This document highlights the first outcomes of a process, facilitated by PICOTEAM member Dr. Jürgen Hagmann

Tackling Complexity in Natural Resource Management Research – moving towards more integrative Research

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TACKLING COMPLEXITY IN NATURAL RESOURCE MANAGEMENT RESEARCH - MOVING TOWARDS MORE INTEGRATIVE RESEARCH

Background

Research over the past 30 years by the international agricultural research community has been highly successful in boosting productivity and alleviating poverty in developing countries. Today, however, there is greater recognition that agricultural advances and development often have effects that resonate across a landscape, sometimes undermining the broader base of natural resources that people depend on critically for a wide range of needs. Ian Johnson, chairman of the Consultative Group on International Agricultural Research (CGIAR), has observed that the mismanagement of natural resources may be the 'Achilles heel' of long-term sustainable development.

This is driving a demand for broadening research and management approaches to embrace a range of variables and to take account of issues at multiple spatial and temporal scales. These approaches have generally been described as ***integrated natural resource management (INRM).***[1] The fundamental purpose of INRM is to inform the overall management of the system in which technological innovation is taking place.

Natural resources are influenced by day-to-day management decisions of large numbers of actors - both small and large in scale. Each decision influences the interests of a manager but also the environment of all other managers, both now and in the future. Many of the institutions aimed at balancing different stakeholder interests are of limited effectiveness.

What is INRM?

The keyword in the INRM concept is 'integrated'. INRM implies integration across disciplines, across scales (space, time), across components and across stakeholders and managers (villagers, officials, researchers etc.). Thus the scope is from organisms to plots to global scales. It is also from households to villages to districts up to international agreements. The limited duration and geographical scale of many projects is inimical to INRM; projects are often unable to deal with off-site and long-term changes and impacts.

INRM Defined

Integrated natural resource management is a conscious process of incorporating multiple aspects of natural resource use into a system of sustainable management to meet explicit goals of resource users, managers and other stakeholders (e.g. production, profitability, risk reduction and sustainability goals).

How integrated do we need to be?

Why, if so many people are talking about integrated approaches, are successful comprehensive cases so hard to find? Part of the reason is that there has been an influential school of thought that portrayed INRM as being all-embracing and integrating everything. In reality it only makes sense to integrate those additional components, stakeholders or scales that are essential to solving the problem at hand. If this more limited view of INRM is accepted then there are very many examples of successful INRM. The fundamental issue is that the marginal costs of adding each additional component, stakeholder or scale into the system have to be considered and have to be less than the marginal benefits of such additions. This highlights the need for a clear articulation of the problem, the establishment of appropriate research hypotheses and, above all, a high probability of tangible benefits within reasonable time frames. Perhaps the most difficult problem facing practitioners of INRM is the decision as to when to stop adding additional components into the system. ***INRM should be seen as a careful extension of the research or management domain to include those additional variables, stakeholders, scales and drivers of change*** that can reasonably be expected to have an influence on the sustainability of the interventions being designed.

Closing the gap between research and management

- **Action research.** INRM is driven by actual problems and based upon shared learning from real life situations at operational scales. Through

[1] This document is a continuation of the debate on INRM following the workshop in Penang in late 2000. Individual scientists from CIAT, CIFOR, ICRAF, ICRISAT, IWMI and TSBF have participated in the development of the emerging understanding of INRM through their participation in post-Penang meetings and through email dialogue. The governments of Denmark, Germany, Japan, Netherlands and Norway have funded the work of the task force for INRM.

Examples of INRM

- *Integrated management of vegetation and soil in a plot or field to achieve higher nutrient use efficiency.*
- *Interventions in the ecology of farms to achieve integrated pest management.*
- *Management of forested landscapes to achieve balance in yield of forest products and water, whilst retaining biodiversity.*
- *Adaptation of farming systems at large scales to enhance carbon sequestration.*

participatory action research, researchers become actors by engaging in dynamic action and analysing the effects and lessons for development of practical solutions to problems rather than 'neutral' analysis of static systems from outside. The action research may take place at various levels, from households to villages up to the highest institutional levels.

- **Moving towards adaptive management.** INRM is best achieved as part of an adaptive learning paradigm. Adaptive management is a key component of much INRM because it implies monitoring the behaviour of the system and seeking to determine patterns and causality of change in order to trigger management interventions. In many situations there will be multiple layers of managers rather than a single management entity and potential for conflicting perspectives amongst these different layers.

- **Breaking down the distinction between research, extension and management of natural resources.** INRM implies a closer relation of research to management - in its ultimate expression a breakdown of the distinction between research and management. It operates in a context of an innovation system, where multiple actors contribute to innovation. INRM research will not normally be planned or designed independently of management.

  INRM research is more concerned with better decision-making, maintaining options and resilience, and reconciling conflicting management objectives as a foundation for better management and technological *change* than with producing technological packages. However, in the process of designing such improvements in decision-making, INRM will throw-up technological problems. Some of these will be addressed through systems level process research, which is interdisciplinary, e.g., a water x soil x vegetation problem in the hillsides. Others will require discipline-based, component research, e.g. a plant pest problem to be solved. And INRM may be centred on specific technologies that provide options for improved resource management, such as the adaptation of an improved crop variety to specific farming conditions. INRM as described here is more a changed approach to research and management than a specific set of technologies. The ultimate integration of the elements of management of any natural resource may not be achievable. However, an attempt to modify existing research and development efforts to achieve higher levels of integration does, on balance, seem to be a sensible thing to do.

- **Realigning scientific and development culture to INRM.** Conventional scientific culture has many elements that are not favourable to achieving INRM. For example, such research focuses attention on controlled 'plots' or 'demonstration areas' and the need to show changes that can be directly and immediately attributed to research. Development practitioners often view this sort of research as a burden. In INRM there is a close relationship between research and development, requiring that we rethink the full spectrum of components that currently constitute our scientific culture (See the box for thoughts on research dissemination).

- **INRM organisations.** INRM makes assumptions about the capacity of organisations to deal with multi-sectoral, multi-stakeholder and multi-scale issues. INRM is favoured by the existence of strong

Research dissemination

Research delivery and communications should ideally not be an issue within the locality where INRM research takes place. If the relationship between managers and researchers is optimal then the significance of research results should be apparent to all. The 'product' of research will not be a policy or technological 'package' needing to be delivered or replicated. Rather it will be a change in behaviour on the part of significant actors in the system resulting from their shared learning with the scientists. For these same reasons there is a limit to the extent to which results of INRM research can be disseminated to wider domains of application. There will be variability in the extent to which knowledge developed in one location may or may not be useful in other locations. However, we need to conceptualise the processes that lead to positive changes and make them transparent and 'learnable'. So, the outcome of INRM research to a large extent is process knowledge, conceptual knowledge, approaches and methodologies, which need to be communicated well. This demands even more communication than conventional research products.

integrative organisations or, alternatively a single management organisation for a geographically circumscribed area. Examples of the latter, such as the Tennessee Valley Authority and The Murray Darling Basin Authority, seem to exist only in the developed world. The US Forest Service Ecosystem Management processes in the Pacific Northwest are an example of an integrative institution but operating in a relatively simple system with only a moderate number of stakeholders, secure property rights and strong legal frameworks.

Tools and methods for INRM

- **Systems thinking.** The complexities of resource management systems are seldom sufficiently acknowledged. Systems theory and methods provide valuable concepts and tools to cater for these complexities. INRM should not be seen as synonymous with predictive models of whole systems - such models, especially if they have to be developed in the course of an INRM programme, are unlikely to be of much use within a swiftly moving action research process. Nonetheless, particular predictive models can be valuable tools in articulating our current understanding of any NRM system. Action research will normally be carried out as cycles within cycles, e.g. short, well-defined learning cycles may give rise to opportunistic learning cycles on particularly pertinent topics, and these will take place within long-term cycles of ecosystems. Action research will invariably be interfaced with systems models to explore longer-term impacts. It is within the frame of such systems thinking that diverse technological options for addressing a given INRM problem can most effectively be developed.

Cases of INRM

Integrated conservation and development programmes (ICDPs) have often failed because they have not used INRM principles. They might work better if they were established with a science-supported structure within the management organisation. Science should track responses in the system and seek to determine causalities when management pulls the levers. Management interventions will constitute the experiments and scientists will improve the quality of learning and feedback from these experiments. In real life many ICDPs have failed because they have attempted to achieve change through interventions at the margins, for instance by the establishment of demonstrations, or the introduction of new technologies or activities. They appear rarely to have taken the existing development trajectory as the starting point and sought to influence that trajectory.

Complexities for INRM arise from:

- *Multiple scales of interaction and response.*
- *The high frequency of non-linear trajectories, uncertainty and time lags in complex systems.*
- *Multiple stakeholders with often contrasting objectives that complicate the task of identifying research and management aims and finding trade-offs among them.*
- *The context-specificity of INRM sites.*
- *The problem of maintaining integration in the face of numerous components and interactions.*

- **Measuring impact.** Measurement of the impact of INRM or INRM research is as complex as measuring the impact of education, improved public health etc. Impacts of such research are more difficult to isolate than in component research. The impact of INRM will tend to be manifest through improved performance of the system and the improved ability of farmers and other decision-makers in adapting to external changes. This can be tracked through indicators of system performance and performance of different actors, and will reflect the combined impacts of research, management and other (external) drivers of change. Measurement of the performance of actors and stakeholders with regard to their behavioural changes are made in conjunction with explicit assumptions of plausible actor strategies that trigger higher systems performance. INRM research monitors these assumptions and plausible strategies and improves them through learning from successes and failures.

- **Scales of operation - negotiation domain.** INRM involves negotiating trade-offs between different interests at different scales. The scales at which INRM is possible may be limited by the scales at which it is possible to get a reasonable consensus on desired outcomes. INRM seems to work best in situations where indicators of success are negotiated amongst a small number of stakeholders. For example, upstream and downstream farmers in the Murray Darling Basin, erosion prone farmers and watershed managers in the Tennessee Valley, small numbers of villagers in S. Zimbabwe. It will become progressively more difficult to separate research and management or to establish the attribution of

impacts in a situation where a large numbers of stakeholder groups are occupying a diverse landscape.

- **Scales of operation - spatial contexts.** INRM will normally be conducted within a specific locality, with appropriate linkages made to other scales in order to capture off-site effects and external drivers. There are, however, other models of INRM that apply to domains that are not geographically continuous, for instance to a particular farming system discontinuously distributed across a large area. There may also be single problems that require an INRM approach to be applied across a very large area, for instance the restoration of degraded lands in Northeast Asia, and the management of desertification in Africa and Australia.

- **Institutional analysis and development.** A major focus of INRM research is the development of new institutional arrangements and policies, which foster integration in different contexts and across scales. This implies that institutional and organisational change is facilitated within and across organisations through INRM - from village level institutions to policies and laws that come from other scales. Institutional development will be particularly important in the case where common property and open access resources prevail, especially where these resources are valued differently at different scales. For example, the existence of a globally endangered but locally valueless species in an area of extreme human poverty. Policy changes will play an important role in cases where resource tenure systems, for instance, are a constraint to the effective negotiation of conflict resolution mechanisms by stakeholders.

- **Scaling-up** will not always be an appropriate concept. The conventional view of small-scale testing of technologies for widespread dissemination assumes that the determinant factors and processes are the same at different scales. The difficulty that this poses for the scaling-up of research is one of the drivers of the demand for INRM approaches. Dominant system drivers will often be scale dependent. If large scale applications are intended it will be necessary to start with the identification of major system drivers at that scale and ensure that scaled-down attempts at early experimentation and learning are realistic and take full account of determinants of uptake and impact at larger scales.

- **Knowledge management.** Agreement on desired outcomes presupposes an ability to measure and manage for those outcomes. This will require data collection, data management and monitoring. A significant starting requirement for doing INRM may be a comprehensive data set, probably spatially referenced, for the management area. A shared understanding of observations of change in systems properties will be important. A significant proportion of the scientific investment may need to go into the establishment and management of databases and in efforts to make them mutually understandable to different stakeholders. However, the significance of informal knowledge must not be downplayed. Different stakeholders will have knowledge of the system that may not be amenable to simple formalisation. Different researchers will have insights into the system, insights that will often not have been formalised through analysis and publication. Ensuring the sharing of informal knowledge may in many cases be more important than formal knowledge management.

- **Facilitation.** A key feature of INRM is facilitation - facilitation to achieve integration of stakeholders, integration of researchers and as a core component of action research.

Where to now?

A range of large-scale environmental problems are now threatening the long-term performance of many agricultural, forestry, livestock and fisheries systems. This creates a significant challenge for the science of INRM. It is going to be increasingly necessary to grapple with the issues of scale and complexity in natural resource systems. INRM approaches have been used in the past, but a comprehensive framework has been applied in extremely few practical cases so far. There are major challenges to experiment with this framework and work out modalities to carry out effective INRM research to address emerging environmental problems. This in itself will be a major learning effort that requires new competencies of researchers and ways of organising research. Research organisations will need to reflect on their modus operandi and scientific culture, and rise to the challenge of re-organising for maximum effectiveness in a complex world.

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