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Embedded scales: interdisciplinary and institutional issues

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1. Sustainability as research and policy problem

Sustainability has over the past two decades developed as a widely recognised, higher-order social goal.[1] As such, sustainability has become a focus of attention for a variety of disciplines and other knowledge systems (eg. Indigenous, local, policy networks), manifested as a variety of more specifically defined policy problems, and become a matter of broader public debate. It is useful to consider sustainability as a higher-order social goal, as this encourages consideration of similar goals, and a clarification of reasonable expectations of progress given the nature of the task. The 'natural partners' of sustainability include democracy, the rule of law, justice, equity, and so on, and it is obvious that understanding of these, and significant advance on them in research and in policy, is a process that will operate over generational time scales at least (Connor and Dovers 2004). Only a little over a decade since the first coherent international statement of sustainability as a policy agenda (UN 1992), it should be expected that sustainability defined in this way will be contested, vague, and understood differently by different groups in society.

One area of different interpretations of and approaches to sustainability is across the wide range of disciplines and other knowledge systems that are engaging with sustainability problems. The great bulk of these knowledge systems were fundamentally shaped over periods when sustainability was not a prominent issue, or when dealing with multiple scale, long time frames or the integration of ecological, social and economic concerns was required. It can therefore be expected that, with respect to sustainability, most disciplines and knowledge systems will reflect an inadequate past rather than display a future-oriented competence.

Another area of difference in approaches to sustainability occurs within institutional systems and the range of organizations within these systems that have to deal with sustainability problems. As with knowledge systems, human institutions and organizations are largely prisoners of history, having been shaped over periods when sustainability and the integrative demands it presents were not considered important. Thus institutions will reflect past understanding, problems and imperatives rather than recent or emerging problems like sustainability. Moreover, different locations within institutional systems – for example government departments, the law, interest groups – will evidence different foundations in disciplines, professions and other ways of understanding the world. The groups and organizations that make policy and design management

[1] The differences between sustainability and sustainable development (and, in Australian policy and law, 'ecologically sustainable development') are acknowledged but not discussed here.

interventions in mixed human-natural systems, and decide what knowledge is needed to inform this endeavour, are deeply but sometimes not obviously linked to knowledge systems.

There is a crucial paradox here – previous and existing understanding (eg. disciplines) and institutional arrangements (eg. structures of governance) are the prime causes of sustainability problems, but are of course also the prime means of addressing these problems. That is, human culture has created ecologically unsustainable and humanly undesirable situations, but human culture is the only means by which we can address the problem (Boyden 1987). But this task should be recognized as supremely difficult and one that will take a long time. Enterprises such as the Millennium Assessment, and countless other large and small research and policy processes, are components of the effort intended to achieve a transition to more ecologically sustainable and humanly desirable societies.

The differences in understanding and approach by different disciplines, knowledge systems and institutions concern many dimensions of sustainability. One way of clarifying these aspects is to define the key *attributes of research and policy problems* in sustainability, which include (Dovers 1995; 1997):

- systemic problems causes, located deep in patterns of production and consumption, settlement and governance;
- expanded and variable spatial and temporal scales;
- pervasive uncertainty and poor information;
- irreversible and/or cumulative effects;
- complexity and connectivity within and across problems;
- participatory demands and needs; and
- poorly defined policy and property rights and responsibilities.

The focus of this paper is on one of these problem attributes: comprehending and dealing with broadened and variable spatial scales and extended and variable temporal scales operating and interacting within interdependent human-natural systems, and the way in which different disciplines, other knowledge systems and institutions engage with this.[2]

The inadequacy of disciplines and institutions is now widely recognized and much activity has and continues to address this situation – recent reviews are offered in Becker and Jahn (1999), Berkhout et al (2002), Page and Proops (2003) and Connor and Dovers (2004). However, issues of scale are not often engaged with explicitly or in an organized fashion in the literature, although there are exceptions in discussions of disciplinary difference (eg. Reboratti 1999) and in discussions of scale-oriented institutional issues such as subsidiarity (eg. Connor and Dovers 2004). Even in discussions of interdisciplinary challenges in a domain defined by a focus on scale such as landscape ecology, a critical focus on scale is either minimal or only implicit (eg.Tress et al 2003). As with other key dimensions of sustainability problems, better understanding of the different ways in which scale is understood and dealt with is necessary for improved research and policy responses to sustainability. Indeed, it has been proposed, in an analysis of the growing interdiscipline of environmental history, that scale and locale present a prime 'intersection' for interdisciplinary interaction and learning (Pawson and Dovers 2003).

This paper

In view of the situation as described above, this paper offers some observations on the differences in constructions of scale across disciplines and within institutional systems. In particular, it seeks to emphasise the difference between *apparent and embedded scale*; that is; beyond simply recognizing *what* scale a discipline or institution constructs and operates within, towards

[2] In this discussion, the term 'scale', unless otherwise specified, covers both spatial and temporal scale.

understanding *why* different but equally valid constructions of scale exist. It also suggests some avenues forward for those involved in sustainability research and policy. The paper is propositional rather than definitive, and is intended to clarify issues of scale in institutional and interdisciplinary domains and prompt discussion of these, rather than to resolve such issues. Part 2 of the paper summarily considers embedded scale in disciplines and knowledge systems, and Part 3 considers embedded scale in institutional systems. Part 4 briefly combines these two and identifies linkages between knowledge and institutional systems. Part 5 suggests some strategies for advancing understanding and responses to the issues identified.

2. Disciplines, knowledge systems and scale

Academic disciplines are by definition organized and perpetuated by a shared set of knowledge and beliefs. This applies also, although perhaps in less institutionalized and organized forms, to other knowledge systems including Indigenous, local and professional and to those shared within recognizable interest groups and policy communities. These sets of beliefs about the way the world works – or at least those parts of the world with the knowledge system is concerned – allow 'members' of the relevant group to communicate and organize their interventions in and judgements about the world. These sets of presumptions, assumptions, metaphors and explanations can be viewed as a multitude of competing or separate discourses (Dryzek 1997). Core to a disciplinary discourse are a mix of both highly apparent and far less visible or explicit 'epistemological commitments' (Schoenberger 2001). These define the parameters of a recognizable discipline. Sometimes, different disciplines have different fundamental understandings of the same phenomenon or process: for example, a neoclassical economist will have a different understanding of human motivation than, say, an cultural anthropologist or environmental psychologist. Sometimes, a discipline may have no knowledge, opinion or assumption about something with which another discipline is deeply concerned: for example, a political scientist would not think about how molecules form in the earth's atmosphere while an atmospheric chemist would, even if both are engaged with the issue of climate change.

When disciplines, and other knowledge systems, come into close proximity around a defined problem – in this case some aspect of sustainability - it is crucial that such epistemological commitments, or the assumptions defining theory and method, are made apparent and explained to members of other discourses. I would argue that scale is one area where most disciplines have a 'position', whether implicit or explicit, and where ensuring that the different constructions of scale and what those mean for how the problem will be approached need to be made apparent.[3] Such clarity is an essential part of the (currently imperfect) art and craft of interdisciplinarity.

It is impossible and moreover unnecessary at this point to survey the embedded or apparent scales in the large number of disciplines and knowledge systems pertinent to sustainability, so some illustrative examples will suffice.

Discipline/sub-discipline:	**Typical scales** (spatial, temporal)
Neoclassical economics:	- individual, household, firm, economy, trade - short term (months-years).
Ecology: a) ecosystem theory	a) ecosystem, longer term

[3] Other key areas around which disciplines might fruitfully gather for mutual explanation include the bases of human motivation, uncertainty and burdens of proof, and qualitative versus quantitative modes of description and analysis.

b) community ecologist	b) community, shorter term.
Law:	
a) common	a) legal tradition
b) statute	b) jurisdiction, enactment/repeal.
Psychology:	- individual, days-years.
Sociology, anthropology:	- group, years-decadal.
Chemistry:	- non-spatial, instantaneous.

Many of these examples will be obvious enough and would not be thought to require explication. However, some may not be obvious, particularly to members of another, perhaps distant, discipline. Especially important is the issue of accounting for *intra- as well as inter-disciplinary* variation, in scale and much else besides. While individuals or knowledge-defined groups will be aware of fractures and difference within their own discipline or knowledge system, there is a common tendency to assume homogeneity in others. Yet it is clear that, on scale as well as other things, significant variation occurs within any discipline. The examples of ecology and law in the table above illustrate. The choice of collaborator from another discipline is a crucial choice that will influence, if not determine, the problems defined, methods utilized, data gathered and conclusions reached. Yet it is common for one group – say natural scientists – to seek input from 'an economist', without realizing the implications of whether that economist is neoclassical, evolutionary, or ecological. And vice versa. (However, that is an improvement on and a finer resolution choice than the situation where a natural science group seeks a 'social scientist', or vice versa, without further specification!)

It is useful to delve a little further, to go beyond *what* scale is understood and influences the approach of a discipline or sub-discipline, and to explore *why* it is used. This is the issue of apparent scale versus underlying logic, or embedded scale. For genuine collaboration between disciplines and other knowledge systems, the underlying logic of the scale adopted or implied is just as important what that scale is. The following examples serve to illustrate.

Apparent scales (examples)	**Underlying logics (examples)**
Spatial:	
- individual, household, policy or industrial sector, locale, bioregion, catchment, sub-national, nation state, inter-governmental, regional, global.	- consumption, distribution of taxa, nutrient fluxes, jurisdictions, administration, legal competence, information availability, trade flows, transport systems and other infrastructure, international treaties and agreements.
Temporal:	
- instantaneous, hours, days, weeks, months, seasonal, annual, decadal, generational, geological.	- chemical reactions, half-lives, life cycles, flowering, agricultural production, human longevity and fertility, political mandate, profit reporting, tax cycles, memory, data relevance, evolution.

This very simple schema is a start toward a more thorough documentation that would aid communication across disciplines and knowledge systems. Such a detailed level of understanding is not a trivial undertaking, especially when multiplied across the many other matters, aside from scale, that each discipline should know about the others. However, genuine engagement between different ways of knowing the world demands nothing less.

One final comment on interdisciplinarity and understanding difference. One iteration of the elements of successful interdisciplinary endeavours includes the presence and application of a *critical capacity*, to allow not simply recognition of difference but also sharp inquiry into the underlying beliefs and construction of one's own or others' knowledge that determine such variations (Barnett et al 2003). It is the case that many disciplines, including economics and the natural sciences, do not have a tradition of critical analysis of the basis of and claims to knowledge, and this suggests that those disciplines in the social sciences and humanities with such a tradition should play an important role in bringing this to interdisciplinary projects (in a respectful and mutually informing manner, not a nihilistic, social constructionist one).

3. Institutions and scale

Humans interact and organize toward collective goals through complex settings of formal and informal institutions, and it is increasingly appreciated that sustainability represents a severe challenge to existing institutional arrangements. Institutions exist and operate over multiple scales. Properly, *institutions* should be construed as the deeper rules and regularized patterns underpinning societies, as distinct from *organizations* which manifest those deeper settings, and from variable *policy processes* and *management regimes* through which specific concerns are defined and addressed (generally, see Goodin 1996; for a discussion of the terminology and a conceptual framework for comprehending institutional change, see Connor and Dovers 2004). Also, it is unhelpful to regard institutions as singular, even when a particular institution (eg. the common law) is obvious and important, but rather we should recognize complex, multi-scale, hierarchical *institutional systems*, which although more difficult to describe and analyse is a more realistic interpretation of contemporary reality.

Important institutions change for the most part unevenly and slowly, although there are revolutionary exceptions. More ephemeral organizations and even more ephemeral policies change more often and substantially. As with disciplines and other knowedge systems, institutional systems and important components within them by definition reflect past rather than present imperatives and understanding, and represent at once a barrier to enhancing sustainability and the primary means of doing so.

Along with many other attributes of institutions, the spatial and temporal scales over which they operate, and which they recognize, are both variable and likely to be at odds with the scales over which sustainability problems operate. Existing institutions are historically defined, path-dependent phenomena, and key attributes of them (scale, mandate, issue focus, etc) are therefore also historically defined. This is obvious, and is the driver of scale-oriented policy and management changes seeking to extend understanding and action to spatial scales such as landscape, catchment and ecosystem, across political and administrative borders, and over longer time horizons. Most of these efforts, though, are within the realm of simpler (and easier) organisational or policy change rather than attending the more resilient and influential underlying institutional structures. For example, overlaying a whole-of-catchment management layer on political boundaries may enhance scale-relevant management to some degree, but is a minor adjustment to the profound inconsistencies between natural processes and human-environment

interactions on the one hand and inherited political and administrative boundaries on the other. It must be recognized, however, that one spatial logic, such as the catchment for dealing with water and salinity, makes little sense in terms of other societal concerns such as community development, economic planning, education, much biodiversity or infrastructure provision. It is important to recognize that one spatial or temporal logic can never serve to integrate more than only a few societal concerns, and that multiple scales of policy and management, and thus of institutional and knowledge systems, are an absolute necessity even if more difficult to do. The world is not neat and simple, and thus neither the knowledge or institutional answers to complex problems, or the scales which these express, can be neat or simple.

As with knowledge systems, it is necessary to clearly recognize the multiple scales over which different components of institutional system operate, and to make more apparent the basis or logic underlying these scales. One cursory example can illustrate the multiple scales at which different elements of the institutional systems within which a resource management problem will exist, using fisheries as an example:

Scale of concern:	**Institutions/organizations (examples):**
Fisher:	Family, bank, village elders, local co-operative, marketer.
Village/community:	Fisheries department office, co-operative, social networks, nearby villages, other resource users (eg. tourist industry).
Region/ecosystem:	Fisheries, conservation and trade departments (provincial), other resource industries.
Nation state:	Provincial and national agencies, parliaments, Courts, constitution, NGOs, neighbouring states.
International:	Other nation states, multi-lateral organizations, international instruments, NGOs.

Such a scheme could be developed more accurately and at a finer resolution for this example and any other resource issues. To complicate matters, the scales evident in the institutional setting for one societal concern (say, fisheries) will be different from those for other concerns (say, transport or education), and the agendas of people at any scale, from community through to national parliament, will include multiple issues of concern and multiple interactions between a number of different institutional scale complexes. And, such 'mapping' would need to be done in each context, as the institutional system even in one jurisdiction will vary across specific settings and issues. Behind each institutional and organization scale lies an underlying logic (eg. mandate, legal competence, substantive issue), recognition of which is important even if the logic is so embedded as to be irremovable and clashes with sustainability imperatives.

It should be recognized that the embedded scales of formal institutions (eg. government, law, international instruments) are likely to be more easily comprehended and described than those of informal institutions such as social networks, or interest coalitions working through NGOs. For example, much rhetoric about 'community' in resource management implies or states this at a simple local spatial scale. However, in natural resource utilization and conservation, community

or social institutions typically operate at multiple and not always 'local' scales, expressing logics including kinship, informal trade, reciprocal use arrangements, and so on. Also, relevant local knowledge is not restricted to only (spatially) local matters. Local knowledge and perceptions of national politics or global phenomena may be highly influential in both local resource use and prospects for local institutional change.

While the realities of institutional change may well mean that rapid or significant change will be difficult, understanding embedded scales in institutions is a prerequisite for constructing and implementing even minor positive changes. This represents a task which demands multiple perspectives and thus knowledge systems to be brought to bear in any given situation, as it is certainly the case that comprehending and analyzing complex human institutions demands skills and methods not to be found in any single discipline. For a start, non-policy oriented disciplines, such as most natural sciences, do not have any great purchase on institutional issues, and even strongly policy oriented disciplines, such as economics, law or public administration, have purchase on only limited aspects. As was recognized earlier, the historically-defined inadequacies of such policy and institutionally-oriented disciplines with respect to sustainability need to be recognized, to prompt critical evaluation of their underlying assumptions by themselves, and by disciplines such as ecology or hydrology which have purchase on important natural processes which current institutional arrangements handle poorly. Moreover, especially when informal and local institutions are important – as they are in issues addressed by the Millennium Assessment – disciplines such as anthropology and history, and other knowledge systems such as Indigenous and local, become important perspectives. This linkage between knowledge systems and institutions is discussed briefly in the next part of the paper.

4. Knowledge, institutions and scale

Parts 2 and 3 above indicate the often not instantly apparent complexity of embedded scale across and within, firstly, the disciplines and knowledge systems relevant to understanding sustainability problems and, secondly, institutional systems through which policy responses to these problems will be conceived and executed. This part in a very summary fashion considers the implications of bringing together these two, and the interdependence of knowledge systems and institutions.

Comprehending multiple and variable scales in knowledge systems and in institutional systems present significant and important intellectual and practical challenges separately, but together produce an enlarged degree of complexity and difficulty. The necessary mapping and analysis of institutional scales will require multiple disciplinary and knowledge perspectives, and the mapping task is likely to lead to the recognition of additional perspectives required for accurate mapping and for ensuing analysis and prescription.

The linkages between knowledge and institutional systems go deeper than this. Formal disciplines are institutions in their own right, and other knowledge systems can be viewed as more formal (eg. the knowledge systems and discourses of professions) or less formal institutions (eg. local knowledge systems). The organization and boundaries of knowledge systems are *institutionally defined*, but are at the same time *determinants of institutions* through the role of knowledge and perception in shaping our interactions with human and natural systems. Important institutions are determined by and continue to determine knowledge systems – for example, the theory and practice of law. Powerful organizations reflect particular ways of knowing the world and thus ways of intervening in the world through policy prescriptions: the case of the influence of neoclassical economic thought in central government agencies and the resultant market-oriented policy fashions in many countries over the last two decades is an obvious example (eg. Castles 1989; Dovers and Gullett 1999). In the fisheries case touched upon above, discipline-defined understandings have influenced the key policy positions in fisheries debates, with a bio-economic

perspective on the one hand and social anthropology and local interest perspectives on the other defining very different positions on issues of sector restructuring and the introduction of individual transferable quota (Connor and Dovers 2004, Chapter 7). The 'epistemological commitments' of disciplines are expressed (often only implicitly) not only in the academic literature but through policy and management organizations as well.

At a more obvious level, components of the institutional system in any given situation define the knowledge that is valued in decision making, and thus the disciplines and embedded scales that are admitted or encouraged to contribute to policy debate and formulation. Those who define the parameters of a research exercise – whether locally, nationally or internationally – will at the same time be deciding what disciplinary and other knowledge is required, and thus the scales that are addressed. The decision to include some knowledge and not others may be unwitting and well-intentioned, or it may be more deliberate – policy agencies often seek input from advisers or consultants based on concordance with the agencies own intellectual leaning and political agenda. Equally obvious is the role of powerful research funding bodies in recognizing or encouraging some disciplines or styles of research over others, such as traditional discipline-defined research funding schemes that have difficulty handling interdisciplinary research proposals. The linkages between institutions and knowledge are deep and pervasive, even if at times somewhat opaque.

All this instructs that the incorporation or at least recognition of multiple perspectives on knowledge and scale must be at the stage of *problem definition and research design*, not added later once the parameters of research and the trajectory of the program have been perhaps irrevocably set. The contribution of some disciplines may be minor and brief, but nonetheless very important. A natural science project on resource use, for example, may only require some early imput from a relevant social science in the design phase so that the eventual results are relevant to social or policy dimensions. Alternatively, social scientists exploring resource allocation alternatives may need only occasional input from relevant natural scientist to ensure relevance and accurate description of the biophysical system. In other cases, the interactions will need to continue in a close fashion throughout. Multiple strategies are required, to be chosen by reference to the problem at hand rather than by reference to a favoured option, be that option a research method or a policy or institutional response. Again, the world is not neat, simple or certain, and thus our responses nee to be varied and uncertain.

A final issue concerning the interaction between knowledge and institutions is that of ongoing policy and management learning relevant to sustainable development. In the face of complexity and uncertainty – two key attributes of policy problems in sustainability – our current and planned interventions and actions should be construed as experiments, in the manner of 'adaptive' management regimes, policy processes and institutions (eg. Dovers and Mobbs 1997; Dovers and Wild River 2003). Experiments cannot be ensured of succeeding, and learning from both successes and failures and from the more common mixture of the two is imperative. Yet policy learning even in traditional public policy processes is neither a well-understood or properly practiced art and craft (May 1992), and learning across scales and disciplines and resource management contexts is particularly hard (Connor and Dovers 2004). Across the world, countless scattered and unconnected 'experiments' in resource management and sustainable development exist, and both the disciplines and knowledge systems involved and the institutional settings in which the experiments occur shape the possibilities for accruing understanding. These possibilities are defined by outlets available for publication and communication, inclusion or exclusion of different individuals and groups, language, perceived relevance of other studies and management activities, resources, and so on. Some experiments are highly localized or specific and the results and lessons are available to a very limited number of people, even though they may be of relevance and interest to other discrete experiments. In other cases, such as the MA, there are processes for connecting disparate activities with a large endeavour. Yet even across

well-known, large and well-organised programs, communication and learning may be limited. Despite the promises of an interconnected information world, there is great scope for better communication and connection, and this presents a challenge both to disciplines and knowledge systems, and the institutions that enable and shape research and policy and management.

5. Avenues forward

This part of the paper suggests avenues for further attention to the issues of scale across and within knowledge and institutional systems that have been identified and discussed above. It is apparent that rapid advance at an overall level, and certainly toward any 'meta-theory' or overarching methodological approach (a probable impossibility anyway) will be very slow. However, with adjustment to existing programs of research and policy, and modest investments in additional activities, considerable advances might be made at more tractable levels. The following arise from the discussion above, and are presented for discussion and further development:

- The task of *making explicit embedded scales* in knowledge systems, with respect to both natural systems and social and institutional systems, is a first step. In interdisciplinary interactions, such clarification and explanation should be part of the problem-definition and research/policy design phases, not as add-ons later, as embedded scale (and any other hidden theoretical or methodological assumption) will influence the questions asked, the data gathered, and the findings reached. This task applies to *intra-disciplinary* variations in constructions of scale as well as between disciplines. This clarification task is applicable in a number of contexts: in small scale interdisciplinary collaborations, large research projects, research programs, organisations, and policy processes and management regimes. In particular, this needs to be evident and widely accessible in the literature through increasingly available explanatory and analytical reviews of disciplinary positions on and contributions to thinking about sustainability.
- In any research or policy project, it may be useful to undertake an explicit process of *'mapping' the multiple, formal and informal scales* discernible within the management, policy and institutional context (whether graphically, in text or through modelling) (whether graphically, in text or through modelling), and linking these to the multiple scales within the knowledge systems most relevant to the project.
- Once embedded scales are rendered explicit, *analysis of the underlying logic and usefulness of different constructions of scale* that are being brought to bear on a specific question is required. The style of this analysis will be shaped by a balance between a necessary sharp and critical stance on the one hand, and an appreciation of difference and multiple valid interpretations on the other. The practical strategies for such analysis will vary according to context and opportunity – through insertion in existing or planned collaborative efforts, in problem definition in policy making, through joint conferences and other meetings, and so on.
- There is scope to identify *particular foci for research and policy discussion*, where different constructions of scale can be explored in detail, and with reference to important aspects of sustainability. An example is the governance concept of *subsidiarity*, a notion inseparable from issues of scale which has been defined and discussed especially in European policy communities but which underlies many debates over modern governance and public administration (see, for example, Connor and Dovers 2004). Subsidiarity instructs that decision making and functional competence should be placed at the lowest appropriate level within modern complex, hierarchical systems of

governance (not, as some neo-liberalists would have it, simply the lowest level possible). Largely, debates over this concept are informed by policy-relevant disciplines such as law, political science and public policy, however the application of subsidiarity to sustainability problems begs the input of various natural and other social sciences and indeed the humanities, all of whom bring critical understanding (and different constructions of scale) pertinent to the nature of sustainability problems.

- Whether around such a particular foci in a generic sense, or whether defined by the relevant problems in a specific research or policy exercise, *theoretical and methodological development* to reconcile different constructions of scale. A useful scoping stage across the sustainability domain in this sense would be to describe, analyse and perhaps consolidate relevant approaches developed or proposed within existing interdisciplinary domains ('interdisciplines') concerned with sustainability including ecological economics, integrated environmental assessment, landscape ecology, environmental history, human ecology, political ecology and green social theory. Theoretical and methodological development may seek to produce a range of outcomes, including conceptual frameworks, formal models, policy principles or prescriptions, or integrated assessment methods. However, it should be accepted that multiple, valid theoretical and methodological tools will exist, and the further challenge is to improve understanding of which approach is best suited to a specific task and set of circumstances – filling and perfecting a toolkit rather than seeking the singularly best tool.
- Given the complexity and uncertainty associated with sustainability problems and our responses to them, including scale aspects, attention needs to be given to *connecting many, disparate inquiries and experiments*, at and across scales, to create a larger and more coherent body of knowledge and of policy and institutional options. For example, the improvements in fine resolution understanding arising from the Millennium Assessment process offers a basis for developing broader insights, but this requires additional efforts and resources in consolidation and synthesis, informed by a recognition of the issue of transferability of findings across research projects, and especially across political, cultural and institutional contexts.
- In applied research and any policy- or management-oriented activity, imposition of of a requirement for clearly *differentiating the differences between proposed/possible scales of institutions and governance*, based on the 'realities' of ecological or social factors and processes, *and existing/probable ones* based on the equally valid (even if sometimes regrettable) 'realities' of political or legal competence, administrative boundaries or economic structures. For example, catchment, eco-region or culturally-based scales of resource management or even governance may be preferable to existing jurisdictional arrangements to better address some aspects of sustainability, but perhaps not for others and, besides, institutional reform may present significant barriers and other options may be more fruitfully explored. That is, while a full range of options for institutional reform, including spatial and/or temporal scale aspects, should be generated from investigations, the practicalities of implementation should be considered.

These strategies, if sufficiently supported and pursued, should improve our understanding of scale issues, as well as the purchase of research endeavours on sustainability problems, and the efficacy of management, policy and institutional prescriptions. Other strategies doubtless exist and should be proposed and explored. While rapid advance is unlikely, and singular theoretical or methodological 'fixes' certainly impossible, much of the above is more in the nature of communication, clarity and 'adding value' to existing or easily obtainable understanding through integration and synthesis, and as such is achievable. Underlying all these recommendations, and all the issues raised in this paper, is a simple rule: be clear about scale, and take scale seriously.

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