COMMUNICATION SUPPORT FOR SUSTAINABLE NATURAL RESOURCE MANAGEMENT

Niels Röling

1 THREE PERSPECTIVES

When it comes to getting things done in terms of sustainable Natural Resource Management (NRM), different perspectives can guide one's actions. This article first considers the dominant perspective of the bio-physical scientist. It then looks at the economist's perspective which focuses on the generalizations that emerge from studying the rational decisions of large numbers of people. Finally, it introduces the social actor perspective, which emphasizes that people are intentional sense makers, who hold diverse and conflicting objectives, socially construct their realities and negotiate for advantage, accomodate interests and sometimes reach consensus. The social actor perspective is the point of departure for professionals involved in the paradox of inducing voluntary change through communication.

1.1 The dominant perspective of the bio-physical scientist

The dominant perspective assumes a reality which exists independently from the human observer. A typical example is the definition of a system as 'a part of reality with clearly defined boundaries'. In this perspective, a model is a construct of an existing system (Rabbinge in Röling, in press). For us, the system itself is a construct. In other words, the bio-physical scientist assumes that there is a difference between (1) reality where laws of nature apply, and (2) the models to test and understand such laws. A typical example is Newton's Law of Gravity which holds whereever bodies with mass interact, and the model to test it: the apple falling from the tree. We would say, of course, that in the unfolding history of the flux of events and ideas (Vickers in Checkland and Casars 1986) an event (the falling apple) triggered the construction of a very helpful law (idea) which allows us to predict other events much better than before and to make more sense of our domain of existence.

The dominant view holds further that by using scientific methods, it is possible to create true knowledge. Through our senses, reality can imprint itself on the mind. Thus it is possible to build a representative picture of it. The role of social factors in building knowledge is irrelevant. Of course, selective perception and other psychological parlour topics are well known, but they do not affect the basic perspective. A scientist can also make a 'human' error, say (s)he drops a petri dish because (s)he suddenly thinks of the director of the lab who has published the scientist's results without acknowledgement. But that has nothing to do with the fundamental point of departure: through the senses, reality is reflected in the mind.

Bio-physical scientists 'dis-cover', 'unveil', or 'lay bare' the truth. In Dutch, the word truth, *waarheid*, is feminine. A romantic metaphor suggests itself to the Dutchman. Truth is a beauty sleeping in the forest. The scientist is a wandering knight who finds her. He lifts the veil, and lays bare her secrets. Nowadays one would speak of an undesirable intimacy. But given that the scientist is a knight, he gets away with it, of course.

The scientist uses law-like generalizations to build representations of the world. We call them models. In recent years, computer simulation techniques have allowed the development of inter-disciplinary models of great power. These models are very useful for NRM. One can calculate the consequences of alternative decisions. These 'scenarios' make visible the consequences of different choices for the same natural resource. This type of modelling is applied widely and has gained much status. In the Netherlands, it is a favourite tool of the Scientific Council for Government Policy. The models provide objective truths for politicians.

In actual fact, the models only provide a partial perspective, of course. A typical example is a model study to calculate the ability of the world to produce the food we need. It takes into account such aspects as available soil resources, water, energy transformation potential, etc. In West Africa, high potential areas for food production can be identified, with excellent soils, water availability etc. But let us now apply a different, economic, perspective. The high

potential areas are likely to be densily populated. Farm sizes are becoming smaller as are the surpluses which families can sell on the market. This means that the farmers cannot afford the fertilizers required to effectively use highly responsive varieties. From a different perspective, a bread basket thus becomes a food deficit area.

People do not feature in the bio-physical models. They are a n end-of-pipe problem: after scientists have determined what should or could happen, it is left to politicians and others to use instruments to make it happen. How they do it is not the concern of the scientist. In the scientist's perspective, communication for development has the function of transferring scientific discoveries and technology (= applied science in this view) to users. Given our focus on NRM, the position of ecology as a science deserves special mention. Ecology explicity and by definition incorporates the use which people make of the eco-system. But ecology does not try to understand why people make such use of their bio-tope. In that sense it is still a bio-physical science. Later on (Figure 1) we shall present an effort to incorporate both the bio-physical and the social actor perspective in one paradigm.

1.2 Taking a constructivist perspective

In the past, truth was revealed. God spoke through the burning bush. Later, truth was discovered, as we have seen. In the past 25 years, we have increasingly come to realize that what we call truth or reality is constructed in social interaction. There are multiple realities. Biological research of the observing organism has shown that projection of the environment on the nervous system through the senses is impossible (Maturana and Varela 1987; 1992).

If we believe in one absolute truth, disagreement can only mean negation. If there are multiple realities, disagreement means negotiation, accomodation, learning, and the ability to reconstruct someone else's reality (Maturana no date).

In the constructivist perspective, scientific knowledge is also constructed (e.g., Knorr Cetina 1981; Collins 1985,1992). Typical is the recent failure of the US Supreme Court to establish once and for all the criteria for what is scientific and what is not. What is scientific depends on agreement between a group of people who have been given the power, or have taken it, to determine what is scientific. If any rules are applied, these are the result of negotiation and history .

Constructivism is exemplified by our three perspectives. We already discussed what guides the bio-physical scientist's design for action. The second perspective is the **economic** one. In this perspective, people are of central interest, but they are assumed to have an in-built objective: to optimize utility. Once you have assumed that, you do not need to worry anymore about the what or the why. You can start working on the how and focus on designing goal seeking policies, measures, and devices. In other words, both the scientific and economic perspectives get results by assuming objectives. In that sense, scientists and economists can be said to engage in 'hard systems thinking' (Checkland 1981).

The third, **social actor perspective** (e.g. Long and Long 1992; Leeuwis 1993) does not do this. In fact, it only assumes that people or groups are social actors who are intentional, construct their realities, and can exert 'agency', i.e., make a difference in the world. No other assumptions are made. What is of interest is to study with an open mind what actors actually do.

By emphasizing intentionality, instead of assuming objectives, the social actor perspective pays up-front attention to the diversity of conflicting goals, attitudes, values, aspirations, and standards. Given this diversity, the emphasis is on the arenas in which actors struggle, negotiate, accomodate and sometimes agree to increase the level of social aggregation at which agency can be exerted.

The social actor perspective also studies how actors create different and multiple realities or life worlds, and how these are maintained or adapted in social interaction.

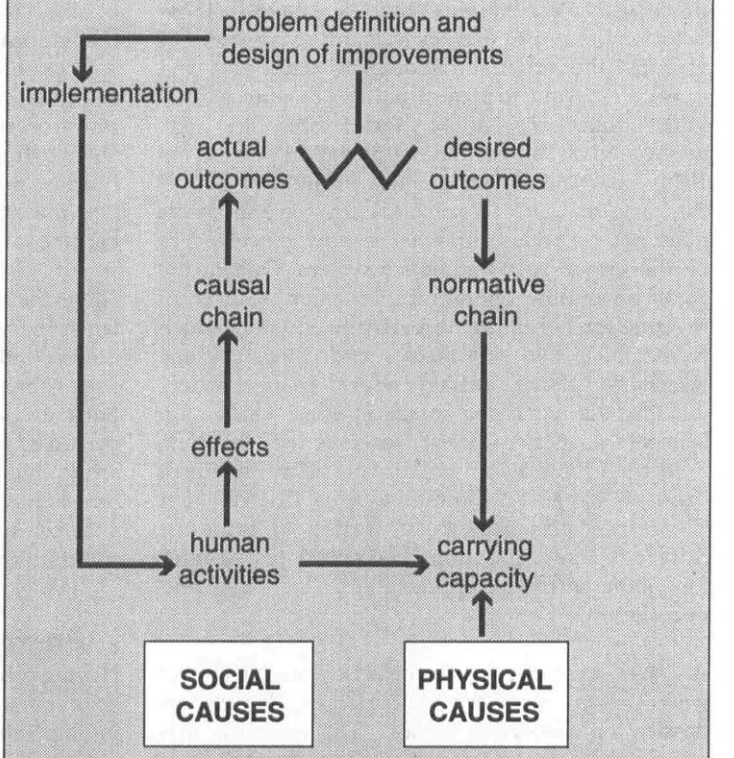
A typical example of the difference between the social actor and the two other perspectives is provided by the English settlers in Western Australia. They live like county squires and grow wheat and sheep. Thus they realized a dominant ideal of nineteenth century England and recreated a familiar reality, notwithstanding the fact that the Mediterranean climate and fragile eco-system could have better been exploited by another farming system (scientist's perspective) or that primary production is not as lucrative as adding value (economic perspective).

In concluding this section on the three perspectives, it is important to reiterate that they are complementary. It is not scientific or economic knowledge per se that is useless, but rather that uni-disciplinary perspectives, hard systems thinking, etc., cannot accommodate the multiple dimensions of NRM. Hence our emphasis on the social actor perspective which is usually neglected. But bio-physical science and economics have vital roles to play in getting out of the human predicament.

2 SOCIAL ACTORS AND NRM

For many years, communication professionals focused on transfer of technology, including the diffusion of innovations. That is, they basically took the perspective of the bio-physical scientist and became professionals in promoting the utilization of scientific knowledge. From a point of view of sustainable NRM, there is merit in this. By communicating scientific results, for example by making visible the progressive degradation of eco-systems, such transfer can have a powerful influence by providing arguments for social actors to reconstruct reality, to renegotiate desirable futures, and adapt wants to feasible gains.

FIGURE 1: PROBLEM-IN-CONTEXT APPROACH TO NRM PROBLEMS



Adapted from W. de Groot 1992

However, a self-imposed limitation to transferring scientific knowledge makes the professional communicator miss many opportunities for voluntary change towards more sustainable NRM. Let us look at some typical aspects of the human use of natural resources.

2.1 NRM as a social process

NRM problems are commonly seen as belonging to the area of expertise of ecologists, climatologists, hydrologists, limnologists, biologists, and so forth. This is remarkable. NRM problems are always perceived and caused by people. A problem is a difference between wants and gains, i.e., between an intended or desirable outcome and a perceived (constructed) actual outcome. In the case of NRM problems, the actual outcome in the equation is always the result of human activity which has undesirable consequences. And action to improve natural resource use is the translation of desirable outcomes into criteria, standards and eventually designs. Based on this reasoning, de Groot (1992) has developed a 'problem-in-context' model for environmental science which is a break-through in the sense that it gives a clear place to the role of the social actor in sustainable NRM issues (Figure 1).

The problem-in-context model makes clear that the design of improvements and their implementation requires intervention in the social causes to stay within the (normatively established) carrying capacity of the natural resources.

2.2 Conflicting interests

When NRM is a problem, it is because the resource is over-exploited for often conflicting human purposes. Take Yellowstone Park, a powerful symbol of wilderness guided by the invisible

hand of Nature (Keiter and Boyce 1991). The Park is visited by 3.5 million people every year, making humans the most significant species in the Park. Accomodating them clearly interferes with 'natural processes'. Park staff are divided between those who want to optimize the learning experiences of visitors (the original mandate of the Park) and those who want to protect natural resources. It is Park policy to allow forest fires to rage unchecked as a 'natural' rejuvenation process. In 1988, a particularly serious fire brought to a head the fact that the Park area in several ways does not coincide with what is now perceived to be the larger Yellowstone eco-system. Outside the Park, tin mining operations, a major source of revenue for Wyoming, threaten the aquafers which feed the 'Old Faithful' and other geysers. Ranchers blame buffalo which roam widely outside the Park for infecting their cattle with brucellosis. Major forest reserves of the State Forestry Commission are threatened by the forest fires. A 'Greater Yellowstone Area Coordination Committee' has now been created to bring the different interdependent stakeholders together for joint problem appreciation, learning and negotiation.

Another example is provided by subterranean water resources in the Netherlands. Holland is dessicating, believe it or not. The reason is that ground water is depleted more rapidly than it is replenished. Drinking water companies, farmers, industries and private citizens each pump away unchecked, without consulting each other, and without adapting use to available supplies. The consequences are many, such as the drying out of natural wetlands and stream beds, die-back of forests, increasing expenses in exploiting ground water resources, and reduced ability to resist infiltration of saline water. There is a clear realization that what is lacking is a mechanism for integral decision-making about ground water. In the Netherlands, thought typically turns to some expert authority to handle the problem, a different approach from creating a co-ordination committee or other platform of stakeholders.[1]

Such examples show that different social actors, bent on pursuing their own 'projects' to satisfy their own interests, misuse the available resources. The use each makes of the natural resource affects the ability of others to satisfy their needs. The stake holders in the natural resource are therefore inter-dependent. And as natural resources become scarcer, this inter-dependence becomes greater. In the end, natural resource management problems ('sustainability') always translate into social problems, involving conflict, power, and struggle. It is only when they become social problems that sustainable NRM becomes an issue.

Given the basic social nature of environmental problems, the very stuff of sustainable NRM becomes accomodation between conflicting interests, 'land use negotiation' (Brinkman, in press) between positions of power, accomodation between different perceived realities, and agreement about uses which are in line with the perceived carrying capacity of the natural resources under dispute. Such an analysis suggests new roles for the professional communicator.[2]

3 STRATEGIES FOR VOLUNTARY CHANGE

Having roughly sketched what we 'see' with a social actor perspective, we shall now try to draw the implications for the professional communicator by outlining some of the strategies for voluntary change that are suggested by the perspective. We begin with conditions for sustainable NRM.

3.1 The conditions for sustainable NRM

We have seen how NRM problems emerge when they become social problems, when the stake holders in the natural resource become inter-dependent, leading to scarcity (and hence to resource exhaustion and degradation), poverty, and conflict.

This suggests an important condition for sustainable NRM: the natural resources perceived to be a problem must be managed as one whole. Two approaches can be taken to improve the problem situation: (1) the stakeholders form a platform for integral decision-making (e.g. the Greater Yellowstone Area

[1] See also E. Ostrom, 1990, **Governing the Commons: The Evolution of Institutions for Collective Action**, Cambridge University Press, Cambridge, for a discussion of very similar problems in the U.S.A.

[2] The interested reader is referred here to the substantial theoretical and case study literature on the management of common property resources including discussion of the 'Tragedy of the commons', 'The prisoner's dilemma', 'The assurance problem' and 'The property rights' approaches to non-exclusive goods. This literature is reviewed in Ostrom E., 1990, and Lane, C. and Moorehead, R., 1993 'New directions in natural rangeland resource tenure and policy', **Discussion Paper** IIED London.

Coordination Committee), (2) some expert authority is empowered to manage the natural resource (e.g. the solution being contemplated in the Netherlands to solve ground water depletion). In both instances, the natural resource can be defined at different system levels of aggregation. At each, a concomitant platform or authority is required. Some examples might clarify this crucial issue of levels.

At the farm level, sustainable management means that the farmer begins to manage the farm as an agro-ecosystem. Instead of growing individual crops, the farmer manages the rotation and optimizes fertility management across crops. Nutrient losses are minimized by recycling wastes and by optimizing resource flows between animal and plant production. Suitable biotopes for natural enemies of pests are created deliberately. Run-off and erosion are controlled by planting contours and creating terraces. The 'platform' in this case is the invidual farmer or household who must carefully balance time inputs and outputs, wants and gains, household needs and the carrying capacity of the resources available. A typical authority at the farm level is the Dutch Government which will make mineral bookeeping compulsory in 1996 as a basis for raising levies on the quantity of minerals released in the environment.

It is not difficult to see that the farm level often does not provide sufficient control for sustainable NRM. Erosion, salination, drainage, pest control, free range grazing, the use of common land, etc., nearly always require platforms for decision-making and/or authorities at a higher level of aggregation if the resource is to be managed in a sustainable manner. 'Platforms' involve meetings of farmers who perceive the same problem, realize their interdependence for solving it, and come together to agree. Such agreement involves giving up some autonomy for the advantages of belonging to a collective. Hence platforms give rise to social dilemmas and fear of free riders (Messick and Brewer 1983). A typical example of such farmer platforms are groups of Indonesian rice farmers who work together to combat rats (van de Fliert, *et al.* 1993).

At still higher levels of system aggregation, one can think of water catchment areas, irrigation schemes, polders, valleys and so forth. One interesting combination of platform and authority to deal with problematic NRM at such higher levels are the Land Care Committees established in Australia to combat erosion and salination (Campbell 1992). These committees are vested by law with statutory powers and can, therefore, handle 'the big stick' to bring recalcitrant land users into line, if necessary. But Land Care Committees are made up of locally respected people and typically focus on creating platforms to renegotiate land use in a given catchment or other resource system.

At a global level, the need to make integral decisions about the world's oceans, air, ozone layer, CO^2 levels and absorption capacity, and biodiversity has become obvious since UNCED, the UN Conference on Environment and Development held in Rio de Janiero in 1992. That such integral decision-making directly affects the equity of access to resources is exemplified by George Bush's remark during that conference: 'The US way of life is not negotiable'.

Having sketched the conditions for sustainable natural resource management, we now briefly look at three communication strategies for improving the sustainability of NRM.

3.2 Making things visible

The first strategy, making things visible, comes close to the transfer strategy we have discussed earlier as part of the bio-physical science perspective. But there is a difference if one anticipates the intentional sense maker, as one is compelled to do by the social actor perspective. In this perspective, scientists construct realities. Their contribution is not to add to the body of knowledge but to create fresh perspectives (Bohm 1993). These perspectives re-enter society and are used in the construction of reality by social actors. Giddens (in Leeuwis 1993) calls this the 'double hermeneutic'. Whether scientists think the earth turns around the sun or vice versa does not affect the behaviour of these celestial bodies. But realities constructed by social actors can affect realities of other social actors and hence their activities. This is the basic mechanism by which professional communicators can make a difference.

From this point of view, communication of the realities constructed by bio-physical scientists about natural resources and the way human activity affects them is of vital importance for NRM. Making visible the effects of human activity is a necessary, but alas not sufficient, condition for sustainable NRM. 'Silent Spring' is still the classic example. The importance of making things visible is underlined by the relentless struggle of actors with interests in a natural resource to resist acceptance of results of scientific

work about their impact on the resource. Instead of 'transfer', making things visible is a highly political activity, which must be carried out with great attention to strategic anticipation. This involves credibility of the source, procedures which are commonly accepted as 'scientific', the deft use of social pressure and public opinion, avoiding 'capture' by environmental radicals with low credibility, and so forth.

Even then, it may take years for the unsustainable use of a given natural resource to become a social fact and a public issue. Such time lags might well be an important threat to human survival. We seem to know fairly little about the process by which scientific work with respect to NRM becomes common knowledge and a base for political action, let alone that we know how to accelerate that process.

3.3 Fostering policy acceptance

As we have seen, one approach to sustainable NRM is to create a legal body with resources to acquire expertise and with power to enact regulation of behaviour on behalf of the body politic. This approach is more favoured in countries such as Holland with a tradition of respect for civil authority than, for example, the US, where fear of litigation has made it more or less unworkable, and where the Environmental Protection Agency favours 'environmental dispute resolution' and other forms of direct negotation with stake holders (De Soet 1990).

Regulation is seldom effective in itself, unless it is accepted by the public or at least by the stake holders involved. It often is accepted because it removes fear of free riders and thereby creates space for activities which were considered desirable in the first place (van der Ley and Proost 1992).

Professional communicators focusing on policy acceptance look at communication as an instrument of policy (Aarts and van Woerkum 1993). Formerly, the notion of 'instrument' was taken seriously. Communicators were technical experts in how to get people where you want them. To this end, they carried out scientific (usually behaviouristic social psychological) research on the determinants of behaviour, and then devised media strategies to manipulate these determinants (Kok 1984). It stands to reason that persuasive advertising and political campaign techniques and marketing concepts played an important role in these efforts. Nowadays the approach is being adapted to take into account the social actor perspective, which leads to interest in emotion, argumentation, the construction of facts, etc. Instead of banging the public over the head with a blunt instrument called 'communication', the concept is shifting to fostering an interactive discourse between public and policy makers. But most money can still be made if communicators stay within conventional instrumental thinking and promise expertise in getting done what politicians desire.

3.4 Facilitating platform processes

Perhaps the most interesting communication strategy for promoting sustainable NRM is the facilitation of platform processes (Röling, in press). It is what one could call a 'participatory approach'. It focuses on creating and/or strengthening platforms of stakeholders in a threatened natural resource by creating 'rich pictures' of the diversity of interests and life worlds of the stake holders (e.g. van Beek 1991), fostering shared problem appreciation (Vickers in Checkland and Casar 1986), creating an information system about the natural resource for decision support, facilitating negotiation and accomodation between stake holders, increasing the system level of aggregation at which platforms function, etc. Typical methods used are Participatory Rapid Appraisal (PRA), non-formal education techniques, and soft system methodologies (Checkland and Scholes 1990). Facilitation of platform processes is increasingly being recognized as a crucial societal need. Examples include:

1 The rediscovery of common property resource management as an effective and suitable approach to sustainable NRM (McKean 1992);

2 The development of 'social fences', i.e., deploying local people who have a stake in protecting natural and agricultural resources, instead of (often badly equipped and paid) guards and electric fences, in a SIDA project in Andra Pradesh (Jiggins, in press);

3 The development of Participatory Technology Development (PTD) with local farmers as an approach to agricultural innovation in agro-ecosystems with great diversity and variability, high risk and complex farming systems (Jiggins and de Zeeuw 1992). PTD is also being applied in the context of sophisticated systems research into the development of sustainable alternatives to high input agriculture in the Netherlands. The input of farmers as complex system managers proves indispensable;

4 The redefinition of the evaluation of social programmes. The evaluation product is no longer seen as a set of conclusions, recommendations and value judgements, but rather as an agenda for negotiation on the requirements, concerns and issues remaining unsolved in a mutual exchange of ideas. Evaluation's function shifts from external measurement of effect, to raising awareness and mutual comprehension among interested parties (Abma 1993);

5 The development of alternative environmental conflict management or dispute resolution tools. Instead of elite decision-making by a higher authority who then 'sells' its decision or uses policy instruments to achieve compliance, environmental mediation in the US (embodied in EPA's Regulatory Negotiation Project) uses facilitators to discuss and negotiate with all parties about administrative measures until all agree or until a set period has lapsed (e.g. Susskind and Cruikshank 1987);

6 The creation of Landcare Groups in Australia. More than 3,000 of them (and many more sub-groups) now act as platforms for decision-making about threatened watersheds and other agro-ecosystems. The Australian approach has stirred world-wide interest, as has the use of facilitators to help Landcare groups become operational (Campbell 1992). Similar legislation has been enacted in the Netherlands ('ROM *gebieden*' or Spatial Planning and Environment areas) to deal with natural resource units subject to a multitude of conflicting claims with unsustainable consequences.

7 Water management associations in irrigation (e.g., Uphoff 1992);

8 Farmer Field Schools, a participatory non-formal learning approach effectively used for the introduction of integrated pest management in irrigated rice in Indonesia as part of FAO's Regional IPM Programme in South East Asia (van de Fliert 1993);

9 RAAKS, the Rapid Appraisal of Agricultural Knowledge Systems, a participatory tool developed to help stakeholders in 'theatres of agricultural innovation' to achieve synergy through collective knowledge management (Engel and Salomon 1993, Engel, forthcoming);

10 Soft Systems Methodology, an important generic approach for participatory development, originally developed in the corporate context (Checkland 1981; Checkland and Scholes 1990), and later applied to NRM (e.g. Bawden *et al.* 1991).

Although regulation and policy acceptance will probably continue to play their part in efforts to enhance the sustainability of NRM, it seems that facilitation of platform processes is gaining increased centrality in such efforts. A better understanding of platform processes and their facilitation seems an essential condition for improving NRM. One of these processes is information. Information is an essential prerequisite for platform building. The use to which information is put in NRM platform processes seems to have several dimensions: informing about increasing resource scarcity or pollution, advocacy, identifying common ground between different users and interest groups, feedback about the effects of collective action, etc. The multiple use of information is an important focus of platform facilitation.

4 A NEW COMMUNICATION PROFESSIONAL

Sustainable NRM gives rise to a new type of communication professional, whose skills have little to with 'exension'. He/she has a thorough grasp of the social actor perspective, and feels at home at the interface between the natural resources (which are the realm of bio-physical scientists), and the stake holders in those resources whose activities threaten their continued use. The new professional is thoroughly at ease in the management of the conflicts, social dilemmas, and opportunities for agreement that arise in the growing interdependence between different stake holders in the same natural resource. The new professionals operate within social, political and economic contexts. The problem they face is how to agree on goals within such a context, especially with respect to the dilemma in choosing between people's livelihoods and conservation.

Of course, the first job advertisement for a professional with a social actor perspective has yet to appear in the New Scientist and the other journals that pay attention to NRM. All we can do is to keep up the pressure. Do we need a new meta communication professional to help us do that effectively? It will certainly be quite a battle to gain recognition among those who presently consider NRM their fiefdom.

REFERENCES

Aarts, M.N.C. and van Woerkum C.M.J., 1993, **De integratie van communicatie en overheidsbeleid.** Wageningen: Agricultural University, Department of Communication and Innovation Studies

Abma, T.,1993, **Beyond the Technocratic Orientation to Evaluation.** Rotterdam: Erasmus University, Institute for Health Care Policy and Management, Faculty of Medicine and Health Services

Bawden, R.J. and Packam R., 1991, 'Systems praxis in the education of the agricultural systems practitioner', Richmond (NSW): University of Western Sidney-Hawkesbury. Paper presented at the 1991 Annual Meeting of the International Society for the Systems Sciences. Östersund, Sweden

van Beek, P., 1991, 'Using a workshop to create a rich picture: defusing the ponded pastures conflict in central Queensland', paper for the Workshop on Managing Complex Issues in Uncertain Environments: Systems Methodologies in Agriculture. Brisbane: Queensland Department of Primary Industries, 26-27 August

Bohm, D., 1993, 'Last words of a quantum heretic', interview with John Morgan, **New Scientist,** 137 (1862), 27 February: 42

Brinkman, R., forthcoming, 'Recent developments in land use planning'. Keynote address at the 75-year Anniversary Conference of the Wageningen Agricultural University. To be published in L.O. Fresco *et al.* (eds), **Future of the Land: Mobilizing and Integrating Knowledge for Land Use Options,** Chichester: John Wiley

Campbell, A., 1992, 'Taking the long view in tough times: Landcare in Australia', **Third Annual Report of the National Landcare Facilitator.** Canberra: National Soil Conservation Programme

Checkland, P., 1981, **Systems Thinking, Systems Practice,** Chichester: John Wiley

——and Casar, A., 1986, 'Vickers' concept of an appreciative system: a systemic account', **Journal of Applied Systems Analysis** No 13: 3-17.

——and Scholes, J., 1990, **Soft Systems Methodology in Action.** Chichester: John Wiley

Collins, H.M., 1985, 1992, **Changing Order: Replication and Induction in Scientific Practice,** Chicago: Chicago University Pres

Engel P. and Salomon, M., 1993, **RAAKS Manual: Rapid Appraisal of Agricultural Knowledge Systems,** Wageningen: Agricultural University, Department of Communication and Innovation Studies

Engel. P., forthcoming, **Knowledge Management in Agriculture: a Fundamental Requirement for Sustainable Development,** doctoral dissertation, Wageningen: Agricultural University

van de Fliert, E., 1993, 'Integrated pest management. Farmer field schools generate sustainable practices: a case study in Central Java evaluating IPM training', published doctoral dissertation, **WU Papers,** 93-3, Wageningen: Agricultural University

——, van Elsen K., and Nangsir Soenanto, F., 1993, 'Integrated Rat Management: A Community Activity. Results of a Pilot Programme in Indonesia', **FAO Plant Prot. Bulletin,** Vol 41No 3

de Groot, W.T., 1992, **Environmental Science Theory: concepts and methods in a one-world problem-oriented paradigm,** published doctoral dissertation, Amsterdam: ElsevierJiggins, J.L.S. , in press, **Changing the Boundaries: Womancentred Perspectives on Population and the Environment.** Washington (DC): Island Press

Jiggins, J.L.S. and de Zeeuw, H., 1992, 'Participatory technology development in practice: process and methods', in C. Reijntjes, B. Haverkort and A. Waters-Bayer (eds), **Farming for the Future: an introduction to low external input agriculture,** London: Macmillan and Leusden: ILEIA: 135-162

Keiter, R.B. and Boyce, M.S., 1991, **The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage.** Boston: Yale University Press

Knorr Cetina, K., 1981, **The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science,** Oxford: Pergamon Press

Kok, G.J., 1984, 'Gezondheidsmotivering. GVO als wetenschapsgebied', inaugural address, Maastricht: University of Limburg

Leeuwis, C., 1993, **Of Computers, Myths and Modelling. The social construction of diversity, knowledge, information and communication technologies in Dutch agriculture and agricultural extension,** published doctoral dissertation, Wageningen: Agricultural University. Wageningen Sociological Series

van der Ley, H.A. and Proost, M.D.C., 1992, 'Gewasbescherming met een toekomst: de visie van agrarische ondernemers: een doelgroepverkennend onderzoek ten behoeve van voorlichting', Wageningen: Agricultural University, Department of Communication and Innovation Studies

Long, N. and Long, A., (eds), 1992, **Battlefields of Knowledge: the interlocking of theory and practice in research and development,** London: Routledge

Maturana, H.R. (no date) 'Reality: the search for objectivity, or the quest for a compelling argument', Santiago: University of Chile, Faculty of Sciences

—— and Varela F.J., 1987, 1992, **The Tree of Knowledge, the biological roots of human understanding,** Boston, Mass.: Shambala Publications

McKean, M.A., 1992, 'Success on the commons. a comparative examination of institutions for common property resource managment', **Journal of Theoretical Politics** Vol 4 No3: 247-281

Messick, D.M. and Brewer, M.B., 1983, 'Solving social dimemmas: a review'. Chapter 1 in: L. Wheeler and P. Shaver, (eds) **Review of Personality and Psychology** 4: 11-44

Röling, N., forthcoming, 'Platforms for decision-making about eco-systems', Keynote address at the 75-year Anniversary Conference of the Wageningen Agricultural University. To be published in L.O.F. Fresco *et al.* (eds), **Future of the Land: Mobilizing and Integrating Knowledge for Land Use Options,** Chichester: John Wiley

de Soet, M.C., 1990, 'Omgaan met milieuconflicten in de besluitvorming: de consensusbenadering voor win/win uitkomsten', **Milieu** 1990/1: 8-13.

Susskind, L. and J. Cruikshank, 1987, **Breaking the Impasse. Consensual Approaches to Resolving Public Disputes,** MIT-Harvard Public Disputes Programme, New York: Basic Books

Uphoff, N., 1992, **Learning from Gal Oya. Possibilities for Participatory Development and Post-Newtonian Social Science,** Ithaca: Cornell University Press