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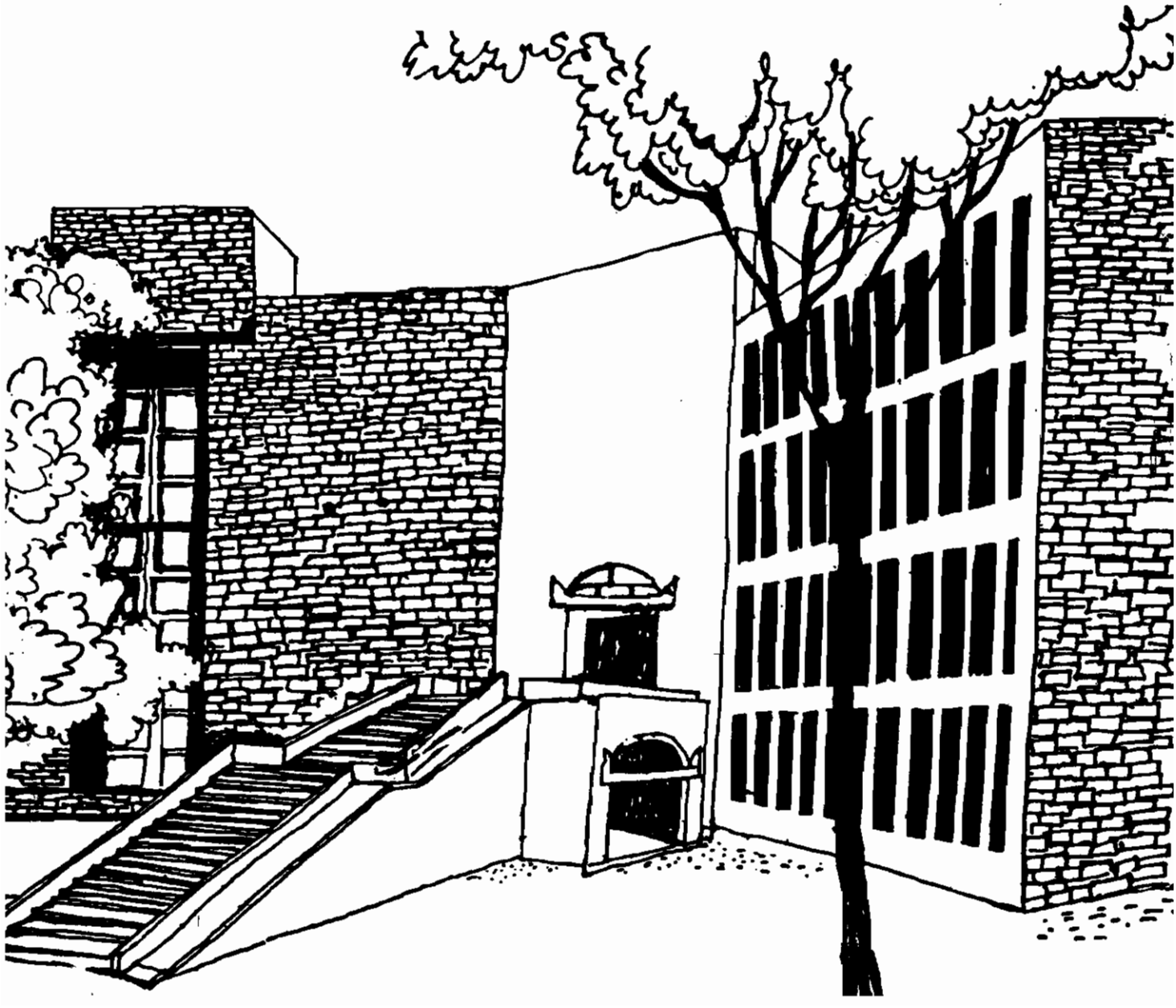

FISHING IN THE 'TROUBLED' WATERS: RECOGNIZING, RESPECTING, AND REWARDING LOCAL ECOLOGICAL KNOWLEDGE, INNOVATIONS AND PRACTICES CONCERNING AQUATIC BIOLOGICAL DIVERSITY

By

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Abstract

The study of indigenous ecological knowledge has become an important building block of any participatory approach to natural resources management. It is not the outsiders alone who benefit from the study of indigenous ecological knowledge but even the communities themselves may benefit a great deal if they are provided the opportunity to learn from each other as well as from formal science.

In this paper, I look at the relationship among knowledge providers and the outside users with specific reference to aquatic biological diversity. Given the asymmetric relationship among the knowledge providers and the users, I draw attention to the efforts made by Honey Bee Network in influencing the ethics and equity of the knowledge exchange among various stake holders. I discuss the concept of sacred waters and other institutions for conserving aquatic biodiversity. Different kinds of material and non-material incentives for individuals and communities are described. Suggestions are made for changing the ethical basis of knowledge and resource exchange among those who conserve resources and those who use them besides other policy and management interventions that can empower local communities and enrich modern science and technology in the context of aquatic biological diversity.

Fishing in the 'Troubled' Waters: Recognizing, Respecting, and Rewarding Local Ecological Knowledge, Innovations and Practices Concerning Aquatic Biological Diversity

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Introduction

Studies of indigenous ecological knowledge are getting attention not only among resource managers, policy-planners and Parties to the Convention on Biological Diversity (CBD) but also within and among local and indigenous communities themselves. During modernization, many of these communities have realized the threat of knowledge erosion and are attempting to take control of such knowledge, which outsiders have often documented and appropriated without sharing benefits with the providers. External researchers rarely share the gains made through publication, value addition to or commercialization of this knowledge. Their relationships with the knowledge providers are extractive and utilitarian, with no accountability, hence this paper's title 'troubled waters'. Fishing for knowledge in such waters is fraught with risks and threats.

This paper deals first with the empirical context of local knowledge about aquatic biological resources. 'Local' and 'indigenous' are here considered as synonymous terms. Such resources are considered by some users as existing in a wider socio-ecological context than simply to be exploited by humans. Some local communities have elaborate rituals which they perform before hunting or fishing, so as to seek the permission of the spirits that guide their own lives, those of aquatic and other living systems and the connections between these. Examples are given from Honey Bee network and the activities of the SRISTI (Society For Research and Initiatives for Sustainable Technologies and Institutions), a developmental voluntary organization hosting textual, electronic, and multi-media data bases on indigenous technological, educational and institutional innovations that help overcome the barriers of localism, literacy and language. Local communities and innovators can learn about new ideas, innovations and institutions from different areas through a combination of local language textual facilities, sound, pictures and films. Thus even an illiterate person can learn from ideas not just from the same village and through sound and films.

The paper then discusses the relationship between biodiversity and poverty and suggests appropriate incentives for different kinds of local knowledge and related contextual settings, proposing certain directions for policy and research towards a better understanding of aquatic biodiversity through local ecological, technological and socio-cultural knowledge systems. The development of the database of the Society for Research and Initiatives for Sustainable Technologies and Initiatives (SRISTI) is given as an example of a tool that could be used for this kind of lateral learning. SRISTI has several kinds of data bases, for instance (a) common property resource institutions having examples of self design collective solutions of resource management problems dealing with grazing, fisheries, water, forest etc., from 23 countries; (b) more than eight thousand technological innovations and outstanding examples of traditional knowledge for sustainable natural resource management, (c) medicinal plants, and (d) natural products, patents

on herbal products, educational innovations in primary education, literature on sustainable natural resource management (more than 23000 reprints and documents) , rural development, etc.

Making connections: understanding the *context*, in order to appreciate the *content* of the local knowledge.

How context changes content

The following story illustrates the relationship between context and content. Akbar was a Moghul King during the fifteenth century and was very popular among his subjects due to his secular orientation. He had a quick witted minister called a Birbal. Akbar and Birbal used to play games of one upmanship. Each one would try to prove that the other was not very intelligent. Once Birbal asked whether the king believed in the dictum 'as is the king, so are his subjects.' Akbar replied of course, that it was true. Since he was a wise king, so should be his subjects. Birbal suggested that they should test this assumption. He wanted to prove that Akbar was not a very wise king, though of course in the lighter vein. Birbal drew a line on a paper. He asked the king to challenge everybody to shorten the line without erasing it. After several weeks, a child came forward. He drew longer line adjacent to the original, which then appeared shorter. The context changed the content. Similarly, once the context of a knowledge system is changed, as is seen next, its content and the scope of its applicability changes enormously.

Three indigenous communities in Alaska and four in Chukotka Russia **[Chukotka, is an autonomous okrug (national area) in far northeastern Russia, in Siberia. It is north of the okrug of Koryakia and also bordered by the Bering Sea, the Chukchi Sea, and the East Siberian Sea. The total area is 737,700 sq km).** were studied by Huttington and Myrin (1995, http://nmnhwww.si.edu/arctic/html/tek.html) to analyze their knowledge about beluga whales. They studied the timing, location and movements of beluga whales around each community. How the status of ice, fish, wind, and presence of killer whales affected the belugas was described in detail. The researchers realized, during relaxed but intensive discussions with the local community members, that these discussions would veer towards some other subjects seemingly unconnected. The researchers tried to bring the discussion back to the topic but before they succeeded in doing that, they discovered a new connection. A structured inquiry would have made accessing such data impossible. For example, one digression was about beavers. Beavers, a local respondent informed, build dams in the streams where salmon and other fish spawn. When the beaver population expands, the spawning habitat of salmon may be reduced. In turn, this affects the belugas, which feed on salmon. Hence, as these authors pointed out, traditional ecological knowledge cannot be preserved merely by documentation. This requires combining knowledge with experience, which in turn means conserving the way of life which produced the knowledge. The same authors discovered similar observations by communities that live very far apart. For example, a community in Alaska and another in Russia both described how belugas assist a female in their group while giving birth: one beluga swims on either side of the female, helping to squeeze out the calf.

Aquatic Biodiversity in a Local Community Context

Chambers (1998) has reviewed the cultural conflicts that can occur over aquatic natural resources, with the aquatic example – the Japanese indignation at worldwide protests on their killing of whales. The Japanese counter with a question of their own, about the ethics of killing domesticated animals. Chambers thus asks: who is biodiversity conservation for? He found that conflicts are bound to arise whenever local knowledge, (cultural) and environmental values are at

variance with the values of a wider public, be it at multinational corporation, the international community, or a state.

Merculieff (1990), Commissioner of the Sea Otter Commission, Alaska, raised a fundamental issue about the politics of defining resource boundaries and the legitimacy of the particular ways of local people in dealing with these. Distressed at the poverty of many of the First Nation peoples of Alaska, he decried the tendency of 'Animal First' activists to deny such peoples their autonomy in pursuing a sustainable coexistence in their ecological context.? **Merculieff (in Gupta, 1991)** observed:

> "They do not understand that in their desire to protect animals, they are destroying culture, economic and spiritual systems which have allowed humans and wild life to be sustained over thousand of years... Theirs (Animal First activists concept) is based upon a belief that animals and humans are separate and they project human values into animals. Ours is based on the knowledge from hundred of generations which allows us to understand that humans are part of all living things – and all living things are part of us. As such it is spiritually possible to touch the animal spirit. In order to understand them. Our relationship with animals is incorporated into our cultural systems, language and daily lifestyles. Theirs is based upon laws and human compassion...Because we are intricately tied to all living things, when our relationship with any part of such life is severed by force, our spiritual, economic, and cultural systems are destroyed, deep knowledge about wild life is destroyed, knowledge which western science will never replace...I leave you with this last thought – we have an obligation to teach the world what we know about proper relationship between humans and other living things" (see Gupta, 1991a)

Sacred Waters

Biegert (1998) recalled striking narratives which contrast the perspectives of First Nation North Americans about waters with those of white settlers. He gave the example of the late Philip Deere of Oklahoma, medicine man of the Muskogee Nation, who termed rivers and streams as the veins of the world. Clogging them, one could say without doubt, would clog not just the in life in them but the life of humans as well. The sacredness of water in all such cultures indicates that by polluting waters we are also polluting the spirits that sustain these waters. Ecological indicators of aquatic life may be observed from terrestrial plants, showing the artificiality of separating the world into aquatic vs. terrestrial or floral vs. faunal. An example from Cree culture highlights a striking case of how a fish migration is forecast. Roue and Nakashima 1998) described a very productive fishery at Fort George Cree, on the first rapids of the La Grande River, for two species of white fish, cisco *(Coregonus artedii)* and whitefish *(C. clupeaformis)*. The Cree people forecast the return of these fish from sea to the La Rapids by looking at the flowering of fireweed, *(Epilobium angustifolium)* growing along the banks of the river close to the fishing sites. The Cree prepare their nets when these weeds flower. The same authors described a very rich knowledge system which has grown around the capture, processing, storage, and disposal of these resources and their byproducts. For example, fish scales are fed to dogs which are used for traction work. Regrettably, while locating hydropower dams, authorities did not pay heed to local concerns about conserving sites of economic, spiritual and sociocultural importance (Roue and Nakashima 1998). The fishing sites were sites not just for capturing fish but also lot for social exchange and the generation and sharing of knowledge. Similarly, Raygorodetsky (1998) details how the Gwichin **Nation** of North Western Canada select the best sites and times for fishing and use ingenious ways to utilize every part of the fish they collect. The communities have also evolved institutional arrangements to share nets and to share catches

of fish, like charr *(Salvelinus* spp.*)* with those who do not have access to these resources. For whitefish, elaborate arrangements existed for locating eddies at river tends where flow is slower and where fish congregate), for repairing nets, and for setting these under the ice for fishing in winter, after making holes in the ice.

Osseweijer (1998) illustrates some local knowledge and rituals associated with fishing in Aru archipelago, Indonesia. Tobacco offerings are made by to the ancestral keepers of pearl oysters and sea cucumbers before embarking upon diving. The Beltabur community leaders hold that the sanctity of sea has to be maintained by correct behavior, just as in our own backyard in the village. People are not supposed to make any noise, shout or engage in rowdy behavior while at sea. The ancestors of the sea might otherwise get angry and send big waves or strong winds as indicators of their displeasure. People have their own beliefs about the way retribution is provided for not following the rules of good behavior at sea. Osseweijer (1998) recalled a local belief that when two local communities were fighting about the rights over certain territories, the sea cucumbers became rare during that period, as if the elders in the community did not like the conflict.

Wallace and Steiner (1998) showed how local communities in Hawaii relate marine and terrestrial biodiversity. For some marine species, they recognize a counterpart terrestrial species. Dudley (1990) (cited by Wallace and Steiner 1998) described how this sometimes happened. In Hawaiian medicine, whenever one took a land-based medicinal herb, the first food to taken next had to be the marine species paired with this land-based herb. Polynesian culture, it seems, here by established such relationships between the use of aquatic and terrestrial species. This deserves the attention of policymakers, not just for its ethical, spiritual and cultural dimensions but also for its scientific aspects.

The Honey Bee Database

The Honey Bee Database **(1990-1999)** has been established ten years ago to scout, spawn, sustain, disseminate and reward grassroots innovators and experts in traditional ecological, technological, educational and institutional knowledge developed by local communities and individuals without any outside help. This data base can be accessed by innovators and others who am to empower them by adding value to their innovations and share benefits with the knowledge providers and innovators in a fair and equitable manner. Some examples of its entries for the use of plants in fisheries and aquaculture are given in Table 1. SRISTI members and the Honey Bee Network have been involved in the documentation, experimentation, and dissemination of indigenous knowledge, innovations and practices in the agricultural and animal husbandry sectors for 16 years, working closely with farmers, and using a variety of methods to document about 7,500 innovations and practices from 3200 villages in Gujarat (SRISTI 1996) and in other parts of India. In addition, innovations have been documented from local communities in many countries in Africa, Asia and Latin America. Through the Honey Bee Newsletter, grassroots innovations have been disseminated to more than 75 countries. This has produced probably the world's largest database on grassroots innovations, with name and address of the innovators (individuals or communities) and communicators in most cases.

This database has seventy one entries on the traditional use of fish and fish products, wastewater etc., for curing animal diseases, improving crop productivity (grape vines are supposed to particularly benefit from fish compost) etc. Such local knowledge about aquatic diversity and its uses has not been adequately appreciated and there is a strong case for launching a global drive to strengthen efforts in this direction.

Table No 1

	Market dominated	Nature dominated
1. Communication system	Digital	Analogical
2. Pooling of resources	Very low	Very high
3. Reliance on common properties	Low	Very high
4. Settling of books of account	Very short term	Long term
5. The proportion of women headed or managed households	Very low	Very high
6. Women participation rates	Very low	Very high
7. Reciprocities	Specific	Generalized

Source: Gupta, 1992, 1995

Biodiversity, poverty and knowledge erosion: incentives for conserving diversity, and related knowledge, innovations, skills and institutions

Biodiversity cannot be conserved by keeping people poor even if, historically biodiversity survived largely under such conditions (Gupta 1990). Our studies **(Gupta, 1989, 1991,1997)** have shown that many of the communities which conserve diversity have remained poor because of their superior ethical values. This happens when many healers refuse to demand or accept any compensation or payment for their services provided to individuals with in and outside their community. Further, when they decide not to pluck more plants that are necessary for immediate use, they forego an opportunity of accumulating wealth by processing the herbal diversity in larger quantities and sell or dispense it to others for consideration. There are others at the same time (inlcuding local people as well as large corporations -national as well as international) who have no hesitation in extracting biodiversity without taking care of regenerating the same. The challenge is to modify ethical positions that threaten biodiversity and, at the same time, to ensure improvements in livelihood prospects for indigenous peoples, through the implementation of CBD. These communities will then continue to conserve biodiversity along with their associated ethical and cultural values.

The rate of erosion of local knowledge about biodiversity has never been so high as it is in the current generation in areas which did not go through large scale annihilation of local tribal communities as happened in many Latin American countries or in African countries through influx of Missionaries. There are several factors which explain this: changing structure of families from joint to nuclear, consequently weakening links between grandparent generation (having much of this knowledge) and grand children generation(the parents' generation is alienated from this knowledge systems already due to heavy influence of modernity), lesser esteem for this knowledge in primary school curricula, transition from oral to written culture and inability or unwillingness of many older healers and herbalists to share this knowledge or agree to its transcriptions, or do it themselves, unwillingness also arises in many cases because the outsiders like ethnobiologists have extracted the local knowledge, commercialized it or published it without any attribution and reciprocity or benefit sharing and thus offended local communities. Knowledge erosion is a threat as serious as resource erosion it self. Reasons are obvious. If there is no knowledge about given resources, plants become weeds. It becomes not only difficult to locate what is useful or known but also incentives for conserving what is not known go down. In ecological economic terms, the option values decline if the probability of finding some thing useful in current generation is lower because of loss of knowledge about resources. Conserving biodiversity without conserving associated knowledge systems is thus like building and maintaining a library without a catalog. It is true that users of such a library might in fact develop a catalog over a long period of time but meanwhile the users would suffer. By analogy, biodiversity users, without a knowledge base, will not benefit from centuries of experimentation and knowledge accumulation by local communities and indigenous people. It is true that formal scientific knowledge of plants and animals is diverse and rich. However, the bases upon which different communities have classified and organized their knowledge as well as practices, are similarly complex and dynamic.

There are three crucial assumptions underlying this perspective. First, not all knowledge, innovations and practices prevalent in a community are communal in nature. There are individuals who have great expertise in various aspects of local knowledge that is not known at all or known only partly to the local community. Second, not all the knowledge in use by a community is traditional in nature. There are many examples of contemporary innovations by local communities, developed collectively or individually. Third, local knowledge can be conserved perhaps in a more sustainable and dynamic manner (that is in a manner that it grows through constant experimentation and innovation rather than just be maintained as a fossilized form of historical knowledge produced at one point of time and carried forward by succeeding generations) if the associated cultural values and ethical institutions contributing to conservation of biodiversity are also conserved and/or strengthened. The implications are obvious. Incentives for the conservation and sustainable use of biodiversity will have to be sufficiently flexible and diverse so as to provide for the growth and development of the traditional as well as the contemporary knowledge that is held by individuals as well as groups. The same or similar incentive structures or philosophical assumptions cannot provide adequate motivation to conserve what exists and restore what is lacking. Devising appropriate incentives is challenging because many local communities lack access to some basic needs and are impoverished. Factors that have contributed to this linkage between high biodiversity and poverty are discussed by Gupta (1989, 1991a, 1993). SRISTI (1993) has noted the following factors (see also Gupta, 1990, 1992).

(a) The biodiversity is high in the rain forests, mountains, some of the arid and semi arid areas, humid areas, primarily due to diversity in soil, climate and other physical and social structures.

(b) The poverty is high because markets are often unable to generate demand for diverse colors, tastes, shapes and qualities of natural products. Products of mass consumption particularly when processed by machines have low variability because throughput by machines has to be of uniform quality and maturity level (for instance for processing tomatoes to make ketchup, local varieties will not be suitable because these are not synchronous in maturity, have uneven ripening status and thus, taste, color and flavour can not be standardized). The cost of inventory, transportation, display in shelves of a large varieties of say tomato is obviously quite high compared to only one of few varieties. Consumers who do not demand larger varieties either because they have not been exposed to the same or are unwilling to pay the extra costs, also contribute to lower demand of biodiverse products.

(c) The regions of high diversity also have very poor public infrastructure (just in tandem with weak private market forces) because the people have limited surplus to attract public servants, and they are less articulate and organized to create political pressure (except through insurgent movements as is becoming evident from different parts of the world).

(d) The low demand for ecological and technological skills of these communities characterizes them as 'unskilled' labor fit for being a part of the urban slums, squatters, or other similar work force. Once the knowledge system is devalued, the cultural and social decline follows. The tenuous relationship with the nature is ruptured. The ecological degradation spurred by various external resource extractors is aided and abetted by many poor as well as not so poor people for whom survival in short term seems possible only through eco-degrading strategies. Thus when demand for local biodiverse products (main items for the communities to dispose off) is low, exchange value thus is also low, consequent purchasing power is less, poverty is bound to follow. Supply of basic needs also gets constrained due to administrative and political apathy towards people in these regions where population density is low and thus number of votes and other kinds of political pressures are less.

To overcome many of these constraints, four kinds of incentives have been proposed (Gupta, 1991, 1995, 1997):

The matrix resulting from the interaction of two variables a) nature of reward, whether material or non-material and b) target of reward, whether individual (including group of individuals) or community provides the framework for designing these four incentives for rewarding innovations.

Forms of Reward

Target of Reward	Material	Non-material
Individual		
Collective		

I INDIVIDUAL –MATERIAL

These rewards are in material form such as patents, copy rights or trademarks, user fees, royalty, monetary reward, fellowships, land assignment or equipments, etc., to individuals.

These could arise from those who license technologies of herbal or animal based recipes by local individuals or educational or research grants etc.

II INDIVIDUAL - NON-MATERIAL

Documentation, coverage in press, TV and other media, Public felicitation, Invitation to lecture in schools, centres of learning and research. Invitation to conferences, workshops attaching name of innovator to the innovation (an incentive frequently used by the local communities themselves, photographs being placed in village or district councils, access to new skills. SRISTI has been giving SRISTI Sanman (honour) for last five years to outstanding innovators at grassroots level.

III COMMUNITY – MATERIAL:

These are relatively quite important. The rewards in material form to communities or group of people help generate right signals for mobilizing collective action so important for conservation. The instruments of such rewards could include risk funds, trust funds, priority in the development or allotment of infrastructure such as schools, health care system, access roads etc., Free or easy access to data banks, access to external expertise, Community awards, Community grants/ risk funds, External aid in developing common property assets, Marketing intervention for organic produce etc.

IV COMMUNITY - NON-MATERIAL

These are rather difficult to implement but may have quit endurable impact particularly when the rewards change the values of the communities in positive direction. Rewards include policy changes to ensure greater control over local natural resources, removal of perverse incentives (that is indications which encourage non sustainable use of resources) for conservation, favourable policy environment for eco-friendly products, conservation practices, media attention, community awards, capacity building through transfer of technology, building up of negotiation skills, pedagogy changes, inclusion in the curriculum of lessons which raise social esteem for local eco-friendly practices and innovations etc.

The magnitude, manner and form of incentive or benefit may influence the degree of involvement of the local communities or individual innovators in future projects of biodiversity conservation.

- Incentives could be in cash or kind, conditional (linked to research) or unconditional
- Community incentives could be of direct nature or they could be indirect. They could be provided at one point in time or over an extended period of time.
- Incentives could be provided by external agencies or by the local communities themselves. The improved status of the innovators on account of social recognitions may or may not be associated with greater say in decision making at the societal level.
- Incentives may focus on empowerment of local communities so that they may have better negotiating skills and better knowledge for conservation of local resources. Alternatively the incentives may be targeted directly at conservation. Incentives targeted at community may lead to action either at the community level or even at the individual levels.

The concern for local knowledge has been there for a long time. Singh and Varma (1969) asked a question about the continued relevance of indigenous knowledge, in the context of animal husbandry. The modern health system for human beings was quite weak. For animals it was even weaker. Local communities even today rely in many parts of tropical developing world on local knowledge of animal husbandry. This is indicative that mainstream education and public policy still do not give due attention to the peoples' knowledge system. One implication of this is the downgrading of that knowledge system in the eyes of young people of the same community. Once esteem for local knowledge goes down, there are less incentives for young people to acquire that knowledge and to experiment and rejuvenate the same. This leads to serious discontinuities in the intergenerational flow of knowledge. Once the "local experts", the older generation, are gone and there are no successors, the knowledge held in trust by those individuals for future generations is lost forever. Young people are not acquiring the skills of local experts because of a lack of incentives. However, some of these skills might lead to new career options; for instance, the skills of restoring the health of the degraded lands, water bodies or forests as international conventions and their implementation gain momentum.

The failures of the State delivery system to consult local communities, including local experts, before implementing large-scale projects intended to benefit the rural poor, have often led to adverse impacts on livelihood and survival strategies of local communities. The existence of perverse incentives such as subsidies for non sustainable technologies (free electric power in many Indian states leads to excessive withdrawal of ground water and its use in inefficient manner) has also blocked the efforts of local innovators and conservers who are interested in developing and promoting sustainable natural resource practices. The near absence of a legal and institutional framework to implement incentives for biodiversity conservation has led to overexploitation of diverse biological resources by the corporate sector, as well as by other users, without compensating indigenous peoples.

Knowledge systems for survival and sustainable biodiversity management

It has been generally believed that the knowledge systems of local communities and indigenous peoples are holistic in nature. Centuries of association with an environment have produced a deep understanding of the interrelationships among the different elements of a landscape or a habitat. Because fluctuations in the environment require adaptive responses, communities have developed a wide range of diversified survival strategies at intra and inter-household levels and at community level. However, local and indigenous knowledge systems, while generally holistic, have some reductionist elements. In order to cope with the complexity of ecological change, some people in the community specialize by knowing more and more about less and less. Such specialized expertise requires focusing, targeting and steering strategies on specific themes or aspects of nature. A good archer may be good because he/she does not look at all of the interconnections between target, the wind and the world around it.

So-called Western science is biased in favor of reductionist relationships, whereas local knowledge systems are biased in favor of systemic linkages and an holistic perspective on nature. Where efficiency of resource use has to increase, for coping with increasing population pressures (where applicable), scarcity, fluctuations in the environment, or other contingencies, a blending of formal and informal science may be necessary. Achieving sustainability in resource use requires the fusion of sacred with secular, formal with informal, and reductionist and holistic views.

The production of knowledge and its application takes place in a given socioecological context, through innovations over a long period of time. It has been suggested that this context influences and to some extent shapes the world views of people, which in turn influence the heuristics used for generating new solutions and knowledge (Pastakia 1995). The heuristics are like decision rules which also are accompanied with criteria of choice. Local and indigenous knowledge system are not static. They evolve, adapt and transform dynamically with time. New materials are incorporated, new processes are developed and sometimes new uses or purposes are evolved for existing knowledge as well as the acquisition of knowledge. Hence, there is a need for rewarding not only traditional knowledge but also contemporary innovations. The concept of Traditional Resource Rights (Posey et al. 1995) implying recognition of the primarily customary rights does not do full justice to the individuals who are responsible for contemporary creativity and innovation. Depersonalizing the process of knowledge production and reproduction, limits the type of incentives considered and results in resources ending up only in the hands of governments or, in rare cases, of local community leaders. Moreover, communities that have kept local experts poor, by not valuing their knowledge systems adequately, are unlikely to pass on to them externally-generated incentives. A homogeneity of local communities and a convergence between the interests of local community leaders and those of local experts are often assumed, but this is difficult to accept. The asymmetry in knowledge systems and related power differentials are apparent in discourses on incentives and consultations. These have been dominated by so-called representatives of indigenous communities, though of western origin, both in terms of numbers and ideas. For instance in various consultations by UNEP and CBD the local communities are largely represented by the more articulate indigenous people from western countries. Many communities have suffered in the past and *they* should be heard. To anyone familiar with the miserable conditions in which most local communities live and strive to conserve biodiversity and associated knowledge systems, it should be obvious that their problems and concerns are very different from those articulated at most international fora. Moreover, the concerns of local experts and innovators within impoverished communities may be very different from those of the rest. of the people. How can their concerns be heard and addressed?

Many international consultations and studies on knowledge systems have identified a need to distinguish among different types of knowledge and recognize the need for building bridges between local or indigenous knowledge vis-à-vis formal scientific knowledge(e.g. Atte 1989; Gupta 1989, 1991a, b, 1995, 1997,1998, SRISTI, 1993, Honey Bee1990-99, Skolimowski, 1981, Berkes 1988, Warren, Slikerveer and Brokenshaw, 1995. Both formal and informal science are capable of producing abstract as well as practical knowledge, although the latter tends to produce more of the practical kind. Different incentives might nurture different type of knowledge. However, the same knowledge systems can pursue different functions simultaneously, in various combinations. For instance, a fishing community might use classificatory skills to deal with variations in the movements of fish and locations of spawning sites. It might use indicators for spotting the sites where fish would be found in abundance at different times of the year. It might have to use systemic linkages to relate temperature, wind velocity, turbidity of the water and behavior of the fish, to decide how far to go in the ocean without courting too much risk or uncertainty. One way to understand the complexity of knowledge systems is to link the functions of nature with processes of sense making i.e. drawing meaning from empirical observations. Berkes provides a strong argument for sensitivity in 'sense' making. He observes (1988),

> The traditional ecological knowledge of the Cree is empirical knowledge, as in the observations of the "disappearance of animal in extremely cold weather, the way black bears try to cover their tracks before denning, the sensing and the avoidance of (predatory) otters by the fish. However, the "sense" the Cree make of empirical

> knowledge is not scientific, mechanistic, or analytic (re:Skolimowski,1981). That is not to say that the Cree approach is either superior or inferior to the Western scientific one, but it is different.....the Cree model of caribou cycles shows a better fit with the actual caribou population dynamic in Quebec – Ungava Peninsula than does the current scientific model.

Diversity, complexity, simultaneity and change in ecological systems are codified in knowledge and practices through language and culture (Gupta 1989). Just as Inuits are recognized as having highest number of words for classifying snow, fishing communities have many words for distinguishing and discriminating different kinds of sea conditions, fish spawning sites etc., (Johannes, 1981). Conceptually, any community, which is dependent upon a resource for its survival, has to develop a pattern or a set of categories to deal with variations in the availability of that resource. For example, farmers have a rich taxonomy for clouds and soils and, in some cases, for insects and other animals. Leather workers have taxonomy for leather, carpenters for wood and likewise fishing communities for water and aquatic life.

In the context of the CBD, its very important to understand and to appreciate that different indigenous and local communities develop knowledge systems through a tradition of invention and also develop languages through which to articulate their knowledge systems. If a language dies, a knowledge system partly or completely dies with it. Hence, conservation of language becomes a crucial factor for conserving taxonomies because each word, conceptually speaking in the context of a natural resource, is a category. Modern science will benefit a great deal and so will the ability of humans to understand their environment and cope with it, if the scientific basis for these categories is better understood. The etymological roots of different words might elucidate the process of codification of knowledge over time in languages, as influenced by exogenous knowledge systems migration, and wars and other social interactions. Palomares, Garilao and Pauly (1998) provide an interesting study of local names of the fishes in Philippines drawing upon FishBase data base maintained at ICLARM. They present a rather counter intuitive insight that in subsistence fisheries fifty per cent species did not have Philippine name where as in commercial category, as many as almost 90 per cent had such names. Since the number of species in subsistence category was only 34 as against 455 in commercial category, the difference may be explained by the possibility that subsistence category of fish were not so crucial to survival of a community. But commercial category were apparently very crucial and thus the variety of names.

Formal science, in its effort to generalize over large time and space boundaries, often masks finer categories. Indigenous knowledge systems (LKS) often do the opposite. LKS help in distinguishing small variations in phenomena and do so within relatively speaking, small habitats. Higher the extent of local fit of a resource management strategy in LKS with local environmental conditions, lesser may be the negative externalities on the environment. But it also means an inability or limited ability of local community to deal with wider connections. For the sustainable development of this planet, both telescopic and microscopic visions are needed: ability to see connections among larger systems and also to appreciate interconnections at micro levels; in other words, we need both reductionist science and an holistic vision. Functional and causal knowledge systems are different. Farmers have been known to do right things for wrong reasons. Their practices do not become invalid merely because a supposed causal connection has no known factual basis. Even in modern science, there are effective medicines for which the causal mechanisms came to be known only after a long history of use; e.g., aspirin. A knowledge system should not therefore be downgraded merely because of such limitations. Rituals and some symbolic totems may be ways of constraining particular healing strategies lest they be used in inappropriate cases, doses or situations. A marriage between local and exogenous knowledge and between formal and informal science will succeed only on the basis of reciprocal respect and a

well-deserved restraint in exploring their logical bases. Hence, many local knowledge systems emphasize the questions that should not be asked rather than those that should be. Modern minds reject such boundaries to inquisitiveness, but the sacredness of certain kinds of knowledge rests on faith and its power. It is true that superstitions particularly those that cause definite harm to local communities as well as those that generate other kinds of social or ecological biases, have to be tempered with a scientific attitude. It is not easy to determine when faith becomes a source of superstition. Thus, there is a great need for exercising care in understanding and especially in attempting to influence local conservation practices. In their attempts to unravel the mysteries underlying local faiths, outsiders can erode the power of local experts and institutions without putting anything better in their place. Reductionist knowledge by itself has rarely generated the social responsibility required to guide collective behavior towards conservation. The sacredness of certain sites, species and symbols must be respected even if modern minds find this incomprehensible or even irrational.

The production and reproduction of knowledge

The process of local knowledge production and reproduction may differ. Production of local knowledge can be through (a) discovery of problem-solving on a small scale or in an episodic manner and (b) through interaction with wider knowledge systems, ranging from networking with kith and kin to networking with external partners etc.

In a dynamic knowledge system, some knowledge is lost when it becomes redundant on account of changing perceptions of needs, changes in access to resources, and changes in socio ecological conditions. In a vibrant culture, much of the knowledge that is passed down from one generation to another depends upon social structures and the needs of changing times. Knowledge related to livelihood strategies is embodied in practice. Once the livelihood strategies themselves undergo change due to reduced or modified access to the underlying natural resources as has happened in most developing countries, the LKS get fragmented and also become inadequate to take care of given resource in a sustainable manner. Cultural knowledge is embedded in rituals, folklore, art and other cultural and social artifacts and processes. Some other specialized forms of knowledge such as making and retting nets or making fish traps may be reproduced by local experts individually rather than at community level in a given community.

Knowledge that is embodied in practices usually takes the form of skills which are learned. Skills can be repetitive and non-repetitive. Judgmental skills are often scarce. Individuals who possess such skills may become recognized as local experts. Examples of such judgmental skills are weather forecasting, judging the quality of diamonds (diamond polishing using labor intensive methods has grown into an important off-farm employment in many of the villages of Gujarat, India) cattle judging, and diagnosing human and animal ailments and problems of soils, lakes, finding out potential sites with rich fish population etc.

The Performance of Indigenous Knowledge:

The performance of indigenous knowledge has been reviewed by Richards (1987). Performance from an indigenous perspective might include a number of criteria that are considered by formal science as less relevant: e.g., risk management, contributions to system maintenance, soil health etc. The same practice could have different impacts on the natural resource base depending upon the criteria emphasized by a community while deciding appropriability of a practice in given cultural and spiritual context. The values underlying the choice of a criteria serve as a guide for dealing with each other (social equity), with non human sentient beings and with nature (ecological responsibility) and super-nature (ethereal or spiritual beliefs). For instance bowhead

whale which was a protected species for 65 years was allowed to be killed by Canadian government in July 1998 for consumption as well as ceremonial purposes by a Inuit community. Bowhead Traditional Knowledge Study coordinated by Keith Hay of Nunavat Wildlife Management Board revealed existence of 350 bowheads rather then "few tens" believed by the scientists. This number made permission for killing one whale a year for ceremonial purposes quite sustainable. Such an approach was gaining ground in Canada's public policy a great deal, observed Daniel Buckles with International Development Research Centre (New Scientist, October 17, 1998). Traditional knowledge embedded in culture and embodied in practice serves as the mechanism to preserve and pass on sustainable livelihood strategies to future generations.

Communities give expression to their belief systems, norms, values, and ideologies through folk art, crafts and rituals, taboos, myths, symbols etc. These values are also reflected in their livelihood strategies which are also closely woven with local institutions, social networks, kinship networks and knowledge systems.

The ecological context in a given region or for a given community defines the nature of environmental risks or threats. A drought, a flood, erosion of biodiversity or an increase in salinity levels are examples of threats. The regions that have low exposure to such threats are preferred by markets and are therefore at an advantage, in land based community strategies. Given the low transaction costs of exchanging resources in these regions, the adaptive responses of their households are fast. Their social structures are also different to those of disadvantaged regions that have higher perceived or real exposure to risks or threats. In Table 1, we have enumerated the key contrasts that characterize the advantaged (market-dependent) and disadvantaged (nature-dependent regions).

The market dependent communities are the ones in which most exchanges are mediated through markets. The commoditisation of labor, product and skills is high. In contrast, the communities that draw their major sustenance through use of natural resources, often without much value addition, are defined here as nature-dependent communities. The regions where each type of community predominates are also contrasted here. The market-dependent regions are the high growth green revolution regions, commercial fisheries while the nature-dependent regions are rainfed drylands, hill areas or forest fringe areas and small scale fisheries.

One particular dimension of this contrast between nature-dependent communities and market-dependent communities is like comparing analogue and digital systems. Many local experts have a symbolic language through which they communicate their understanding of a problem. Many scientists and policymakers do not appreciate this basis of communications and jump to the conclusion that such expertise involves more 'mumbo jumbo' than actual skills. In some cases, this might be so, but to generalize this over entire packages of traditional knowledge in contemporary institution contexts is quite unfair. The persistent neglect of traditional ecological and technological knowledge as well as contemporary creativity of local communities and individuals needs to be avoided. The bridges between knowledge that has evolved through several generation of interaction between humans and nature one on hand and the western scientific scholarship evolved over few centuries only will enrich both. The fair trial of contemporary creativity by formal scientists will enlarge the repertoire of those institution builders who want farmers and fisherfolks to have low cost nature friendly technologies coupled with institutional structures restraining greed and unleashing respect for the rights of unknown and unknowable (that is perfect strangers like future generation.

Communities and individuals who have long conserved biodiversity **HAVE** not done so entirely on the basis of an utilitarian logic. The efficiency of ethics may sometimes be tempered by the inefficiency of technology which local communities use. That is while the local communities may not like natural resources to be exploited beyond their sustainable limits, they may use non sustainable and inefficient technologies. Use of such technologies in the wake of unfair competition with well equipped marker forces may lead them to use dynamite kind of destructive technologies for fish catch. Extractive uses of biodiversity could be sometimes less conducive to the long-term conservation of a species, even though the norms and values guiding the extraction may be very noble. This happens when poachers combined with impoverished local communities may bring a species to almost extinction even though local extraction may be much less than outsiders. Once ethical values, cultural norms and belief systems become weak, the inefficiencies of extraction methods may start generating negative feedback effects. That is, the restraint for extracting diverse resources within their sustainable limits becomes weaker. The important point to note is that improvement in technical methods may not necessarily lead to evolution or restoration of ethical norms. The challenge thus is to devise incentives that fulfill four conditions of sustainability: (1) access to biodiversity for local communities, so as to ensure their sustainable livelihood systems, should take priority over access for outside institutions or individuals; (2) assurance to individual healers or other local experts, communities and other stake holders of sustained access to the resources and viable collective responsibility for using biodiversity; (3) blending traditional skills/abilities to convert biodiversity resources into investments with or without value addition; and (4) conservation of cultural lifestyles and value systems in such a manner that basic needs are met without impairing the life support systems of local communities.

Unless arrangements are made for sharing value added knowledge and benefits from value added gains(made possible by converting local knowledge into economically profitable investments or enterprises) and other learning made in the process in the local languages and in an easily understandable manner, the collectors have no ethical right to collect more of such knowledge. Codes of conduct for genebank managers, researchers, funding agencies, and other development managers should provide for such sharing in an unequivocal manner. Local communities have already paid a heavy price because the designers of dams, hydropower projects, waterways, commercial prospectors of biological resources and landfill programs that have damaged wetlands have ignored their knowledge and institutions. These communities must not be robbed of the only resource left with them; i.e., their knowledge.

Some concrete actions that can invigorate ongoing efforts to build upon local knowledge about aquatic resources are:

* Changes in methods and curricula, at different levels so as to incorporate insights from local innovations, ecological knowledge and institutions in education for conservation and sustainable use of biodiversity;
* development of a bold global program to document, to disseminate (in local languages), to experiment with and to add value to local knowledge, as, for example, in the Honey Bee Network;
* multimedia and multi-language databases on local knowledge, creativity and innovations to encourage people-to-people learning and also as an incentive measure to encourage local communities to share their knowledge;
* development of knowledge networks, to link local creative communities, using various media, so as to help lateral consultations among the people, experts and policy-makers;
* documentation of ecological indicators, to monitor the health of aquatic ecosystems sharing this information among stakeholders and validating it through participatory research;

* prioritization of benefit-sharing mechanisms that build bridges between excellence in formal and informal knowledge systems; with non-monetary incentives given as much importance as monetary incentives, both for individuals and for communities;
* incorporation of local knowledge in developing descriptors of aquatic germplasm.

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TABLE - Examples of local knowledge on fisheries, from the Honey Bee Database

Staining Fishing Nets.

details: Kesari colour and salt solution are used for staining nets. The process consists of dissolving 400 gms of pakkadaaneka rang (kesari) in about 50 litres of boiling water and then two kilograms of salt mixed thoroughly. This is sufficient for staining eight to ten nets weighing eight kilograms each. After this, the nets are to be dried. The freshly knotted nets should be stained within 90 days after the first staining and repeatedly stained whenever the nets get bleached, which is normally two times a year. This method, fisherfolk say, increases the life of the fishing nets. Source Honey Bee 7 (4) 1996.

Preservative for Fishing Nets.

details: The bark extract of *Terminalia tomentosa* is used as preservative for fishing nets. The preservative is made by boiling bark in water. Later the extract is filtered and the fishing nets are dipped in the filtrate. After treating they are dried in the sum. This process has to be repeated three to four times. The fisherfolk point out that this treatment helps in keeping rodents away from the nets, imparts antifungal and antibacterial properties, and it is inexpensive and efficient. Sri Chandrahas Shankar Takikar, Shashi Shankar Takikar and Vishnu Shankar Takikar, Shedikuli village also highlighted the practice of washing fishing nets in saltwater and then in freshwater, later dried in the sunlight.

Fishing-Plant Products for Killing of Fish

details: Sometimes to catch fish on a large scale, tribals use various parts of different creepers and trees as fish-killers. This method is used in streams carrying a larger number of fish and when it is possible to stop the water-flow for a short time. Any of the following may be used: i) Bark of 'chinara' ii) Leaves of 'punja' iii) Plant of 'agari' iv) Fruit of 'gala' v) Plant of 'chido' along with root. One of the above is pounded on stones near the stream and suspended in the water after stopping water flow with bunds made of branches, clay and stones. The fish die soon and they are picked up manually or with a net like scooping implement of bamboo know as 'aswo'. Among all these plants, 'chido' is extremely poisonous for fish. The quantity of material used generally depends on size of stream. Honey Bee 4 (2 and 3): 24, 1993.

Protecting fishes from 'ood' (other) attacks subject: Fisheries.

Details: In almost all the districts of Assam, India the otter 'ood' (English name: *Lutra lutra)* attack fish in the ponds causing a heavy loss to fish farmers. Sri Hussain Ali Master of Ambagan area of Nagaon district of Assam has protected his fish by growing turmeric on the embankments of his fisheries. He says that odour of the turmeric leaves keeps oods away from his pond. His idea has been copied by many others in the area. Honey Bee 1 (1) 1995.