**Some piece of cake!**

# Crafting Interdisciplinarity in Teaching Management of Natural Resources and Sustainable Agriculture

**Experiences from the M.Sc. Programme in Management of Natural Resources and Sustainable Agriculture, NLH**

by

Paul Vedeld

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Noragric
Agricultural University of Norway
P.O. Box 5003
N-1432 Ås
Norway
Tel.: +47 64 94 99 50
Fax: +47 64 94 07 60
Internet: http://www.nlh.no/noragric

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**By Paul Vedeld**

***Abstract***

*This paper discusses challenges of designing and implementing an educational programme where interdisciplinarity is an important ambition. The paper recommends that a joint and comprehensive theoretical perspective on interdisciplinarity is developed. Such a perspective should be more than a crude adding of insights from different disciplines. Surprisingly many actors in the field tend to equate interdisciplinarity with this. One should rather see interdisciplinarity as a fruitful meeting ground and a process for translation and integration of disciplinary perspectives. Less than seeing it as processes of creating new and improved disciplines, interdisciplinarity is better interpreted in a socio-cultural and phenomenological perspective. Knowledge is seen as primarily generated under different epistemic networks, and an important role for an interdisciplinary programme becomes to develop skills in candidates to "identify, select, translate and integrate knowledge from different disciplines within a coherent framework". A "disciplinary approach to interdisciplinarity, where a complimentary perspective on disciplinarity versus interdisciplinarity is cultivated. From a coherent perspective on theories in interdisciplinarity, it becomes possible to consciously develop explicit theories for interdisciplinarity in education and coherently identify goals, measures and instruments in this respect. It is recommended to focus on both theoretical and practical experience-based skills in working with interdisciplinarity. This implies using practical assignments in the field and problem based learning approaches to develop candidates' abilities to select, translate and integrate knowledge.*

# 1. BACKGROUND FOR THE PROGRAMME

## 1.1 INTRODUCTION

In 1986, the Agricultural University of Norway started a M.Sc. programme in Natural Resource Management and Sustainable Agriculture (MNRSA). Looking back at the start of the programme, it was developed in the wake of an on-going academic and political process where the environmental discourse increasingly became part of a mainstream public debate. This was partly due to that the links to broader issues of welfare, economic growth and employment were made explicit.

After the 1972 UN Stockholm Conference on the Human Environment, there was a global building of institutions, organisations, public bodies and policy frameworks to address

environmental challenges. The 1980's saw important global interventions like the World Conservation Strategy (1980) and the report of the World Commission on Environment and Development (1987). Environmental and resource management studies entered the curricula of many universities in the North. Diverse philosophical and ideological positions were articulated on environment and development. New social movements and NGOs engaged in environmental awareness creation and action at local levels. Media focussed on global environmental challenges. More knowledge was generated on both local and global challenges and threats. The intellectual context was illustrated by the convergence of two major discourses, the development and the environment discourse, into the sustainable development discourse (Shanmugaratnam, 1997).

This convergence meant breaking new intellectual ground. Bringing together a variety of disciplinary researchers and with ambitions of a more holistic, systems oriented, interdisciplinary programme was new and challenging. Interdisciplinary educational programmes on environment and development were still marginal in universities, although a body of theoretical writings on the need for such programmes had started to appear. In 1986, staff was appointed by the Agricultural University of Norway to accomplish the challenging task of designing the MNRSA programme. There were few models to follow. To develop a satisfactory programme, the staff had to rely on its own experience, understanding, imagination and available literature. The mandate was open ended, but it specified one thing: the programme should be relevant to the South and should contribute to human and institutional capacity building for sustainable resource management and for agricultural development (Shanmugaratnam, 1997).

The "Management of Natural Resources and Sustainable Agriculture" program focussed on the relationships between the livelihood of poor people and available resources. The programme acknowledged the modern concept of sustainable development, namely that such development depends upon an interaction of ecological, social and economic systems, and simultaneously recognises the importance of institutions and political opportunities and constraints.

The programme aimed at educating not mere individuals, but qualified persons within institutions concerned with the sustainable utilisation of resources to meet human needs. The MNRSA Programme was thus seen as one way of producing knowledge to serve human and

institutional capacity building. This was thought achieved by giving basic training in interdisciplinary approaches to planning and management of agriculture and natural resources in developing countries. Students were exposed to theories, policies and practices in order to understand processes that promote social and economic development in rural communities.

Primary production systems and proper management of natural resources is recognised as perhaps the most important engine for economic development in poor countries and seen as a driving force in poverty alleviation. On average, 80% of poor people live in rural areas in most developing countries and more than 50% of the gross domestic product in many countries are derived from primary production systems and the environment. Development of sustainable agricultural production systems and improved management of natural resources is thus vital for improving food security, creating job opportunities and maintaining the resource base upon which primary industries depend. That, in turn, enhances rural people's opportunities to voice their opinions and concerns, and to participate in democratic political processes. Support to the agricultural sector encourages women's roles in the society, because poor countries' farms are often run by women. The programme trains students to become important actors in management of natural resource and sustainable agriculture in their respective countries. It is designed specifically for planners, managers, people working in NGOs, and teachers concerned with integrated resource management.

## 1.2 HISTORICAL BACKGROUND

The programme was one of the first full-fledged M.Sc. programmes to receive support from Norad[1]. The programme originally recruited 20 students with bachelor degrees in agronomy, natural or social sciences primarily from East Africa, Nepal and Sri Lanka, reflecting Norad policies at the time. We also admitted 5 Norwegian students. Over time, the programme has developed a more global constituency. It has also continuously been up-dated and reformed, according to changes in perceptions and priorities from research, academics and in response to donor priorities and recommendations from various evaluations.

Recent changes include improving and expanding the coursework package and to develop sandwich co-operation programmes with third world institutions. Students are taken to

[1]The Norwegian Agency for Development Co-operation

Uganda or Nepal to experience university studies under different ecological, cultural and social environments. The change also involves institutional co-operation at a practical level between Noragric and the co-operating universities.

Over the last 15 years, the programme has graduated almost 500 M.Sc. students. Several similar M.Sc. programmes and courses based on efforts from previous students are now running at a number of co-operating institutions in developing countries, at present at Sokoine University in Tanzania, Egerton University in Kenya, Debub University in Ethiopia, Makerere University in Uganda, Peshawar University in Pakistan and in Tribuvhan University in Nepal. The programme has also generated a substantial network for the university at large, both a formal network of previous MNRSA students, but also number of more informal but successful research and development co-operation efforts.

The main intention of this paper is to take stock of what has been done in the MNRSA programme, assess experiences and from this, outline some main ideas for the future. This paper thus first describes the programme, goals, contents and outputs. The paper then gives an account of some of major thrusts, especially on interdisciplinarity experiences and on the struggles on how to approach and craft it. It is not a piece of cake! The paper then makes some critical assessments of the programme and some tentative suggestions for new initiatives. The paper is aimed at an audience of teachers, students and others occupied with how to design and implement education programmes where interdisciplinarity is an important component.

# 2. GOALS AND MEANS OF THE PROGRAMME

## 2.1 OVERALL AMBITIONS OF THE PROGRAMME

The overall aim of the MNRSA Programme is to contribute to a more sustainable development path in developing countries by means of enhancing academic competence and capacity of relevant institutions and individuals in natural resource and agricultural planning and management.

## 2.2 GOALS FOR THE PROGRAMME

The major *theoretical goal* is to develop a fruitful combination of theoretical knowledge and experience-based approaches that contributes towards better understanding of "nature-society relationships". This includes an interdisciplinary perspective on natural resource management and environmental problems with a focus on natural eco-systems and primary sectors (agriculture, forestry, fishery, wildlife, pastoralism etc.) and how people as individuals and in social contexts co-operate or conflict over access and use of resources. This involves understanding the multi-layered nature of such processes and larger issues of governance, of power use, authority lines, rights and duties and the complex structures and processes framing the multiple arenas where decisions over resource use take place (Wilson and Bryant, 1997, Phaelke and Torgerson, 1990).

The major *proficiency goal* is that such knowledge should enable institutions and candidates to interpret and be able to generate practical processes of social change in terms of empowerment, equitability and sustainability. Proficiency can be explicit or tacit, but is often linked to the actor recognizing a problem or a phenomena from experience. From his experience he has a repertoire on how to handle the issue (see Polanyi, 1966, Molander, 1996).

The programme also includes an *attitude goal,* candidates should develop their ability to think critically and analytically. They should acquire a reflective action repertoire concerning issues of sustainable use of resources, biodiversity conservation and social issues concerning distributional effects and human rights perspectives - "a concerned and enabled citizenship".

Creating competence is more than giving the students appropriate theoretical and practical knowledge and attitudes – cognitive skills. To generate what we see as competent candidates, we also need to address personal and social abilities needed to address the wider world in their future work. This relates both to preconceived properties such as abilities to learn, concentrate, work consistently and also to conditions that can be influenced throughout the study such as self-confidence, motivation, ability to share, attitudes, sense of responsibility etc. Social preconditions relate to ability and willingness to communicate and interact and to analyse, understand and interact with social systems and structures. All these issues together

constitute the candidate's competence in what could be called a "holistic and critical learning" approach.

## 2.3 MEANS

### 2.3.1 The overall structure and process of the programme

The means to reach these goals is reflected in the structure and functions of the study programme. It is a course/module based programme over four semesters. The first semester is multi-disciplinary, students are introduced to what are core supporting courses in tropical ecology, resource economics, social anthropology and statistics. This provides the students with a common platform from which more interdisciplinary perspectives are developed over the coming semesters. The first semester thus has a stronger focus on disciplines relative to the second semester's focus on subjects and topics. There is also a seminar in which students are given opportunities to develop and present their own papers and perspectives.

The second semester is more interdisciplinary. The main course in management of natural resources forms the core of this semester, with emphasis on more theoretical aspects of natural resource management. Aspects of sustainable agriculture and tropical production systems are also given in this semester in addition to a course in research methodology that emphasizes the development of an interdisciplinary thesis proposal.

In the third semester, there is an even more applied interdisciplinary ambition. Students are sent to Uganda or Nepal for 7 weeks of course-work in a sandwich model, being exposed to a developing country university environment. They take applied field courses in rural development, in research methods and in project planning, management and evaluation. After this, they do thesis fieldwork for three months.

Last semester is spent at NLH, where they take courses in political ecology and a thesis seminar where they have to put forward and defend thesis ideas and perspectives in public settings. The main effort is the thesis write-up, where the students through analysis of data and discussions have to apply their acquired knowledge to themes and problems interdisciplinary in nature.

### 2.3.2 More detailed programme course content

The course work consists of a set of mandatory courses. In addition to these courses, students may on a voluntary basis attend other courses offered by NLH. Currently, the mandatory courses carry a total of 90 credits and the thesis carries 30 credits to conform to the standard requirements of the Agricultural University of Norway (see Table 1).

The second year provides an opportunity for the student to carry out problem-oriented research. This gives practical insights into major issues related to resource management and agricultural production. The research work give students experience in adapting theories to field situations, extracting data and information, performing scientific analyses, communicating results, and applying conclusions for relevant policies. Students are trained in developing communication skills with peasants, scientists and policy makers.

**Table 1. Organisation of courses and research in MNRSA programme**

| Semester | Course | Credits |
|---|---|---|
| First semester | **MN 200 Tropical Ecology** | 5 |
| First semester | **MN 220 Statistical Analysis** | 10 |
| First semester | **MN 230 Social Anthropology** | 5 |
| First semester | **MN 240 Resource Economics** | 10 |
| First semester | **MN 350 Environment and Development Seminar** | 5 |
| Second semester | **MN 310 Research Methods** | 5 |
| Second semester | **MN 330 Tropical Agricultural Production Systems** | 10 |
| Second semester | **MN 370 Main course in Management of Natural Resources** | 15 |
| Third sem. reg. centre* | **MN 320 Exercises in research methods** | 5 |
| Third sem. reg. centre* | **MN 311 Project planning and management** | 5 |
| Third sem. reg. centre* | **MN 340 Rural Development** | 5 |
| Third semester** | **Thesis (field work)** | 15 |
| Fourth semester | **MN 390 Political ecology** | 5 |
| Fourth semester | **MN 355 Research and thesis writing seminar** | 5 |
| Fourth semester | **Thesis** | 15 |

** Uganda or Nepal ** Uganda, Nepal or home country*

The MNRSA student chooses a research problem that concerns management of natural resources and the environment. This secures that knowledge and skills gained in the first year are put to use. Typical issues are poverty, environment and conflict, soil fertility management erosion and soil erosion, overgrazing, salination, deforestation, conversion of forests and wetlands to agriculture and land degradation processes, land tenure and use conflicts, biodiversity conservation and conflicts with local people, agrobiodiversity and local rights, carbon sequestration and land issues, conflicts in pastoral communities over sustainable use of pastures and water resources, agroforestry, integrated pest management, indigenous soil nutrient management and other land improvement strategies, coastal zone and protected areas management, and more directly on planning and management issues and issues over linkages between poverty, distribution and the environment.

In the last semester, the students take two courses, one seminar, where oral and written skills are developed relative to the thesis-work. A course in political ecology helps students to contextualize their research work through analysing the research topic in a political ecology setting.

## 2.4 OUTPUTS

The output of the programme has been candidates with an M.Sc. degree in MNRSA and specialized in areas relevant for work in their home countries. Such work has been both practical and theoretical as the programme admitted and educated academic staff from universities and colleges as well as public and private sector employees working with planning and management. Many of the candidates have been part of NLHs substantial institutional co-operation programmes and have constituted an important element in a more comprehensive, long term institutional development strategy.

**The candidates**. The candidates have been equipped with essential theoretical knowledge, analytical techniques and practical tools enabling them to be able to perform well in professional capacities as planners, managers, NGO staff and teachers from developing countries involved in integrated resource management in developing countries.

**Institutions in the South.** The candidates being actors within institutions, have often been part of more long term institution- building efforts between Noragric and their host institutions, but we have also developed triangular and south- south relationships. This has been carried out in several countries, and includes for example cooperation between India and Ethiopia and between Eritrea and South Africa.

The candidates have also been encouraged to develop an understanding for the importance of building up an international network in this scientific area.

**Staff and institutional issues at Noragric**: The staff at Noragric have developed links to and become part of more conscious long term institution-building efforts between Noragric and candidates' host institution, and have also contributed in developing triangular and south-south relationships.

The staff at Noragric also disseminate results of students' thesis work in a wide range of publications from international refereed journals, through lectures and posters to web-based abstracts of the theses.

# 3. CRAFTING INTERDISCIPLINARITY IN AN M.SC. PROGRAMME

As stated, it became clear for the staff at the onset of the programme that the broad scientific focus in the environmental and development field had to address issues of interdisciplinarity. Approaching interdisciplinarity has proven to be life long marriage to a less than willing wife! Below I bring up some central themes concerning how the field of environment and development presupposes multi- and interdisciplinary approaches and a brief historical introduction to the interdisciplinary research field. I furthermore present some deeper perspectives around the field and how the experiences from our M.Sc. Programme address these issues. We also discuss important possible constraints to interdisciplinarity. The themes are spiced with examples from our own attempts on defining as well as teaching interdisciplinarity to a mixed groups of students.

## 3.1 THE FIELD OF ENVIRONMENT AND DEVELOPMENT AND INTERDISCIPLINARITY

The MNRSA programme has been developed in light of particular facets of natural resource management and development related concerns. Given the scientific ambitions of the programme and the theoretical and proficiency goals, certain features are crucial. Natural resource management and sustainable agriculture rests on principles of ecosystem and agro-ecosystem dynamics, on insights in arranging institutions of property rights, on describing and explaining social norms and rules as well as customs and traditions governing resource access and use. It also involves understanding economic behaviour, resource use and constraints and the valuation of costs and benefits of different resource use arrangements and information flows, how resource management is conditioned by important macro policy frameworks and environments. The field thus centers around people, institutions, land and nature. Environment and development issues thus require complex theoretical sets of knowledge. The practical skills and execution of tasks furthermore demand not only knowledge from diverse sources including the local community, but also conceptual frameworks to integrate that knowledge and to comprehend resource management problems with a view to finding

sustainable, legitimate and feasible solutions. The students thus cannot, in our experience, adequately address a particular environmental management problem without having a minimum of insight in both natural and social sciences and their perspectives on important issues in question. There is no obvious main science in environment and development studies. The demands for knowledge in this context point towards a broad spectre, a depth and an ability to see knowledge generated within different singular disciplines in context. We shall therefore show that one has to apply a genuinely interdisciplinary perspective and a substantial problem-based approach in order to meet the rather challenging aims set by deciding to educate "environmental experts". It is furthermore not without costs for the involved students that meet completely new subjects and themes for the first time (see Box 1).

**Box 1. Meeting new sciences is a challenge!**

It really hurts for natural science students to meet subjects like economics, philosophy of science and anthropology for the first time. When faced with an economic perspective on optimal value trade-off between conserving a forest as a biodiversity resource versus cutting it down, harvesting the timber and converting it to crop land. Openly, knowingly and through a scientific approach choosing the latter is shocking for many ecologists. Or being presenting to a social construction perspective for understanding local people and be able to address local participation and social institutions in a cognitively sound way. The natural science students meet a scientific world with much more open discussions over foundations of the science, of conflicting paradigms and sets of values. What frustrations!

The social science students tend to generally down rate the importance of "ecological and technical" knowledge. In a project where one has to discuss issues over biodiversity conservation and local participation, they often display an initial systematic and striking lack of interests for the quality and the quantity of the biodiversity resource. Much more emphasis is put on actors interests, power games, the "good against the bad guys". "Do we really have to read and know all these technical details in ecology and on production systems ?! "

There is an important difference between theoretical knowledge and practical skills. The students may thus be good at theoretically describing and analysing conflicts over and causes of deforestation in a country, but from there to be able to handle the problem in practical, technical and operational ways is a long shot. For example, understanding how different groups may react to or adapt certain policies often requires a type of hermeneutic or tacit knowledge not easily conveyed in classroom situations (Polanyi, 1966, Molander 1996). It is not easy to explain why Norwegian farmers may respond rather positively to a tax on pesticides, but very negatively to a similar environmental tax on nitrogen fertilizers. Knowing this, as all Norwegian extension workers would, assumes that one has a kind of first hand, intrinsic knowledge of the farmer's lifemode, preferably acquired through practical interaction with farmers (see Vedeld and Krogh, 2000, Vedeld, 1997). A similar example is interpretation of nitrogen fertilizer use in a forest; where the forester sees positive effects on tree growth, the ecologist sees disruption of terrestrial ecosystems and biodiversity. MNRSA-students should

be able and willing to address and understand tacit and experience-based knowledge that is so important for all actors and in particular local resource managers.

The field of environment and development thus preassumes particular sets of knowledge to be taught. This is both particular disciplinary knowledge, but also knowledge that easily falls between (department) chairs and that emanates from integration of disciplinary knowledge. The field also preassumes transdisciplinary knowledge that is developed from encounters between theoretical and experience-based knowledge.

## 3.2 A BRIEF HISTORICAL ACCOUNT OF INTERDISCIPLINARITY

From history of science we learn that there are constant changes in disciplines, sub-disciplines and research fields both numbers and in terms of types and quality of knowledge generated, in the content and body of different sciences, in the theories and methods, symbols and metaphors, as well as values found within and between disciplines over time. Science and disciplines are social constructs, where changes can be linked to internal scientific progress. However, changes are also brought about through both internal and external social and economic factors and also to external pressures, power use and funds allocation. Recent research also demonstrates how changes in organisational structures and processes impact upon scientific progress (see fi. Whitley, 2000).

The old academic ideal was that one tutor, being the universal genius, would teach students in all fields. This is hardly tenable today. More recent history of science describes a revolution in terms of increased knowledge generated in an exponentially expanding number of disciplines and sub-disciplines. Any discipline today contains a variety of sub-disciplines, with often quite different epistemological frameworks. The variation within a discipline can even be larger than between disciplines. Brun, 2000 refers to Whitely, 1993 about the specialization within disciplines going so far that one can question if it is the discipline or the speciality within the disciplines that constitute the "basic unit of intellectual and social organisation". Ziman, 1999, suggests that "scientists typically move within a field that covers less than 5% of established disciplines like physics, chemistry or biology". The number of scientific journals have grown from a few hundred in 1800, to 10 000 in 1900 and to 100 000 in 1950 (Sørlin, 1986 in Brun, 2000). Specialization may thus seem to be a particular feature of modern scientific progress.

Few disagree that knowledge creation within scientific boundaries forms the core of scientific activity today. In line with Kuhn's theory for changes in the disciplinary matrix, for scientific revolutions, changes come about to a large extent through anomalies within the discipline. These anomalies may eventually create changes within the discipline or there may be a break-away to new separate disciplines or at least to new research fields.

How do the broader research fields develop? Maybe analogue to Kuhn's description, but more fuzzy, with less uniform rules for how knowledge is to be generated. In the environmental and development field, where economists and ecologists meet, we see that proponents of the two sciences meet as they study the "same" object in the real world, but with very different epistemic frameworks (see Vedeld, 1994). Within a science, there are sanctions and norms to conform researchers to stay together and allow for cumulative knowledge generation (puzzle-solution activities according to Kuhn). Between sciences, such mechanisms are less. In cross epistemic encounters, it could be that involved scientists see that they may be able to generate or offer genuinely new knowledge, precisely because encounters are more open and less constrained and that they therefore are willing to continue cooperation despite less rules and clarity. So, concomitant with increasing specialization efforts in disciplinary science, there may thus be a wish, and a need for increased across-disciplinary activities of various kinds.

Looking at the environment and development field, it is not difficult to see how the field has exploded over the last 20 years, with inputs from a variety of sciences and research fields, with a cacophony of "non-unidirectional" approaches; on theories, methods and models.

*MNRSA staff have continuously had to address, select from and furthermore develop own approaches in this complex and rapidly changing research field. In such endeavours, we always meet the difficult questions around the limitations of focused disciplinary approaches versus broader, looser, integrative ones.*

### 3.3 DEVELOPING PERSPECTIVES ON INTERDISCIPLINARITY

#### 3.3.1 Some definitions

*When we started the MNRSA- programme, there was little time to develop an explicit philosophy to the environmental field as a meeting ground between disciplines and even less time to develop an explicit and staff unifying theory on interdisciplinarity. Our main concern was more on covering what we assumed to be crucial disciplines and important topics*

*relative to the overall programme objectives. We however, soon realized the need for explicit interdisciplinary thinking and development among staff ("the Noragric approach"), and the need for developing good practical ways to teach. Below, I describe some of these processes.*

Going back in time, a seminal OECD report (1972)[2] addressed explicit needs for interdisciplinarity in research, in education and in society at large. According to Klein, 1990, this report, based on a seminar in 1970, managed to focus existing scattered debates and discourses within many of research fields and disciplines on the topic of interdisciplinarity into a more organised research and development field.

The report defines interdisciplinary in a broad way to be " the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organising concepts, methodologies, procedures, epistemology, terminology, data and organisation of research and education in a fairly large field. An interdisciplinary group consists of persons trained in different fields of knowledge (disciplines) with different concepts, methods and data and terms organised into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines" (Apostel,1972:25-26).

The report pointed out that interdisciplinarity occurs in a variety of contexts, and that it relates to issues such as the need for particular knowledge, the needs of students in particular fields, the needs related to professional training and the needs of society. It often arises as a challenge to the organisation, given the existing structure and functioning of universities and other academic institutions.

Interdisciplinarity is complex, both as a product in terms of results from R&D efforts and as a process of communication. One can make some useful distinctions (based on OECD, Apostel et al, 1972):

- **Multi-disciplinarity**; applying consciously different sciences to the same phenomena, but with no explicit integration or co-operation.

[2]" Interdisciplinarity in teaching and research".

- **Inter-disciplinarity**; integration of knowledge through various types of border crossing between disciplines. It surpasses mere additive approaches. The integration in production, education and application is an important component in knowledge creation.
- **Cross-disciplinarity**; polarized, but unidirectional co-operative research efforts.
- **Trans-disciplinarity**; integration is a major component, but there is also an element of including experience based knowledge and "non-scientific" everyday knowledge.

Multi-disciplinary research activities are widespread. A particular research field or topic is (for a variety of reasons) commonly approached by many different scientists from different disciplines. Such efforts are, however, often not coordinated much. The scientific findings in the different sciences on the same topics still often lead to comparisons by involved scientists; especially concerning empirical findings and discoveries (often less on comparing more basic theoretical and methodological matters). It may thus be that multi-disciplinarity often becomes "the mother of interdisciplinarity" in the sense that researchers initially become interested in empirical findings generated in other sciences, and then start to read up and develop more sophisticated approaches to utilizing both findings and more theoretical and methodological perspectives. (I return to this issue below).

*We have deemed it important for the MNRSA-programme that students actually attain a competence in what we believe are core sciences in the field of natural resource management and sustainable agriculture; ecology, agronomy, economics and anthropology. Only with such core competence can they be able to approach, comprehend and execute issues of explicit translation and integration. It involves a disciplinary approach to interdisciplinarity.*

As we shall discuss below, interdisciplinarity will involve conscious efforts of translation and integration; of establishing common languages, platforms, arenas and processes where various types of "border crossing" is facilitated.

Furthermore, the discovery or acceptance that much fruitful knowledge is generated through action and developed through experience over time, in both scientific manners and in more everyday situations, has paved way for trans-disciplinary approaches as a supplement to multi- and interdisciplinary efforts.

*In the beginning, the staff struggled to find ways to move away from purely disciplinary and multidisciplinary approaches. Is has taken long time to develop theoretical perspectives on interdisciplinarity as well as practical ways to convey this to students in the programme. From our "disciplinary approach to interdisciplinarity", we have made the first semester of the original MNRSA programme more multi-disciplinary than interdisciplinary. In the second semester, more explicit interdisciplinary approaches are presented in courseworks and in working with students' thesis proposals. In the third semester, the students carry out fieldwork for theses to be finalized in the fourth semester. Throughout these two last semesters, the students have to work with topics requiring at least multi-disciplinary and usually inter-disciplinary approaches.*

### 3.3.2 The evolution of theoretical approaches to interdisciplinary

Looking back at our original approach on interdisciplinary, it had a rather crude cognitive and rationalistic approach, focusing on different disciplines and their relative merits in a rather reductionist way, where the main emphasis was multidisciplinary, teaching different subjects in parallel and leaving integration, translation and development efforts to the (struggling) students.

Over time, the focus in the MNRSA programme become broader, and we studied interdisciplinary perspectives from history and philosophy of science, such as Kuhn, 1962/69 and Bernstein, 1983. These authors focus more explicitly on science as a socio-cultural activity. We later came to study the works of Julia Klein, 1990, who produced interesting ideas on the history of interdisciplinarity along similar lines. She problematises interdisciplinarity as a knowledge integrative activity, where unifying, diversifying and synthesizing integration aspects are discussed (see below).

Even more recent approaches (see for instance Brun et al, 2002) address two additional issues in more detail. This relates to how one should cater for both theoretical and experience based practical knowledge. Furthermore, interdisciplinarity should be understood relative to epistemic communities and epistemological networks where knowledge is generated (aspects of such thinking can also be traced to Latour, 1986 Dreyfus and Dreyfus, 1986 and to Knorr-Cetina, 1983). This involves both phenomenological and socio-cultural perspectives.

From such perspectives, Brun et al, 2002 develop a conceptual framework, where they see interdisciplinarity as transepistemic communication across knowledge regime boundaries: through Architectural, Translational and Pioneering Knowledge Networks. The first (AKN) concerns the construction of links and bridges between independent sets of knowledge, as in the construction of a particular multi-component product ("combining blackboxes"). The translational (TKN) knowledge network concerns more direct communication, where knowledge is translated in ways where the outcome becomes understandable for all. The pioneering knowledge network (PKN) concerns involved actors transcending present knowledge regimes and generating new territories of knowledge.

*We now include this kind of thinking in the MNRSA-programme. In the third semester, students are exposed to more practical and experience based challenges in natural resource management that force them to utilize their insights in different disciplines. They have to integrate and synthesize their knowledge, through field courses and through carefully supervised fieldwork. In the last semester, they approach the complex realities of natural resource management through seminars and thesis writing. They take a course in political ecology focussing on environment and development discourses and competing narratives. We also teach and apply a number of the more recent interdisciplinary approaches and methods within the environment and development field, where these dimensions are encompassed (see Table 2).*

**Table 2. Approaches used in the MNRSA programme to facilitate interdisciplinarity**

| Approach | Origins | Examples of application | Staff involved |
|---|---|---|---|
| The livelihood approach | Pretty, 1995<br>Chambers | Rural development<br>Poverty and environment | Haug,<br>Nyborg |
| The stakeholder analyses | Grimble et al, 1996 | Protected areas and people<br>Rural development<br>Dev. project assessments | Vedeld<br>Sjaastad/Vedeld |
| Systems approaches | Georgescu-Roegen 1971<br>Conway, 1987 | Carbon sequestration<br>Rangeland and people<br>Farming systems | Aune<br>Oba |
| Farming and production systems approaches | Ruthenberg, 1983 | Crop diversification<br>Rural development | Berg<br>Johnsen |
| Entitlement/endowment approaches | Sen, Sengupta,<br>Leach et al, 1997 | Diversification/differentiation<br>Environmental entitlements | Vedeld, Shanmugaratnam |
| The narrative approach | Adams et al, 2002 | Development strategies<br>Environmental policy strategies | Benjaminsen, Vedeld |
| Common pool theories | Ostrom, 1990<br>Agarwal, 2000 | Managing village commons<br>Rural credit systems | Vedeld, Sjaastad |
| Rights based development | Sen, Sengupta, | Local people /protected areas | Benjaminsen, Wisborg |
| Social capital | Bordieu,1971, | Ruraldevelopment/local heterogeneity | Benjaminsen, Kaarhus |
| Actor-structure networks | N. Long, 1991 | Relationships,farmers/wider society | Vedeld, 1997, Vedeld et al 2003 |

These theoretical models and approaches reflect architectural, translational and pioneering knowledge approaches. They emanate from environments that have been working in research fields where interdisciplinarity has been prevalent for a long time, such as IDS in Sussex, East Anglia; IIED; Essex; Wageningen and other knowledge centres.

We have reached an understanding in the programme where we apply what Lattuca, (2002:712) names a "disciplinary approach" to interdisciplinarity, in contrast to a postmodernist view where the disciplines are "not central to the modes of enquiry". Knowledge is constructed under a "disciplinary matrix" and must be interpreted and used in that perspective.

We furthermore see interdisciplinarity in a socio-cultural perspective, where we believe that any discipline is best understood as a social institution where sets of common values, norms, perspectives, methods and experience based knowledge hold the science together and apart from others. We still believe it is important to avoid a relativistic approach. There is on the other hand a problem related to the thought of a total global rationality, as the knowledge must be understood within the discipline, and that rationality in this sense belongs to the discipline (see Vedeld and Krogh, 2000).

The MNRSA profile has thus evoluted from a rather crude rationalistic, multidisciplinary perspective over to socio-cultural and phenomenological approaches.

### 3.3.3. Interdisciplinarity and integration

We have defined interdisciplinarity as processes of integration of knowledge in production, education and application. We believe it is important to take a step down and discuss more detailed elements of what integration- and translation – is about.

Interdisciplinary generation of knowledge emerges in different ways. Possibilities lie in the fact that the universe of information, theory, methods, approaches and knowledge potentially available is much larger outside than within a compartmentalized disciplinary world. A key constraint lies in finding ways to integrate such knowledge in a consistent and meaningful way.

**Unifying integration** may be defined as "***the application of a single theoretical perspective on to a wide range of previously distinct disciplines***" (Boden, 1996). In such cases the knowledge is reconfigured, theories and research areas are reshaped for new purposes. Unifying integration could also be used within disciplinary activities. *An example, used in the MNRSA programme, is a systems theory, used within several of the courses taught to the student, including ecology, political ecology, social anthropology and agricultural production systems. Another example is the application of rational choice or alternatively a social constructivist framework for analysing human behaviour in natural resource management found in a variety of social sciences.*

**Diversifying integration** "allows the heterogeneous quality of science to be maintained, and knowledge is integrated through "***developing knowledge bridges and platforms"***. Such explicit integration links heterogeneous types of knowledge better than more traditional disciplinary science tend to do. Such integration broaden our knowledge base. There are of course numerous examples of this also within a discipline, linking sub-disciplines and linking knowledge sets between natural sciences. Biotechnology is one such example. But having an explicit and conscious perspective on what this integration implies from an epistemological point of view is seldom found within a discipline. *An example of diversifying integration used in environmental politics in the MNRSA programme is the explicit stress on how physical properties of natural resources impact upon the choice of policy instruments. If there is rivalry in consumption of a good, such as livestock and grazing, the fact that the same grass cannot be eaten by two animals has implications for the choice of management system. Also, if the physical properties of the resource prevent users from excluding others from the use, this will also have bearings for the choice of management system for the resource (Vedeld and Vatn, 1999; Randall, 1987). To take account of this requires a knowledge link. The political scientists must have the ability to see the how ecological conditions frame the particular problem. And the ecologists have to understand how human agency will respond to possible "technical ecological solutions" to the problem.*

**Synthesizing integration** occurs when ***"new quality of knowledge is generated from simpler forms of knowledge"***. This would generate new knowledge from two or more qualitatively different types of knowledge ("amalgation"). *An example used in the MNRSA-programme is how findings pertaining to non-equilibrium ecological models for rangeland grass production and developments within game theory have bearings for concepts of optimal stocking rates in*

*livestock/rangeland economics. It will also affect practical rules for handling carrying capacity as a conceptual tool in animal husbandry/rangeland management*.

Another dimension, linked to the innovative role of interdisciplinarity and moving towards transdisciplinarity, is that many researchers working with practical or applied problems link up to other types of knowledge; experience-based, tacit knowledge, everyday knowledge, indigenous or local knowledge. These sets of knowledge form a Zarepta Jug from which more traditional research may be vitalized, both concerning problem formulations, discoveries and approaches. *In the MNRSA programme, students are exposed to theories on indigenous knowledge in anthropology classes, in classes on agricultural production systems and in ecology. In addition, in the third semester, students also carry out field research involving exposure to and interaction with local people.*

Interdisciplinary research work takes place through the spread of new theories and concepts, through the explicit development of common platforms and sometimes through the unification of theories, concepts, methods etc. by means communication and collaboration.

**3.3.4. Interdisciplinarity, integration and translation**

One should problematize the concept of "integration" versus translation. An integration perspective seems to partly assume that science to a large extent is cumulative and additive, and that one can merely add together perspectives in different ways, "integrate". This is however, often not the case (see Vedeld, 1994). The concept of interdisciplinarity as integration, presented by Relke, 1994, is somewhat misleading as much of the efforts of transfer of knowledge between sciences in fact involves a translation and an innovative transformation process. The knowledge is created under different logic structures and may be both incompatible and incommensurable, and it is not always easily "imported" as ready-made building blocks. This latter perspective links better with the perspective on pioneering and translational knowledge networks (see Brun 2002). Interdisciplinary efforts thus involve both integration and translation processes.

Bernstein (1983) discusses some dimensions of translation processes; "Kuhn and Feuerabend show us that we can understand the ways in which there are incommensurable paradigms, forms of life and traditions that we can understand what is distinctive about, without imposing beliefs, categories and classifications that are so well entrenched in our own language games that we fail to appreciate

their limited perspective". According to Bernstein, such openness may improve our understanding of ourselves. The incommensurability thesis is an attack on objectivism, not on objectivity, and it "calls into question the modern version of objectivism which assumes that there is or must be, a common, neutral epistemological framework within which we can rationally evaluate competing theories and paradigms or that there is a set of rules that will tell us how rational agreement can be reached on what would settle the issue on every point where statements seem to conflict."

According to Bernstein, "Kuhn's thesis does not talk about the problem of relativism in the sense that we are prisoners of our framework and cannot therefore be irrational. The thesis is a clarification of just what we do when we compare theories, paradigms and language games, we can compare them in multiple ways. We can recognize losses and gains. We can even see how some of our standards for comparing them conflict with each other. We can recognize- especially in cases of incommensurability in science- that our arguments and counter-arguments in support of rival paradigm theories may not be conclusive. We can appreciate how much skill, art, and imagination are required to do justice to what is distinctive about different ways of practicing science and how- in some areas scientists see different things (Bernstein, 1983)".

Furthermore, as communication across scientific borders is maintained over time, communication becomes more precise and less time is wasted. Communication alters character from multidisciplinarity to interdisciplinarity (from Vedeld, 1994).

If integration efforts are more focussed on import and export of empirical findings, translation involves the deeper interpretation of findings in view of basic theoretical assumptions and perceptions, modes of explanation, the use of basic metaphors and symbolic generalizations, accepted methodological and inherent values and approaches and practices found within different disciplines. In Kuhn's perception, any paradigm has both a cognitive and a normative element. The translation perspective, in my opinion, thus takes a fuller account of a comprehensive socio-cultural perspective on interdisciplinarity. Knowledge creation is, in spite its scientific and rational ambition and attempts to streamline practice, <u>also</u> a social phenomenon and process. This means that the social context, with its values, norms and accepted practice in which knowledge is formed is important in knowledge creation. The epistemic frameworks are thus different for different disciplines.. The economist would be expected to have a different view on for example environmental values or management of biodiversity compared to an ecologist (Vedeld, 1994). Using the concept of "integration" is

somewhat reductionistic and reveals an ambition of instrumental dissection of knowledge in order to integrate as compared to seeing interdisciplinarity as also being a hermeneutic translation process involving interpretation and more comprehensive understanding of "knowledge products" prior to "border crossings" and integration".

**In sum;** one may see integration and translation activities as complimentary in interdisciplinary efforts. The activities may provide new knowledge within a discipline, one can build bridges and increase the breadth of knowledge and one can fill in gaps between existing fields of knowledge "in seas of ignorance". It may provide ways out of "specialization driven dead ends" in research. In many cases it generates novel knowledge.

*For the MNRSA programme staff, there has been a growing awareness that one should see sciences as logical, man-made constructions where knowledge is produced under particular preconditions including also social relations. The knowledge generated may be compatible with other sets of knowledge or it can be incompatible, in which particular translation mechanisms would have to be found. The knowledge can in other cases be found to be commensurable or incommensurable, in which "there is no common yardstick by which to measure scientific validity or progress". Such cases would again require a <u>different</u> type of translation process (Vedeld, 1994).*

### 3.3.5 Interdisciplinarity is a process, more than the formation of a new discipline

Many claim that interdisciplinary efforts naturally gravitate towards the establishment of new disciplines. The number of disciplines, sciences and faculties *has* increased over time. A dominant mechanism has been the differentiation and specialization of scientific knowledge, also through interdisciplinary endeavours. Klein (1996) describes this as a process from disciplinary to interdisciplinary to new disciplinary approaches. Such a path resembles to some extent Kuhn's description of the rise and fall of paradigms.

Working interdisciplinary does not imply a target to develop a new discipline. It may, in most cases, seem wiser to maintain disciplinary boundaries, while also working together in fields of common interest. Most knowledge is generated within the realm of disciplinary boundaries, and rather than seeing the two as alternative ways of generating knowledge, one may regard them as complimentary. I also refer to Bernstein (1983) on the "incommensurability thesis". In real life, there is a lot of borrowing and trading of knowledge between disciplines. I also believe that a discipline disciplines you, for better or for worse, and attempts to create a new

discipline ("environment studies, development studies") can easily generate new "disciplinary problems". In fact, one can quickly develop into a situation where new rigid and mainstream effects of a new science blocks intellectual openness and true scientific development. In one sense, it may seem contradictory or paradoxical, that an interdisciplinary quest should lead to a new discipline. In this context, interdisciplinarity should primarily be understood as a process for knowledge generation, rather than a new scientific product.

*Thus, we still teach courses, partly as disciplinary, in MNRSA, and our philosophy is not one of creating a new science such as for example environmental or development studies. Instead, students are provided with an understanding of the complexity of interdisciplinary approaches and learn about both the possibilities and constraints that lie within different disciplines and in having a disciplinary or even an interdisciplinary bias or focus.*

### 3.3.6 Interdisciplinarity, disciplines and power

Even if we in the MNRSA programme try to advocate for the positive complimentary between disciplinarity and interdisciplinarity, there is no doubt that many disciplinary researchers do not like or respect interdisciplinarity for a variety of reasons. And there is of course an element of critique from interdisciplinary proponents about what they see as the "fragmented and narrow approaches" of disciplines and that the positive innovative role of interdisciplinarity in important research fields makes it an important contributor to scientific development. This challenge creates tensions. From Foucault, 1980, on power and knowledge, he addresses disciplines as also disciplining activities, where scientific conduct, roles, norms and social relations are closely tied to systems of power.

*Even a well-established study programme like the MNRSA programme is constantly subject to pressures from outside and above for moving the programme in more disciplinary directions and disciplinary departments within our university repeatedly advocate for taking over the responsibility for the MNRSA-programme.*

## 3.4 THEORIES IN AND FOR INTERDISCIPLINARITY

Since the inception of our MNRSA-programme, substantial research advances have been made worldwide in the development of an interdisciplinary research and development field. Whereas the theories developed **in** interdisciplinarity highlight theoretical foundations for

understanding the **production** or generation of interdisciplinary knowledge, the theories **for** interdisciplinarity highlight how we can use the knowledge to **disseminate** (teach) and **apply** interdisciplinary knowledge and perspectives. The three activities, production, dissemination and application, involve crucially different analytical entities and they also represent three institutionally different organizational forms of knowledge and its application.

*The MNRSA-programme has tried to address all three dimensions. Staff has worked with developing theoretical and practical positions, and students in the programme have been given lectures, papers and seminars where explicit theoretical approaches to interdisciplinarity were taken up, and where concepts, approaches and experiences were discussed. Staff also raise issues within their disciplinary courses, and discussed links to other sciences and subjects. Students, on their part, also have to address and apply interdisciplinary approaches in their own work.*

But let us look a bit closer at how we have tried to encompass interdisciplinary approaches in our education efforts.

## 3.5 HOW TO APPLY INTERDISCIPLINARITY IN EDUCATION EFFORTS

### 3.5.1 Using interdisciplinarity in education efforts

In production of knowledge, an integration or translation effort requires that the researchers are able to understand underlying concepts, methods and knowledge from different sciences. The present generation of researchers, has seldom been trained explicitly in this as a point of departure. They may still possess abilities in this direction, such as when their research actually has involved more than one epistemic framework.

For new generations of researchers, educators and practitioners, the education should secure that such skills are developed to an extent where one is able to both integrate and also convey interdisciplinary knowledge.

The integration in the application of knowledge furthermore demands a mix of scientific and skills-based knowledge, both in terms of methods and theory and as individual personal competence.

If we regard interdisciplinary knowledge generation as a process, dissemination and education efforts becomes particularly challenging. One needs both knowledge *in* and *for* interdisciplinarity in terms of how to promote and enhance candidates' knowledge and skills.

In a report from Gothenburg University (Egneus et al, 2000:32) they discuss what "components" should be included to promote interdisciplinary approaches in education. Below we discuss some such elements, partly based on insights from that report (Table 3).

**Table 3. Components to promote interdiciplinarity in education**

| |
|---|
| 1. Have a clear goal for interdisciplinarity for students |
| 2. Staff develop reflective perspectives on theories in and for interdisciplinarity |
| 3. Design conscious package of courses to promote interdisciplinarity |
| 4. Design a designated flow of courses to create a good learning process |
| 5. Develop good methods for teaching and communication |

*(partly based on Genius et al, 2000)*

In the following, I address these issues in more detail.

### 3.5.2 A clear goal for interdisciplinarity for students

For a student with a major in biology, and electives in chemistry and physics, there will be less requirements to cross science and faculty boundaries and this would imply a more multi-disciplinary approach. By, contrast, building a programme around a complex research field, like the MNRSA has done, constitutes a challenge because different sciences necessarily have to play a role and more serious integrative efforts are required.

We thus saw that the students had to be given both theories in interdisciplinarity and from this, abilities to see merits of different sets of knowledge and perspectives developed in alternative epistemological networks.

*A still running debate in our programme is whether interdisciplinarity should be seen as an individual skill or as a communicative tool? Or phrasing it differently; Should the aim of the programme be to develop candidates that can do interdisciplinary work by themselves in "one head", or should the aim be to develop master of one discipline, but with particular skills needed to work in teams with scientists from other disciplines*[?]

There has been a rather common assumption that most scientists for cognitive and social reasons feel obliged or forced to become discipline-oriented scientists (Ziman, 1999). Brun (2000) is critical to underlying assumptions of such views. He claims that present scientific practice is, on the contrary, by force (economic, technological, political reasons) becoming increasingly interdisciplinary, and there are reasons to think that this trend will continue. Furthermore, the ability to work multi- and interdisciplinary is now becoming an increasing asset in research[3].

Going further, many fields, especially vocational ones, are by nature eclectic; medicine, engineering, history, geography and literature studies. All these contain insights and perspectives from a variety of disciplines. Most scientists de facto address and use more or less consciously a variety of disciplines in their scientific work.

Even though scientists integrate and translate to varying degrees, it may still be fruitful to rephrase the initial question; in what areas and contexts do we need generalists and in what areas do we need specialists?

Brun (2000:46) quotes Jungen in stating that an interdisciplinary specialist should be able to "select and integrate knowledge from different disciplines within a coherent framework". This requires that the person in question can understand the underlying assumptions of each discipline (concepts, models, theories, etc.) used within the disciplines and construct a framework for integration. This will require specific skills such as: differentiating, comparing, contrasting, relating, clarifying, reconciling and synthesizing (Klein, 1996). Egneus et al (2000) take it a bit further and add, "decoding value patterns and normative assumptions governing theories, frameworks, concepts, the shifting from absolute answers and solutions to tentativeness and reflexitivity including epistemological reflection and critique of disciplinary knowledge. This requires training. Generalists must develop an "integrative habit of mind".

Specialists, on the other hand, are crucial in areas where the need for integration of sciences is lower. Brun (2002) cites Sørensen (1997) who claims that society needs polyvalent specialists rather than generalists, these are persons that are specialists, but with the ability to

[3] Working interdisciplinary is not even new. Pareto was an economist and sociologist, Weber trained in law, economics and history, Boyle in chemistry and physics, and Curie in chemistry and physics. Many researchers thus display and have displayed a synthesizing capacity in their research work.

communicate. Brun finds Sørensens' views too narrow. There are many reasons behind interdisciplinary ventures and various forms of interdisciplinarity require different types of knowledge and skills. Generalists and the specialists fulfil different job descriptions.

*In the MNRSA programme, there has been a clear ambition to develop generalists that are suited for meeting complex environment and development problems in a scientifically sound way and with abilities to integrate and translate insights from different sciences. We are well aware of the dangers of being too ambitious on behalf of our candidates, and much of what we talk about needs long term, maybe life long experience and learning. The candidates definitely need to test their insights and skills in real life situations.*

### 3.5.3 Staff and interdisciplinarity

Working with staff over joint perspectives on interdisciplinairty is like the never ending story. A Norwegian proverb states that "controlling researchers is like herding a pack of cats".

Researchers trained in disciplines may lack both willingness and ability to consciously join interdisciplinary ventures. In our setting, it is seen important that staff have similar perspectives on the issue, and that their approaches in teaching and supervision follow similar lines of thinking. Through seminars, workshops, staff discussions, presentations, joint research and publications and through working together with students for classes and supervision, one has gradually built a competence in the field, but it takes time.

In many ways, the institution has a stronger formal commitment to interdisciplinarity that many of the staff, but the development of educational programmes at M.Sc. and Ph.D. levels has gradually made more staff creative in thinking and working with both theories in and for interdisciplinarity.

As an example from teaching efforts; I teach a course in resource economics. As we recruit students from different disciplines, we try to utilize this variation as an asset in teaching. I split the newly arrived students into different groups according to their scientific background, and asked a group of foresters and a different group of social scientists to answer the same three questions (Table 4).

**Table 4. Groupwork in the MNRSA-programme displaying challenges of interdisciplinarity**

| Task | The forester group | The social science group |
|---|---|---|
| 1. Describe the problem of overgrazing in Africa in maximum 5 points. | 1. Reduced vegetation cover<br>2. Low infiltration capacity<br>3. Reduction in biodiversity<br>4. Reduction in regeneration<br>5. Increased soil erosion | 1. Loss of livelihood, increased food insecurity<br>2. Lower incomes affect productivity<br>3. Increased disease due to lack of food<br>4. Migration<br>5. Social conflicts |
| 2. Explain the problem through ranking three main factors causing the problem. | 1.Change in grazing practice<br>2.Increase in livestock numbers<br>3. Lack of palatable species in area | 1. Cultural values of livestock - prestige<br>2. Increasing human population<br>3. Market forces, price of meat |
| 3. Outline a solution through ranking three main factors or instruments. | 1.Destocking<br>2. Stall feeding<br>3. Zoning for rotational grazing | 1.Education awareness and extension services<br>2. Diversified income generating activities<br>3. Gov. policy on destocking and family plan. |

The differences were more striking than I had anticipated. Studying their answers tells us about a systematic difference in focus; in how to describe, explain and prescribe a particular environmental problem. The foresters focus on nature and the "welfare of nature". The economists focus on human adaptation, social systems and of the "welfare of man". We would hope for less systematic differences by the end of the study programme. Students' translation and integrative efforts should be better mirrored in their approaches than displayed in this initial investigation and exercise. The exercise, however, was still very useful as it displayed that science-derived borders are real. I also believe that it created a very useful process of self-reflection among the students.

Over time and through experience the staff has developed approaches and techniques to promote interdisciplinary thinking and practice among students (see also Table 3). I still believe that there will be constant needs for maintaining and developing perspectives and practices among staff, for both theories in and theories for development.

### 3.5.4 Conscious composition of courses, blocks and programmes

In designing the MNRSA-programme, a comprehensive analysis was made of the fields and blocks of knowledge the candidates should be acquainted with. From this, a structure and a system were created to cater for the different knowledge and ability goals we had defined.
(The selected course works are described in section two). The design of individual courses and what subjects and topics to be raised are also crucial for the level of integration that can take place. A course in environmental politics, for instance, may use anthropology, political science, sociology or economics as a point of departure, or can consciously use combinations

or blends of perspectives. Setting pre-conditions for broad, problem based topics in the thesis work has been seen as crucial for the learning process in the programme.

We also try to develop respect for relative merits of different sciences, and stress that much of what we need of knowledge in management of natural resource and sustainable agriculture is formulated within disciplinary frameworks (" A disciplinary approach to interdisciplinarity).

Still, for certain broad or complex issues, a single discipline may not cater to the issue at hand. For other issues again, there are particular benefits to be reaped by means of interdisciplinary approaches where knowledge in different ways is utilised from different disciplines to develop new insights. Interdisciplinary approaches can thus both be constructive in its own right, and can serve as a useful corrective to more disciplinary approaches.

What can interdisciplinary approaches contribute to in research and education? One could claim that interdisciplinarity has a particular advantage in enhancing science's ability and guide students and practitioners to help approach and solve complex problems.

Important challenges in society *are* increasingly complicated and complex and prove difficult to describe, explain and solve by means of one discipline and its precise but narrow contribution. It is often that such diffuse and open ended problems are better solved or assisted solved through interdisciplinary, open and broad approaches.

The increasing degree of complexity in environmental problems often requires a multitude of knowledge from different sciences and fields and knowledge with several properties (theory, methods, concepts) appropriate to approach the issue in question. Below (Box 2) is an example from West Africa used in our MNRSA-classes. It highlights the complexities in problem description and explanation and how the combination of different sets of scientific theory and methods improve our understanding of a particular issue.

**Box 2. A case on interdisciplinarity from Niger (based on Timberlake, 1985)**

Some farmers in Niger were offered an Asian new rice type that gave much higher yields per haa in trials carried out by CIMMYT compared to traditional African rice types. Farmers tried the new variety for one year, but returned to their old time tested varieties. The trials still showed that yields and productivity were much higher than the local varieties. After some time, a multi-disciplinary team undertook an evaluation of the effort. Experienced agronomists, anthropologists, economists and nutrition experts joined hands and found the following,

- The new variety had lower gluten content. The traditional porridge they used to make got an undesirable flavour and texture compared to what farmers enjoyed as the "traditional porridge".
- The new variety had shorter stem, increasing labour requirements in peak periods to control the lower water level, constraining other labour-intensive household activities.
- The thicker stem encouraged more loss to birds preying on the yield as the birds could sit on the plant and eat the grains, impacting the real life yield level.
- The lower water level in the field inhibited fish coming into the water compared to the levels they had with the traditional, local variety.

Conclusion: the disciplinary approach promoting "increased yield" did not fit well with the peasant's own rationale for adaptation. The interdisciplinary approach revealed reasons for non-adoption, and formed a broader base for future research and development activities in the field.

The MNRSA-philosophy has been that there is no viable alternative to multi- and interdisciplinary approaches when dealing with natural resource management and sustainable agriculture. Real-life and even scientific problems do not respect disciplinary boundaries. Given a goal to educate generalists in the MNRSA-field, the broad and interdisciplinary approach seems warranted. Students are compelled to address complex issues in term papers and through their thesis work and have to display abilities to combine perspectives from different sciences, and through this see things a disciplinary approach would not capture.

### 3.5.5 Conscious developing interdisciplinarity through a learning process

Process is important. Given the aims for the programme, we stage the courses and the ambitions assuming that students mature over the study period in response to what they are exposed to. We furthermore consciously select a scientifically and culturally heterogeneous group of students. A common feature, though, is that most of them come from a scientific tradition as social or natural scientists or as agronomists/foresters. One aim we have for the programme is then to use the very diverse composition of the group to promote insights in and awareness about contrasting and complimentary perspectives by designing a programme that gradually open the student's eyes and minds (Table 5).

**Table 5. Learning steps and theoretical knowledge, practical skills and attitude goals**

| Cognitive steps | Theoretical knowledge (Bloom's taxonomy) | Skills (Simpson's taxonomy) | Attitudes (Kratwohl's taxonomy) |
|---|---|---|---|
| **6. Visionary ability** | Ability to **assess** the value of a certain phenomena for a given goal (criticize, differ, decide, select) | Ability to **innovate and develop** skills, and be able to select action and method and further develop it (change, innovate, improvise, master, complete) | Ability to **develop and profile a consistent value set** from which action can be taken and that is developed into a deeply rooted basic norm set, and with a stable and consistent personality and pattern of behaviour |
| **5. Reflective ability** | Ability to **synthesize** and put together knowledge to new sets of knowledge, patterns and ways to work (suggest, generalize, organise, produce, deduct) | Ability to **refine complex skills,** use efficiently, fast and safe combinations of skills at levels 1-4, working methods of complex patterns (improve, make, arrange, prepare, produce) | Ability to **organize a set of values/norms,** abstract and generalize a set of committed norms and values, and decide upon what values that are important for one's action |
| **4. Rule making ability** | Ability to **analyse** and understand so well that one can decompose knowledge in separate entities and find links (split up, identify, classify, separate, compare) | Ability for **routine action,** when the action is so well mastered that it has become a habit and a possible and planned reaction in given situations, (adjust, small corrections, put together, adapt, choose) | Ability to **appreciate**, to recognize and prefer certain meanings, attitudes and norms to others, engage and commit to the work for certain values and norms. Take a stand. |
| **3.Symbol generating abilities** | Ability to **use** knowledge in new settings (read, use, demonstrate, measure, register) | Ability to **imitate** and aimlessly try out an activity demonstrated (treat, copy, repeat, try, set up) | |
| | Ability to **understand** and formulate the knowledge in own words (prove, explain, translate recognize, interpret) | Ability to **prepare** mentally, physically and emotionally for the practical task (utilize, prepare,concentrate,show interest) | Ability to **react**, not only receive but also react to information and impressions |
| | Ability to **repeat** pieces of knowledge as they have been presented Describe, define, repeat, present, cram, list) | Ability to **perceive** a situation through recognition, discovery, observation, registration and sensing. | Ability to **receive**, to be attentive and sensitive to information and impressions |
| **2. Emotional ability**<br><br>**1. Physical ability** | Little ability in acquiring theoretical knowledge before physical and emotional abilities are in place | Little ability in acquiring practical skills before physical and emotional abilities are in place | No or little ability to develop attitudes, values and norms before basic physical and emotional abilities are in place |

Two categories of steps that require individual innovative abilities and activities - the other steps can be taught.
Based on Bloom, 1956, Krathwohl, 1982, Simpson, 1982.

As Søbstad et al, 1982 state, knowledge, skill and attitude goals are interrelated (see Table 6). We want our students to acquire knowledge and skills, but also to develop a sound set of critical values and norms from which problems and conflicts concerning natural resource management are addressed. If we regard the programme period as a continuous process of learning and maturing, we see the basic courses in the first semester bringing students at best to levels 3-4. A main aim for us at this point in time is that students develop sets of disciplinary knowledge in relevant fields, and that this forms a key knowledge base from which they can repeat, understand and analyse.

They then move a further through semester two and three while developing ever more reflective and visionary knowledge, more complex and innovative skills and ability to address real world issues. They should now also be able to develop a more consistent set of values related to their work. This may not be met fully throughout the thesis work and may not be reached till later in their work career.

We hold up the thesis as "the jewel in the crown", where the students really have to analyse, synthesize, assess, innovate from perspectives, methods and also from values formed throughout coursework and fieldwork experiences. They can imitate and carry out routine actions concerning approaching natural resource planning and management issues. They also learn how to identify different value systems and different approaches held by different actors through the thesis work and through the course in political ecology. Much of this also depends on good relationships with their tutors.

In the programme, focus has been put on theoretical perspectives. There has been less focus on profession-oriented studies with conscious development of practical skills and proficiencies, on how to construct vegetation and soil maps, how to monitor diversity of plants, forests, fish, wildlife, of learning how to make physical and environmental plans, on how to tackle real life conflicts, how to manage projects and in general more exposure to real life situations and skills etc. There is at present a gradual shift in the study programme towards more emphasis on the latter. The MNRSA programme now takes students into a regionalization or sandwich programme where students spend 7 weeks at a developing country university taking courses in practical project planning and management, monitoring natural resources and learning more in practice and in the field about natural resource management and sustainable agriculture.

The attitude goals include interests, attitudes, values and value systems. Values are quite broad and are difficult to attach to particular actions. Tolerance is an important aim, but how to measure it? Openness to different disciplines is important, but how to register and measure it? In the main course and in the newly established course in political ecology, our aim is to develop students' ability and interests in formulating their own values and enable them analyse other actors' value systems.

We do believe that seeing this maturing process of knowledge, skill and attitude goals of students is of key importance for the programme.

### 3.6 CHALLENGES OF INTERDISCIPLINARITY – PIECE OF CAKE?

Interdisciplinary approaches and ventures are more popular in political, bureaucratic and in private enterprise environments than in academia. Different reasons can be found for this. Some reasons are good, others not so good, one could even generate a conspiracy theory that disciplinary research environments feel threatened by interdisciplinary research and often use more or less constructed arguments to sow doubts about interdisciplinary efforts. But let us look at some common arguments.

**The general quality of "interdisciplinary work" is not good enough.** Any field of research attracts different researchers, scholars and practitioners, and with a lack of coherence and substantial heterogeneity, results from research and activities tend to vary substantially in quality. Keeping the breadth of knowledge makes it difficult for researchers to maintain a sufficient depth of knowledge. However, given that much research in general is interdisciplinary, this critique may hold good only for certain types of interdisciplinary work.

**There is no textbook or uniform perception of quality in interdisciplinary research.** Integration and translation activities do not have a well-formulated epistemological and methodological basis. How do you assess the quality? At present, such assessment is more experience-based and it is developed through practical work. This lack of consensus on definitions, methods and approaches is a major constraint to increased academic and practical acceptance of interdisciplinary research. There is no universally accepted or legitimate yardstick by which the quality of interdisciplinary efforts can be assessed.

Lattuca, 2002, talks about the "serendipitous meetings" that often generate interdisciplinary undertakings, and her point underscores the lack of "disciplined approaches" and the lack of "time tested and licensed way of seeing things" as Kuhn discusses. She also describes the way an informant (economist) sees drawbacks of interdisciplinarity; " One of the reasons why I thin interdisciplinarity is always fighting an uphill struggle is because it is not only multi-vocal, it's not only less certain, but it has a softer feel about it. People who have a narrow disciplinary focus are able to sat things they think with great confidence. What can interdisciplinary people say with great confidence?"

**There are substantial communication problems** especially between natural and social sciences. In many ways, crossing boundaries is easier if the epistemologies are similar as between natural sciences, but more difficult if they tend to differ substantially as between for example economics and ecology (Vedeld, 1994). Crossing boundaries *is* difficult and it tends to antagonize persons and systems guarding mainstream scientific approaches against "intrusion and anomalies".

**Constraints in education efforts.** There are many challenges facing teachers and students concerning interdisciplinarity. Some typical examples of problems are raised in Table 6.

**Table 6. Typical problems encountered in interdisciplinary education efforts**

| |
|---|
| 1. Differences in the epistemological characteristics of disciplinary knowledge makes integration of different subjects in education a problematic undertaking |
| 2. Differences in disciplinary traditions in teaching and learning makes interdisciplinarity a challenge |
| 3. Different learning views held by students makes crossing of boundaries problematic for the students themselves |
| 4. Different conceptions academic staff have of teaching and learning itself makes collaboration across faculty boundaries difficult |
| 5. Problems in translating produced disciplinary and interdisciplinary knowledge into a communicative teaching system add a complex dimension to curriculum development. |
| 6. Integration and translation of knowledge are too often left to the students themselves |

Based on Egneus et al (2001: 35-36).

Much of these problems have already been discussed. In education, it is crucial that the staff have conscious conceptions about what interdisciplinarity is and how they plan to promote interdisciplinary thinking and practice through their teaching activities. This is not easy at all. Furthermore, the teacher then have to master curriculum development and to possess a broad grasp of different relevant subjects.

The students on their side must have enough skills in different subjects and be able to generate sufficient distance to the different epistemologies to handle the complex issues of translation and integration. We cannot expect a 100% success rate on these issues, but improving student performance is important.

Additional factors constraining interdisciplinarity are **substantial institutional and organisational constraints**. It is basically mainstream disciplinary department, faculty and

university led systems that rule the ground concerning development and approval of education programmes, research grants, jobs, journals and promotions.

However, it is possible to see a trend whereby new and innovative institutions to a larger degree than traditional departments and faculties are able, willing and even obliged by external funding and other factors, to move in a more applied and often more interdisciplinary direction in their research and development activities. This has been termed the "Mode 2 production of knowledge" (Gibbons et al, 1994). Values from outside, from donors, from corporations and others, can influence research environments through epistemic encounters, creating new and interesting approaches in knowledge generation processes (Ibid, 1994:37).

*Looking back at the MNRSA programme, it would most likely not have been developed inside an ordinary department at NLH. It was formed and developed as an interdepartmental effort, led by the international centre and supported by NORAD.*

The programme staff have clearly changed attitudes over time, from rather traditional disciplinary approaches in research and in teaching over to more explicit interdisciplinary efforts, and an increased openness and willingness to accommodate different epistemological frameworks in teaching and supervision work. But it takes time.

# 4. CONCLUSIONS AND NEW IDEAS FOR THE PROGRAMME

## 4.1 CONCLUSIONS

Environmental education is important. There is a strong need to develop environmental managers and planners with sound theoretical footing and with good practical skills for natural resource and sustainable agriculture management.

This field of environment and development presupposes insights from a variety of disciplines. Acknowledging the fact that much knowledge generation is heavily compartmentalized and developed under different epistemic networks, one also needs abilities to "select and integrate knowledge from different disciplines within a coherent framework".

There are different perspectives on interdiscplinarity. Developing the MNRSA programme has implied a travel from rather crude, rationalistic multi-disciplinary approaches where rather direct lending of empirical insights were the main perspectives; over to more critical realistic approaches involving socio-cultural and phenomenological persepctives.

**Table 7. Different approaches to interdisciplinarity**

| **"Disciplinary approach" OECD et al 1972** | **"Interdisciplinarity as integration" Klein et al, 1990** | **"Knowledge network approach" Brun et al, 2002** |
|---|---|---|
| Multi- disciplinarity | No integration | Autonomous knowledge networks |
| Inter - disciplinarity | Diversifying integration | Architectural knowledge networks |
| Inter - disciplinarity | Unifying integration | Translational knowledge networks |
| Trans- disciplinarity | Synthesizing integration | Pioneering knowledge networks |

We have reached an understanding where we apply what Lattuca, (2002:712) calls a "disciplinary approach" to interdisciplinarity, in contrast to a postmodernist view where the disciplines are "not central to the modes of enquiry". Most knowledge is constructed under a "disciplinary matrix" and must be interpreted and used in that perspective. The knowledge is not devoid of its roots and context; even interdisciplinary knowledge has traceable roots. We thus see interdisciplinarity in a socio-cultural perspective, where a discipline is understood as a social institution with sets of common values, norms, perspectives, methods and experience based knowledge holding the science together and apart from others.
A discipline or an epistemic community can thus be understood as a social institution, socially constructed and maintained through norms, rules, everyday activities and with sanctions against violators. Interdisciplinarity involves efforts to communicate across such frameworks.

I think it is useful to see interdisciplinary efforts of translation and integration of various types of knowledge and insights as part of any discipline's everyday research and development activities. Almost all research efforts involve insights from more than one discipline. It is thus an inherent part of scientific activities in all camps. Interdisciplinarity is, following this, not something to be for or against as a principle and an activity to be understood outside disciplines or science at large. There are unfortunately, also in the environmental field, proponents of different holistic and alternative approaches that go too far in equating interdisciplinarity with a farewell to science and to academic discipline. I personally have problems when I see statements like, "Everything is connected to everything, all is cause *and*

effect, or interdisciplinarity is the quest for the unified science that captures all problems". It is important to avoid such relativistic approaches.

We thus do not talk about interdisciplinarity in terms of a blurred holistic universe or the quest for the unified science that takes up and solves all environmental problems in the best way. This implies a misconception about the nature of knowledge generation and how science is organized and managed. I think it is important to stress the normal science features of interdisciplinarity and not let it decay to a sub-culture for zealots.

Going back to Kuhn's thesis about incommensurability and incompatibility, we should rather understand and address knowledge as it is; generated through different logic systems or epistemic frameworks. Interdisciplinarity is a fruitful meeting between epistemic frameworks.

To believe that an ultimate solution for knowledge generation lies in a new and improved discipline where "all" is covered is following this not a viable solution. It is rather so that processes of comparing and contrasting and the dimensions inherent in incompatible and incommensurable epistemic frameworks contribute to bringing science and knowledge creation forward in a fruitful way. It also supplies useful competition to disciplinary efforts. It is additionally important to stress in this context that science and knowledge generation efforts are not only cumulative, they skip, falter and jump, sometimes in productive ways.

Maybe seeing interdisciplinarity as one of several *processes* for knowledge creation is a fruitful perspective, rather than thinking about it as a process for the development of a new ("and better") discipline. Much of the problems encountered in scientific inquiry are in fact caused by rigid discipline mainstreaming processes.

The MNRSA programme has also developed an understanding of differing between theories *in* interdisciplinarity as presented above, from theories *for* interdisciplinarity; for how to teach and apply theories. Many research and education efforts purporting to be interdisciplinary, lack theoretical or explicit perceptions on what interdisciplinarity is about.

We do not claim to have a master-plan or even a very good approach for interdisciplinarity in education but we stress the importance of first of all having theoretical and skills- based goals for the programme, also relative to ambitions for the interdisciplinarity efforts. In our context

we believe that our generalist candidates should be able to "select and integrate knowledge from different disciplines within a coherent framework". This requires among others, staff that are devoted to presenting their fields of study in a way that promotes such abilities and skills; and a staff that continuously develops new approaches and techniques in this respect.

Apart from the above, we also the emphasize composition and staging of courses towards creating a maturing process for the students; both for knowledge, skills and attitude goals of the programme.

## 4.2 RECOMMENDATIONS

A major challenge is to improve the consciousness about interdisciplinarity among staff and students and increase the level of integration between courses and activities. The students should also receive more help in developing knowledge and skills in this context.

### 4.2.1 On theoretical perspectives

One element to be scrutinized is the conscious inclusion and or increased emphasis on issues that first of all are topical and important for the programme, but at the same time promote interdisciplinarity. Such issues may relate to resource use conflicts and conflict resolution, complex urban environmental challenges, issues over global environmental negotiations, and the complex policy games and their link to natural resource and environmental challenges of different stakeholders. We also want to consider increased focus on pollution, human health and food and human nutrition issues.

### 4.2.2 Relationships between theoretical and experience based knowledge

There is a balance between theoretical and practical knowledge. As generalists, students need exposure to the real world, even if there is "nothing more practical than a good theory".

Students should learn how to collect actors' experience-based knowledge in the field, both social and natural science data. In addition, students should have first hand experience in documenting, describing and communicating tacit and experience-based knowledge as reflected in local institutions and displayed through local knowledge practices.

The MNRSA programme already has a focus on such knowledge, but increased emphasis in this field seems warranted, both relative to the generalist goal, but also through enhancing the candidate's ability and eye for broad integrative perspectives.

### 4.2.3 On practical teaching methods - problem based learning

In the MNRSA programme, a renewed focus will be put on teaching methods. This also relates to ambitions of interdisciplinary and developing the capabilities and skills of students.

We plan to increase and professionalise the use of **problem based learning,** where students to a much larger extent than before have to take responsibility for their own learning. In classic science oriented education students are taught, observe and learn how to apply the knowledge to practical problems. In the PBL approach, the students are given a problem to be addressed and have to find out for themselves what type of insight and knowledge they need to approach the problem. The problem itself becomes the focus for attention, and students have to find out how different sciences can contribute to approaching, defining and solving the problem. This approach is ideal for promoting interdisciplinarity and integration awareness and skills. The present thesis work has in particular important elements of this thinking, but can still be expanded from present day practices.

### 4.2.4 On staff development initiatives

Staff development is a continuous process. Apart from training, courses, seminars and workshops in the field, it is important for staff to teach together, do research and assignments together and also socialize in more relaxed contexts. These are all important processes of creating good relations and a better working environment.

Apart from formal training courses in education and programme design, in pedagogics and in theories in and for interdisciplinarity we also want the staff to develop joint teaching materials. We would also like to publish a book on theoretical and practical experiences of working with interdisciplinarity.

Charging batteries is also important, such as short and medium term sabbaticals, where staff should seek other environments world-wide that also work consciously with issues raised in this paper.

## 4.3 CRAFTING INTERDISCIPLINARITY IS NOT A PIECE OF CAKE

The paper had addressed various challenges in designing and implementing education programmes, and has in particular dealt with challenges of how to craft interdisciplinarity into a programme dealing with environment and development challenges.

We believe that interdisciplinarity is both important and necessary. We do not see it as an alternative to science in general, but as a crucial compliment. We show in the paper that it is already a substantial element of most scientific activities. In some research environments, however, it still seems to enjoy a B-status, but we do think this will change.

Many education programmes and research efforts we have met over the years claim to address, include and involve interdisciplinarity, but do seldom explicitly define, clarify or develop plans for how it is to be designed, accomplished, documented or evaluated. This is puzzling, but still true.

We strongly believe that a good interdisciplinary process must be consciously crafted. Actors need theories *for* interdisciplinarity. This preassumes the establishment of common concepts, theories and tools. One also needs theories for how to adapt processes and structures for communication across scientific boundaries and establish meeting grounds in order to form interdisciplinarity as practice.

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