

INTEGRATED VERSUS MULTI-DISCIPLINARY RESEARCH: PROSPECTS FOR ENVIRONMENTAL RESEARCHERS.

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Introduction

If 'sustainability' is an icon of environmentalists in southern Africa, so too is 'integration' for scientists drawn into this arena. Scientists seem to be less capable than their compatriots, however, at substantiating their ideals. Popular environmentalism thrives on various forms of civic pressure on government and industry to 'clean up their acts'. Conservation agencies can show that they have implemented appropriate principles such as 'community participation'. Governments too cannot be found wanting when they emphasise their administrative responsibility, as in South Africa's Integrated Environmental Management (IEM) policy. Scientists, in contrast, have told others what to do, but seem unable to practise what they preach. This doubt was voiced recently, indeed, by South Africa's Minister of Water Affairs. In an address to the International Association for Impact Assessment, he noted that the different sciences were 'currently fragmented and caught up in their own worlds'.¹

The scientists' ideal of integration is for combined thought and action by researchers from different disciplines in the design of projects, in field work, in analysis, and in development planning; in short, a crossing of disciplinary boundaries. The common practice is multi-disciplinary research; that is, 'teams' composed of researchers from different disciplines who follow a common project brief, but work according to the tenets of their own sciences, and whose results are combined afterwards. The gap between ideal and practice is tangible, but to question is to open Pandora's Box. Indicating that integrated research is an ideal suggests that the multi-disciplinary format is problematic, not least for giving a lie to procedures that proclaim to be integrated. Although integrated research is substantively different from multi-disciplinary research, the latter has been the basis of efforts to develop an integrated approach in South Africa (Council for Environment, 1989; Department of Environment Affairs, 1992; Department of

Environmental Affairs and Tourism, 1996). Any challenge, therefore, has to untangle a host of theoretical and methodological issues, but, whatever the difficulties of that engagement, they are complicated by the fact that environmental research is often governed by political and economic agendas in support of 'development'.

Opening the Box

Although the government is revising South Africa's IEM policy and Environmental Impact Assessment (EIA) procedures, there has yet to be substantive integration of the social and bio-physical sciences. We have witnessed, instead, the promotion of Social Impact Assessment (SIA) as an adjunct to, even separate form of, EIA. This distinction betrays an ambiguous approach to environmental research. If social issues are as complex as those of 'nature', then one may justifiably query divisions in multi-disciplinary research whereby there are often more bio-physical scientists than social scientists. Social scientists would reject, of course, the compartmentalisation of research that occurs in the bio-physical sciences, because an approach that draws together historical, cultural, social and economic variables is precisely what they are supposed to bring to a project. Yet the obvious extension, a drawing together of social and bio-physical scientists in the design, fieldwork and analysis of a project, is not sanctioned in the multi-disciplinary format.² The social scientist is forced, instead, into a curious position: an integrationist who must work within the boundaries of the social sciences only. Financial and time constraints, furthermore, dictate harsh pruning of the scope and depth of attention given to the diverse phenomena that require study. A focus on the present and future is tacitly endorsed in response to the development agenda, for example, at the expense of historical and cultural variables and, importantly, of their relevance for development planning. Integration, therefore, is an aspiration in research, but how to integrate is still a question short of an answer.

In contrast, there is not so much doubt beyond the world of environmental science. There are entrepreneurs who re-label old practices as new cloth; notably in the eco-tourism industry's use of the high-cost/low-density model of tourism. There are, nonetheless, changes in economic practice as industries and the government assess the costs and benefits of environmentalism. These changes must be judged, however, against their effect upon the majority of the country's citizens who cannot afford to delay their struggle against poverty. 'Poaching' from nature reserves continues. Agri-business finds it relatively easy to lure rural residents into mono-cash cropping (eg sugar cane; timber). Squatters seemingly have little time for environmental aesthetics, in their struggles to secure a place

in the cities, but this disposition is actually encouraged by informal settlement upgrade procedures (McCarthy et al, 1996). In sum, environmentalism belies integration in environmental management.

The short answer to these criticisms is that scientists are avoiding neither the problems with current research practice, nor the ideal of integration. A case in point is the Drakensberg/Maluti Catchment Conservation Programme which was conducted in the late-1980s (Bainbridge et al, 1991). It was initiated at the behest of the Lesotho and South African governments, and was co-ordinated by the Natal Parks Board and the Range Management Division of Lesotho's Ministry of Agriculture. The programme began and ended with arbitrary delineation of a 'Managed Resource Area' as a basis for conservation plans. The limitations of the programme had to be confronted, however, when efforts were made to attract funding for the plans. Generally, funding is linked to demonstration of an 'integrated' perspective, expressed often in terms of community participation and management, which could not be substantiated in this case (Quinlan and Morris, 1994; Quinlan, 1996). Consequently, the conservation blueprint had to be re-appraised, and steps towards definition and implementation of an integrated approach have been taken via a number of workshops. Likewise, the Water Research Commission in South Africa has acknowledged similar difficulties with regard to its responsibility for finding answers to the country's problematic supply and use of water. In 1991, for example, it held a workshop to assess an EIA study on a dam proposal, to which it invited a number of social scientists who, arguably, represented the most critical intellectual currents in academia and in Non-Government Organisations. The commission did not retreat from an exercise fraught with tension, such as rejection of standard EIA analyses, and a decision-making format that had previously been endorsed by bio-physical scientists. In like fashion, the commission has continued to explore the issue of integration.³ Furthermore, local endeavours are underwritten by international interest. This was highlighted at a recent workshop of the Global Change and Terrestrial Eco-systems project of the International Geosphere-Biosphere Programme. A primary goal of that workshop was to provide a model for integrating the research of social and bio-physical scientists. A solution proved to be elusive, but the workshop has stimulated further effort to find answers (Odada et al, 1996).

A reason for the lack of solutions is not hard to surmise. It is a function of the complexity of the research and development agendas (reflected in the lengthy and sometimes awkward titles given to programmes). Workshops too may not be the best place to start, but could be forums for distillation of insights gained by researchers who have learned to ask different questions by working together

in the field. While innovation-in-the-field is a starting point, the limitations of current practice must be acknowledged. I argue that a substantive basis for integrated environmental management will continue to be elusive as long as the multi-disciplinary format of research is retained. Below, I use a recent programme in order to illustrate the pertinent methodological issues.

Confronting Complexity

During 1994 and 1995, a regional planner and myself were involved in the socio-economic component of the Transkei Inshore Fisheries Programme. This programme was conducted by the Oceanographic Institute in Durban, and funded by the Development Bank of South Africa. Its general aim was to assist the Eastern Cape regional government in planning economic development of the Transkei. The programme was designed as a three-stage project. The first stage was a bio-physical survey of marine life along the coast. This was followed by a socio-economic research stage which sought to indicate 'the most effective ways of exploiting the marine resources from the view points of efficiency, equity and sustainability' (Robertson et al, 1996:2). This stage was expected to overlap with the third stage of development planning; notably, of identifying 'the elements of a possible support programme and investigate the technical, financial and institutional aspects of the proposed investment project' (Robertson et al, 1996:2). The socio-economic component of this programme involved two studies, commissioned after completion of the first stage, and conducted at the same time, but independently of each other. One study was conducted by ourselves, the other, by two marine biologists. The biologists conducted a questionnaire survey along the whole coast, in order to assess the extent of human exploitation of marine organisms. In view of time constraints (13 days for field research; completion of the report within three months), we opted to do a case study of a locality in order to illustrate the type and complexity of inter-relationships between local residents, marine organisms, tourists and tourism enterprises.

The order of the programme was jolted, however, at the end of the second stage. The marine biologist who had the unenviable job of completing the third stage, queried our long report. We revised it, reducing the empirical content in favour of analysis to support our recommendations. In the face of continued doubt, our report was sent for independent evaluation by a geographer who has extensive experience in environmental research and tourism. This hiccup had a satisfactory ending, but also revealed the many tensions in environmental research.

The question which prompted an evaluation was a common one; namely, how to combine the results of the different research sub-projects? A synthesis was necessary, having arrived at the point where the research had to serve the demand for a development plan. The evaluator accurately recognised weaknesses in our report. While endorsing the logic and content of our analysis, the evaluator expressed concern about the lack of discussion on methodology, and the strength of the data to support our analysis and recommendations. In other words, the evaluator noted the need for a sound basis (methodologically rigorous, empirical research), in order to begin the process of successive translations: from data analysis to conclusions about ecological relationships; to opportunities to change those relationships; to conclusions about means for engineering desired changes (recommendations); to summation of recommendations in a development plan.

Our response accommodated these concerns, but questioned the capacity of the multi-disciplinary format to allow a rigorous synthesis of research results and development planning. Briefly put, we argued that:

- Synthesis is not a procedural step well into a project, but the hinge upon which a project rests, and therefore, it must be grounded in the design, organisation and methodology of the different sub-projects. The point is that by the time a synthesis is attempted in a multi-disciplinary project, the variety and confusion of the bio-physical and social science research methodologies hinders sound assessment of the results, let alone design of development plans;
- this sort of research is an exploration for appropriate analytical concepts which can cover the complexity of ecological relationships, and is not simply an application of proven methods. Accordingly, as in our case, the methodology often has to be constructed during field work. The result is uneven research practice;
- efforts to distil the research are curtailed by the imperative for the reports to produce development solutions, not theoretical explorations.

Once these constraints are acknowledged, the different threads of confusion in multi-disciplinary programmes become evident.

Firstly, the socio-economic component of a programme is usually designed as a distinct, but compatible counterpoint to the bio-physical research. Yet the researchers are often tacitly encouraged to adopt a broader 'eco-systems' view, which requires bio-physical and social scientists to step into each others' disciplinary domains. The consequence is a compounding of the limitations of multi-disciplinary research. In the Transkei programme, for example, the two sets of researchers worked independently of each other, thereby endorsing a disciplinary-based exploration. The insinuation of a broader research agenda

posed, however, a dilemma of what route to follow: the standard and expected disciplinary course, or the ill-defined 'integrationist' course? This is the crux of the problem, because the choice is always presented in any project that proclaims commitment to sustainable development. Project preambles usually imply an 'integrated' perspective, even though the research briefs, procedures and financial schedules usually do not do justice to this aim.

Secondly, the presence of competing research agendas leads to confusion about the development agenda. In the Transkei programme, the multi-disciplinary format characterised 'development' as a product to be evaluated by a process of disaggregation. A 'pure' research agenda of compartmentalised studies would produce results that would illustrate problems, and suggest solutions for translation into practical plans. From our perspective, the linear coupling of a research agenda with a development agenda side-stepped the fact that the latter agenda actually drove the programme. 'Development' encapsulated a specific aim, and the broader history of ecological relationships in the area. Put differently, the programme did not presume a reflexive perspective. Inevitably, the inclusion of this perspective in our study design was a source of confusion that was exacerbated by being unstated, for it is an axiom in anthropological research. Furthermore, confusion is inevitable when researchers respond differently to the development agenda. The Transkei programme, for example, was based on a tacit judgement; namely, that the marine life on the Wild Coast was being degraded. The programme was designed to test this 'hypothesis', the results of which would dictate development recommendations as interventions to prevent degradation. This basis was confounded by the programme's embodiment of an eco-systems approach, however, for the latter dictated that 'development' would have to be pre-figured in order to generate hypotheses about ecological relationships. The emphasis would be on the dynamics underlying ecological relationships; that is, on processes as opposed to observable or deducible relationships. Recommendations, in turn, would recognise 'development' as an historical process that had shaped present conditions and would continue to generate changes. Adopting this approach inevitably rebounded upon us and the programme. Not only did it mean working against the premises of the multi-disciplinary format, but also, in the absence of clear guidelines, constructing a methodology as we worked.⁴

At this point, it might be argued that revisions to IEM policies and procedures are helping to resolve the confusion. Environmental research is, undeniably, in the making and improving with experience. I contend, however, that revisions to procedures often highlight rather than resolve the confusion.

Revisions to research practice

It can be argued that Participatory Research methods, and their modification with experience (eg Rapid Rural Appraisal; Participatory Rural Appraisal) are innovations that improve not only how research is done, but also the results and scope for implementing 'sustainable' development plans (Behnke and Scoones, 1993; Chambers, 1992; Uduku, 1994). At a more mundane level, there is a case to be made for modifying existing procedures. It may be said, for example, that the evaluator in the case of the Transkei programme outlined a feasible revision of the multi-disciplinary format.⁵ The obvious solution in many projects would be for the researchers to review their analyses together, and to openly acknowledge their theoretical assumptions. This means, in practice, a longer research process than is usually contemplated, and one that we actually discussed briefly during the course of the Transkei programme. It would require a process of the following order: each discipline to produce an initial report; followed by a preliminary synthesis report which distils the analysis; followed by a combined appraisal and distillation of each discipline's input; followed by a final report which outlines development recommendations and their rationale. This practice could be affirmed as being an application of the principle of monitoring which is already outlined in South Africa's IEM policy. The innovation would be the introduction of monitoring to the researchers themselves, in the early stages of a project, on the grounds that this would improve its application generally, as opposed to its current tail end position and status in the IEM policy (Council for the Environment, 1989; Department of Environment Affairs, 1992).

Revision, however, would still be like closing the stable door after the horse has bolted. The horse, in this instance, is the development agenda that eludes incorporation into the research agenda. A revision such as that contemplated above, would bring researchers closer to the ideal of integration. The exercise, nonetheless, would be time consuming, tedious, and misdirected. It would be an attempt to mediate problems with the multi-disciplinary format, as opposed to recognising the need to re-formulate research methodologies. It would reinforce, moreover, the 'process-product' conundrum that is common in environmental management. The conundrum is that acceptance, revision and implementation of a development plan is often frustrated by enactment of research methodologies (eg Participatory Research), and principles that help to define integrated research (eg 'community participation'; 'capacity building').

The root of these problems is the ambiguous conception of the development agenda in applied environmental research. In the first instance, the multi-disciplinary format was really a revision of established research methods, in order to address concerns about environmental degradation. The complexity

of this ecological process was translated as a question of balancing Conservation with Development (IUCN, 1980; Council for the Environment, 1989). The multi-disciplinary format suggested itself as a logical means to address this question, for allowing the knowledge and expertise of both the bio-physical and social sciences to be taken into account. This formulation of the problem, together with the means to investigate it, could be proclaimed as 'integrated', in the sense of combining seemingly disparate phenomena and knowledge.

As scientists began to question conventional perspectives on Development, various forms of Participatory Research offered a solution to the problem of how to incorporate the development agenda of programmes. Recognising that this agenda is subject to the vagaries of political and economic interests, Participatory Research promised to manage them by means such as collaboration and consultation. These principles affirmed democratic methods of adjudicating competing interests; allowed scientists to contribute their expertise; and assisted the understanding of ecological relationships by enabling the subjects of research and development to contribute their knowledge. In turn, an integrated perspective could be proclaimed on the basis that these methods drew together development agencies, researchers, and the subjects of research.

There are, however, two fundamental limitations with this progression. Firstly, revision of established research methods put 'development' under a spotlight, but revealed only a silhouette of the attendant movement to change research practice. The result was tension between the focus and means of research. Testimony to this tension is the presence of EIA and SIA procedures, coupled with Participatory Research. The former endorse the multi-disciplinary format, and are designed to mediate development interventions. The latter insinuates a crossing of disciplinary boundaries, and a re-evaluation of how 'development' is conceived and implemented. Methods such as Rapid Rural Appraisal exacerbated the tension, for being an application of Participatory Research, but also an attempt to assuage developers' demands for speedy answers to how development proposals might, or should be modified. Secondly, scientists cannot lay claim to 'integrated research' when the innovations are actually attached as a counterbalance to orthodox methods, and often, to be practised by social scientists only. In other words, what passes for integrated research cannot be substantiated.

The political ramification is that scientists who try to juggle these tensions run the risk of exposing a lack of rigour upon which their credibility lies. Consider, for example, the principles of collaboration and consultation. These principles are often espoused on the grounds that they allow scientists and development agencies to include the needs and knowledge of the subjects of research and

development. The deeper purpose, in view of environmental degradation, is to promote mutual education of these subjects, researchers, and development agencies, in ways that alter the consciousness of people about their actions. Dialogue, in a word, is a premise of sustainable development. Yet, whatever methodological basis is promoted by a researcher (McCarthy and Quinlan, 1995) a nagging question remains; namely, how credible is the argument for dialogue when scientists seem unable to get it right between themselves.⁶

To summarise, I have argued that the multi-disciplinary format undermines innovation in research and development practice, by imposing constraints upon realisation of an integrated format. On the one hand, the argument is against bio-physical scientists' faith in orthodox procedures, and in current innovations that have emanated from the social sciences. On the other hand, the argument is against social scientists' reliance upon contribution of democratic methods in research. Recognising the subjectivity of scientific knowledge - in short, science's evocation of political and economic ideologies - is not only cause to support appropriate political practice in applied research, but also a basis on which to re-assess the value of the multi-disciplinary format. Without such questioning, scientists can inadvertently allow others to dictate the role of the researcher.

In the light of the above, I have argued that multi-disciplinary programmes fail to achieve their basic aim; that is, to create knowledge (the research agenda) so that needs can be effectively evaluated and re-ordered (the development agenda). There are, in other words, significant tensions in current research practice. I argue below that there are three major axes of tension. By examining these tensions as a matrix - as embedded in any research event - I direct attention to the lack of coherence in the multi-disciplinary format.

The matrix of tensions in environmental research

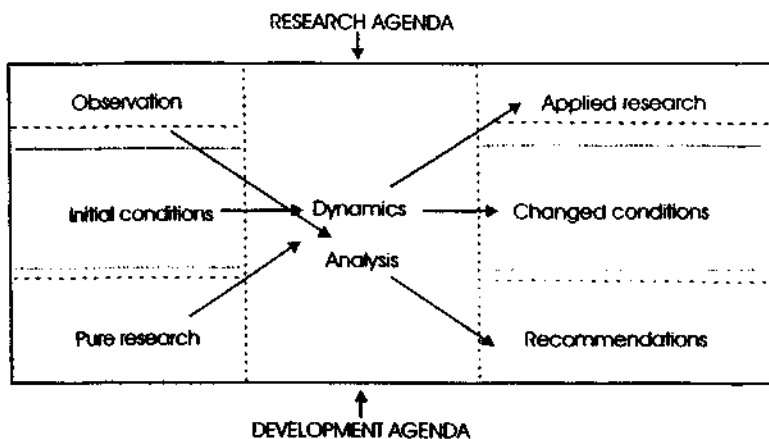
Figure 1 is a schematic representation of three cross-cutting axes that, together, create the tensions that exist in environmental research. These axes are:

1. Observation - Analysis - Recommendations;
2. Initial conditions - Dynamics - Changed conditions;
3. Pure research - Applied research.

The multi-disciplinary format can be read from the diagram, as a progression from left to right, and top to bottom. This reading highlights the orthodox application of scientific expertise, by which the development agenda of a project is fulfilled on the basis of a research agenda. Reading the diagram from the base upwards, however, gives an indication of the tensions that have arisen as scientists revised research practices. The allusion here is to the primacy of the

development agenda that was tacitly recognised in EIA studies' aim of assessing the 'impact' of particular development proposals on environments. This rationale simply reversed the linear structure of orthodox practice. A loose label for this approach is 'enquiry by design'. This means presentation of a recommendation on what to do, based on ideals of what people want, followed by modification of the proposal in response to prevailing conditions and perceived changes to the latter. The process culminates in the application of a revised design. The rationale is embodied in Participatory Research, wherein the subjects of development proposals are a key source of information on the feasibility of a plan. The root of the tensions can be read, however, from the intersection of the different forces that frame environmental research. For environmental scientists, the dynamics of ecological relationships are still difficult to study, because of the variety of contextual variables that impinge on analyses.

Figure 1: Research Matrix



1) *Observation - Analysis - Recommendations*

Much environmental research in South Africa is underwritten by a positivist logic that presumes an unfolding of solutions on the basis of scientific observation. The tension here is that this foundation is not as secure as researchers and sponsors might wish, because any implemented recommendation will feedback onto observed conditions, and change the empirical basis of the

recommendation. As researchers encounter the complexity of ecological relationships, they inevitably realise that development solutions are not easily deduced from the data, which leads to reflection, and to doubt about the research methods and the development goal. Analyses, in turn, are bound to diverge as the researchers respond differently to the research agenda and to the development agenda. In short, environmental research is fraught with uncertainty.

This uncertainty comes from realisation that the multi-disciplinary format relies more on convention than on creativity. Orthodox concepts and distinctions, such as the division between 'nature' and 'society', are retained by separating the bio-physical and social science sub-projects. Likewise, the standard principle of experimental manipulation is used to accommodate the development agenda. Different development options, seen as interventions, are assessed in terms of how they might affect particular bio-physical and social conditions. Consequently, the casting of Development as an extraneous influence on ecological phenomena, confuses the intent to re-consider conventional understanding of development, and to recast it as an ecological process. Synthesis of research results is confounded, in turn, by simplistic accounting under the guise of cost-benefit analyses or impact-mitigation summaries.

In sum, environmental research takes researchers beyond confidence in established methodologies. This generates uncertainty perhaps even, doubts about the development paradigm within which research is conceived and executed.

2) *Initial conditions - Dynamics - Changed conditions*

This axis may be recorded fully as: observed ecological patterns at the start of research, which leads to analysis of their dynamics, in order to understand their magnitude, duration, and inter-relationships, as a basis to predict changes assuming intervention in the form of a development project, and to predict individual and matrix-wide changes initiated by subsidiary interventions and responses.

This is the central axis because the validity and purpose of the research depend on understanding the dynamics. This is, however, also the most problematic axis because it is based on an assumption that sophisticated methods for studying behaviour and experience within each discipline are adequately combined in programmes. The multi-disciplinary format combines different disciplines in name only, and rarely allows for co-ordination let alone experimental fusion of research techniques. The usual result, common in EIA studies in the early-1990s, is simplistic presentation of pattern at the expense of the different disciplines' capabilities to explore the nuances of ecological processes. Having conducted research independently of each other, the research 'team' is ill-prepared to

present coherent insights into ecological relationships. On the one hand, the research may reveal particular problems, and show what not to do. The recommendations may be well grounded and persuasive, for being derived from sophisticated research carried out within a particular discipline. On the other hand, the researchers are not in a position to present persuasive arguments on what to do, both corrective measures and interventions that would be 'sustainable'. At best, the experience may indicate where further research is required, but that is not really the answer which sponsors want to hear. Furthermore, the need for further research is really a function of the inadequate methodological basis of the research as much as awareness of the complexity of the situation. Researchers, therefore, can justify further research only by tacitly questioning the credibility of their work, which is hardly solid ground for convincing sponsors. Consequently, inconsistencies generated by multi-disciplinary research, and the weak position of the researchers, creates opportunities for abuse of the research. Participatory Research, for example, can easily be used as a reference to 'democratic process', in order to legitimate preconceived development interests. In other words, pressures in applied research such as conservationist concerns, and dominant political agendas, are not balanced by coherent, broader and deeper investigation that is the scientists' responsibility.

From a social science view, these problems seem to stem from the perpetuation of a positivist approach as a result of environmental research and management policy being underwritten by the bio-physical sciences. This view may be simplistic. What is closer to the mark, but still not definitive, is that the social sciences and the bio-physical sciences view each other through the prism of development, at a cost to the integrity and value of each discipline, and to the aspiration for integrated research. In sum, however crude current combinations of social and bio-physical research, they direct attention to the dynamics of ecological relationships. As each discipline explores the complexity of these processes, there is a need for clear explanation of methodology. This is necessary, in order to improve communication between the sciences, and to help substantiate reasons for re-defining the form and content of the research.

3) *Pure - Applied research*

The axis of pure and applied research is proving to be a confounding convention for researchers. Applied environmental research can be described as the use of proven means for particular ends. This convention is endorsed by the proliferation EIA and SIA studies, and workshops on how to do them. Yet environmental research is highly experimental. The course is not clearly known,

and old distinctions require re-evaluation. If, for example, sustainable development is to mean anything, at least doing 'development' differently from the past, then the notion of development must be questioned as a suitable paradigm. Although there still is a distinction between pure and applied research, it is being challenged by reconsideration of the nature of ecological processes. Researchers may yield to convention by demonstrating capacity to produce results according to the premises of their own disciplines, or broader scientific boundaries in the case of SIA studies. Yet the limitations of these approaches inevitably surface during field research. Consequently, researchers are drawn towards constructing new methodologies.

It is in this context that notions of social compacts and research partnerships, for example, are being voiced. These innovations are likely to falter, however, if researchers do not incorporate a re-evaluation of the methodological underpinnings of environmental research, and retain a critical view on the notion of 'development'.

Conclusion

The multi-disciplinary format is proving to be ill-founded for environmental research. This is not to suggest a deep malaise, but to draw attention to what is being done to put research onto a footing more consistent with its ideals. These ideals are encapsulated in the concept of integrated research. Integrated research has proved, however, to be an elusive concept to put into practice.

A harsh judgement would be that the considerable effort to enact IEM and 'sustainable development' has proved to be superficial. A sympathetic view, in contrast, would acknowledge the constraints in applied research, which have emphasised the need for practical solutions, not theoretical explorations. Yet, in both instances, the conclusion is that integrated research does not mean revision of established procedures, but substantive re-formulation of the methodological underpinnings. This is not an impossible exercise, even though it involves untangling a host of political, theoretical and philosophical threads that were woven into initial procedures, and which have since taken on a life of their own. Politically sensitive analyses, for example, have started the process (Harvett, 1995; Hindson et al, 1996; Spence, 1996). Likewise, the focus here upon methodological issues unravels some of the confusion.

The discussion has examined the general objective of applied environmental research in South Africa. This objective is to understand ecological processes, with a view to enabling design of development plans that will modify, but sustain and become part of desired ecological processes. Although the discussion has not questioned the technicist premises of this objective, it has emphasised a standard caveat of research. The caveat is, research design and its implementation are significant variables that influence how ecological processes are understood

and acted upon. In short, the research agenda will dictate what boundaries are drawn around 'the environment' for subsequent confirmation by a development plan. In assessing the multi-disciplinary format against the ideal of integration, the key point is that how, and what boundaries are drawn by researchers is the central problem in environmental research and management. On the one hand, the transcending of known boundaries, and the conscious and inadvertent creation of new boundaries, by researchers, development agencies and their subjects, lies at the root of environmental research (eg how farmers define and test 'known' ecological limits for crop and animal production; political agendas of 'capacity building' and 'empowerment'; the quest to do 'development' differently from the past). On the other hand, while research may help to predict the consequences of proposed development plans, there is always an element of uncertainty because even small interventions can have large, unforeseen ramifications.

It is this uncertainty which IEM policies and attendant multi-disciplinary research procedures seek to minimise, but they are inadequate for the task. Distinguishing the superficial from the fundamental in ecological relationships is a primary research goal, and a premise of development planning. The inclusion of social scientists in applied projects was an acknowledgement, albeit parsimonious, that what is immanent in ecological relationships is subject as much to human imagination, as to bio-physical conditions. Although the concept of 'integration' has been used to describe these considerations, retention of the multi-disciplinary format begs the question of whether the means have resolved this uncertainty, and helped to redefine 'development'. To contend that a resolution is impossible, as some might do with a suitably post-modernist flourish, misses the point. Uncertainty about development plans will always prevail, to some degree. Uncertainty about research methodology, in contrast, is the opportunity for integration of the bio-physical and social sciences. Initial engagements between bio-physical and social scientists may be acrimonious, as challenges are made against premises such as the distinction between 'nature' and 'society', and for substantive formulation of positions such as the view that all organisms are both agents and subjects of ecological processes. That engagement is happening nonetheless, but tracing the theoretical and philosophical threads is another story (Davis, 1996; Davies, 1995; Descola, 1992; Giddens, 1990; Ingold, 1992; Long, 1992).

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NOTES

1. *The Mercury*, 2nd October 1996.
2. The separation occurs at the highest levels of research organisation. The International Geosphere-Biosphere Programme and the World Climate Research Programme are bio-physical science projects which are linked to, but separate from the social science-based International Human Dimensions Programme.
3. These include financial support of the Ntshongweni Catchment Management Programme in Natal (WRC Project No K5/684), and an inter-disciplinary workshop on soil erosion (7-8th November 1995, Pretoria).
4. A detailed account of our analysis is presented in: Kiepiel, J and T Quinlan (1997).
5. The evaluator, I believe, is not beholden to the multi-disciplinary format; indeed, his report gave us space to pursue our line of argument.
6. A pertinent feature of this problem is lack of clarity on common concepts. 'Need', for example, is frequently cited in descriptions and analyses, but is rarely defined even in social science sub-projects, despite its use to justify Participatory Research, and critical assessment of the development agenda. The significance of this concept, and of 'value', is discussed in Kiepiel and Quinlan (1997).