Series on Science for Sustainable Development No. 4

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Science, Traditional Knowledge and Sustainable Development

ICSU Series on Science for Sustainable Development

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Science, Traditional Knowledge and Sustainable Development

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Preface

In addressing the goals of sustainable development, the role of science is crucial; scientific knowledge and appropriate technologies are central to resolving the economic, social and environmental problems that make current development paths unsustainable. However, science does not constitute the only form of knowledge, and closer links need to be established between science and other forms and systems of knowledge in addressing sustainable development issues and problems at the local level such as natural resources management and biodiversity conservation. Traditional societies, usually with strong cultural roots, have nurtured and refined systems of knowledge of their own, relating to such diverse domains as astronomy, meteorology, geology, ecology, botany, agriculture, physiology, psychology and health. Such knowledge systems represent an enormous wealth. Not only do they represent other approaches of the acquisition and construction of knowledge and harbour information often as yet unknown to science, but they are also expressions of other relationships between society and nature in general and of sustainable ways of managing natural resources in particular.

However, the research community, with the exception of some disciplines specifically focused on studying traditional societies and traditional knowledge, such as ethnology, ethnobotany and ethnoscience, has not yet engaged in ways of better linking science to other knowledge systems. To do so would bring important advantages to both sides, and provide, to those in need of knowledge for pursuing sustainable development goals, a broader range of empirical information.

For scientists to reach a common understanding of the importance of traditional knowledge, it is essential to distinguish clearly between science, pseudo-science and traditional knowledge. The first four chapters of the present Report represent the findings of an ICSU Study Group asked to establish such a distinction following the 1999 World Conference on Science (WCS) organized by the United Nations Educational, Scientific and Cultural Organization (UNESCO), in cooperation with ICSU. UNESCO itself has also moved towards implementing the WCS recommendations by launching an international project on Local and Indigenous Knowledge Systems in a Global Society (LINKS). I am pleased that this Report is published in cooperation with UNESCO. It is my hope that the Report will be used as an inspiration for the way ahead in coupling science with traditional knowledge, and in developing partnerships between the scientific communities, the holders of traditional knowledge, in particular indigenous peoples, and other stakeholders in sustainable development.

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Introduction

The Declaration on Science and the Use of Scientific Knowledge adopted by the World Conference on Science[1] affirms that scientific knowledge has led to remarkable innovations that have been of great benefit to humankind. Yet at the same time it also notes the challenge remaining to use this knowledge in a responsible manner to address human needs and aspirations. This is a task that needs many partners, and which calls for a broad collaboration between science and society in meeting the challenges of the future.

In paragraph 01 of the Declaration it is stated:

"*The sciences should be at the service of humanity as a whole, and should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life and a sustainable and healthy environment for present and future generations.*" For scientists to be better equipped for these tasks there is a need for them to be aware of the social and cultural settings of their endeavour.

For many sustainable development problems at the local level proper interaction between science[2] and local and indigenous cultures is crucial in order to find viable solutions. In this connection paragraph 26 of the Declaration (Annex 1) observes: "*...that traditional and local knowledge systems as dynamic expressions of perceiving and understanding the world, can make and historically have made, a valuable contribution to science and technology, and that there is a need to preserve, protect, research and promote this cultural heritage and empirical knowledge.*"

This principle is expanded in the Science Agenda - Framework for Action also adopted by the WCS under the section entitled "Modern science and other systems of knowledge". Of critical interest to this Report are the following two recommendations (Annex 1):

"*Governmental and non-governmental organizations should sustain traditional knowledge systems through active support to the societies that are keepers and developers of this knowledge, their ways of life, their languages, their social organization and the environments in which they live, and fully recognize the contribution of women as repositories of a large part of traditional knowledge.*"

"*Governments should support cooperation between holders of traditional knowledge and scientists to explore the relationships between different knowledge systems and to foster interlinkages of mutual benefit.*"

It is also included in the recommendations coming from World Conference on Science that the attainment of sustainable development, calling for balanced interrelated policies aimed at economic growth, poverty reduction, human well-being, social equity and the protection of the Earth's resources, commons and life-support systems, is one of the greatest challenges which the world community has ever faced. We must enhance and harness knowledge and our scientific capabilities to develop sustainably.

At its 30th Session in Paris 1999, the General Conference of UNESCO adopted the two principal documents of the WCS, the Declaration and the Framework. The 26th General Assembly of ICSU held in the same year in Cairo, Egypt, also unanimously endorsed the two principal documents of the WCS. Both ICSU and UNESCO urged members and Member States respectively to make both documents widely known among members of the scientific community and decision-makers. Further, it was agreed by both governing bodies to promote the principles set out in the Declaration, and to take the appropriate steps to translate into concrete action the

1. The World Conference on Science (WCS), organized by UNESCO in co-operation with ICSU, was convened in Budapest, Hungary, from 26 June to 1 July 1999.

2. While the term 'science' used in this Report refers to the natural sciences in the first place, it is often meant to include all domains of the sciences (including the biomedical and engineering sciences, and the social and human sciences).

Science Agenda - Framework for Action by implementing the recommendations set out within it and by forging new partnerships to this end.

The ICSU General Assembly acknowledged "the importance of empirical knowledge built up over generations and grounded in practical evidence but emphasized at the same time that such knowledge must be distinguished from approaches that seek to promote anti-science and pseudo-science." It is for this reason that the ICSU General Assembly requested the ICSU Executive Board to carry out a critical study of this issue. The ICSU Executive Board established an Ad hoc ICSU Study Group for this purpose (Annex III). This Report makes the findings and conclusions of the Study Group available to a larger public in the context of the preparation of the World Summit on Sustainable Development (WSSD). The first four chapters of this Report, following this Introduction, represent an edited version of the Study Group's own report. In the last two chapters of the present Report, the Study Group's own recommendations which were targeted only on possible ICSU follow-up, have been expanded significantly in scope in order to provide guidelines for participatory research aimed at interlinking scientific and traditional knowledge, and for the type of partnership initiatives advocated by the World Summit on Sustainable Development.

Throughout the preparatory process of the World Summit on Sustainable Development, governments and other stakeholders have stressed the need for making greater use of both scientific knowledge and technology on the one hand, and traditional knowledge on the other. Many issues related to sustainable natural resources management and to biodiversity conservation, as well as its sustainable use, require indeed a coupling of scientific and traditional knowledge. Thus, moving towards sustainable development in many areas will require a closer cooperation between scientists and the holders of traditional knowledge which include local people in general and indigenous peoples in particular. Necessarily, for addressing concrete sustainable development problems this cooperation will have to be expanded to include other relevant stakeholders such as national governments and local authorities, business and industry, and other major groups identified in Agenda 21. At the meetings of the UN Commission for Sustainable Development during the first half of 2002 devoted to the preparations of the World Summit on Sustainable Development, representatives of the International Scientific and Technological Communities, Indigenous Peoples and of Business and Industry have initiated a dialogue and have agreed to explore, together with UNESCO, the possibility of developing a small number of partnership projects in different parts of the world.

The Nature of Traditional Knowledge

In this report the term "Traditional Knowledge" is used in the following sense, which is in accordance with common usage of the term in the literature:

"Traditional knowledge is a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, spirituality and worldview." [3]

Traditional knowledge provides the basis for local-level decision-making about many fundamental aspects of day-to-day life:

- hunting, fishing and gathering;
- agriculture and husbandry;
- preparation, conservation and distribution of food;
- location, collection and storage of water;
- coping with disease and injury;
- interpretation of meteorological and climatic phenomena;
- manufacture of clothing and tools;
- construction and maintenance of shelter;
- orientation and navigation on land and sea;
- management of ecological relations of society and nature;
- adaptation to environmental/social change.

It is important to note that the term 'traditional knowledge', is only one of several designations currently employed by practitioners in the field. A variety of scientific, social and political considerations make it all but impossible for a single term to suit all settings – each one has its shortcomings (Nakashima and Rou 2002). The terms 'traditional knowledge' and 'traditional ecological knowledge' (TEK), for example, may be misleading as they underscore knowledge accumulation and transmission through past generations, but obscure their dynamism and capacity to adapt and change. Another widely used term, 'indigenous knowledge' (IK), emphasizes attachment to place and establishes a link with indigenous peoples. For some, however, this connection is problematic because it narrows the term's application and excludes certain populations who may not be officially recognized as 'indigenous people by their respective governments, but who nevertheless possess sophisticated sets of knowledge about their natural environments. In contrast, terms such as 'local knowledge' are easily applied to a variety of contexts, but suffer from a lack of specificity. Other terms that are encountered in the literature include 'indigenous science', 'farmers' knowledge', 'fishers' knowledge' and 'folk knowledge'.

Traditional knowledge, like any other form of knowledge, is developed within certain cultural groups over a given period of time and within specific environmental and social settings. At the same time, history has demonstrated how knowledge has been actively shared and exchanged among societies, and in this matter, holders of traditional knowledge are no different. They acknowledge, accept and adopt elements from other knowledge systems, just as other societies adopt elements of traditional knowledge.

As with any other system of knowledge, traditional knowledge is embedded within particular worldviews. In this respect modern science is no different, it is also anchored in a specific worldview and, more to the point, a specific view about people's relation to nature that is strongly instrumental (Thomas 1983). In contrast, the worldview embraced by traditional knowledge holders typically emphasizes the symbiotic nature of the relationship between humans and the natural world. Rather than opposing man and nature as in

3. The formulation endorsed by the ICSU Study Group.

Western thought, traditional knowledge holders tend to view people, animals, plants and other elements of the universe as interconnected by a network of social relations and obligations (i.e. Feit 1973, Fienup-Riordan, 1990).

Holistic cosmologies that intertwine elements that are ecological and social, as well as empirical and spiritual, have confounded scientists who seek to separate 'fact' from 'superstition'. The scientist's dualistic approach, however, presents certain dangers. Practices that appear in the first instance as superstitious to the outside observer may, once additional knowledge about the environment and culture is acquired prove to be appropriate and empirically sound ways of coping with environmental problems. Furthermore, practices may have latent meanings that may only be revealed through a fuller understanding of the culture as a whole. Traditional knowledge interweaves empirical, spiritual, social and other components. In general, by isolating elements from such a holistic worldview, one runs the risk of misrepresenting both the elements and the whole.

Distinguishing between Science, Pseudo-Science and Traditional Knowledge

This section discuses the relationship among science, pseudo-science and traditional knowledge. It first addresses the notoriously difficult problem of the demarcation between science and pseudo-science. Once the characteristics of pseudo-science are clarified this provides a basis distinguishing pseudo-science from traditional knowledge.

The Demarcation of Pseudo-science from Science

Philosophers of science have debated the demarcation of pseudo-science from science for many decades. Unfortunately, hope of finding a criterion that would unambiguously demarcate pseudo-science from science has not been fulfilled, and is no longer entertained (see Curd and Clover 1998).

The main reason for the abandonment of this project is a growing awareness of the diverse and fractured approaches to knowledge within science itself. Different sciences are much more dissimilar to each other than previously thought, and there is little hope to expose the unity of science by an appeal to a unique scientific method or any other means (Feyerabend 1993, Galison and Stump, 1996). Consequently, the demarcation of science from pseudo-science can not be achieved by identifying a single universal criterion. What counts as good scientific practice in one scientific field may be outdated or even inappropriate in another scientific field. At best, there are different criteria whose validity depends on the respective scientific context and, furthermore, on time, which is very unsatisfactory. In addition, many practices, ideas, concepts, models, hypotheses and even speculations in a lively field of science are of a heuristic character without being explicitly marked as such in every instance of their occurrence. Moreover, the degree to which a specific element of science is accepted as a heuristic device or as a more or less solid result may vary from one scientist to the other. These factors make the contrast between science and pseudo-science appears somewhat blurred.

However, the project of demarcating pseudo-science from science is not so hopeless even if the inner diversity and the heuristic elements of science are taken into account. Two main approaches present themselves. The first one is broadly sociological, concentrating on social aspects of pseudo-science, and the second one is epistemological. Commencing with the sociological approach, it is noted that a pseudo-scientific field from its inception is always in more or less explicit competition with a corresponding science. Further, it is typically not propounded by people educated in the scientific field with which it is competing. For example, there is a movement against relativity theory that defends ideas about time and space that are more in agreement with common sense than relativity theory. Proponents of the movement are typically not physicists but people often educated in other scientific disciplines. A better known movement is creation science, which competes strongly with evolutionary theory. Again, many if not most proponents of creation science are not professional biologists, and the extra-scientific, i.e. religious base of the movement is obvious. However, this sociological approach results only in a necessary but not in a sufficient condition for a demarcation of pseudo-science from science. Pseudo-science does stand in competition with some established scientific tradition, but so sometimes do minority views within science, fighting a prevalent tradition, without becoming unscientific. Thus, we need additional evidence in order to characterize a field as pseudo-scientific, and this evidence relates to its cognitive content.

The second approach to demarcate pseudo-science from science is epistemological. It is based on a somewhat more advanced form of a characterization of science given at the World Science Conference in Budapest in 1999 (Hoyningen-Huene 2000). According to this account, science is characterized as being systematic to a higher degree than comparable pieces of everyday knowledge. Science is more systematic than everyday knowledge with respect to the following six aspects:

- how science describes;
- how science explains;
- how science establishes knowledge claims;
- that science has an ideal of completeness;
- how science expands knowledge;
- how science represents knowledge.

Due to its ideal of completeness, science has inbuilt dynamics regarding the improvement of knowledge. This dynamic can abstractly be described as the tendency to constantly increase the systematic character of knowledge and thereby to make progress. Descriptions become more systematic by higher degrees of accuracy of observation, explanations become more systematic by theories that are more and more comprehensive, new and more accurately repeated experiments increase the degree of systematic testing and thereby the efficiency of detecting mistakes, repeated surveys of the field increase the awareness of knowledge gaps, and so on. In any area of science, the tendency to make knowledge more systematic in all practical possible directions can be observed.

In contrast, many of the pseudo-scientific fields are comparatively static. It is extremely rare for such fields to attempt a systematic assessment of their cognitive claims. In particular, where claims are of an essentially probabilistic nature, like in all talk about tendencies or (not exactly specified) influences, systematic statistical testing procedures are called for. However, very rarely do pseudo-scientific movements get involved in any sort of statistical testing procedures; anecdotal evidence prevails. If cognitive claims of pseudo-scientific movements are systematically evaluated at all, this is usually not done by the movement itself in a self-critical way, but by science. Furthermore, in pseudo-scientific fields usually no attempt is made at a systematic expansion of cognitive claims into new areas; typically, with respect to scope, pseudo-scientific movements are extremely conservative. Mostly, the dynamics to be observed in pseudo-scientific fields (if any) is defensive: it consists at most of attempts to oppose the counter-attacks of the respective scientific tradition.

In conclusion: Pseudo-science is an enterprise that is always in competition with science; it poses as science by mimicking it. However, a closer look reveals that pseudo-science displays a developmental pattern that is very different from the developmental pattern of science proper. Whereas science tries to increase the degree to which it is systematic with respect to all those aspects where this is feasible, pseudo-science is mostly static and if moving forward at all, it is only enhancing its protective belt against criticism from the scientific tradition it tries to displace.

On the Demarcation of Pseudo-science from Traditional Knowledge

The demarcation of pseudo-science from traditional knowledge is fairly straightforward. As noted earlier, traditional knowledge is a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment. Thus, it has typically originated independently of science in a particular cultural setting, and critically, independently from Western culture. Traditional knowledge is therefore neither intended to be in competition with science, nor is such a competition the necessary result of their interaction. On the contrary, traditional knowledge has informed science from its very beginnings and it continues to do so today. If competition between science and traditional knowledge arises at all, then the initiative typically comes from people who want science to replace these other forms of knowledge. Pseudo-science, on the other hand, tries at least partly to de-legitimize existing bodies of scientific knowledge by gaining equal epistemological status. The existence of pseudo-science as an enterprise in competition with science is thus invariably bound to the existence of science itself whereas traditional knowledge is independent of science.

Interactions between Science and Traditional Knowledge

While interaction between traditional knowledge and science has recently emerged as an issue of widespread interest and concern, in actual fact the dialogue between these knowledge systems has a long history. The important role that traditional knowledge has played in the development of modern science has been clearly demonstrated by historians of science. This includes contributions not only to the expansion of empirical data but also to the construction of schemes by which this information is ordered, as well as the development of scientific methods and concepts.

The dialogue between scientists and traditional knowledge holders has an extensive history within occidental traditions. Noteworthy examples include the physics of Galileo, who used knowledge of ballistics developed by craftsmen at the arsenal in Venice, and Linnaeus' codified use of Latin binomials for plant and animal nomenclature, that was founded on studies of Sami (Lapp) naming and classification systems (Balick and Cox 1997).

During the colonial period, when Europe was 'discovering' the world, the disciplines of ethno botany and ethno zoology were established to grapple with the sudden influx of biological information from distant places. These disciplines grew by leaps and bounds with the establishment of botanical gardens and the publication of herbal and treatises in Renaissance Europe from the sixteenth century onwards (Ambrosoli 1997), all bolstered by substantial inputs of traditional knowledge. The primary mission, however, was not to understand these other knowledge systems *per se*, but rather to glean from them useful information for the further development of western science during the colonial period. Efforts focused on compiling lists of novel plants and animals that were 'useful' to local populations and consequently, thought to be of potential utility 'back home'.

During the colonial period scientists did not rely only on local experts to identify species of interest. They adopted entire classification schemes that order and interpret these ecological systems according to an indigenous logic. In this manner, Western taxonomic knowledge and practice were significantly transformed by their encounter with traditional systems of knowledge and meaning. For example, Rumphius' seminal eighteen century work, *Herbarium Amboinense*, relied heavily upon indigenous descriptions of plant ecology, and in particular Malay systems of classification (Peeters 1979; Ellen and Harris 1999). During the nineteenth and twentieth centuries, this tapping of local knowledge became routine, and many additions and revisions to scientific taxonomic understandings "ironically depended upon a set of diagnostic and classificatory practices, which though represented as science, had been derived from earlier codifications of indigenous knowledge" (Ellen and Harris 1999). Thus science has a long history of expansion through the appropriation of traditional knowledge, at times with little acknowledgement of the origins of these borrowed 'discoveries'.

A marked shift occurred in the interaction between science and traditional knowledge during the middle of the twentieth century with the emergence of a new umbrella discipline. Ethno-science is a scientific approach to traditional knowledge that is rooted in the pioneering work of Harold Conklin among the Hanunoo of the Philippines in the 1950's. Conklin (1957) dedicated his study of a society's knowledge of its natural environment on a rigorous examination of indigenous semantic categories. The distinguishing feature of Conklin's methodological approach was his focus on indigenous taxonomies of almost 2000 plant species and his appreciation that this knowledge was intimate to Hanunoo culture and worldview. Subsequent research confirmed the subtle and meticulous nature of indigenous knowledge, illustrating for example that this 'science of the concrete' (Levi-Strauss 1966) names and orders large numbers of plant and animal taxa, bypassing in many cases those known to science. Ethno-science focused its attention on indigenous taxonomies, stimulating considerable debate over the extent to which these classification systems exhibit universal characteristics (Berlin 1974, 1992, Atran 1991, Bulmer 1967, Friedburg 1974, Ellen and Reason 1979, Ellen 1998).

Ethno-botanical research has continued as a strong tradition, particularly in India and in Mexico. Extensive work has focused on "sacred" groves occurring throughout India that are protected and managed by local communities. Research into these groves integrates botanical, ecological and management perspectives with local socio-cultural frameworks. Such approaches have examined the relationship between traditional knowledge and biodiversity conservation in terms of how prohibitions may contribute help to managing and preserving ecosystems (Ramakrishnan *et al* 1998).

Early research in Arctic North America on Inuit (Eskimo) knowledge of the bio-physical environment, in particular the ice environment, was conducted by Nelson (1969). Subsequently, research on indigenous knowledge in the circum polar region was stimulated by the need to resolve territorial land claims and as a result, document land use and related traditional ecological knowledge (Freeman 1976, 1979). The application of traditional knowledge to the assessment of the environmental and social impacts from large-scale development projects emerged soon after (Berkes 1988, Nakashima 1990, Rou and Nakashima 2002).

In the Pacific Islands, research was initiated on traditional knowledge and systems of marine resource tenure. The pioneering work of Johannes (1978) on the demise of traditional conservation methods in Oceania set the stage for a number of important contributions in this domain, such as on the knowledge of the marine fishers of Palau, (Johannes, 1981) a UNESCO anthology on *Traditional Knowledge and Management of Coastal Systems in Asia and the Pacific* (Ruddle and Johannes 1985) and more recently, Hviding's writings on maritime knowledge and tenure in the Solomon Islands (Hviding 1996). These studies focus upon traditional knowledge of marine species including their habitat, aggregation behaviour, spawning migration and taxonomies. In addition, they illustrate that there exist elaborate indigenous conservation and management practices for marine biodiversity.

During the 1980s, researchers in multilateral and bilateral development agencies began to recognize the significance of indigenous knowledge for sustainable development, both for environmental conservation and technologies for agricultural productivity (Bennett 1992). For example, scientists in the CGIAR (Consultative Group on International Agricultural Research) system began to value participatory technology development, using the traditional practices and indigenous knowledge of local populations as a starting point. Work on indigenous soil classification and management systems has been undertaken by Warren (1992) within a broader framework of illustrating participatory approaches to development in Africa. The Center for Indigenous Knowledge for Agriculture and Rural Development (CIKARD) has promoted indigenous knowledge systems as a critical resource base for development and the design of sustainable agricultural systems. Work done on indigenous soil characterization in northern Zambia by Sikana (1994) clearly demonstrates that local knowledge is relative and site specific. Having reviewed both research and development work on rural people's knowledge and western agricultural science undertaken in Africa (Scoones and Thompson 1994) one can conclude that both systems are value-based, context-specific and influenced by social relations of power. It is advocated that to engage with local knowledge systems, research must come to terms with contrasting sets of ideas, values, representations and performances.

Most recently, there has been renewed recognition of indigenous knowledge as a potential source for biodiversity science. Traditional peoples knowledgeable about their local flora and fauna have continued to draw the attention of scientists to new species (e.g. primate species recently discovered in Central and South America, ungulates in Southeast Asia, and plant species throughout the tropics). In the 1980s and 1990s, this taxonomic knowledge has attracted the interest of pharmaceutical and agricultural companies (Chadwick and Marsh 1994), triggering concern about bio-prospecting and the intellectual property rights of local communities.

Traditional knowledge and traditional medicinal practices continue to provide for the primary health care needs of some 80% of the world's population (WHO *et al.* 1993). In China (Lin 2001) and India (Mishra 2002), traditional medicine is actively supported and researched. Even western medicine, founded on Greek traditions, continues to be strongly influenced by traditional knowledge. In the USA, plant materials continue to be an important component in 25% of prescriptions (Farnsworth and Soejarto 1985). Disowning the role of traditional knowledge in medicine would disenfranchise a large majority of the world's population, ignore much of what constitutes modern medicine, and curtail discovery of new drugs and the treatment of diseases for which we still have no satisfactory cures.

Conservation strategies can be based on traditional knowledge and resource use (Redford and Padoch 1992, Redford and Mansour 1996) and enable effective management and partnerships without which conservation goals are unlikely to be attained. This also raises a number of challenges including land tenure, genetic resource ownership, intellectual property rights and benefit sharing (ten Kate and Laird 1999), and confronts scientists with issues of professional ethics (Cunningham 1996).

Traditional knowledge is providing empirical insight into crop domestication, breeding, and management (Conklin 1957, Boster 1984, Nabhan 1985, Brush 2000, Johns and Keen 1986, Salick, Cellinese, and Knapp 1997), as well as principles and practices of swidden agriculture, agro-ecology, agro-forestry, crop rotation, pest and soil management and other agricultural activities (Bunch 1982). Traditional knowledge also informs science about natural forest management and biodiversity management (Nabhan 2000, Posey 1985, Peters 1990, Pinard 1993, Pinedo-Vasquez *et al.* 2001, Salick 1992).

Coupling Science and Traditional Knowledge: Towards More Equitable Partnerships

The study of indigenous knowledge has expanded and has received increased interest from research and funding bodies. The debate has grown from what constitutes and is the value of indigeneous knowledge to include "how can such knowledge systems be used to ensure equitable benefit sharing of the resources with the contributing communities" (Slikkerveer 1999). In the context of the application of traditional knowledge in sustainable development this marks a shift away from interactions and exchanges of knowledge that have previously concentrated on technology transfer, based on 'top-down' approaches to development, towards more equitable partnerships (Sillitoe 1998, 2001).

There are a number of complex obstacles to protecting the rights of holders of traditional knowledge, innovations, practices and technologies. International property right regimes may pose barriers to equitable benefit sharing (Dutfield 1999). One of the most practical means to negotiate and move forward in this complex area has been the drawing up of codes of ethics and research guidelines. Numerous international professional associations and societies have been addressing the important issues concerning rights, participation, disclosure, consent, veto, confidentiality, protection, compensation, reward sharing, research support and access (Laird and Posey 2002). Patent and copyright laws, have evolved within very particular socio-economic and political contexts. They are designed to protect individuals or companies whose specific 'inventions' require safeguarding in view of their perceived market value. Yet it is difficult for such arrangements to accommodate traditional knowledge, which is collectively owned, whose 'invention' extends across several generations, and whose intent is not commercial profitability but rather understanding about the natural environment, support for subsistence, and social meaning.

Given these inherent incompatibilities, the application of conventional intellectual property rights (IPR's) may have impacts quite other that those intended. By protecting select elements in isolation from the larger cultural context, IPR's encourage fragmentation and atomisation of the cultural system. By designating knowledge 'owners', they may trigger social dissention between those recognized as proprietors and other community members that are excluded. And finally, as conventional IPR's serve to protect knowledge by setting the rules for their commercial exploitation, they in fact deliver up local knowledge to the global market place (Barsh 1999). Existing IPR arrangements are culturally inappropriate for protecting traditional knowledge systems. Today efforts are turning towards the considerably more challenging task of defining completely new or *sui generis* systems for protection.

Universal education programs provide important tools for human development, but they may also compromise the transmission of indigenous language and knowledge. Inadvertently, they may contribute to the erosion of cultural diversity, a loss of social cohesion and the alienation and disorientation of youth. A classic example from African school curricula concerns the instruction about the four seasons. This ethnocentric representation of nature as an annual cycle of "spring, summer, autumn and winter" is completely at odds with the real life experience of North African children. Its uncritical imposition erodes confidence of youth in their own experience and in the cultural interpretation of the world provided by their parents and grandparents.

In short, when indigenous children are taught in science class that the natural world is ordered as scientists order it, and that it functions as scientists believe it functions, then the validity and authority of their parents' and grandparents' knowledge is denied. While their parents may posses an extensive and sophisticated understanding of the local environment, classroom instruction implicitly informs that science is the ultimate authority for interpreting 'reality' and by extension local indigenous knowledge is second rate and obsolete.

In many communities, there is an urgent need to reconsider the articulation between exogenous and endogenous knowledge flows and the pedagogical methods that guide these processes. Actions are urgently needed to enhance the intergenerational transmission of local and indigenous knowledge, in order to empower communities to build their own sustainable futures based upon both endogenous and exogenous knowledge.

Greater emphasis must be placed on levelling the playing field and appreciating traditional knowledge not as sets of information but as integral components of other living and dynamic societies and cultures.

Traditional knowledge conservation therefore must pass through the pathways of conserving language (as language is an essential tool for culturally-appropriate encoding of knowledge); ensuring knowledge transmission; strengthening the control of traditional societies over the processes of change that affect them; and conservation and continued access to the environments upon which their way-of-life depends.

The Way Forward

It is acknowledged in the introductory note to the Science Agenda – Framework for Action of the World Conference on Science (Annex 1) that modern science does not constitute the only form of knowledge available to further the development of humankind. Traditional knowledge systems harbour an enormous and, for the most part, untapped wealth of information that is acquired and constructed within a wide range of cultures. It is also acknowledged that these unique knowledge systems are increasingly weakened in the face of globalization and the growing dominance of a single view of the natural world as espoused by science.

The valuable contribution to science that has been made by traditional knowledge systems was recognized at the World Conference on Science. Further, the need to preserve, protect, research and promote this empirical knowledge was advocated. To assure mutually beneficial and enriching exchanges between these two distinct knowledge systems requires the development of a way forward that is based on two lines of action. The first concerns recommendations for action within the scientific community to raise awareness about the unique values of traditional knowledge systems. The second area of action that must be predicated on the first, concerns establishment of a foundation upon which to build partnerships that can constructively couple science and traditional knowledge.

Measures to be Taken by the Scientific Community

Scientists and scientific institutions should promote dialogue and build awareness and understanding within the scientific community about traditional knowledge and its relationship to science. Specifically, they need to:

- Recognize that science does not constitute the only form of empirical knowledge about the world;
- Encourage research into the history and philosophy of science to identify and highlight the tangible contributions that traditional knowledge systems have made to the development of science;
- Raise awareness of the important distinctions between traditional knowledge, science and pseudo-science;
- Recognize that traditional knowledge systems offer unique and valuable approaches to the acquisition and construction of knowledge, processes that can only be addressed by acknowledgement of the specific cultural milieu within which they are reproduced;
- Recognize that scientists are also influenced by their own cultures in which they learn, work and research;
- Promote and support research into traditional knowledge systems that represent considerable stores of, as yet “undiscovered”, knowledge and potential for mutually beneficial exchanges with science.

Actively support and strengthen the systems of acquisition, transmission and maintenance of traditional knowledge in the societies that are keepers and developers of that knowledge. Specifically with respect to building appropriate bases to articulate equitable exchanges between traditional knowledge and science:

- Understand that knowledge in traditional societies, contrary to an often held perception, is also dynamic and constantly evolving;
- Recognize that there also exist traditional processes of transmitting and acquiring traditional knowledge, and that these processes deserve to be maintained and supported;
- Recognize, support and encourage research into the role of women’s traditional knowledge that has often been neglected.

UNESCO, ICSU and other scientific bodies should work together to advocate and implement these measures.

Building Partnerships for Enhancing Knowledge and Action

Partnerships between the S&T communities and local and indigenous peoples will in many areas be essential to promoting sustainable development. The founding principle to foster positive interaction between holders of traditional knowledge and the scientific community is that collaboration must be initiated between equal partners. This goal cannot be attained unless partnerships are founded upon mutual respect and understanding, transparent and open dialogue, and informed consent and just returns for the holders of traditional knowledge through the flow of rewards and benefits. These commitments are critical, as the fields of interplay between traditional and scientific knowledge extend well beyond research and environmental management into areas involving business, government and development intervention. Recommendations to assist in the development of responsible approaches to the coupling of traditional knowledge with science in sustainable development must address a broad range of stakeholders.

In the first place the S&T community must be ready and committed to implementing necessary changes in the conduct of science aimed at sustainable development goals which are particularly relevant for working with the holders of traditional knowledge. A much greater share of research must be integrated problem-oriented and interdisciplinary, addressing the social, economic, and environmental pillars of sustainable development. Traditional divides between the natural, social, economic, and engineering sciences and other major stakeholders must be bridged. Research agendas must be defined through broad- based, participatory approaches involving the holders of traditional knowledge and those in need of scientific information.

In the formulation of partnerships the issue of ownership of knowledge must be understood and acknowledged as the starting point for building effective partnerships between other stakeholders and the holders of traditional knowledge. The holders of traditional knowledge must be fully recognized as the rightful owners of their intellectual heritage. Scientific research must pay due attention, and give due credit, to those peoples who produce and hold that knowledge.

In traditional societies the acquisition, transmission and maintenance of knowledge most often takes place outside of the formal classroom setting. Local social and cultural frameworks of authority, meaning and representations of knowledge must be understood, respected and upheld. The recognition of the ownership, use and practice of traditional knowledge systems in their local context (social and cultural) provides the necessary foundation to forge equitable partnerships. It is only on this basis that scientific research and traditional knowledge can be articulated on equal terms in sustainable development, research and resource management.

Beyond the building of collaborative partnerships at the local level between members of the scientific community and holders of traditional knowledge, it will be necessary to expand these collaborative partnerships to include national government agencies, local authorities, business, industry, NGOs and, appropriate intergovernmental organizations. At the most fundamental level, it is critical for the scientific community and other partners to understand that for indigenous peoples respect for their territories and self-determination are basic preconditions for partnerships.

In this respect, the following principles should be applied:

- Ensure the full and effective participation of traditional knowledge holders during all stages of elaboration of sustainable development policies, plans and programs, alongside the scientific and technological community;
- Acknowledge and respect the social and cultural bases, including the authority structures within which traditional knowledge is embedded;
- Recognize the rights of traditional people to own, regulate access and share benefits of their unique sets of knowledge, resources and products
- Ensure that traditional knowledge holders are fully informed of potential partnerships and that these are only entered into with prior informed consent;
- Promote models for environmental and sustainable governance that incorporate principles of genuine partnership and collaboration between scientific and traditional knowledge;
- Promote training to better equip young scientists and indigenous people to carry out research on traditional knowledge.

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Annexes

Annex I – Texts pertaining to Traditional and Local Knowledge from the UNESCO-ICSU World Conference on Science

Declaration on Science and the Use of Scientific Knowledge

Par. 26 Considering …that traditional and local knowledge systems as dynamic expressions of perceiving and understanding the world, can make and historically have made, a valuable contribution to science and technology, and that there is a need to preserve, protect, research and promote this cultural heritage and empirical knowledge…

Par. 38 Intellectual property rights need to be appropriately protected on a global basis, and access to data and information is essential for undertaking scientific work and for translating the results of scientific research into tangible benefits for society. …There is also a need to further develop appropriate national legal frameworks to accommodate the specific requirements of developing countries and traditional knowledge, sources and products, to ensure their recognition and adequate protection on the basis of the informed consent of the customary or traditional owners of this knowledge.

Introductory note to the Science Agenda-Framework for Action

Par. 35 Modern science does not constitute the only form of knowledge, and closer links need to be established between this and other forms, systems and approaches to knowledge, for their mutual enrichment and benefit. A constructive inter-cultural debate is in order, to help find ways of better linking modern science to the broader knowledge heritage of humankind.

Par. 36 Traditional societies, many of them with strong cultural roots, have nurtured and refined systems of knowledge of their own, relating to such diverse domains as astronomy, meteorology, geology, ecology, botany, agriculture, physiology, psychology and health. Such knowledge systems represent an enormous wealth. Not only do they harbour information as yet unknown to modern science, but they are also expressions of other ways of living in the world, other relationships between society and nature, and other approaches to the acquisition and construction of knowledge. Special action must be taken to conserve and cultivate this fragile and diverse world heritage, in the face of globalization and the growing dominance of a single view of the natural world as espoused by science. A closer linkage between science and other knowledge systems is expected to bring important advantages to both sides.

Science Agenda-Framework for Action

Par. 32 Modern scientific knowledge and traditional knowledge should be brought closer together in interdisciplinary projects dealing with the links between culture, environment and development in such areas as the conservation of biological diversity, management of natural resources, understanding of natural hazards and mitigation of their impact. Local communities and other relevant players should be involved in these projects. Individual scientists and the scientific community have the responsibility to communicate in popular language the scientific explanations of these issues and the ways in which science can play a key role in addressing them.

Par. 33 Governments, in co-operation with universities and higher education institutions, and with the help of relevant United Nations organizations, should extend and improve education, training and facilities for human resources development in environment-related sciences, utilizing also traditional and local knowledge. Special efforts in this respect are required in developing countries with the co-operation of the international community.

Section 3.4 Modern science and other systems of knowledge

Par. 83 Governments are called upon to formulate national policies that allow a wider use of the applications of traditional forms of learning and knowledge, while at the same time ensuring that its commercialization is properly rewarded.

Par. 84 Enhanced support for activities at the national and international levels on traditional and local knowledge systems should be considered.

Par. 85 Countries should promote better understanding and use of traditional knowledge systems, instead of focusing only on extracting elements for their perceived utility to the S&T system. Knowledge should flow simultaneously to and from rural communities

Par. 86 Governmental and non-governmental organizations should sustain traditional knowledge systems through active support to the societies that are keepers and developers of this knowledge, their ways of life, their languages, their social organization and the environments in which they live, and fully recognize the contribution of women as repositories of a large part of traditional knowledge.

Par. 87 Governments should support cooperation between holders of traditional knowledge and scientists to explore the relationships between different knowledge systems and to foster inter-linkages of mutual benefit.

Annex II – Resolution of the 26th General Assembly of ICSU on the Follow-up to the World Conference on Science

1. World Conference on Science

The 26th General Assembly of ICSU

Noting the successful holding of the World Conference on Science in Budapest from 26 June to 1 July 1999;

Recognizes and appreciates the partnership with UNESCO in the organization and staging of the Conference;

Records its grateful appreciation to the Hungarian Government and the Hungarian Academy of Sciences for their generosity and cooperation in hosting the Conference;

Expresses concern about parts of the documents adopted by the Conference, notably paragraph 26 of the Declaration on Science and section 3.4 Modern science and other systems of knowledge of the Framework for Action; of particular concern is the phrase “traditional and local knowledge systems”. The importance of empirical knowledge built up over generations and grounded in practical evidence is acknowledged but such knowledge must be distinguished from approaches that seek to promote anti-science and pseudo-science, and which degrade the values of science as understood by the ICSU community. ICSU reaffirms its support for the values and methods of verifiable science;

Recognizing that the relation between traditional knowledge and modern science is both important and a highly complex political and sociological question and one that cannot be addressed in a few lines of a wide-ranging document;

Requests the Executive Board of ICSU to set up a critical study of this issue.

With the above reservations, the 26th General Assembly of ICSU

Decides to endorse the two principal documents of the Conference: the Declaration on Science and the Use of Scientific Knowledge and the Science Agenda - Framework for Action, taking into account the concerns expressed; and

Urges all ICSU Members to:

distribute and make both documents and this resolution widely known among members of the scientific community, promote the principles set out in the Declaration, and take the appropriate steps to translate into concrete action the Science Agenda - Framework for Action by implementing the recommendations set out within it, forging new partnerships to do so;

Keep the ICSU Secretariat regularly informed of all measures they have taken to implement the Science Agenda - Framework for Action.

Annex III – The ICSU Study Group

At its meeting on 19 September 2000, the Executive Board of ICSU decided to set up a small Study Group to prepare a report on this issue for the next session of the General Assembly in Rio de Janeiro in September 2002. The mandate specifically asked the Study Group:

(i) to carry out the required analysis of the relationship between traditional knowledge systems and modern science; and

(ii) to give advice to ICSU on further action (see, in particular, paragraph 87 of the WCS Framework for Action).

The Study Group was established in mid 2001 and was asked to prepare a Report for the next GA of ICSU in 2002. This meant that the Study Group had to submit its Report to the EB of ICSU by the end of January 2002. The Study Group met three times: a first organizational meeting on 2-3 October, 2001; a working session on 10-11 December, 2001; and a final session on 28-29 January, 2002. All meetings have took place in Paris.

The membership of the Study Group was as follows:

- **Jens Erik Fenstad(chair)** is a Professor of Mathematics at the University of Oslo, Norway. He was Vice-Rector of the University and a former President of the International Union of History and Philosophy of Science (Division of Logic, Methodology and Philosophy of Science). He was a member of the Executive Board of ICSU and is now the Chair of the UNESCO World Commission on the Ethics of Scientific Knowledge and Technology.
- **Paul Hoyningen-Huene** is the Director of the Center for Philosophy and Ethics of Science at the University of Hannover, Germany. He gave the plenary lecture on "The Nature of Science" at the World Conference on Science (WCS) in Budapest, 1999.
- **Hu Qiheng** is a Research Professor on Automatic Control of Chinese Academy of Sciences. She is the past Vice-President of CAS and Vice-President of China Association for Science and Technology (CAST). She is a member of the ICSU SCRES (Standing Committee on Responsibility and Ethics in Science) and heads the Internet Society of China.
- **John Kokwaro** is a Professor of Botany at the University Of Nairobi, Kenya. He is a specialist in systematics and ethnobotany. He is a Fellow of the Linnean Society, London, and was the first Executive Director of the African Academy of Sciences.
- **Douglas Nakashima** (observer) is a Programme Specialist in the UNESCO's Science Sector, Paris, France. He heads the UNESCO project on «Local and Indigenous Knowledge Systems in a Global Society (LINKS)». He was a co-organizer of the WCS Session on «Science and Other Systems of Knowledge».
- **Jan Salick** is the Curator of Ethnobotany at the Missouri Botanical Garden, USA. She is a Past-President of the Society of Economic Botany, a member of the US National Committee of the International Union of Biological Sciences, and a Fellow of both the American Association for the Advancement of Science and of the Linnean Society.
- **Wesley Shrum** is a Professor of Sociology at Louisiana State University, USA. He is Chair of the US National Committee of the International Union of History and Philosophy of Science and Secretary of the Society for Social Studies of Science.
- **B. V. Subbarayappa** is a Professor at the National Institute of Advanced Studies in Bangalore, India. He was the Executive Secretary of the Indian National Science Academy and a former President of the International Union of History and Philosophy of Science (Division of History of Science). He chaired the WCS Session on "Science and Other Systems of Knowledge".

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