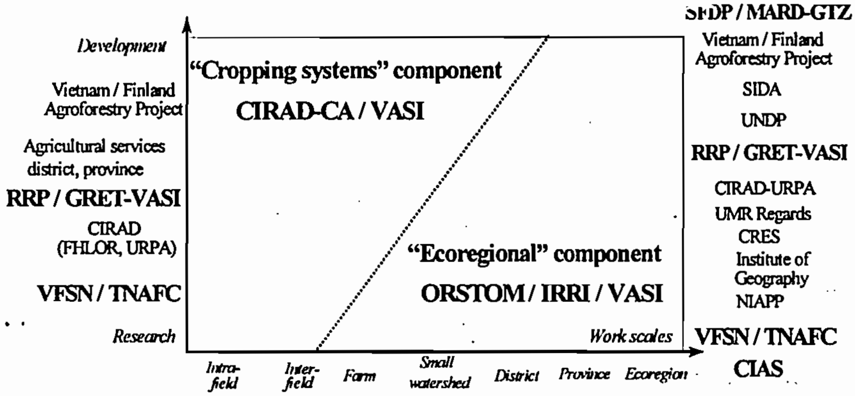

Figure 2. SAM Project's institutional framework: a continuum across scales and across research and development activities through partnership mechanisms. For acronyms see Appendix.

The SAM Project approach and methodology

The Mountain Agricultural Systems (SAM) project was designed as a response to the above presented challenge: implementing the EcoR- I (Ecoregional initiative for the humid and subhumid tropics and subtropics of Asia) approach in the highlands of the Red River Basin (RRB). As shown in Figure 2, it associates the Vietnam Agricultural Science Institute (VASI), CIRAD- CA (Annual Crops Department of the Centre for International Cooperation in Agronomic Research for Development, Montpellier, France), ORSTOM (Institut Français de Recherche Scientifique en Coopération pour le Développement, France) and IRRI (International Rice Research Institute, Philippines). It is conducted in close collaboration with several Vietnamese Institutions (Thai Nguyen Agroforestry College, FIPI, NIAPP, NCST Institutes, Vietnam Farming Systems Network, district and provincial agricultural services), and with European (e.g. GRET, GFA/GTZ) and international organizations (e.g. CIAT, ICRAF).

The SAM project combines case studies in a limited number of sites with the development of a knowledge base on NRM in the RRB uplands. The case studies:

- Confront local realities with constraints of field work, and thus become real partners in the discussions with other groups involved in communication platforms on NRM;

- Provide gap-filling research with disciplines, approaches, and sites complementary to existing activities; and

- Help to develop methodological tools adapted to local NRM and socio-economic development issues.

These interdisciplinary studies, when implemented on the different R&D sites, provide *empirical data* for feeding the knowledge base. The comprehensive and up- to- date information is essential for the database to go beyond a descriptive inventory of statistical data.

Interdisciplinary case studies to root global understanding in the local realities

In each site, a comprehensive study on land use changes (from field and farm to regional level) is proposed, with more applied research on developing sustainable cropping systems in sloping lands and extension activities on agroforestry participatory development and community learning.

Objectives

Objectives of the case studies are:

- *Characterization* and representation of the intra- and inter- field variability up to the watershed scale, and of cropping systems and farming systems diversity: Accounting and monitoring natural resources as well as flows of goods, people and information; and identifying and ranking limiting factors on sustainable production increase;

- *Understanding* processes of agricultural production, intensification, diversification, farming systems differentiation, migration, land degradation, deforestation, resource base depletion, agricultural policies implementation and commodity chains evolution;

- *Adaptation of research methods* to a high biophysical heterogeneity (taking advantages of this diversity) and to an extremely dynamic technical and economic environment in rapid evolution;

- *Designing, testing and extension of organizational and technological innovations* to enhance the overall system productivity while sustaining the resource base and socio- economic development; and

- Training of partners in the systems approach, in on- farm research, and provision of *Collective learning* towards more sustainable NRM.

Site selection

The following criteria guided the site selection procedure:

- A condition for platform formation is that *stakeholders recognize a common problem*. Their consciousness of the problem is a guarantee for their further commitment and active participation in the project activities. Researchers' contributions are to make the different aspects of that problem visible, at different scales and from different points of view. Thus the sites should be selected from a problem- oriented perspective.

- The dynamic nature of the study also affects site selection. *Diachronic* analysis at each site will be combined with *synchronic analysis* of different sites situated at the successive stages of an evolutionary path. Diachronic analysis requires that enough historical data or knowledge sources are available at the selected site. Synchronic analysis requires that sites be selected according to assumptions on their stage in an evolutionary process (e.g. integration to market, monetization, infrastructure, rural exodus).

- On each site, research activities should be combined with development programmes. A *continuum from basic research to extension activities* will benefit all partners. Research provides development agencies with an understanding of the major factors at work, and also provides guidelines to facilitate the process of social learning. On the other hand, development activities provide researchers with lasting support from local authorities and stakeholders.

- Combination of SAM sites with other project sites should *cover the overall regional diversity*.

As a consequence, two contrasted agro- climatic zones of the RRB uplands have been selected within the SAM project: (*i*) northern provinces of Thai Nguyen, Bac Kan and Cao Bang and (*ii*) north- western provinces of Son La and Lai Chau. Within each zone, sites are selected along a transect from the remote highlands to the Delta rice bowl in order to investigate the interactions between the uplands and the lowlands.

Methods

Systems analysis is the general methodological framework of the project and therefore of the case studies. Systems boundaries are agreed upon by the different partners at the successive hierarchical levels. Studies on the interactions between sub- systems allow emergent properties of the whole system to be represent and to modelled at the relevant level.

Agronomic surveys are conducted at different scales :

- At farm and regional levels they include regional agro- ecological zonation, historical profile of the recent agro- ecological and socio-economic transformations, and functional and dynamic typology of farming systems (Trébuil & Dufumier, 1993; Trébuil et al., 1996). An understanding of farmers' current practices and indigenous knowledge serves as a basis (*i*) to identify research topics suited to local circumstances and constraints hindering farmers' adoption of innovations; (*ii*) to assess the impact of innovation dissemination on the well being of people; and (*iii*) to predict the effects of agricultural practices on the environment;
- At field level, investigations consist of detailed surveys of major crops (to assess yield variability and rank limiting factors).

On- farm experiments support the design and testing of technical innovations, while ensuring farmers' participation and therefore further acceptability of research results.

Spatial applications are developed using aerial photographs, remote sensing imageries and GIS technologies as the spatial dimension of above-mentioned agronomic studies are of great importance in such a diverse environment. They aim at studying the functional relationships among spatial units at different hierarchical levels (e.g. uplands- lowlands interactions at the toposequence level, plots scattering within a farm as a risk management strategy, etc.). Figure 3 shows the type of relationships that are studied at the different scales. At the field level, geostatistical analysis of observations and measurements of agronomic data and mapping of heterogeneity aim at identifying main factors of heterogeneity. This allows to control them and use this information for further research. Other disciplinary approaches will be added when necessary from partner institutions or through networking mechanisms.

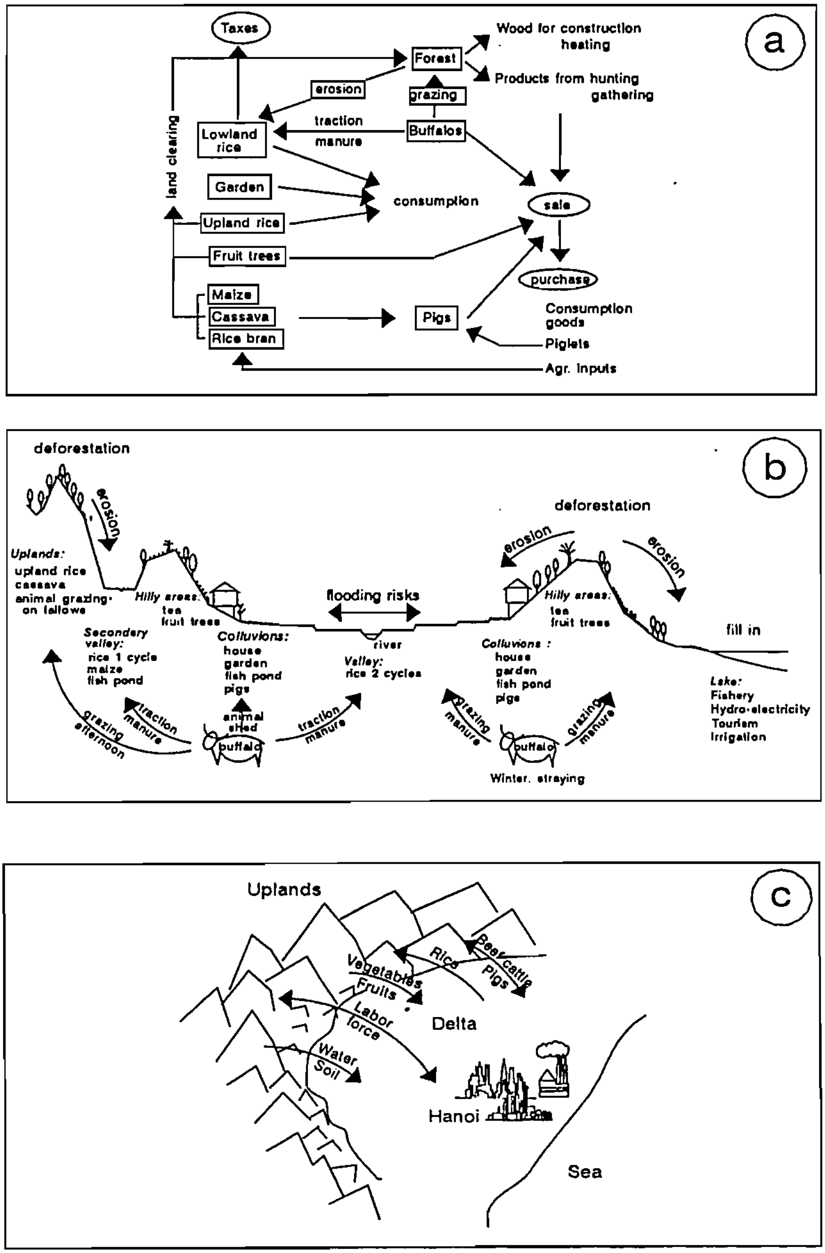

Figure 3. Functional relationships between uplands and lowlands, agriculture and animal husbandry, agricultural and non agricultural activities at (a) farm, (b) watershed (adapted from Dao The Anh & Jésus, 1993) and (c) basin level.

Coordination mechanisms

Integration of scales and multiple perspectives requires to be really practiced interdisciplinarity. The multi-agent simulation model will force dialogue among scientists, help them find a common language and *look for compromises between scientific interest and relevance for development.* NRM learning platforms will be set up at the different R&D sites. Cooperation between the partners makes it possible to create a continuum across the scales and between activities (Figure 2).

Comparison of the two agro-climatic zones selected by the SAM project together with other provinces of the RRB 'covered' by other R&D programmes allows research results to be upscaled up to the basin level.

Towards a shared knowledge base on NRM in the RRB uplands

Objectives

The knowledge base is a tool for *integration* to higher aggregation levels of local and often fragmentary knowledge acquired by the R&D programmes. It aims (*i*) at reconstructing the complete complex picture, through the representation of quantitative and qualitative, synchronic and diachronic information, (*ii*) at understanding processes and dynamics, and (*iii*) at making visible, emergent properties of the systems when upscaled to the ecoregional level.

The knowledge base provides a *communication platform* between scientific disciplines, between researchers, extensionists and other stakeholders in NRM. It is a framework for collective learning on NRM at regional level. It also supports the development of collective agencies that will conduct actual NRM at the relevant level of aggregation.

Content

The type of information to be incorporated in the database ranges from geographic and non-geographic data, pictures, sketch maps, graphic, to textual information and field reports. A first step in constructing the database is to compile existing information on the mountain areas of the RRB. Many reports that already exist about these regions are difficult to access. They are often not properly inventoried or spread over different libraries, and it is very difficult to learn about their existence (Rambo et al., 1997). The problem is also that only very few copies are published and some reports are edited in a format and quality that confine them to the status of gray literature irrespective of their content. A *comprehensive bibliographic* compilation will make this information available in a computerized database.

Statistical data from different sources will be compiled and cross checked. A critical assessment of data reliability will be performed through comparison with empirical data obtained from the case studies.

Structure

The computerized database structure will evolve together with the understanding of the system it is supposed to represent. A rigid database structure fixed at the early stage of a research programme, when the accumulated knowledge on the reality to be represented is at its lowest level, is often a constraint to further integration and handling of information as the project evolves. The *dynamic structure* of the database is provided by object-oriented programming methods (Gayte et al., 1997). Objects representing any type of data can be added or removed at any time and the nature of linkages between objects can be changed, without affecting the overall database structure.

The database integrates different perspectives of the same reality. Its content as well as its structure should thus be *negotiated* regularly by the different partners. The indicators integrated in the database should be meaningful for everyone without reducing the complexity to the lowest common denominator. It should also handle fragmentary information, with missing data, collected under non standardized procedures. Integration of data from different sources requires that keys for transfer and validation of information between different frames of reference be developed.

Database structure is compatible with the development of *multi-agent simulation models* that study the emergence of higher level organization from the behaviour of individuals. The main objective of these models is to force interactions, coordination between scientists of different disciplines towards a common vision (Figure 4). This tool is then used as a catalyst of NRM negotiation platforms among regional stakeholders (Figure 5). It stresses more concerted, and therefore more sustainable, natural resource management.

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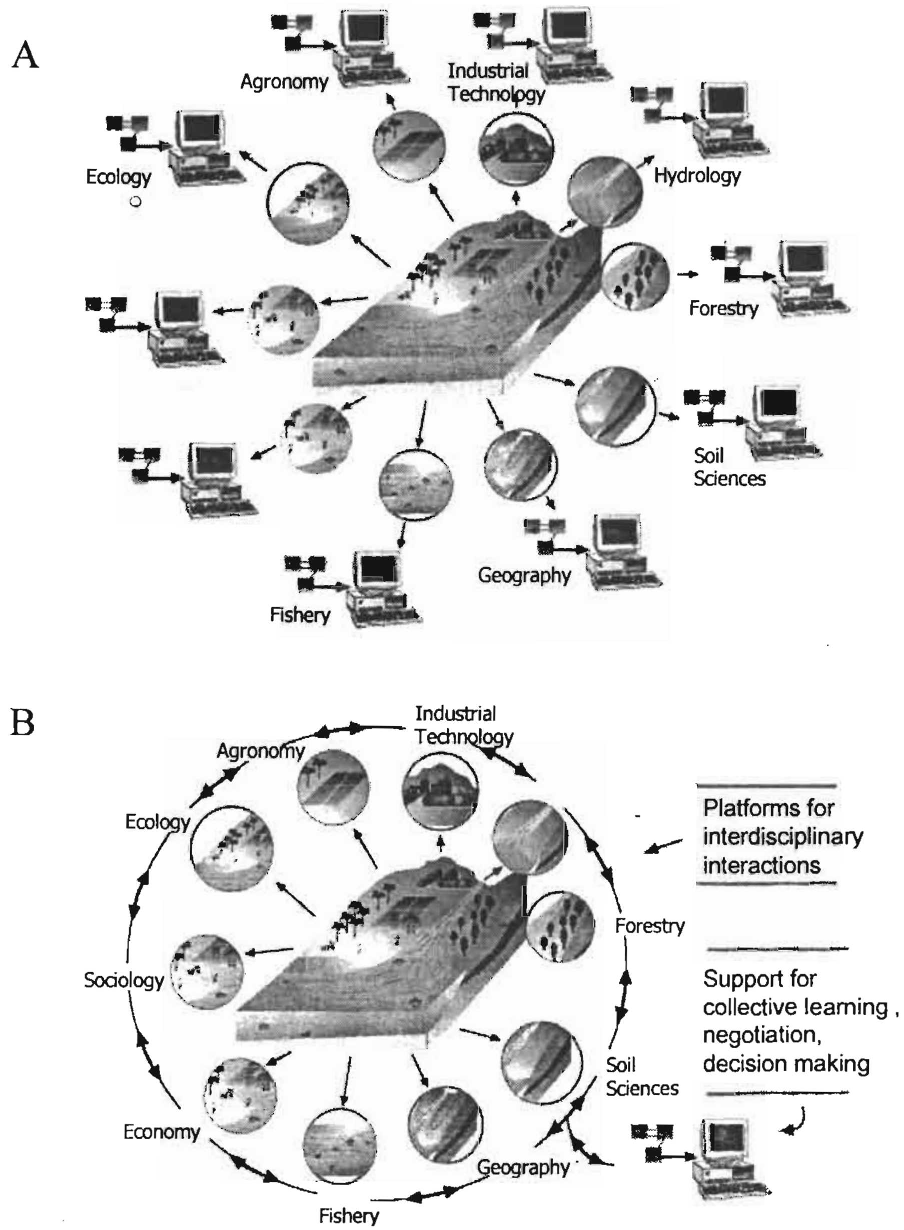

Figure 4. From discipline oriented to integrative simulation models (adapted from Pavé, 1997).

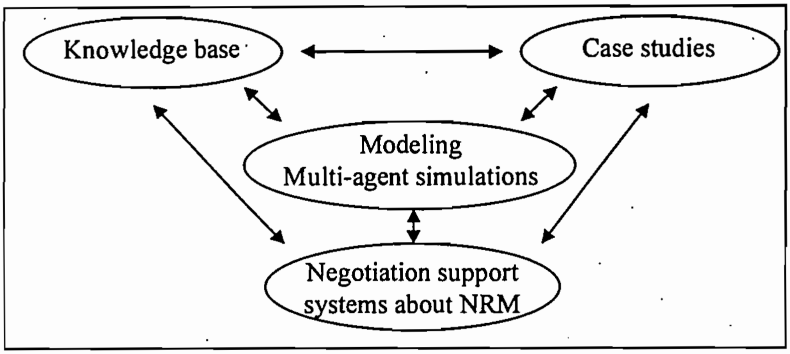

Figure 5. Methodological framework of the SAM Project

Coordination mechanisms

The practical implementation of the knowledge base rely very much on *partnership mechanisms*. SAM Project can not develop R&D activities everywhere in the RRB uplands to cover such a large range of diversity. In order to multiply the research and information management capacity, networking is emphasized between the different R&D programmes involved in NRM in the RRB uplands. However, each research or development programme should keep its own *identity, visibility*, and know-how to be a good component of such a platform. The objective is not to merge existing projects in a mega-NRM-project at each location. Such a proposal would create an unmanageable structure with a decreasing commitment of individuals as its size increases. Instead, the goal is a soft platform (Röling, 1994) at the relevant hierarchical level that allow people to confront their views on NRM and enrich the common picture.

Special attention has to be paid to the mutual benefit of partners joining the knowledge base venture. This activity designed for the common good should also match individual interests. The knowledge base provides partners with the necessary information, concepts and methodological tools to put their own R&D activity into a larger perspective, to assess the domain of extrapolation of their results or investigate other locations where they could be applied. They feed the knowledge base with their own experience and skills and in the process interact with others. Their vision of the system thus evolves as it is questioned by others. Database feeding process works on the information sharing mode much more than on data transfer procedures from individual databases to the collective database. Technical meetings and workshops are organized regularly to share experience and allow tools and concepts to evolve according to new goals and/or to better respond to rapid changes in the RRB.

However, beyond the written research proposal, potential partners should see their interest in joining the project. That is the reason why in a first phase the database relies essentially on SAM project case studies to provide the necessary empirical knowledge. Then the project will be in a favorable position to *demonstrate the usefulness* of the approach and develop more intensive partnerships.

Conclusions

Particular situation of the northern Vietnam mountains pushes towards innovative research and methodologies as the traditional ones show their limits. Difficulties to apply academic, basic research results in the real world does not question the quality of research work neither its usefulness but its compartmentalized mechanisms of problem formulation that often miss some aspects of the problem and responses or solutions that are already brought by local people. This breaks down the traditional boundaries between fundamental, research and adaptive research, as it does between research and development. (Rambo et al., 1997; Manichon, 1998). Ecoregional research cannot rely completely anymore on the paradigm of universality and on the *ceteris paribus* assumption that allow basic research results to be scientifically recognized and published in refereed journals.

The challenge of EcoR-I is thus to produce results that are both scientifically sound and relevant for development. This leads to a rethink of research approaches and mechanisms much more than just changing research topics.

It is much more difficult to work on complex dynamic systems than on homogeneous static parts of it. Reconstructing the picture in its whole complexity requires both high level of disciplinary knowledge and mechanism for knowledge integration. Also, as scientific fields, concepts and tools are becoming more complex no one can handle alone all of them anymore.

It is unfortunately often much more difficult to work together than to work alone. It requires subjecting ones' own knowledge, skills and experience to the test of others, to take a new look at one's own activities, and to test the limits of one's competence. Working in an interdisciplinary mode also requires a common language. Disciplinary fields have evolved independently and now have some difficulties communicating with each other. This miscommunication problem is especially true between the natural and social sciences that are founded on two different paradigms. It is time to join efforts to develop a common vision of the same complex reality and to facilitate collective learning towards more sustainable NRM. This is what the EcoR-I is about.

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Appendix: List of acronyms

CIAT	Centro Internacional de Agricultura Tropical, Colombia.
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France.
CIRAD-CA	Annual Crop Department of CIRAD
CIRAD-FHLOR	Fruits, Horticulture and Vegetable Department of CIRAD
CIRAD-URPA	Research Unit on Agricultural Policies and Prospective of CIRAD
CRES	Center for Natural Resources and Environment
EcoR-I	Ecoregional initiative for the humid and subhumid tropics and subtropics of Asia
FIPI	Forest Inventory and Projection Institute, Vietnam
GFA-GTZ	Gesellschaft für Agrarprojekte-Deutsche Gesellschaft für Technische Zusammenarbeit
GIS	Geographic Information Systems
GRET	Groupe de Recherche et d'Echanges Technologiques, France
ICRAF	International Center For Research in Agroforestry
IRRI	International Rice Research Institute, Philippines
MARD	Ministry of Agriculture and Rural Development, Vietnam
NCST	National Center for natural Sciences and Technologies
NIAPP	National Institute for Agricultural Planning and Projection
NRM	Natural Resources Management
ORSTOM	L'Institut Français de Recherche Scientifique pour le Développement en Coopération, France.
R&D	Research and Development
RRB	Red River Basin
RRP	Red River Programme (VASI - GRET)
SAM	French acronym for Mountain Agricultural Systems project
SFDP	Social Forestry Development Programme (MARD / GFA-GTZ)
SIDA	Sweden International development Agency
TNAFC	Thai Nguyen Agroforestry College, Vietnam
UMR Regards	Unité Mixte de Recherche CNRS-ORSTOM Regards, France
UNDP	United Nation Development Programme
VASI	Vietnam Agricultural Sciences Institute, Vietnam.
VFSN	Vietnam Farming Systems Network, Vietnam

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