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USE OF INDIGENOUS KNOWLEDGE IN ENVIRONMENTAL DECISION-MAKING BY COMMUNITIES IN THE KUMAON HIMALAYAS

A Dissertation in

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by

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ABSTRACT

This study is designed to find out how people in rural communities residing in the middle Himalayas use indigenous knowledge to support environmental decisions while addressing water and land use related concerns. The study not only serves to enrich our understanding of community decision-making, especially as connected to land use and ecological issues, but also helps us understand how youth in village communities in the Himalayan bioregion negotiate a balance between indigenous and exogenous knowledge.

Using qualitative methods including interviews, field observations, and focus groups, the research examines discussions and activities leading to decision-making about environmental issues in the communities residing in the Kumaon region of the middle Himalayas of India.

The study helps answer the following questions:

- In the Kumaon region, what is the relevant indigenous knowledge used to make decisions about specific environmental issues such as land management and water management?
- How much of this indigenous knowledge is used by adult community members while making decisions about the environment?
- How much of this indigenous knowledge is passed on to the future generation (process of intergenerational knowledge transfer)?
- How will youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?

In answering these questions, this study serves to deepen our understanding of how communities in the Himalayas balance the influx of modernization/globalization and engage in decision-making toward environmental sustainability. It supports a better understanding of how to design curriculum and environmental education programs for learning in communities of the

Himalayan bioregion, and perhaps also offers some valuable direction for designing environmental conservation and education programs for the developing world.

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To my son

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Whose smile makes life worth living

Chapter 1

Introduction

Indigenous people around the world have struggled to keep their unique approaches to life and traditional knowledge systems intact with the advent of industrialization and, more recently, globalization (Agrawal, 2005). They have adapted and blended their values, beliefs and practices to subsist under a dominant mainstream society (Rogers, 2003). Most of this knowledge has its roots deep in the places they inhabit, and thus is extremely localized. Ethnographers and other social scientists have started to recognize that people in the "non-Western" world have their own science and practices grounded in this knowledge base (Sillitoe, 1998).

Although indigenous knowledge systems are often very different from the widely accepted western knowledge systems, it has been observed that they play a crucial role in local-level decision-making within areas of agriculture, education, resource management, health care, and many other community-based activities (Kellner and Bosch, 2002).

This study is designed to find out how people in rural communities residing in the middle Himalayas use indigenous knowledge to support environmental decisions while addressing water and land use related concerns. The study not only serves to enrich our understanding of community decision-making, especially as connected to land use and water issues, but also helps us understand how youth in village communities in the Himalayan bioregion negotiate a balance between indigenous and exogenous knowledge.

The study tries to shed some light on the processes of intergenerational knowledge transfer. The processes of intergenerational knowledge transfer are especially critical for the survival of this crucial knowledge base as indigenous knowledge is usually excluded from any formal schooling system (Duvall & Zint, 2007), but is often passed from generation to generation

through traditional methods like storytelling, singing, religious ceremonies, village council meetings, women's group meetings, etc. (Aikman, 1999). With the advent of industrialization and colonization, formal education in most developing nations became a force to produce clerks, administrators and managers. This knowledge system based on western values did not hold the indigenous knowledge system in high regard. Western influxes thus created a myth that indigenous knowledge is unscientific and backward (Gupta, 2007), and the system of transferring indigenous knowledge from one generation to another began to fall apart. As a result, formal education became more classroom-focused, and soon the gap between community and schools began to increase (Niraula, 2007).

This phenomenon of the increasing gap between community and schools exists in the Kumaon region of the Himalayas. In order to help bridge this gap, the Uttarakhand Seva Nidhi (a local NGO) introduced an environment education curriculum into the school system. The curriculum is called *Our Land Our Life* (OLOL). OLOL focuses on local issues, and the embedded pedagogy within the curriculum tries to address the concerns of the rural people in the Kumaon Himalayas. The course currently runs in all the state government schools as the state government of Uttaranchal adopted this curriculum as the official environment education curriculum. The course is implemented from 5th grade to 9th grade (5yrs) and tries to link people's livelihood issues as related to land, water, fodder, crops, trees and other ecological elements to formal education received in schools.

Even though this existing curriculum links local issues to formal schooling, the gap between communities and school still exists and although OLOL focuses on local environmental issues and discusses these issues within the context of local empowerment, it is the only part of the entire school curriculum that focuses on local issues. Therefore, in the Kumaon region, as well as in other parts of the rural Himalayas, in spite of OLOL being part of the official curriculum, the school is often perceived as an agent that introduces the youth to outside

knowledge that is very different from the existing culture and tradition in the region (Jackson, 2003). School education is viewed as a vehicle that provides the youth with resources to help them make a life outside of their village community (Shiva, 2000). The youth who go through a formal education system lack the knowledge about traditional practices that feed into a system that provides sustainable livelihood to the village communities (Goonatilake, 2001). As Pande (2001, pp 48) points out, "In their haste to run away from the village, the young men and women do not seem to have the time to understand their own village and their own people, neither do they receive any orientation towards this in school." For example, in Maichun Village in the Kumaon region, *Palta* was a community activity that involved the entire village community coming together and making compost for their agricultural fields. The practice not only strengthened community bonds but also provided quality fertilizer for agriculture. Jackson (2004, pp 96) observes that "The young youth in the village do not see compost as a resource for sustainable agriculture. In fact, they are ashamed of working on the land: the girls for aesthetic reasons (*nail paint would be spoiled* and the *compost stinks*- were some instant remarks from girls) and the boys for livelihood (*what will we do in the village? We go to the city, earn money and live comfortably*- the boys say). Several families in the village now complain of declining agricultural yields, so much so that "food is not even enough for six months in a year."

The example clearly points out that since the indigenous knowledge is not passed on to the next generation through the intergenerational knowledge transfer system and since most of the formal educational system does not focus on traditional practices, the sustainable livelihood in the village is impacted. Pande (2001, pp 51) also adds, "These impacts were too small to be noticed in the village in the early stages and when they became apparent and obvious for everyone to notice them, it requires resources, the time, and knowledge to regenerate or improve them- a task that nobody in the village can do alone." Therefore, my study holds significant relevance in not only documenting the existing indigenous knowledge but also in looking at how the villagers

might beneficially reincorporate this knowledge into their lives.

What is indigenous knowledge and why is it important?

Indigenous knowledge (IK) can be defined as the process through which the natives of an area have built a relationship with their natural environment (Semali & Kincheloe, 1999). Thus indigenous knowledge is developed over time and tied to a certain community. The community can be urban, rural, nomadic, or tribal (IIRR, 1996). Indigenous knowledge is dynamic, as each generation chooses to adapt the knowledge to suit their needs and values (Agrawal, 2005). But indigenous knowledge is unique to the place and thus is tied to the context. The IK system is often tied to the sustainable livelihood of the people. Generally, the system supports environmental sustainability because it represents generations of observations, analysis, and experimentation. Thus IK provides a powerful problem-solving mechanism for local communities (Tella, 2007).

Indigenous knowledge is often seen as competing with what is called "western modern science" (WMS) or the broadly accepted international knowledge system (Maurial, 1999), but this need not be so. IK and WMS are distinct but overlap considerably (Agrawal, 2005). Each is valuable within its own context (Shiva, 1997). Both of these knowledge systems can complement each other while working toward a common goal such as sustainability (Berkes, 1999). For example, in Colombia, while designing a protocol for wildlife management, conditions were created so as to have an intercultural participatory negotiation process that combined indigenous and Western approaches to wildlife management (Ulloa, Rubio-Torgler and Campos-Rozo, 2004). In this case, indigenous knowledge complements WMS to play a very important role in conservation and sustainability practices within an area. The above example also employs IK to incorporate various subject areas necessary for building a sustainable community practice. The subjects that were taken into consideration were as follows:

- Traditional ecological knowledge: Knowledge about plant communities and associations

(what types of plants can grow together?); knowledge about ecological indicators (plants and animals that can provide information about changing ecosystem processes, e.g., migration of birds associated with seasons); and knowledge about medicinal plants (Bhagwat et al., 2005).

- Social systems: Faith and belief systems play a very important role in every community/society. Thus, beliefs such as sacred groves (holy forests) provide a conservation strategy to maintain a healthy ecosystem. Also, folk tales and stories that are traditional methods of communication are important educational strategies (IIRR, 1996).
- Technology: Equipment for farming (animal-driven ploughs); pots for cooking (made out of clay); and housing material (title roofs, mud walls, and floor varnished with a mixture of cow dung and terra-cotta clay slurry to ward off flies) (Direct observation from prior field trips, 2006).
- Agriculture: Seed saving; natural fertilizers (cow dung); and natural irrigation systems (trapping rain water) (Shiva, 1997).
- Education: Traditional instructional methods (participation of the community); observing and learning (Jegede, 1995); and apprenticeships (Agrawal & Gibson, 2001).
- Government: Village council groups and women's groups (Pande & Hashimoto, 2003).

Given the important role indigenous knowledge plays in improving community livelihood through promoting sustainable practices, in recent times there has been an observable shift in the unchallenged status of Western science (Channa, 2006). There is worldwide recognition about the importance and need to preserve the indigenous knowledge bases (UN Permanent Forum on Indigenous Issues, 2007).). Policies and strategic plans have been drawn, taking into account indigenous knowledge systems. For example, the International Sustainable Biosphere Initiative (ISBI) has redefined its outline of human dimensions for sustainability (Ramakrishnan, 1992). It now incorporates the following important considerations:

- People's perception toward environmental degradation.

- Use of traditional knowledge and established productive systems.
- Identification of local as well as regional traditional values and beliefs, which constrain or promote degradation of natural resources.
- Use of traditional values in evolving strategies for maintenance of biological diversity.

In spite of its growing acceptance in the world, identifying indigenous knowledge within a community is a challenging task. Within communities, IK is often entangled with modern science that is learned in the formal schooling system (Agrawal, 2005) or is enshrouded in religious or cultural practices that are difficult for non-residents to access. But since IK is crucial for building sustainable communities (Semali, 1999), investigating the existing IK system becomes an important task (IIRR, 1996). Finding out how much IK is passed on from generation to generation and how much of this knowledge is retained by the younger generation can provide a provocative inspiration for designing learning environments that are sustainable.

Therefore, this study serves to deepen our understanding of how communities in the Himalayas balance the influx of modernization/globalization and engage in decision-making to sustain traditional land stewardship practices. It also supports a better understanding of how to design curriculum and environmental education programs for learning in communities of the Himalayan bioregion.

Chapter 2

Review of Literature

Understanding IK in traditional communities is fundamental to the design of any learning environment in the Kumaon region of the Himalayas (IIRR, 1996). Learning environments have to take into consideration several aspects of community. These include the community of the classroom, the school, and the connections between the school and the larger community, including the home (Bransford, 2001). The importance of out-of-school learning becomes clear when one examines the relatively small amount of time spent in school compared to other settings. Activities in homes, community centers, and after-school clubs can have important effects on students' academic achievement (Bell et al., 2006). In the Kumaon region, learning also takes place when youth work on family farms, take cattle out for grazing and do landscape related work. Thus the effective instruction begins with taking into account what learners bring to the setting; this includes cultural practices and beliefs as well as knowledge of academic content. There are many studies that have shown that what people learn and how people learn is context-dependent (Mertl et al., 2007). Therefore, a learning environment that takes into consideration the context should help learners link ideas from ecology and formal science to their own lives (Burford et al., 2005). Finally, an educational initiative on sustainability that embraces IK would help learners negotiate different worldviews and value systems about development and livelihood (Palmer, 1998).

Most learning scientists today are pointing out that learning is embedded in culture. By culture, I mean people's everyday lives and practices. Even though this definition of culture is simplistic in anthropological terms, as a learning scientist, I do believe that people learn within

their everyday lives and practices. In a recent report (Banks et al., 2007) published by the LIFE Center (Learning in Informal and Formal Environments) and the Center for Multicultural Education at the University of Washington, learning scientists and educational researchers have suggested that the processes of learning are set in the following principles:

Learning is contextual, and for every individual, learning is a socio-cultural experience grounded in local systems (values, tradition and practices).

Learning is an ongoing process that is grounded in multiple environments that the individual experiences throughout his or her life.

Learning is supported by various societal constructs that contribute to the personal and intellectual development of the individual.

Learning is most powerful when the learners develop concepts in a language supported by their community.

To summarize, Banks et al. (2007) are saying that learners construct knowledge in multiple contexts (schools, home, third spaces, etc.) and learn optimally when content is grounded in their socio-cultural environment. In their report for the National Research Council of the National Academies, Bell et al. (2009) support the above principles by applying them to science learning in informal environments. One of the important conclusions of this report is that science learning is strongly grounded and supported by everyday experiences. These everyday experiences are culturally bound and thus science learning is influenced by cultural practices (Bell et al, 2009).

Although the above reports provide some of the latest evidence that learning is grounded in socio-cultural practices, there have been many studies conducted in the past that provide ample evidence to support the above conclusions. Driver (1994, pp 24) helps to sum up this argument by stating "… knowledge and understandings, including scientific understandings, are constructed when individuals engage socially in talk and activity about shared problems or tasks. Making

meaning is thus a dialogic process involving persons-in-conversation, and learning is seen as the process by which individuals are introduced to a culture by more skilled members." The conclusion that learning is a cultural phenomenon is especially true when it comes to learning about the environment. The IUCN (International Union for Conservation of Nature) defines the process of learning about the environment as follows:

Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self formulation of a code of behavior about issues concerning environment quality (IUCN, 1970, pp 8).

While most environmental education programs today focus on the science explaining the processes of the biophysical surroundings of human beings, very few focus on the interrelatedness between culture and the environment (Smith & Williams, 1999). In their paper "Environment Education: from policy to practice," Barraza et al. (2003, pp 348) emphasize that in order to rethink educational strategies, "The complexity of social, political, and economic aspects of different countries require the formulation of environmental education initiatives grounded on analyses of particular contexts." There is also a necessity to understand each other's cultural contexts and to move away from the Western models of development (Huckle, 1995 pp 293). Thus, matching educational programs to local community learning processes is a key component of designing a successful learning experience for individuals within that community. This argument is also supported by Dillion (2003), who while pointing out the larger gaps in the empirical studies conducted by Rickison (2001), brings out the need to ground education research in learning theories. In his empirical studies of 100 articles focusing on environmental education, Rickison (2001, pp 310) points out several inadequacies in the current environmental education research. In summarizing these inadequacies, he states "the evidence base on learners and

learning, while considerable in size, is less diverse in terms of methodological and theoretical approaches than the wider environmental education research field within which it is situated." Therefore, since IK is grounded in local cultural, social, economic, political and environmental practices, it is critical that every design for learning takes into consideration the IK within a community.

Also, given that knowledge is constructed by every individual (Piaget, 1967), we can assume knowledge is built differently by every individual depending on their age, sex, gender, socio-economic status and related variables. Therefore, this study also roots itself in Vygotsky's theories of social constructivism (Vygotsky, 1978), suggesting that indigenous knowledge is socially constructed: for an individual, the community plays an important role in knowledge building (King, 1999). As Driver (1994 pp 41) points out, "…learners of science have everyday representations of the phenomena that science explains. These representations are constructed, communicated, and validated within everyday culture. They evolve as individuals live within a culture…. Although learning science involves social interactions, in the sense that the cultural tools of science have to be introduced to learners … individuals have to make personal sense of newly introduced ways of viewing the world." Therefore, we can see that indigenous knowledge maps itself squarely on constructivist learning theory as different individuals within a community carry with them different knowledge sets. The knowledge they carry with them varies in relation to age, sex, education, occupation, and socio-economic status. (IIRR, 1996). Thus, indigenous knowledge is about multiple perspectives, and reality is constructed by taking into consideration that every individual will have a different perspective about an event, depending on their age, sex, gender, religious and socio-economic state. (Semali, 1999). Although individuals construct and interpret their own version of IK, at a broader scale or at a community level, IK can be divided into three broad categories:

Common knowledge: Everyone in the community (e.g. reading a traditional calendar)

Shared knowledge: Some people sharing certain interests (e.g. farmers within the community or women in the community)

Specialized knowledge: Few people who are experts or have had specialized training (e.g. Healers and midwives)

Another theory that argues for the reason why indigenous knowledge needs to be taken into consideration to foster learning in the Himalayan communities is the conceptual change theory. The conceptual change theory has its roots in constructivism (Posner, Strike, Hewson & Gertzog, 1982). Conceptual change theory states that effective instruction begins with what learners bring to the setting; this includes cultural practices and beliefs as well as knowledge of academic content (Hewson, 1998). An important component of the conceptual change model is the learner's conceptual ecology (Deemastes, Good & Peebles, 1995). The conceptual ecology of the learner consists of many different kinds of knowledge. In simple terms, conceptual ecology is the learner's existing knowledge that is fortified as the learner moves through spaces, cultures and conversations. (Hewson & Hewson, 2003). The learner uses the existing knowledge (conceptual ecology) in learning new concepts. According to the conceptual change theory, the condition under which conceptual change takes place is when the new conception is intelligible, plausible, and fruitful. If all these three conditions are met, then learning proceeds. However, if the new conception completely conflicts with the existing knowledge, then conceptual learning cannot happen (Strike & Posner, 1992). As will be discussed later, indigenous knowledge is an important component of the conceptual ecology of learners in Himalayan communities and needs to be taken into consideration while designing any learning environment within the community.

Another important theoretical base that applies to indigenous knowledge is informal learning. Informal learning is defined as learning that generally takes place outside of the classroom (Bransford et al. 2006). Since indigenous knowledge is community-based knowledge and usually is not found in school science textbooks (Norberg-Hodge, 1991), I focus on how it is

constructed through informal learning processes. Scribner and Cole (1973) argue that informal learning takes place when youth, depending on their abilities, participate in adult activities. The adult activities in the community are some of the main areas where the youth can learn indigenous knowledge (Badola & Husssain, 2003). Therefore, informal learning forms the backbone of most indigenous communities (Scribner & Cole, 1973), as there is no structure within the community that is built solely for " educating the youth" (Mead, 1964).

Cohen (1971) distinguishes informal learning along three distinct traits:

Occurring in families: Cohen (1971, pp 14) describes this learning source as *particularistic*, meaning "expectations of performance … are phrased in terms of who a person is instead of what he has accomplished."

Occurring in traditional practices: This promotes traditionalism, and "elders are accorded the highest status in the community."

Bringing together emotional and intellectual domains: Informal learning bridges emotional and cognitive processes, as "the content is inseparable from the personal identity of the teacher."

In the Kumaon, most indigenous knowledge exists outside the four walls of the classroom (Pande, 2001) and, therefore, can be strongly linked to informal learning processes.

Ultimately, there is the question of application of IK within the community. Community members often use IK while making decisions related to agriculture, animal rearing, education, natural resource management, health, and many other issues. Because of the fine-grained interdependencies of village life, decision-making affects individuals both at a personal level and at a community level (Hammond et al. 1980). It is one of the most important of all human skills as it affects the perceptions of quality of life and success (Kaplan & Schwartz 1975). Most theories suggest that decision-making involves individuals going through numerous stages, but the most important are: information gathering, knowledge formulation, creating alternatives, and

action. Learning theories support decision-making research as they emphasize the processes of knowledge formulation (Brewer & Stern, 2005). Although both types of knowledge (indigenous and exogenous) play an important role in decision-making, indigenous knowledge becomes an important aspect of decision-making in rural communities especially where the exogenous knowledge does not connect to local practices and lives.

This research project connects three very relevant factors to promote sustainability and improvement in quality of life for the people of the Himalayan communities: Indigenous knowledge, learning, and decision-making about environmental issues as related to the livelihood of the people. The study seeks to find out:

In the Kumaon region, what is the indigenous knowledge relevant to decision making about specific environmental issues such as land management and water management?

How much of this indigenous knowledge is used by community members (adults) while making decisions about the environment?

How much of this indigenous knowledge is passed on to the future generation (high school students)?

How will youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?

In summary, this study will serve to deepen our understanding of how communities balance the influx of modernization/globalization and engage in decision-making to sustain traditional land stewardship practices. It would support a better understanding of how to design curriculum and sustainable environment education programs for learning in Himalayan communities, and potentially serve as a model for broader applications in the developing world.

Chapter 3

Methodology and Research Questions

Choosing an overarching research approach for answering any research questions involving human interactions is tricky ground. Maxwell (2005, pp 2) explains that "the ground is tricky because it is complicated and changeable." The selection of methodology becomes even more difficult in the case of studying indigenous communities, as these communities have often been excluded from methodological development (Burger, 1987). Care needs to be taken while selecting research methods for studying indigenous communities. There is a need to have "indigenous perspectives" entrenched in indigenous research methodologies (Denzin & Lincoln, 2005), as these research approaches represent a set of beliefs that convert themselves into action more readily than outside research methodologies. However, this methodology requires the researcher to come from within the culture; in the case of my study, since there is a lack of indigenous perspective to research the questions, I choose to use the grounded theory approach.

The grounded theory approach is suitable for this research because the study looks at aspects of learning and knowledge transfer in the context of the Himalayan villages themselves. In a nutshell, the grounded theory approach will have the data suggest 'new theories' rather than test existing theories (Litchman, 2006). The data will help theorize what constitutes indigenous knowledge in the Kumaon region of the Himalayas and how different generations of people use this knowledge to make decisions about their environment.

According to Babbie (2004), while using grounded theory the researcher follows three guiding principles:

1. Evaluating the research process periodically: This involves the researcher periodically making sure that the data that is being collected fits the reality.

2. Maintain an attitude of skepticism: All results that attach themselves to the data are treated as provisional until checked out against actual data.
3. Follow the research procedures: As Babbie states "the data collection and the analytical procedures are designed to give rigor to the study. At the same time they help you break through the biases and lead you to examine at least some of your assumptions that might affect an unrealistic reading of the data."
4. Grounded theory expects the researcher to enter the field with no preconceptions about the findings.

This study fits all of these four criteria well. The research questions are aligned such that initially they would inform the researcher of the existing IK in the region and then help create theories on how other community's members use IK. The several strategies for data collection will inform each other and build on each other rather than being separate strategies. Using a grounded theory approach the study will address the following questions:

- In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?
- How much of this indigenous knowledge is used by community members while making decisions about the environment?
- How much of this indigenous knowledge is passed on to the younger generation (high school students)?
- How will youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?

The first step in the research process is to locate and document existing IK in the region. I propose to use the Delphi technique to answer the first research question: **In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?**

The Delphi Technique

The issue of identifying knowledge types (indigenous, traditional ecological knowledge (TEK) or exogenous) is a complex process. There is very rarely a single instance that can be one knowledge type or another. In most instances there is an overlap. Semali and Kincheloe (1999) address this issue of complexity by pointing out that "Indigenous knowledge is an ambiguous topic that immediately places analysts on a dangerous terrain. Not only are scholars unsure what we're talking about but many analysts are uncertain who should be talking about it." Thus the first step is to ensure that there is consensus about the 'definition' of indigenous knowledge/traditional ecological knowledge. I used the Delphi technique to reach this agreement.

The purpose of the Delphi technique is to facilitate information, opinions and judgments from a panel of experts to gain consensus on an issue (Dunham, 1996). The usual objectives for a Delphi assignment are as follows:

1. To understand the process of delivering judgment on an issue that may need deliberation.
2. To look at commonalities between different opinions in order to generate a consensus among the respondents.
3. To synthesize information about a topic that spans multiple disciplines.
4. To inform the respondents about the various different facets of the topic (Turoff, 1970).

The Delphi was coordinated from the office of the USNPSS (the UttarakhandSeva Nidhi Paryavaran Shiksha Sansthan, or the Uttarakhand Environment Education Center - UEEC) in Almora, North India. The plan was to contact the participants, collect answers to all the questionnaires / interviews, and communicate with all the participants. It was anticipated that the process would take about 30-45 days (Yousef, 2007). Recent data shows that using the Delphi technique with about 20 participants and three rounds of questionnaires/interviews conducted mostly through US mail could take about 30 to 40 hours of the coordinator's time (Yousef, 2007).

The Process of Designing the Delphi

- *Identifying the issue/question that is going to be asked:* Since I was investigating environmental issues the subject areas I covered are as follows:
    1. Water management, and;
    2. Land management as related to agriculture, forestry and soil.

The reason I am focusing on the above two issues is because water– and land-related issues are important issues that are directly related to the livelihood and the quality of life of people in the region which relate to indigenous practices and maintain relevance today. Although other aspects of indigenous knowledge, such as religion, are connected to the environment, these aspects are less likely to affect environmental decisions. Religion, although a powerful force in people's lives, as observed in the field does not often shape environmental decisionmaking. For example, I observed a case in which a temple was located along the path of a roadway being constructed; rather than halt the road, or destroy the temple, the builders simply went around it. In contrast, both water and land practices have been identified by prior work in the region as key concerns, both by government and nonprofit workers, and by local inhabitants. Water touches every aspect of human life and, if not managed well, can create hardships. Similarly good land management practices are important so as to provide the people with food and shelter. Thus by focusing on the types of knowledge people use to manage land and water, I would be able to make suggestion towards designing better environmental education programs for helping communities in the region better their quality of life.

Identifying the 'expert' participants in the Delphi: Since indigenous knowledge within a community varies with socio-economic status of the community members, it is extremely important to get members representing all socio-economic groups on the Delphi-panel. I planned to achieve this by getting a representative panel together. The panel was to consist of people with the following background

- Living in the village communities (e.g farmers, teachers etc)
- Non governmental organizations (NGOs) working with the communities to collective resolve environmental problems faced by the village communities (e.g Uttarakhand Seva Nidhi)

- Government researchers who provide advice for the farmers on issues of water and land management.

Keeping in mind that different members in the village would have different types of IK, I attempted to include the following participants in the Delphi:

- Community members from Village: Elders are the best resource on providing information on any kind of traditional practices. The other participants that attempted to recruit were: women who are members of a women's group, women who are not members of any women's group, men who reside in the village and men who reside outside the village.
- I also used members of the Uttarakhand Seva Nidhi on the Delphi panel. The Uttarakhand Seva Nidhi is a non profit organization working with the village communities of the Kumaon region since 1967. The organization has been focused on empowering the communities through designing educational programs based on local needs and aspirations. Thus as this group of people not only resides in the area but also acts as advisors to various environmental projects run by the village community members, their input proved valuable for the Delphi.
- Government researchers who influence and provide advice on various environmental problems faced by the village communities in the area.

Overall I planned to have about 15 to 20 members on the Delphi panel. This range is recommended by Yousef (2007).

- *The first round of questions:* I used an interview format to get through the first round of questions. The interview was in semi structured interview format and will be video taped. The interview will be structured around the following sample questions:
  - **Water Management**
    - *i.* Do community members have sufficient water?
    - *ii.* Where do people get their water? What is the organization distribution system? Where did people get their water before the tap system came in place? What was the organization system before the tap system was put in place by the government?
    - *iii.* Is the drinking water separate from water used for other tasks? Was it the same in the past i.e. before the taps came into the villages?
    - *iv.* What is the storage system today? What was the storage system before the current system was put in place?
    - *v.* What are the problems related to water? Are these problems similar to the ones in the past, i.e., before the tap system came into place?
    - *vi.* What are the traditional practices of water distribution and conservation in the area?
  - **Soil and Land management**
    - ***i.*** Traditionally how do you identify soil types?
    - ***ii.*** What used to be the quality of the soil in terms of, how much water did it absorb and retain?
    - ***iii.*** What happens to the soil in the rains? Is there a lot of run off?
    - ***iv.*** Is the soil fertile?
    - ***v.*** What kind of crops do you grow in this soil?

vi. What are the methods the farmers use to fertilize the soil (past and present)? Which ones are better? How do they make these fertilizers?

vii. How do farmers select land for planting? What are the criteria that the farmers apply to plant certain crops?

viii. What time of the year does land get prepared? Why? What are the indicators that farmers use to determine the time for land preparation?

ix. What methods are used for land preparation? Why are these methods used?

x. Is there any system to plant the crops?

xi. Who is involved in preparing the land?

xii. How do farmers know whether their soil quality is good?

xiii. How do farmers manage the land for weeds?

xiv. Are there any specific crop rotations used to avoid the growing of these weeds?

xv. What are the traditional methods used for seed selection, collecting and storing? What is the current method for getting seeds?

xvi. Are trees allowed to grow near the fields? If yes what type?

xvii. What are the types of trees that are encouraged to grow in the immediate environment of the community?

xviii. What are the views of the local people to use common resources such as forests?

xix. Do farmers own the land they till? Has this been a traditional practice?

xx. What are the challenges people face in terms as land management? How are these challenges overcome?

xxi. How do local people identify the different features of the environment? (forests, grassland etc)? What is the basis of this classification? Is there any further classification within these areas (types of forests, types of grasslands)?

xxii. What are the local beliefs systems about the environment?

xxiii. What are the causes for the changes in the soil/land (degradation, destruction, improvement)?

xxiv. What do people see as a main threat to their land/soil? What are the measures they are taking? What are the traditional methods to conserve the land/soil?

- *Compiling responses from the first round*: I compiled the responses of each of the participants in a brief and precise manner. I tried not to interpret or explain any of the ideas; ideas were transcribed just as the participants have described them on tape. Participants were coded (numbered) to maintain confidentiality.
- *The second round:* I then sent a printed summary of all the opinions back to the participants. In this round the participants were to look at all the other responses and get a chance to refine their own response. They could also ask for clarifications from me (the coordinator) if they failed to understand some other responses. The participants then return the paper back to me with amendments or clarifications noted.
- *Compiling responses from the second round:* I looked at the responses that the participants sent back to me. Any updates from participants were included in the summaries.
- *The third round:* In this round the participants vote for the most appropriate responses to each issue. This method is recommended by Durham (1996) to reach a 'good' consensus. Durham (1996) explains this process by stating "An approach for evaluating the ideas …

which is used in the Nominal Group Technique for "voting." With this approach, the Coordinator asks each member to identify the top five ideas and assign five points to the most promising idea, 4 points to the next most promising, and 3, 2, and 1 points to the third, fourth, and fifth-best ideas. These votes are returned to the Coordinator, who tallies the results and prepares a report. The report notes the rank order of the ideas based on the total number of points received and indicates the number of people who voted for each idea." The process of voting is illustrated below:

- Instructions to the participant: For each of the issue/questions out of the 20 different opinions select the five top opinions you agree with and then give 5 points to the opinion you most agree with, 4 points to the next one, 3 to the next and so on.

  Therefore the participants will select opinions about an issue in the following manner. Below is an example of how the point system would be laid out.

  Issue/question 1:

  i. Opinion 1 (5 points, 4 points, 3 points, 2 points, 1 point)
  ii. Opinion 6 (5 points, 4 points, 3 points, 2 points, 1 point)
  iii. Opinion 3 (5 points, 4 points, 3 points, 2 points, 1 point)
  iv. Opinion 12 (5 points, 4 points, 3 points, 2 points, 1 point)
  v. Opinion 20 (5 points, 4 points, 3 points, 2 points, 1 point)

I then took these results and compiled them once again. The compiled results will look like the example below:

Issue 1: Opinion 20 got 60 points and 12 participants voted for the opinion.

Opinion 6 got 20 points and 10 participants voted for the opinion

Thus for each of the issue/question presented in the Delphi I took into consideration the opinion with the most points. That will be the panelists' collective opinion on indigenous knowledge attached to that issue.

Using this procedure I will be able to answer the first research question: **In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?**

The Second Research Question

The second research question is: **How much of this indigenous knowledge is used by community members (adults) while making decisions about the environment?**

Informed by the Delphi and with the help of the members of the USNPSS I planned to identify two village communities in the Kumaon region of the Himalayas. These village communities were to be chosen based on accessibility—accessibility in terms of participants' physical location, and their willingness to participate in the research study. I then planned to use the following techniques to answer the second research question.

There were to be two main techniques to record use of the existing IK. The first technique would be direct observations of village group meetings concerning any environmental decision-making process. The women's group, village development committee, or any other group could hold these meetings. The second technique was to consist of various probes and procedures, as follows:

- Organization of focus groups: Focus groups can be a data source for identifying IK on land use practices and decision making patterns. Focus groups are important as they capture valuable data about social norms and opinions within a community. Focus groups also highlight the community dynamic and provide insight into how the community members interact and influence each other. The focus groups were to be organized with the help of the local leadership ("gatekeepers"). For example, using the youth group in

the village to discuss issues such as land management practices, organizing a few farmers together to discuss issues related to farming, and also observing women's group members as they get together to discuss the water issues. The structure of questions that would be discussed would be the same as the ones used for the Delphi. Regarding the structure of the focus groups, I introduced myself and explain the purpose and the objective of the focus groups. I made it a point to mention that I am interested in knowing about the traditional practices as related to land and water management. The discussion would revolve around the following questions:

  - How do men and women interact with their natural surroundings?
  - What unique knowledge do they get by this interaction?
  - The discussion can then move on to specific questions that can be the same as those asked in the Delphi.

- Semi-Structured Interviews: Using the same questions as used in the Delphi I planned to conduct semi-structured interviews with various community members. I identified these members based on their role in the community and accessibility.

Once I collected this data, I could identify the indigenous knowledge in the meetings, focus groups and semi-structured interviews by comparing the data to the results of the Delphi (i.e., coding environmental knowledge as indigenous or not based on Delphi results.)

For example in the Delphi if I identified that the indigenous way of managing water is to protect the stream source, then when the adults answer the same question I would look for the above method for water a management in their answer and code it. If they answer differently I would code that as exogenous knowledge.

Thus I will be able to answer my second research question: **How much of this indigenous knowledge is used by community members (adults) while making decisions about the environment?**

The Third and the Fourth Research Question

The third and the fourth research questions are interlinked and can be answered by using the same set of data. The third and the fourth research questions are as follows: **How much of this indigenous knowledge is passed on to the younger generation (high school students)? And how do youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?**

The participants were mostly high school students from the two village communities identified with the help of the members of the USNPSS. There would be three main techniques used to identify youth's knowledge of the IK and the youth's use of IK.

These three techniques are as follows:

- Focus groups: Using the questions designed for the Delphi I would facilitate discussions among student groups (5 to 10 students). These student groups were identified with the help of the teachers. There are many different student groups within a school. Eco-clubs and other after school activity clubs are prevalent. I engaged these groups in group discussions facilitated around the questions of the Delphi. Focus groups were to give me an idea of how much IK the students know and how they use it.
- Role-play activity: I designed a role-play activity for the students in the focus groups. By having the students assume certain roles of stakeholders involved in the local decision-making processes, the students' ideas of how these processes function and what types of information is used while making in local decision making can be assessed. Youth could use their existing knowledge but assume the role of a stakeholder in the decision-making process, and thus some light will be shed on how these young people will make decisions with regards to their environment in the future.

- Semi-structured interviews: Semi-structured interviews with a few students using the questions designed for the Delphi provided useful information on how much IK they know and how they would use IK for potential decision making processes.

Once this data was collected and the IK identified by mapping it on to the results of the Delphi, I was able to answer the third and the fourth research question: **How much of this indigenous knowledge is passed on to the younger generation (high school students)? And how do youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?** I used the same coding scheme (as used for the adults) to map the IK used by youth

Sample Size: Finally, I also need to address the question of sample size. Sample size is dependent on several things:

- Time and money
- Population size
- Variability within the population

In the case of this particular study the sample size was mostly dictated by time and money. I decided to spend about 4 months (2 months in the summer and 2 months in the Fall/ winter) to collect data. It was decided that I would collect data from as many participants as I could during this period.

Researcher Identity

I have been working in this area since 2004. Although my nationality is Indian and I grew up in India, I am viewed by the locals as an outsider as I grew up in South India. Also even though I speak Hindi (as a second language), the dialect of Hindi that I speak is different than the dialect of Hindi that is spoken in the region.

I believe that the most sustainable programs are the ones where indigenous knowledge is complemented by western modern science. I do not believe in using one at the expense of the

other (Agrawal 2005).

But I also think it essential to find out and document the existing indigenous knowledge in the area. I believe documenting this knowledge will help us know what the youth carry with them from the community to the four walls of the school. Finding out what the youth bring to table will help the educators design better curriculum. It is with this desire to create better learning environments for youth that I designed this study.

I also believe that while designing education programs/curriculum taking into consideration local problems will help connect the youth to their place. This might help arrest the rural – urban migration patterns that exists in the region.

Chapter 4

Data Collection and Results

The data collection or fieldwork was divided into two parts. The first part involved assessing the existing indigenous knowledge in the area. The second part consisted of conducting focus groups with adults and youth and then interviewing them to find out how much indigenous knowledge do they use while making decisions about land and water related issues. In this chapter, I outline the process of data collection and the results. The discussion of the results is outlined in chapter 5.

Part 1: The Delphi

Using the Delphi method I found out what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management in the Kumaon region. 13 participants/experts were identified and were requested to participate in this consensus-building exercise. The participation was voluntary and no compensation was offered. The participants/experts were chosen by consulting with the officials of the Uttarakhand Seva Nidhi Paryavaran Shikshan Sanstha (Uttarkhand Environment Education Center –UEEC). The criteria for the selection of the participants was that the individuals would have experience working with the local communities on social, agricultural, economic and related environmental issues.

Keeping in mind the above criteria, the 13 participants/experts who agreed to participate in the Delphi were as follows:

Table 4-1: Details of experts who participated in the Dephi.

Participant number	Occupation	Expertise
1	UEEC employee	Works on the design of the environment education curriculum *Our Land, Our Life* and has a PhD in Botany from the Kumaon University. Has spent his entire life in the region and has been working with the UEEC for the last 20 yrs.
2	UEEC employee	Is the director of UEEC and has a PhD in engineering. Has been actively involved in several social and environmental causes promoted by UEEC for the last 20-25 years.
3	Retired Principal	Works with the UEEC and helps in design and implementation of the environment education curriculum *Our Land, Our Life*. Has grown up in the region and has been working in collaboration with the UEEC for the last 20 years
4	High school teacher	Is a high school chemistry teacher and runs a non government organization (NGO) in the area. The NGO focuses on social and environmental issues such as, issues related to women's equity, water, forest etc. Also runs a youth development group in the region. Has lived in the region his entire life and has run the NGO for the last 25 years.

5	UEEC employee	Has a masters degree in geology and has been working with the UEEC since the last 20-25 years. Is instrumental in forming the Uttarakhand State women's union.
6	UEEC employee	Has been working with the UEEC for the last 15- 20 years and has spent her entire life in the region. Primarily associated with the women's union movement and with the development of preprimary schools (balwadis) in the region.
7	UEEC employee	Has been working with the UEEC for the last 15-20 years and is primarily associated with the development of preprimary schools in the region. Has spent her entire life in the region.
8	UEEC employee	Has been working with the UEEC for the last 15- 20 years and has spent her entire life in the region. Primarily associated with the women's union movement and with the development of preprimary schools (balwadis) in the region.
9	Farmer/House wife	Is an activist with the Uttarakhand women's union and also a local farmer. Has lived her entire life in the region.
10	Primary school teacher	Has been one of the first teachers to implement the local environment education curriculum, *Our Land, Our Life* in the schools. Has been teaching at the primary school

		for the last 30 years and is a local environment activist.
11	Government research scientist	Is an agriculture scientist at the mountain agriculture research institute – (Vivekananda Institute of Hill Agriculture). Participates in designing and implementing programs aimed at bettering/modernizing agricultural techniques. Has been working in the area for the last 7 years.
12*	Government research scientist	Is a mountain development scientist at the GB Pant Institute for Himalayan Environment and Development. Has been working in the region for the last 15 years
13*	Local farmer	Runs a spiritual place (Ashram) nearby. He has been living here for the last 50 years or so and has implemented various sustainable land management and water management practices.

* Although 13 participants participated in the first round 2 participants did not finish the process. The government official was traveling on official business and the local farmer did not feel it was worthwhile to participate in round 2 and 3.

The Delphi procedure was carried out in three rounds. The first round the participants were asked three sets of questions. These questions were asked in interview format in Hindi and in English and were recorded on video. The questions were as follows:

1. What is your definition of indigenous knowledge?
2. What are some practices that use indigenous knowledge for water management? What is the specific indigenous knowledge used within these practices?

3. What are some practices that use indigenous knowledge for land management (as related mostly to forests and agriculture)? What is the specific indigenous knowledge used within these practices?

Participants were free to answer in Hindi or English: all of them were fluent in at least one of these languages (although the local language is Kumaoni, all schooling is conducted in Hindi and/or English and almost all local media are in Hindi or English).

The results of the first round were transcribed and then translated into English. Then both the Hindi and the English versions of all the interviews were given to all the participants. Thus each participant got to see 13 answers along with his/her own. They were then requested to review their answer. At this time they could change/modify their answers if they felt necessary.

The transcripts were collected back from them and the changes the participants had made to their answers were incorporated into the new transcripts. Since the two other participants dropped out of the protocol in the last round, only 11 answers were circulated for round 3. The participants were asked to choose 5 best answers. They were then asked to rank those answers from 1 to 5. 1 being the one they like to most and 5 being the one they like the least. Since all the three answers were on one sheet of paper the participants ranked the answers by the person who answered all three of these questions the best. They did not rank individual questions and answers. Also since all of the answers given by the participants were conceptually similar, some of the participants felt that the ranking was not necessary. However since the process needed to be completed, at the insistence of the Delphi administrator they ranked the sheets containing all of the answers. The participants ranked the answer sheets as follows:

Table 4-2 Participant/answer sheet ranking

Part no.	Answer Sheet ranked 1	Answer sheet ranked 2	Answer sheet ranked 3	Answer sheet ranked 4	Answer sheet ranked 5
1	Participant 5	Participant 7	Participant 1	Participant 9	Participant 8
2	Participant 1	Participant 4	Participant 11	Participant 9	Participant 8
3	Participant 1	Participant 5	Participant 6	Participant 4	Participant 9
4	Participant 1	Participant 4	Participant 3	Participant 5	Participant 8
5	Participant 1	Participant 5	Participant 4	Participant 9	Participant 8
6	Participant 5	Participant 1	Participant 7	Participant 10	Participant 9
7	Participant 1	Participant 5	Participant 8	Participant 9	Participant 11
8	Participant 1	Participant 4	Participant 6	Participant 11	Participant 8
9	Participant 5	Participant 1	Participant 6	Participant 8	Participant 11
10	Participant 1	Participant 4	Participant 5	Participant 8	Participant 6
11	Participant 5	Participant 1	Participant 6	Participant 11	Participant 8

After the participants finished the ranking process the rankings were scored. Each participant who got ranked scored some points. 5 points for rank 1, 4 points for rank 2, 3 points for rank 3, 2 points for rank 4 and 1 point for rank 5. All the points were added up and the answer sheet/ participant with the most points was considered to be the consensus. In the case of the above Delphi the following results were achieved:

Table 4-3 Delphi scores

Participant/answer sheet number	Total score
1	56
2	0
3	3
4	21
5	37
6	13
7	7
8	13
9	10
10	2
11	9

All of the participants did mention that the answers were all conceptually similar and thus difficult to rank but ranked the answers in the insistence of the Delphi administrator.

Results of the Delphi:

The answers of all of the 13 participants were conceptually similar but keeping in mind that there was consensus for answer sheet/participant number 1, the answers given by this participant were taken as the result for research question number 1 and as the concluding result for the Delphi.

Thus the results on the consensus building exercise (Delphi) was as follows:

Question 1 on the Delphi: What is your definition of indigenous knowledge?

Indigenous knowledge is knowledge that comes to you from your ancestors and that has evolved over time. It is knowledge that is attached to a certain place. Also there is a difference between traditional knowledge and traditional practices. Sometime when we follow a practice without understanding the logic behind the practice that is traditional practice, the actual logic behind the practice is traditional knowledge.

Question 2 on the Delphi: What are some practices that use indigenous knowledge for water management? What is the specific indigenous knowledge used within these practices?

1. Water is the basic necessity for life. The example of how the community traditionally manages water is '*Naulas*' (ground water springs). There is traditional knowledge associated with how to build a Naula. The structure is very important. The structure is such that it helps the ground water come to the surface and then stay above the surface.

2. The second thing that traditional knowledge does to manage water is keep the water sources clean. Often times the water sources are designated as religious and thus people have to go in them barefoot, which helps in keeping the source clean.

3. Collecting rainwater is another way we can manage water traditionally.

4. People used to plant native species (Oak and Deodhar) to make sure that there is maximum seepage of water into the soil, as planting these trees helps hold the soil together, thus leading to more water seepage into the ground and increasing the ground water table.

5. Digging trenches (khals) is another way to manage the water.

6. People also build small dams (choys) to stop flowing water

7. To keep the soil together and to help stop water runoff people around here build depressions (guls) around their farms.

8. There are traditional devices (Earthen pots) to store water and keep it clean.

9. There is encouragement to use running water rather than stored water because the logic is that running water has a natural filtration system

Question 3 on the Delphi: What are some practices that use indigenous knowledge for land management (as related mostly to forests and agriculture)? What is the specific indigenous knowledge used within these practices?

To keep the land healthy people use the following traditional practices:

1. Using organic compost.
2. Seed saving is traditionally considered good land management practice.
3. Mixed farming and crop rotation practices keep the land healthy.
4. Healthy forest keeps the farms healthy by proving more organic litter for decomposition, to make good compost.
5. Not cutting an entire tree for fodder. Cutting the lower branches of the tree keeps the tree from destruction and the more healthy the trees, the healthier the soil and better yield from the land.
6. Sharing labor for agriculture is a good land management practice as there is community participation and thus makes sure everyone keeps their piece of land healthy and bad practices do not spread.
7. Use organic pesticides and insecticides such as walnut leaves and neem leaves

Given the results above the Delphi procedure above clearly points out the answer to the first research question, **In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?**

Part II: Second Phase of Data Collection

Part II: The second phase of data collection was focused on how much of the indigenous knowledge as indicated by the Delphi is used by the adults and the youth in the area. The research questions were as follows:

- **How much of this indigenous knowledge is used by community members (adults) while making decisions about the environment?**
- **How much of this indigenous knowledge is passed on to the future generation (high school students)?**
- **How do youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?**

The data collection procedures in this phase included facilitating focus group discussions and also interviewing the participants (youth and adults).

Selection of participants for the second phase of the data collection: In consultation with the UEEC members the area east of Almora was selected to conduct data collection. This area was selected because of two reasons:

1. The people in the area are more closely associated with the UEEC and thus getting introductions to conduct focus groups and interviews proved easier.
2. In the past, as a part of another project, I had conducted research in the area West of Almora. Thus, choosing an area that is different than the area where I had worked in the past helped with avoiding some potential bias.
3. Also since UEEC is the gatekeeper for allowing researchers in the area, research needs to be conducted keeping in mind the needs, goals and objectives of the UEEC. The UEEC is a gatekeeper in the sense that they were not only hosting me for conducting this research but also I have tried to align this research so as to help their goals and objectives. The

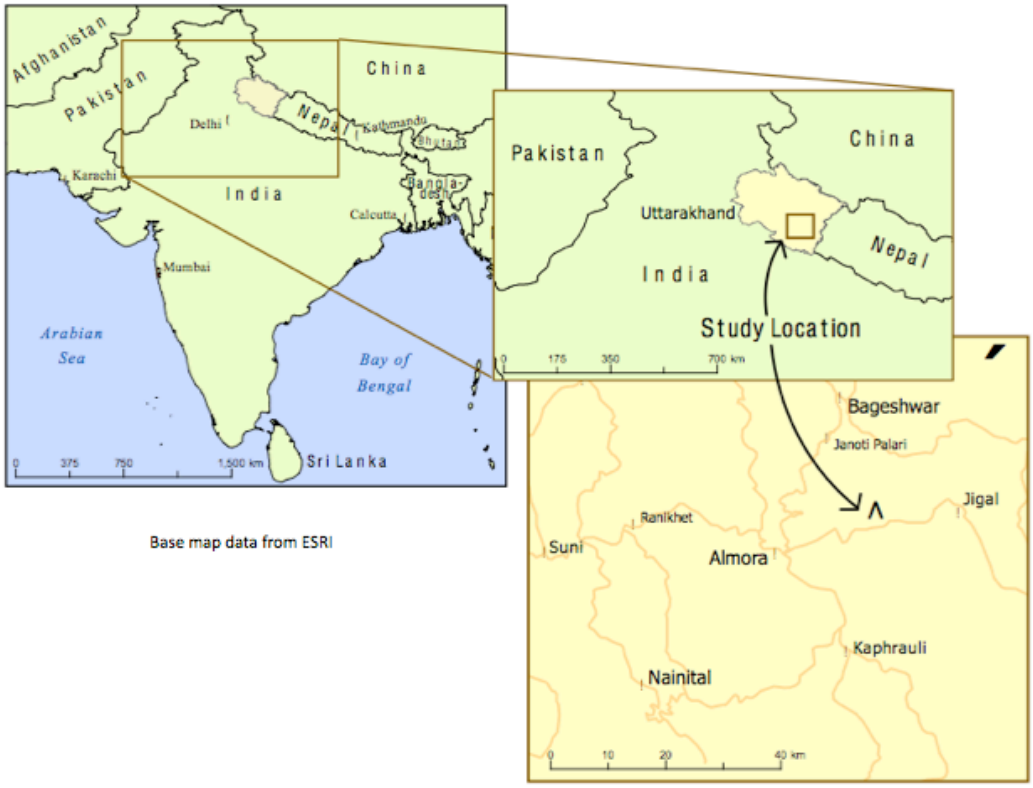
UEEC decided that there is more focus needed in the eastern region, as they have not been able to focus their effort in that region due not having resources to hire more staff.

The adult participants for the study were recruited from two villages east of the city of Almora. The first village was Chanoli and the second village was Maichun. The youth that participated in the study also were from the same area and were recruited from two different high schools. The first school was Panvanaula high school and inter-college and the second school was the Garudabanj high school and inter-college (In India, high school runs through 10^{th} grade, while inter college includes grades 11 and 12). Both these schools are run by the state government. Youth from Chanoli and Maichun attend the Panvanaula high school and inter college. The youth and adult participation in the study was voluntary. Overall a total of 9 adults (approx age range 35-70 yrs) and 29 (6, 7 and 8 grade) youth participated in this phase of the study.

Physical Description of the Study Area

Physical description of the study area*:* Both the schools and the villages are located in Almora district, in the Himalayan State of Uttarkhand, India. Chanoli village is about an hour walk away from the road while the Maichun village is about a ½ hour walk from the road head. Both the schools are located about 5 minutes walk from the roadhead.

4-1 Map showing location of study area



Base map data from ESRI

This phase of the study was divided into two procedures: Focus groups and interviews. I did not observe any *in situ* community meetings because there were none held during the time I collected my data. The focus groups and interviews were organized around the questions that were designed after looking at the outcomes of the Delphi procedure. The focus groups and the interviews with the adults and the youth revolved around the following questions:

1. What are the environmental problems in your village?
2. What are the problems in your village associated with water? What would you do to resolve these problems related to water?
3. What are the problems associated with the land (agricultural and others)? How will you resolve these problems?

For example an interview revolving around the above questions with one of the adults looked as follows:

Sameer (introduces himself): Hello, I work with the Uttarakhand Seva Nidhi and I am here today to find out how people in this area make decisions related to their environment problems. I am especially interested in knowing how community members in this area resolve water and land problems. So thank you very much for agreeing to be a part of this interview.

Participant: No it's not a problem.

Sameer: okay, so my first question to you is that are there any problems related to the environment in your village.

Participant: No, there are not many issues related to the environment in our village.

Sameer: So everything is fine? You do not have any issues related to water or land or any other issues?

Participant: No everything is fine.

Sameer: So where do you get your water from?

Participant: From the tap.

Sameer: Where does the water come from, into the tap?

Participant: From up there from Dhoni (another village)

Sameer: Have you seen the source?

Participant: No I have not seen the source. But our youth go there sometimes when the pipeline breaks down.

Sameer: So what do you do when the pipeline breaks down and there is no water.

Participant: We go and talk to our village leaders and they in turn talk to the government to fix our water problem.

Sameer: How long has this pipeline been here?

Participant: About 10 -12 years.

Sameer: Who put it in your place?

Participant: The government put it in our village?

Sameer: Where did you get your water before the pipeline?

Participant: From the Naula (ground water spring)

Sameer: Where is this naula?

Participant: There about 1 -2 km from here.

Sameer: but does anyone go there now?

Participant: Sometimes when the water in the tap goes away.

Sameer: So do the villagers take care of this naula, maintain it and keep it functional.

Participant: No nobody does anything to take care of it.

Sameer: But then what will happen if the water in that naula goes away?

Participant: We do not do anything, maybe go to another source or wait for the tap water to come back. Usually the tap water does not go away for that long so as to cause a problem. We like the naula water more than the tap water but getting the water from the naula is a big problem. The tap water is convenient.

Sameer: Are there any other problems you face in terms of land and agriculture?

Participant: No but we have a lot of monkeys who eat up our crops. That has become a big problem. Also sometimes there is less rain but we cannot do anything about that.

Sameer: Do you think there is any relationship between the forests and agriculture

Participant: Yes the monkeys, they come from the forest and destroy our crops.

Sameer: So what do you do about the monkeys?

Participant: Nothing; we have to keep vigilant and shoo them away when they attack the crops.

Sameer: All right, thank you for the interview.

The interviews with youth had a similar structure where in there was initial discussion on the general environment concerns and later the conversation was narrowed down to specific problem solving processes with regards to water and land management issues. I questioned the youth to find out how well they understand a certain concepts related to water and land management. For example, most of the youth have said that the solution to resolving some of the water problems is to plant more trees. In order to understand how well they understand this concept the follow up question to this answer would be "can you tell me how planting trees specifically would resolve the water problem?" I also asked the youth "where did you learn this concept?" By asking where they learned the concept I tried to understand where the youth were gathering most of their knowledge related to environmental problem solving.

The focus group discussions also revolved around the same set of questions. Although the focus groups were structured around the above questions their conduct itself was slightly different than the interviews.

For the focus group, to start the discussion I opened the conversation with trying to understand what the participants felt about the road that was being built in the area. This story of the road worked as an excellent icebreaker and conversation builder. The story of the road was that, while walking back and forth from the village Chanoli I noticed that there was a road that was being built in the area. There was a lot of land that had been deforested because of the road. This observation served me well as I would often start the focus group by asking the group *"so what do you think of this road that is being built. So many trees are being cut down and do you think this is going to have an impact on the environment".* The conversation was then furthered into discussing specific water and land related issues.

Coding the interviews and the Focus Group Discussions

Coding the interviews and the focus group discussions: A total of 29 interviews were conducted with student from both the schools (13 from Garudabanj and 16 from Panvanaula). I

conducted three focus groups with the youth in the Panvanaula school and 4 focus groups with the youth in the Garudabanj school. In terms of the adults I conducted 8 interviews (only 6 of which were usable due to equipment failures and relevance of the answers) and 1 focus group.

Once all of the interviews and focus groups were transcribed I coded every utterance for the use of indigenous knowledge as indentified by the Delphi. I also coded each of the utterance for four different subcategories, within the main category of indigenous knowledge. For example, if I coded an utterance for use of *naulas* as the main category of indigenous knowledge, I further sub-coded the utterance into four different categories. These sub categories were as follows:

Table 4-4: Coding for subcategories for interviews and focus groups

The participant is aware and thinks that the particular solution is a viable solution to resolve problem	1
The participant is aware but does not think of the particular solution as a viable solution to resolve problem- for example will prefer tap water	2
The participant supplements new knowledge with traditional knowledge. For example will take initiative to use *naulas* along with tap water and not just use the *naulas* when tap water runs out.	3
Did not mention at all	4
Interview failed due to equipment problem	0

The main categories of traditional knowledge for which every utterance was coded were as follows:

Traditional/indigenous knowledge with respect to water as found out in the results of the Delphi:

1 Use of *Naulas* (ground water springs)

2 Keeping water source clean.

3 Rain water harvesting.

4 Plant native species of trees (Oak and Deodhar)

5 Digging trenches (khals)

6 Build small dams –(choys)

7 Build depressions – (guls around their farms)

8 Use traditional devices to store water and keep it clean.

9 Use running water rather than stored water

Traditional/indigenous knowledge with respect to land management as found out in the results of the Delphi:

1 Using organic compost.

2 Seed saving is traditionally considered good land management practice.

3 Mixed farming and crop rotation practices.

4 Healthy forest keeps the farms healthy

5 Not cutting the entire tree. Cutting the lower branches.

6 Sharing labor for agriculture.

7 Use organic pesticides and insecticides such as walnut leaves and neem leaves.

Therefore the following is an example of the complete coding systems with the main and the sub categories:

Participant: If the tap water runs out we go to the village leaders or government official and get them to fix the problem and in the mean time use the water from the naulas.

This utterance was coded for the main traditional knowledge category as **Use of *naulas*** and the utterance was further coded as **aware but do not think of as a viable solution to resolve the problem – 2.** The reason why this utterance was coded as **2** is because although the

participant is using the naula, he/she feels like the solution to resolving their problem is that the government should fix the tap. A category **1 Aware and think of as a viable solution** utterance would be as follows " *We should use the naula water and take care of the naula"* and a category **3** utterance would be *"We use the naula and the tap water as the tap water is convenient but we cannot use it for drinking, we prefer the naula water for drinking.*

Thus after coding for traditional/indigenous knowledge use, I also coded the data for other solutions. These solutions I call exogenous or non-traditional solutions. There were several of these other/exogenous/non traditional solutions that were offered by the adults and the youth. The main categories of exogenous/nontraditional solutions that the adults offered to resolve water issues were as follows:

1 If there is a water problem then we need to have the government / village leaders fix the problem.

2 *Naulas* and Gadheras can be used only if the tap water runs out.

3 We have to sit together for meeting and collectively solve the problem.

4 We cannot do anything.

The non-traditional solutions offered by the youth to resolve water problems in the village were as follows:

1 Educate the community members

2 Sit together for a meeting and collectively solve the problem.

3 Since youth study these issues in school adults need to listen to them.

4 Manage cattle grazing.

5 Petition the government/village chief to resolve the water issues.

6 Stop corruption

7 Build hand pumps and wells.

8 Maintain and repair existing pipelines.

9 Distribute/Ration water.

Since all the participants who mentioned these solutions thought of them as viable solutions, the utterances were sub-coded as **1-Aware and think of as viable solution** and **4- Did not mention at all.**

There were not many non-traditional solutions presented by participants to resolve some of the land management issues. The adults suggested that keeping the monkeys away from the crops was the most important non-traditional solution to some of the land related problems. The youth did not mention any other non-traditional solutions. Some of the non-traditional solutions presented by the youth to resolve the land related problems were:

1 Stop pollution

2 Human population control

3 Stop migration towards the city.

While all the adults mentioned the monkey problem, none of the youth mentioned the monkey problem. However the number of youth who mentioned each of three problems listed above is as follows:

Table 4-5: Non traditional/non indigenous solutions presented by youth to resolve some of the issues related to land.

Non traditional/non indigenous solutions presented by youth to resolve some of the issues related to land.	**No of youth who suggested this as a solution**	**Youth focus groups**
Stop pollution	2	3
Stop population growth	1	0
Stop out migration	0	1

Results for Research Question Number 2

Results: For research question number 2: **How much of this indigenous knowledge is used by community members while making decisions about the environment (land and water related issues)?**

This question is broken down into two parts: land and water.

How much indigenous knowledge is used by community members (adults) while making decisions related to water issues:

For adults the results of the focus group and the interviews were combined as their answers were similar. Also since there was only one focus group, it seemed prudent to merge the information shared by the adults during the focus group and the interview.

In terms of using *naulas,* 57.1% of the adults are aware of this traditional knowledge but do not think of it as a viable solution and 42.9% of adults think that the new system should be supplemented with the traditional knowledge system.

Table 4-6: Adults proposing *naulas*

		Frequency	Percent
Valid	Aware but do not think as a solution	4	57.1
	Supplement with traditional	3	42.9
	Total	7	100.0

Only 14.3% of adults think that keeping the water source clean is a viable solution to resolve the water issues and 85.7% adults did not mention this as solution.

Table 4-7: Adults proposing clean water

		Frequency	Percent
Valid	Aware and think as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Only 14.3% of adults mentioned rain water harvesting as a solution to water issues in their community and 85.7% did not mention this at all.

Table 4-8 Adults proposing rainwater harvesting

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Only 14.3% of adults mentioned planting native species of trees as a solution to water issues in their village and 85.7% did not mention this at all.

Table 4-9 Adults proposing planting native species of trees

		Frequency	Percent
Valid	Aware and think of as a viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Only 14.3% of adults mentioned Storing water as a solution to community water issues

Table 4- 10 Adults proposing proper storage of water

		Frequency	Percent
Valid	Aware and think of viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

None of the adults mentioned trenches as a method to resolve water issues.

Table 4-11 Adults proposing use of trenches

		Frequency	Percent
Valid	Did not mention at all	7	100.0

Also none of the adults mentioned using running water as a way to solve some of the water related problems in their community.

Table 4-12 Adults proposing use of running water

		Frequency	Percent
Valid	Did not mention at all	7	100.0

To summarize, most of the adults are aware that *naulas* are the traditional source of water but do not think of it as a sustainable solution to resolving the water problems in the village. Most of the adults have mentioned that they like the tap system better, as it is more convenient than getting water from the *Naulas*. None of the adults knew the source of the tap water and none of the adults knew the actual process behind the practice of building the *naulas* and keeping them clean.

Other than the *naulas*, a majority of the adults did not mention any of the other traditional water management practices. Only one of the participants mentioned that keeping the water source clean, harvesting rain water, planting native species of trees and proper water storage methods as sustainable methods of water management.

Results for Research Question Number 2

Land:

How much indigenous knowledge is used by community members (adults) while making decisions about issues related to the land:

The results of the focus group and the interviews were combined as the answers were similar. Also since there was only one focus group, it seemed prudent to merge the information shared by the adults during the focus group and the interviews.

In terms of understanding that healthy forestland is good for agriculture, only 14.3% of the participants were aware and mentioned this as a viable solution to solve some of the land related issues while 85.7% did not mention it at all

Table 4- 13 Adults proposing keeping forests healthy for good land management.

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

In case of mixed farming, however, about 71.4% thought it was a good idea to engage in mixed farming practices in order to keep the land healthy. While 28.6% did not mention this as a solution to good land management practice.

Table 4- 14 Adults proposing mixed farming

		Frequency	Percent
Valid	Aware and think of as viable solution	5	71.4
	Did not mention at all	2	28.6
	Total	7	100.0

Only 14.3% of the adults thought of not cutting the entire tree as a viable solution to sustainable land management, while 85.7% of the adults did not mention this practice at all.

Table 4-15 Adults proposing not cutting entire tree for fodder.

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4-16 Adults proposing use of organic fertilizer

		Frequency	Percent
Valid	Did not mention at all	7	100.0

None of the adults mentioned this practice.

Table 4- 17 Adults proposing seed saving

		Frequency	Percent
Valid	Did not mention at all	7	100.0

None of the adults mentioned this practice.

Table 4- 18 Adults proposing sharing labor practices

		Frequency	Percent
Valid	Did not mention at all	7	100.0

None of the adults mentioned this practice.

Table 4 -19 Adults proposing using organic insecticide and pesticide

		Frequency	Percent
Valid	Did not mention at all	7	100.0

None of the adults mentioned this practice.

Table 4 -20 Adults proposing crop rotation

		Frequency	Percent
Valid	Did not mention at all	7	100.0

To summarize, most adults thought that mixed farming was a good method to keep the agricultural land healthy. They did not explain it in terms of "more diversity leads to healthy

farming practices;" they described it as follows: "we plant multiple crops at the same time because if one of the crops fail then there is another one to help us survive the year."

Only 14.3% of adults mentioned that healthy forests help keep the agriculture land healthy by providing more leaves for decomposition, leading to richer soil and also the roots of the trees help keep the soil erosion in check.

Also, only 14.3% of adults mentioned that managing trees for fuel and fodder is important. They mentioned that the tree cannot be chopped in its entirety. Only the branches below can be cut; the branches toward the top should not be cut. This will help the tree grow in the future.

Results for research question number 3: Water

Results for research question number 3: **How much of this indigenous knowledge is passed on to the future generation (Youth)?**

Answer to this question is also two fold: water and land.

Water:

How much of this indigenous knowledge related to water management is passed on to the future generation (Youth)?

The students that were interviewed were from the 6^{th,} 7th and 8th grade from two different high schools. In the Kumaon region, the students enter the high school system at 5th grade and remain in the high school system until 10th grade. After this, they go to junior college (11th and 12th grade). All of the students are exposed to the local environment education curriculum *Our Land, Our Life*.

As far as the youth knowing about *naulas* and thinking of them as a viable solution to resolve the water issues face by the community, 28.6% of the youth saw this as a viable solution while discussing this issue in the focus groups. Also in the focus group discussions, 42.9% of

youth were aware of the *naulas,* but did not think of them as a viable solution, and 28.6% of students did not mention this particular solution at all.

Table 4 -21 Youth proposing using *naulas* – focus groups

		Frequency	Percent
Valid	Aware and think is a viable solution	2	28.6
	Aware but do not think is a viable solution	3	42.9
	Did not mention at all	2	28.6
	Total	7	100.0

During individual interviews, 3.4% of the students said that *naulas* are viable solutions to resolve some of the water related issues, but 48.3%, although aware, did not think of this as a viable solution to resolve the water problems. 6.9% thought it was good idea to supplement the tap water with the naula water and 37.9% of students did not mention anything about *naulas* at all.

Table 4 -22 Youth proposing using *naulas* – interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Aware and think is a viable solution	1	3.4
	Aware but do not think of as a viable solution	14	48.3
	Supplement new with traditional	2	6.9
	Did not mention at all	11	37.9
	Total	29	100.0

During the focus group discussion, 57.1% thought that keeping the source of water clean was a good idea in terms of water management. 42.9% did not mention this solution this at all.

Table 4- 23 Youth proposing keeping water source clean- focus group

		Frequency	Percent
Valid	Aware and think is a viable solution	4	57.1
	Did not mention at all	3	42.9
	Total	7	100.0

During the interviews only 24.1% of students thought of this as a viable solution for managing water. 72.4% of students did not mention this as a solution at all.

Table 4- 24 Youth proposing keeping water source clean - interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Aware and think of as viable solution	7	24.1
	Did not mention at all	21	72.4
	Total	29	100.0

42.9% of the students in the focus groups thought of harvesting rain water as a viable solution, while 57.1% of students in the focus groups did not mention it at all.

Table 4 -25 Youth proposing keeping rainwater harvesting- focus group

		Frequency	Percent
Valid	Aware and think is a valuable solution	3	42.9
	Did not mention at all	4	57.1
	Total	7	100.0

However, during individual interviews, only 13.8% of students thought of rainwater harvesting as a good way to manage water, while 82.8% of students did not mention it at all as a solution.

Table 4-26 Youth proposing rain water harvesting - interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Aware and think of as a viable solution	4	13.8
	Did not mention at all	24	82.8
	Total	29	100.0

In terms of planting trees, especially native species of trees, all the students in the focus group thought of this as a viable solution to manage water in their community. The individual interviews also told a similar story.

Table 4- 27 Youth proposing planting trees – focus group

		Frequency	Percent
Valid	Aware and think is a viable solution	7	100.0

During individual interviews, a majority 82.8% of students thought planting trees was a good solution to solving some of the water problems in their community, while 13.8% did not mention this at all.

Table 4- 28 Youth proposing planting trees - interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Aware and think is a viable solution	24	82.8
	Did not mention at all	4	13.8
	Total	29	100.0

The focus groups revealed that 28.6% students think that proper water storage is a viable way to manage water. While 71.4% of students did not mention it at all.

Table 4 -29 Youth proposing proper water storage methods – focus groups

		Frequency	Percent
Valid	Aware and think is a viable solution	2	28.6
	Did not mention at all	5	71.4
	Total	7	100.0

During individual interviews, 10.3% thought proper water storage facility is a viable solution for solving water related issues while 86.2% did not mention it at all.

Table 4 -30 Youth proposing proper water storage – interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Aware and think of as a viable solution	3	10.3
	Did not mention at all	25	86.2
	Total	29	100.0

During focus group discussion, only 14.3% thought that digging trenches was a viable solution to manage water, and 85.7% did not mention it at all.

Table 4- 31 Youth proposing trenches – focus group

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

None of the students mentioned this practice during individual interviews.

Table 4 -32 Youth proposing trenches - interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

None of the students mentioned the use of running water as a solution to resolving water issues in their community.

Table 4 -33 Youth proposing the use of running water – focus groups

		Frequency	Percent
Valid	Did not mention at all	7	100.0

Table 4 -34 Youth proposing the use of running water – interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

None of the students mentioned the use of guls as a solution to help resolve water issues in their community.

Table 4 -35 Youth proposing the use of Guls – focus groups

		Frequency	Percent
Valid	Did not mention at all	7	100.0

Table 4 -36 Youth proposing the use of guls – interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

While none of the students in the focus groups mentioned choys as a viable solution to resolving water problems, in the interviews 6.9% of the students did think it was a good idea to build choys and manage water through these small dams.

Table 4 -37 Youth proposing the use of Choys– focus groups

		Frequency	Percent
Valid	Did not mention at all	7	100.0

Table 4 -38 Youth proposing the use of Choys– interviews

		Frequency	Percent
Valid	Faulty interview (equipment failure)	1	3.4
	Aware and think of as a viable solution	2	6.9
	Did not mention at all	26	89.7
	Total	29	100.0

To summarize the results, the number one solution that the students present in terms of managing water using indigenous knowledge is tree planting. In the focus groups (100%) and the interviews (82.8%), the students strongly stressed the need to plant native species of trees in order to hold the soil and increase water seepage into the ground water table.

Rain water harvesting, use of *naulas*, keeping water sources clean, and proper water storage were some other solutions that the students presented to solve the water issues in the community. Although aware of these traditional practices, not all of the students felt like these were viable solutions to resolve the problems related to water management.

Land:

How much of this indigenous knowledge related to land management is passed on to the future generation (Youth)?

The youth's knowledge about how to use traditional / indigenous practices to resolve issues related to their land are reflected in the tables below:

The first practice that was suggested by the panel of experts interviewed for the Delphi was that healthy forests keep the human habitat and cultivated land healthy. During focus group discussions, 14.3% of students suggested this idea to resolve land related problems, while 85.7% did not mention it at all. During interviews, only 3.4% of youth mentioned this as a viable solution to resolving the land related problems, while 93.1% did not mention this at all.

Table 4 -39 Youth healthy forest healthy land– focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4 -40 Youth healthy forest healthy land– focus groups

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	1	3.4
	Did not mention at all	27	93.1
	Total	29	100.0

During focus groups, 14.3% of students thought that mixed farming practices should be promoted to resolve some of the land related problems, while 85.7% of students did not mention this at all. During interviews only 6.9% of students suggested this as a method to resolve land related problems while 89.7% did not mention this practice at all.

Table 4 -41 Youth proposing mixed farming– focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4 -42 Youth proposing mixed farming– interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	2	6.9
	Did not mention at all	26	89.7
	Total	29	100.0

During focus group discussions, 85.7% of students suggested that in order to manage land well, cutting the trees only partially was a viable solution, while only 14.3% did not mention it at all. 82.8% students thought of this as a viable solution to good land management practices during individual interviews, while 13.8% of students did not mention this at all.

Table 4- 43 Youth proposing not cutting entire tree for fodder- focus group

		Frequency	Percent
Valid	Aware and think of as viable solution	6	85.7
	Did not mention at all	1	14.3
	Total	7	100.0

Table 4- 44 Youth proposing not cutting entire tree for fodder- interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	24	82.8
	Did not mention at all	4	13.8
	Total	29	100.0

14.3% of students said during focus groups that combining new practices (using artificial fertilizers) with traditional practices (using organic fertilizer) was a viable solution to land related problems, while 85.7% of students did not mention this at all. During individual interviews, 3.4% of students thought the use of organic fertilizer a viable solution to land related problems, while 93.1% of students did not mention this at all.

Table 4- 45: Youth proposing the use of organic fertilizer – focus group

		Frequency	Percent
Valid	Supplement new with old	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4- 46: Youth proposing the use of organic fertilizer - interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	1	3.4
	Did not mention at all	27	93.1
	Total	29	100.0

During focus groups, 14.3% of students suggested seed saving as a viable solution to problems related to land, while 85.75% of students did not mention this at all.

None of the students mentioned 'seed saving' practices during individual interviews.

Table 4-47 : Youth proposing seed saving- focus group

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4-48: Youth proposing seed saving - interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

None of the students mentioned 'labor sharing' practices.

Table 4-49: Youth proposing labor sharing – focus groups

		Frequency	Percent
Valid	Did not mention at all	7	100.0

Table 4-50: Youth proposing labor sharing - interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

During focus groups, 14.3% of students suggested the use of organic insecticides as a solution to land related problems, while 85.7% did not mention this at all. During interviews, 3.4% of students thought of this idea, but did not think of this method, as a sustainable solution to better land management, and 93.1% of students did not mention this practice at all in their individual interviews.

Table 4- 51: Youth proposing the use of organic insecticide– focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4- 52: Youth proposing the use of organic insecticide- interviews

		Frequency	Percent
Valid	Equipment Failure	1	3.4
	Aware but do not think of as viable solution	1	3.4
	Did not mention at all	27	93.1
	Total	29	100.0

During focus groups, 14.3% of students thought crop rotation a viable solution to manage their land better, while 85.7% did not mention this practice at all. During individual interviews, 6.9% of students suggested crop rotation as a method to resolve land related problems, while 89.7% of students did not mention this practice at all.

Table 4- 53: Youth proposing crop rotation- focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4-54: Youth proposing crop rotation: interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	2	6.9
	Did not mention at all	26	89.7
	Total	29	100.0

To summarize, the majority of the students during focus groups (85.7%) and interviews (82.8%) thought the practice of not cutting trees in their entirety a solution to helping resolve land related environment problems. During focus group discussions, some students (14.3%) also thought that mixed farming, crop rotation, use of organic fertilizer, use of organic insecticide and seed saving are solutions to resolving land related issues. While during interviews, 6.9% of students thought crop rotation and mixed farming were practices that lead to lesser land related

problems. Also during interviews, 3.4% of students thought using organic insecticide and fertilizer good solutions to resolving land related problems faced by their community.

Results for research question number 4

Results for research question number 4: **How will youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?**

Results to this question are two fold. The first part examines the outside knowledge that the students are suggesting as solutions to water and land related issues in their communities. For the purposes of this study the outside (exogenous) knowledge is defined as the practices that the students suggested to resolve water and land related issues within their communities that do not overlap with the practices suggested as indigenous knowledge by the experts who participated in the Delphi. The study focuses exclusively on the indigenous practices that were identified by the Delphi panel. The study does not focus on documenting all the indigenous knowledge in the region.

For water related issues:

Thus the exogenous knowledge-based solutions that the students suggested for resolving the water related problems were as follows:

1. Educating the community members about issues related to good water management practices e.g. planting trees.

During the focus group discussions, about 42.9% of youth thought that educating the community members is important tin solving some of the water related problems. However, during interviews only 20.7% of the students thought of this as a viable solution.

Table 4- 55: Youth proposing educating community members – focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	3	42.9
	Did not mention at all	4	57.1
	Total	7	100.0

Table 4- 56: Youth proposing educating community members - interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	6	20.7
	Did not mention at all	22	75.9
	Total	29	100.0

2. Organize meetings and discussions to come up with a solution for resolving water related issues.

During focus group discussions, 57.1% of students thought organized meetings and discussions were a productive way to problem solve some of the water related issues, but none of these students mentioned this as a viable solution during individual interviews.

Table 4- 57: Youth proposing to organize meetings and discussions – focus groups

		Frequency	Percent
Valid	Aware and think of as a viable solution	4	57.1
	Did not mention at all	3	42.9
	Total	7	100.0

Table 4- 58: Youth proposing to organize meetings and discussions – interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

3. Adults should listen to youth

During the focus group, 14.3% of the students felt that adults needed to listen to their youth to help resolve the water problems in their communities. The students felt that since they go to school and read about various methods to resolve environmental problems, they have good information to contribute to the discussion regarding solutions to water problems within their communities. However, none of the youth mentioned this during individual interviews.

Table 4- 59: Youth proposing adults should listen to youth – focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4- 60: Youth proposing adults should listen to youth – interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Did not mention at all	28	96.6
	Total	29	100.0

4. Petition the government or talk to village leaders and get them to solve the water problem.

The students did not mention petitioning the government or talking to village leaders in the focus group, but 3.4% of the youth in the interviews thought this might be a good idea to resolve some of the water related issues.

Table 4- 61: Youth proposing to petition government– focus groups

		Frequency	Percent
Valid	Did not mention at all	7	100.0

Table 4- 62: Youth proposing to petition government– interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	1	3.4
	Did not mention at all	27	93.1
	Total	29	100.0

5. Stop corruption.

Stopping corruption within the system was a solution presented by 14.3% of the students during the focus groups discussion and by 13.8% of students during the interviews for solving water related problems in their community.

Table 4- 63: Youth proposing to stop corruption– focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4- 64: Youth proposing to stop corruption– interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	4	13.8
	Did not mention at all	24	82.8
	Total	29	100.0

6. Hand pumps (To tap the ground water).

During focus groups, 14.3% of the students mentioned that more hand pumps would be the solution to the water problems. Only 3.4% of students mentioned this as a solution during individual interviews.

Table 4- 65: Youth proposing to use hand pumps – focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4- 66: Youth proposing to use hand pumps – interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	1	3.4
	Did not mention at all	27	93.1
	Total	29	100.0

7. Repair pipes or put in new pipelines.

During focus groups, 14.3% of the students thought of repairing or building new pipelines as a solution to their water problems, and 10.3% of students thought of this as a solution during interviews.

Table 4- 67: Youth proposing to repair pipes and put new pipelines – focus groups

		Frequency	Percent
Valid	Aware and think of as viable solution	1	14.3
	Did not mention at all	6	85.7
	Total	7	100.0

Table 4- 68: Youth proposing to repair pipes and put new pipelines – interviews

		Frequency	Percent
Valid	Equipment failure	1	3.4
	Aware and think of as viable solution	3	10.3
	Did not mention at all	25	86.2
	Total	29	100.0

8. Ration/fair distribution of water.

During focus groups none of the students thought to ration or fairly distribute water was a viable solution to water problems, but during interviews 10.3% suggested this as a solution.

Table 4- 69: Youth proposing to ration water – focus groups

		Frequency	Percent
Valid	Equipment failure.	1	3.4
	Aware and think of as viable solution	3	10.3
	Did not mention at all	25	86.2
	Total	29	100.0

Table 4- 70: Youth proposing to ration water- interviews

		Frequency	Percent
Valid	Did not mention at all	7	100.0

The above data gives us an idea of what outside knowledge the youth are using to resolve the water situation in their community. To find out how the above ideas compare themselves to the traditional/indigenous knowledge as identified by the Delphi, I used the following techniques:

1. Listed all the indigenous/traditional knowledge and the outside knowledge
2. Listed the percentage of students who indicated the use of that particular practice/knowledge as a viable solution (aware and think of as a viable solution). Listed the students who indicated that they would use that particular indigenous practice/knowledge together with the outside knowledge.
3. Ranked all of the choices to see which practice/knowledge the youth are likely to use the most.

Focus groups (water):

The table below gives us the practice/knowledge the students mentioned the most during focus group discussions.

Table 4- 71: practice/knowledge the students mentioned the most during focus group discussions.

Practice	Aware and thought of this idea as a viable solution (%)	Supplement traditional with new/outside knowledge (%)
Planting Oak trees and other specific/broad leaf trees	100	0
Keeping water source clean	57.1	0
Resolving issues by meetings/ discussions	57.1	0
Rain water harvesting	42.9	0
Educating the community members/ villagers	42.9	0
Using *naulas*/gadheras	28.6	0
Water storage devices- tanks	28.6	0
Digging Trenches- khals	14.3	0
Since youth study these issues at school adults need to listen to them	14.3	0
Stop corruption	14.3	0
Hand pumps and wells	14.3	0
Use running water rather than stored water	0	0
Guls- depression around farms	0	0

Choys-small dams around flowing water	0	0
Manage Cattle Grazing	0	0
Petition the government/village chief for help to resolve some of the management issues	0	0
Build new and repair existing pipelines	0	0
Distribute water correctly/ Ration water	0	0

Although the above table suggests that a majority of the students suggested a certain practice to resolve water related problems in their community, it must be made clear that the students used a combination of outside knowledge and indigenous knowledge to make their decisions to resolve issues presented to them during interviews and focus groups related to water in their community.

An example of a student response would be as follows:

Sameer: How should we resolve some of the water related problems within your community?

Student: We should keep the water clean and plant more trees and ask the government to put in more pipelines.

In the response above the youth do not exclusively say that we should use both indigenous and exogenous practices together. While answering the question "what should we do to resolve the water some of the water problems in your community," the youth do mention practices that are a combination of indigenous and exogenous knowledge.

The table indicates that the top two choices that the students have mentioned as solutions to resolving water problems in their village are planting trees (100%) (native species, broad leaf trees –oak, deodhar, etc.) and keeping the water source clean (57.1%) . Both of these are indigenous knowledge sources as indicated by the Delphi. Resolving problems through community discussions and meetings (57.1%) is also a top choice the students made to resolve water related problems faced by the community. This choice is based on outside knowledge as the Delphi panel did not identify it as indigenous knowledge. However community meetings and problem solving is a known indigenous method in rural India (Shiva 2000). This issue is further explored in the next chapter (chapter 5)

Also rain water harvesting (indigenous knowledge) and educating community members (outside knowledge) regarding water conservation and management issues were other choices made by 42.9% of students.

28.6% of students thought that using *naulas* (indigenous knowledge) and proper water storage devices (indigenous knowledge) was a good idea to solve some of the water related problems face by their community. This was followed by 14.3% of students suggesting that digging trenches (indigenous knowledge), adults listening to youth (exogenous knowledge), putting a halt to corruption (exogenous knowledge) and constructing new hand pumps and wells (exogenous knowledge) as ways to resolve water related problems faced by their communities.

Interviews (water): The table below gives us the practice/knowledge the students mentioned the most during interviews.

Table 4-72: practice/knowledge the students mentioned the most during interviews.

	Aware and thought of this idea as a viable solution (%)	Supplement traditional with new/outside knowledge (%)
Planting Oak trees and other specific/broad leaf trees	82.8	0
Keeping water source clean	24.1	0
Educating the community members/ villagers	20.7	0
Rain water harvesting	13.8	0
Water storage devices- tanks	10.3	0
Build new and repair existing pipelines	10.3	0
Distribute water correctly/ Ration water	10.3	0
Choys-small dams around flowing water	6.9	0
Hand pumps and wells	3.4	0
Petition the government/village chief for help to resolve some of the management issues	3.4	0
Using *naulas*/gadheras	3.4	6.9
Resolving issues by meetings/ discussions	0	0
Digging Trenches- khals	0	0
Since youth study these issues at school adults need	0	0

to listen to them		
Use running water rather than stored water	0	0
Guls- depression around farms	0	0
Manage Cattle Grazing	0	0
Stop corruption		

The individual interviews also put forward a similar story as the focus groups. The top two choices that the students have indicated as practices to resolve water problems face by their community are planting trees (native species – broad leaf trees like oak and deodhar) – 82.8% and keeping the water source clean (24.1%). Both of these are identified by the Delphi group as practices supported by indigenous/traditional knowledge.

20.7% of students think educating community members (outside knowledge/exogenous knowledge) is a good idea to resolve some of the water related problems in their community, and 13.8% of students think rain water harvesting (indigenous knowledge) is a good idea to resolve some of the water related problems faced by their communities.

10.3% of students think that proper water storage devices (indigenous knowledge), building new pipelines and repairing existing pipelines (exogenous knowledge) and fair distribution of water are good solutions to resolving water related problems faced by their communities. 6.9% of students think building small dams choys (indigenous knowledge) is a good idea while 3.4 % of students think solving water related problems should include building hand pumps and wells (outside knowledge), asking the government to intervene (outside knowledge) and using *naulas* (indigenous knowledge).

6.9% of students think that their community should supplement the new methods such as pipes with traditional methods such as *naulas* to resolve some of the water related problems.

Land related issues:

When it came to resolving land related issues, the students did not present many exogenous solutions to actively resolve the land related problems. Some of the solutions based on exogenous knowledge that the students suggested were as follows:

Table 4- 73: solutions based on exogenous knowledge -youth

Solutions	Percentage of youth who suggested this as a solution	Focus groups (%)
Manage pollution	6.6	42.9
Manage population Population growth	3.3	0
Stop out Migration	0	14.3

The students (6.6%- individual interviews and 42.9% -focus groups) suggested that since pollution was one of the biggest threats to the land/agriculture, stopping pollution is the solution to resolving land related issues. They felt that more carbon dioxide would lead to more damage to the plants and agriculture. They cited vehicles/road as the source for this pollution.

They also thought that population growth (3.3% -individual interviews) was a threat to land and thus stopping population growth was a solution to resolving land related problems. The argument was that more people leads to more food production, leads to using artificial fertilizers and thus causes the land to degrade.

14.3% of students in the focus group discussion cited that migration from rural to urban places can cause land related problems. The argument was that as people leave for the city there is no one to care for the land and this causes the land to degrade. Thus stopping outmigration to cities would keep the land healthy.

The above data gives us an idea of what outside knowledge the youth are using/would use to resolve land related problems in their community. For finding out how the above ideas compare themselves to the traditional/indigenous knowledge as identified by the Delphi, I used the following techniques:

1. Listed all the indigenous/traditional knowledge and the outside knowledge
2. Listed the percentage of students who indicated the use of that particular practice/knowledge as a viable solution (aware and think of as a viable solution) and also indicated that they would use that particular indigenous practice/knowledge together with the outside knowledge.
3. Then I ranked all of the choices to see which practice/knowledge the youth are likely to use the most while making decision in the future.

Focus groups (land):

The table below gives us the practice/knowledge the students mentioned the most during focus group discussions with regards to resolving land related problems.

Table 4- 74: Practice/knowledge the students mentioned the most during focus group discussions with regards to resolving land related problems

Focus groups	Aware and thought of this idea as a viable solution (%)	Supplement traditional with new/outside knowledge (%)
Not cutting trees	85.7	0
Healthy forests - healthy land	14.3	0
Mixed farming	14.3	0
Seed saving	14.3	0
Organic insecticide	14.3	0
Crop rotation	14.3	0
Stop pollution	6.6	0
Stop Population growth	3.3	0
Organic fertilizer	0	14.3
Labor sharing	0	0
Stop out Migration	0	0

As in the water related focus groups and interviews, the students used a combination of outside knowledge and indigenous knowledge to make their decisions with regards to issues presented to them in relation to the land in their community.

An example of a student response would be as follows:

Sameer: How should we resolve some of the land related problems within your community?

Student: We should stop pollution and not cut the trees.

While answering the question "what should we do to resolve some of the land related problems in your community," the youth do not exclusively say that we should use both indigenous and exogenous practices together, but the youth do mention practices that are a combination of indigenous and exogenous knowledge.

The above table indicates that the top choice that the students have mentioned as solutions to resolving land related problems in their village are not cutting trees (85.7%) This is a practice based on indigenous knowledge sources as indicated by the Delphi.

14.3 % of youth thought that keeping the forests healthy (indigenous knowledge), mixed farming (indigenous knowledge), seed saving (indigenous knowledge), organic insecticide use (indigenous knowledge) and crop rotation (indigenous knowledge) are good land management practices, and these should be used to resolve land related problems in their communities.

6.6% of students suggested that stopping pollution (exogenous knowledge) is a solution to resolving land related problems and 3.3% of students suggested population growth control (exogenous knowledge) as a solution to resolving land related problems face by their community.

14.3% of students thought mixing organic pesticides with new artificial pesticides was a solution to resolving some of the land related problems.

Interviews (land): The table below gives us the practice/knowledge the students mentioned the most during interviews.

Table 4- 75: Practice/knowledge the students mentioned the most during interview discussions with regards to resolving land related problems

Interviews	Aware and thought of this idea as a viable solution (%)	Supplement traditional with new/outside knowledge (%)
Not cutting trees	82.8	0
Stop pollution	42.9	0
Crop rotation	14.3	0
Stop out Migration	14.3	0
Organic insecticide	6.9	0
Mixed farming	6.9	
Healthy forests - healthy land	3.4	0
Organic fertilizer	3.4	0
Seed saving	3.4	0
Labor sharing	0	0
Stop Population growth	0	0

During individual interviews, 82.8% of students offered not cutting trees (indigenous knowledge) as a solution to resolving land related problems. The next best choice was to stop pollution (exogenous knowledge) - 42.9%, followed by Crop rotation (indigenous knowledge) – 14.3% and stopping out migration (exogenous knowledge)- 14.3%.

6.9% of students suggested mixed farming (indigenous knowledge) and using organic insecticide (indigenous knowledge) as solutions to some of the land related problems. These were followed by 3.4% of students suggesting that keeping forests healthy (indigenous knowledge), using organic fertilizer (indigenous knowledge) and seed saving practices (indigenous knowledge) were good solutions to some of the land related problems in their community.

Other related results: In order to get the complete picture of how much knowledge is passed on to the youth and how much of this knowledge youth use to make current or potential decisions about the land and water situation in their village, it was also important to find out where is the source of all of this knowledge. Thus when asked the question "where did you learn about this specific practice?" 72.4% of students said that they learned all of their knowledge in the school, 13.8% identified the source of their knowledge as home, and 3.4% of students indicated that some of the knowledge they learned at home and some of it in school.

Table 4 -76: Where do youth get their information

Where do the youth get their information	(%)
School	72.4
Home	13.8
School and Home	3.4

Summary of all the results

Summary of results for question number 1**: In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?**

The practices based on indigenous knowledge used to resolve some of the water and land related issues are as follows (as identified by the Delphi panel):

Water related:

1. Managing a '*Naulas*' (ground water springs). There is traditional knowledge associated with how to build a Naula. The structure is very important.

2. Keeping the water sources clean. Often times the water sources are designated as religious and thus people have to go in them barefoot, which helps in keeping the source clean.

3. Collecting rainwater.

4. Planting native species (Oak and Deodhar) to make sure that there is maximum water seepage into the soil. As planting these trees helps hold the soil together, more water seeps into the ground and increasing the ground water table.

5. Digging trenches (khals) is another way to manage the water.

6. Building small dams –choys to stop flowing water.

7. Building guls (depressions) around the farms to keep the soil together and to help stop water runoff.

8. Using traditional devices to store water and keep it clean.

9. Encouraging the use of running water rather than stored water, the logic being that running water has a natural filtration system

Land related:

1. Using organic compost.

2. Saving seeds
3. Using mixed farming and crop rotation practices to keep the land healthy.
4. Keeping the forests healthy which provides more organic litter for decomposition, to make good compost.
5. Choosing to cut only part of the tree. Cutting the lower branches of the tree allows the tree to keep living. More healthy trees means healthier soil and better yield from the land.
6. Sharing labor for agriculture encourages community participation and thus ensures everyone keeps their piece of land healthy and bad practices do not spread.
7. Using organic pesticides and insecticides such as walnut leaves and neem leaves

Summary of results for question number 2: **How much of this indigenous knowledge is used by community members (adults) while making decisions about the environment?**

Water related: Most of the adults are aware that *Naulas* are the traditional source of water but do not think of it as a sustainable solution to resolving the water problems in the village. Most of the adults have mentioned that they like the tap system better, as it is more convenient than getting water from the *Naulas*. Also none of the adults know the source of the tap water and none of the adults knew the actual process behind the practice of building the *naulas* and keeping them clean.

Other than the *naulas*, the majority of the adults did not mention any of the other traditional water management practices. Only one of the participants mentioned that keeping the water source clean, harvesting rain water, planting native species of trees, and using proper water storage methods as sustainable methods of water management.

Land related: most adults thought that mixed farming was a good method to keep the agricultural land healthy. They did not explain it in terms of "more diversity leads to healthy farming practices." They described it as follows: "we plant multiple crops at the same time because if one of the crops fail then there is another one to help us survive the year."

Only 14.3% of adults mentioned that healthy forests help keep the agriculture land healthy by providing more leaves for decomposition, leading to richer soil and allowing the roots of the trees help keep the soil erosion in check.

Also only 14.3% of adults mentioned that managing trees for fuel and fodder is important. They mentioned that the tree cannot be chopped in its entirety. Only the branches within the reach of an individual standing on the ground can be cut, the branches toward the top should not be cut. This will help the tree grow in the future.

Summary of results for question number 3: **How much of this indigenous knowledge is passed on to the future generation (high school students)?**

Water related: The number one solution that the students presented in terms of managing water using indigenous knowledge is tree planting. In the focus groups and the interviews, the students strongly stressed the need to plant native species of trees to hold the soil and increase water seepage into the ground water table.

Rain water harvesting, use of *naulas*, keeping water source clean and proper water storage were some other solutions that the students presented to solve the water issues in the community. Although aware of these traditional practices, not all of the students felt like these were viable solutions to resolve the problems related to water management.

Land related: A majority of the students during focus groups (85.7%) and interviews (82.8%) thought not cutting trees in their entirety is a solution to land related environment problems.

During focus group discussions some students (14.3%), also thought that mixed farming, crop rotation, use of organic fertilizer, use of organic insecticide and seed saving are solutions to land related issues. While during interviews, 6.9% of students thought crop rotation and mixed farming were practices that lead to lesser land related problems. Also during interviews, 3.4% of

students said using organic insecticide and fertilizer are good solutions to resolving land related problems face by their community.

Summary of results for research question number 4: **How will youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?**

Water related: Focus groups: The top two choices that the students have mentioned as solutions to resolving water problems in their village are planting trees (100%) (native species, broad leaf trees –oak, deodhar etc) and keeping the water source clean (57.1%) . Both of these are indigenous knowledge sources as indicated by the Delphi. Resolving problems through community discussions and meetings (57.1%) is also indicated as a top choice the students made to resolve water related problems faced by the community. This choice is based on outside knowledge.

Also rain water harvesting (indigenous knowledge) and educating community members (outside knowledge) regarding water conservation and management issues were other choices made by 42.9% of students.

28.6% of students thought that using *naulas* (indigenous knowledge) and proper water storage devices (indigenous knowledge) was a good idea to solve some of the water related problems faced by their community. This was followed by 14.3% of students suggesting that digging trenches (indigenous knowledge), adults listening to youth (exogenous knowledge), putting a halt to corruption (exogenous knowledge), and constructing new hand pumps and wells (exogenous knowledge) as a good way to resolve water related problems faced by their communities.

Water related: Interviews: The top two choices that the students have indicated as practices to resolve water problems face by their community are; planting trees (native species – broad leaf trees like oak and deodhar) (82.8%) and keeping the water source clean (24.1%). Both

of these are identified as practices supported by indigenous/traditional knowledge. 20.7% of students think educating community members (outside knowledge/exogenous knowledge) is a good idea to resolve some of the water related problems in their community and 13.8% of students think rain water harvesting (indigenous knowledge) is a good idea to resolve some of the water related problems faced by their communities.

10.3% of students think that proper water storage devices (indigenous knowledge), building new pipelines and repairing existing pipelines (exogenous knowledge) and fair distribution of water are good solutions to water related problems faced by their communities. 6.9% of students think building small dams choys (indigenous knowledge) is a good idea, while 3.4 % of students think solving water related problems should include building hand pumps and wells (outside knowledge), asking the government to intervene (outside knowledge) and using *naulas* (indigenous knowledge).

6.9% of students think that their community should supplement the new methods such as pipes with traditional methods such as *naulas* to resolve some of the water related problems.

Land related: focus groups The top choice that the students have mentioned as solutions to land related problems in their village are choosing to not cut entire trees (85.7%). This is a practice based on indigenous knowledge sources as indicated by the Delphi. 14.3 % of youth thought that keeping the forests healthy (indigenous knowledge), mixed farming (indigenous knowledge), seed saving (indigenous knowledge), organic insecticide (indigenous knowledge) and crop rotation (indigenous knowledge) are good land management practices and these should be used to resolve land related problems in their communities.

6.6% of students suggested stopping pollution (exogenous knowledge) as a solution to resolving land related problems, and 3.3% (exogenous knowledge) of students suggested population growth control as a solution to land related problems faced by their community.

14.3% of students thought mixing organic pesticides with new artificial pesticides a solution to some of the land related problems.

Land related: interviews: 82.8% of students offered choosing to not cut entire trees (indigenous knowledge) as a solution to land related problems. The next best choice was to stop pollution (exogenous knowledge) - 42.9%, followed by Crop rotation (indigenous knowledge) – 14.3% and stopping out migration (exogenous knowledge)- 14.3%. 6.9% of students suggested mixed farming (indigenous knowledge) and the use of organic insecticide (indigenous knowledge) as solutions to some of the land related problems. These were followed by 3.4% of students suggesting that keeping forests healthy (indigenous knowledge), using organic fertilizer (indigenous knowledge) and saving seeds (indigenous knowledge) were good solutions to some of the land related problems in their community.

Chapter 5

Discussion of Results and Conclusion

The purpose of this research study is to understand what types of knowledge (indigenous/traditional or exogenous/outside) the communities in the Kumaon Himalayas use when they engage in decision making about environmental issues regarding land and water. Understanding the processes of knowledge generation and knowledge building has become more urgent since global environmental problems such as climate change have started to create water and land related problems in the region. Studying the types of knowledge people (adults and youth) use can be useful in designing programs and curriculum for environmental education.

The study explored the types of knowledge people in the middle Himalayas use while making decisions about their environment through four different research questions.

- **In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?**
- **How much of this indigenous knowledge is used by community members (adults) while making decisions about the environment?**
- **How much of this indigenous knowledge is passed on to the future generation (high school students)?**
- **How will youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?**

Let us discuss the results to each of the above questions one at a time.

In the Kumaon region, what is the indigenous knowledge relevant to making decisions about specific environmental issues such as land management and water management?

Using the Delphi method, the study interviewed a "panel of experts," most of whom have been living in the region all of their lives and are associated with the sustainable development movement in the region in some form or the other. The Delphi procedure clearly defined indigenous practices in the region used to manage water and land. The 13 experts reached a consensus on the definition of indigenous knowledge and what kind of indigenous knowledge/practice is used to manage water and land. The panel decided, "Indigenous knowledge is knowledge that comes to you from your ancestors and that has evolved over time. It is knowledge that is attached to a certain place. Also, there is a difference between traditional knowledge and traditional practices. Sometimes when we follow a practice without understanding the logic behind the practice that is traditional practice, the actual logic behind the practice is traditional knowledge."

This definition of indigenous knowledge points out that people may follow a practice but may not understand the scientific process behind the practice. For example, knowing how to drive a car may not necessarily mean that the driver understands the process of how the car functions. Thus the question that comes up is should we consider traditional practices/knowledge as indigenous knowledge?

For the purposes of this study, I have assumed that when people are engaging in indigenous practices, they have a certain indigenous knowledge base that goes along with the practice; I agree with the experts of the Delphi that people may indulge in a certain practice even though they may not understand the complete process behind the practice. This also raises the question that if an individual has his or her own explanation for a practice, then is it an acceptable explanation even if it does not correspond with the scientific explanation? This question is further

complicated in that the experts agree that knowledge evolves along with the environmental changes that take place in the region.

However, this discussion is beyond the scope of this study. The study assumes that people mentioning the use of certain practices based on indigenous knowledge have certain explanations as to why they indulge in the practice. For the purposes of this study, that explanation is understood as indigenous knowledge.

Thus the Delphi panel of experts identified the following practices as practices based on indigenous knowledge.

Water-related:

1. Water is the basic necessity for life. The example of how the community traditionally manages water is "*Naulas*" (groundwater springs). There is traditional knowledge associated with how to build a Naula. The structure is very important, helping the groundwater come to and stay above the surface.
2. The second thing that traditional knowledge does to manage water is keep the water sources clean. Often times the water sources are designated as religious and thus people have to go in them barefoot, which helps to keep the source clean.
3. Collecting rainwater is another way groups can manage water traditionally.
4. People used to plant native species (oak and deodhar) to make sure that there is maximum seepage of water into the soil. Planting these trees helps hold the soil together, thus leading to more water seepage into the ground and increasing the groundwater table.
5. Digging trenches (khals) is another way to manage the water.
6. People also build small dams — choys — to stop flowing water.
7. To keep the soil together and to help stop water runoff, people in this region build depressions — guls — around their farms.
8. There are traditional devices to store water and keep it clean.

9. There is encouragement to use running water rather than stored water because the logic behind it is that running water has a natural filtration system

Land-related:

To keep the land healthy, people use the following traditional practices:

1. Use organic compost.
2. Save seeds.
3. Mixed farming and crop rotation practices .
4. Keep forests healthy to keep the farms healthy by proving more organic litter for decomposition, making good compost.
5. Not cutting entire trees. Cutting the lower branches of the tree keeps the tree from dying and leads to more healthy trees, which means healthier soil and better yield from the land.
6. Sharing labor for agriculture, which means community participation. This ensures everyone keeps their piece of land healthy and reduces the spread of bad practices.
7. Using organic pesticides and insecticides such as walnut leaves and neem leaves

Although the experts agreed that there is a difference between indigenous practices based on indigenous knowledge and the knowledge itself, not all of the experts explained the process behind each of the practices.

Also, one of the important observations in this process is that the experts offered resistance during the third phase of the Delphi procedure. They were reluctant to rank all the answers as they felt that the answers were more or less the same. The experts did not know each other's identity and neither did they communicate with one another, yet there was a large amount of common knowledge that was shared between them. Thus the results support the theory of social constructivism as proposed by Vygotsky (1978) and furthered by Driver (1994), King (1999), and others. As Driver (1994, pp 24) explains, "…learners of science have everyday representations of the phenomena that science explains. These representations are constructed,

communicated, and validated within everyday culture. They evolve as individuals live within a culture…. Although learning science involves social interactions, in the sense that the cultural tools of science have to be introduced to learners … individuals have to make personal sense of newly introduced ways of viewing the world."

The social construction of knowledge can be clearly seen in the results of the Delphi. The results show that this knowledge that is shared among different individuals is not only rooted in the specific culture but is transferred through the medium of practices from one individual to another. Although all the experts shared the knowledge about the practice itself, most of them made personal sense of the knowledge that drove the practice.

Shortcomings of the Delphi panel: Although the Delphi panel identified indigenous knowledge and practices, I do not believe that they have identified all of the practices that are indigenous to the region. An example of this is the practice of community discussions to resolve issues faced by the community as a whole. The Delphi panel has not identified this practice as indigenous. But village communities are often times known to get together to resolve an issue faced by their community. The government of India in an attempt to restore traditional practices in village communities encourages *Panchayat Raj,* a form of local government that involves community discussions and resolving issues at community level (Amstrong & Mangal-Joshi, 2004). While this specific form of community discussion forum (Panchayat Raj) may not exist in the Kumaon region, other forms of community discussion forums may exists within the region. The issue is thus nuanced and complex. The practice of using formal community discussions to resolve issues may have existed in the past (before the British rule). It is documented that community discussion forums or *village sabhas* were part of society until 600 BC (Mathew, 2000). After this, the subcontinent was broken up and different rulers/kings governed different parts (Mathew, 2000). During the British rule (which lasted about 150 yrs) all forms of local problem solving mechanisms were dismantled (Mathew, 2000). It was only after India regained

independence that the local village governing systems were put back into practice. Thus the local community discussion forums exist in a different form than the ones that existed in pre British India, which brings up the issue of how indigenous practices evolve over time. The issue of the evolution of indigenous knowledge will be discussed later in the chapter. For the purposes of this study, I have identified community discussion as a non-indigenous practice, not only because the Delphi panel did not identify it as indigenous knowledge or practice but also because the practice itself does not exist in its original form. There is documentation (Shiva, 2000) about how the caste system has hijacked the practice of community discussion forums, where upper caste members have an upper hand in decision-making processes. Thus since it does not exist in its true indigenous form, I have identified it as a non-indigenous practice.

Also some of the practices that the panel has identified as indigenous can also be identified as a part of the modern conservation movement that has been based on western ecosystem science. One prominent example is that of the practice of planting trees. The Delphi panel identified planting trees as an indigenous practice. This practice can be seen advocated in the modern conservation movement. The practice stemmed from the excessive deforestation that took place for developmental purposes. As the industrialization took priority, deforestation took place at a rate that was unsustainable and thus it gave rise to the need of tree planting (Govinda & Diwan, 2003). However, this is also an indigenous practice and is suggested to be a part of the sacred grove concept, where communities planted trees to appease the gods (Bhagwat, 2005). Thus for the purposes of this study, I have identified this particular practice of planting trees as indigenous knowledge.

I recognize that the issue of 'what is indigenous and what is not' is far more complicated than the scope of this particular study, but the Delphi panel does provide a means to construct a reasonable list of indigenous practices within the region.

The changing nature of indigenous knowledge systems: The Delphi panel has provided a starting point for the discussion of what is the indigenous knowledge in the region, and how indigenous is it? Although the study directly does not ask these questions, I feel they are questions that need to be addressed as communities that associate with this knowledge move in time and space. For example, the men in the village are oftentimes employed in the urban areas and interact with urban resources such as water taps. When they come back to the village, they seek these urban conveniences and try to adapt these conveniences to their context and culture. Thus in the process they add to the existing traditional knowledge systems. These adaptations are not always sustainable, but every once in while an adaptation such as a water tap next to a house becomes a sustainable practice. Then the question arises, when should we identify the water tap as indigenous. This is a complex question that is beyond the scope of this study, but like a restoration ecologist struggles with, how far back in time one should go in order to restore the ecosystem to its 'native' state, similarly there is a struggle here as to how far back in time we should go in order to identify a knowledge practice as indigenous. The way indigenous knowledge evolves, and what constitutes indigenous knowledge, is a complex study that will require a different set of probes. But as I acknowledge the complexity of this issue, I would also like to state that I have tried to address the complexity of what is indigenous knowledge by gaining consensus from local experts. Thus the Delphi panel does not address every single complexity of how these knowledge systems are constructed but provides a starting point and a good insight into the indigenous knowledge systems.

The next step of the research focused on how adults and youth use these practices while making decisions about environmental issues. Question number two: **How much of this indigenous knowledge (as identified by the members of the Delphi panel) is used by community members (adults) while making decisions about the environment?**

The results to this question pointed out that even though most of the adults knew about the *naulas* (natural water sources), they preferred the tap water system. They indicated that the tap water system was convenient and has been a part of their lives for about 20 years. None of them knew the location of the actual source of the tap water system, and when asked what they would do if the water in the taps dried up, the majority of the adults said that they would petition the government to repair the pipeline.

Thus, although the adults are aware of the indigenous practices that provide the water, when it comes to making decisions about their water resources, they prefer not to use the indigenous practices. The reasons for this can be found at multiple levels:

1. There is a possibility that tap water is considered an indicator of progress and development (Udjo, Simelane & Booysen, 2000). Piped water is also often considered "safe" by policy makers and development scholars (Gurung, 2006).
2. The convenience factor plays an important role in why the adults are choosing alternative methods (practices other than indigenous knowledge-based practices). While making decisions about water issues, the adults, although aware of some of the traditional practices, will not prefer to use them for reasons of convenience.
3. Though the adults themselves did not say this, literature in development studies points out the encouragement given to the people in rural areas by policy makers and developmental specialists to switch from traditional practices to more modern practices (information brochure, Vivekananda Institute of Hill Agriculture).
4. Most men in the village migrate to the cities, and it is possible that when they come back to the villages from the urban areas, they bring back with them a desire for urban conveniences and also a mental frame of mind which points to the fact that urbanization equals development (Bookman, 2004, Pande, 2001, Jackson, 2008).

We can observe Vygotsly's theory of social constructivism play out in reality as most adults gave similar answers to most of the questions. Also, as we can observe, learners are constructing knowledge in multiple contexts, and they are using this knowledge that has been constructed in multiple contexts while making decisions about the environment. For example, while making decisions about water issues, the participants chose to use knowledge made available to them through resources developed in urban contexts, but while making decisions about land-related issues, they use some traditional practices. For example, when it came to traditional practices for land use and land cover, most adults said that mixed farming was a preference over monoculture. The explanation behind this practice is that if one of the crops failed, then villagers would have the other one to survive. Other than this explanation, some experts in rural agricultural development point out that smaller farm sizes make it easy and profitable to have multiple crops growing at the same time (Dercon & Krishnan, 1996). The Delphi experts identify this practice of mixed farming as a traditional practice, and it is also possible that the people in the village are still using this traditional practice of mixed farming because there is no input for this practice from the urban sources. People in urban areas do not farm, and thus the villagers have no suggestions coming in from the outside, and maybe that is the reason why they are sticking to what they already know. It is important to point out here that the outside knowledge related to agriculture practices comes directly from Western modern science in the form of genetically modified seeds, fertilizers, etc. It does not come from people traveling back and forth from urban areas but from scientists who work in the area in institutes like the Vivekananda Institute of Hill Agriculture.

Another issue about which the adults felt strongly was the nuisance caused by the monkeys to the farms. That was the connection they made when asked about the relationship between forests and agriculture.

Questions three and four: **How much of this indigenous knowledge is passed on to the future generation (high school students)? And how do youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?**

Question three: How much of this indigenous knowledge is passed on to the future generation (high school students)?

Water-related:

When asked about how they would go about solving water-related problems in their community, almost all of the students said that planting trees (native species) is the most important step. Their explanation for this was that the trees would hold the soil, which in turn will stop water runoff and increase groundwater tables so that the springs and rivers will have more water. This explanation corresponds to the explanation given for planting native species of trees in their environmental education curriculum *Our Land, Our Life*. The students also mentioned using *naulas*, harvesting rainwater, utilizing proper water storage and keeping water sources clean as other ways to resolve water-related issues.

Land-related:

The majority of the youth thought that not cutting trees in their entirety was the number one solution to resolve land-related issues. The explanation behind this solution was that cutting trees would lead to deforestation and thus will cause soil runoff, which would be harmful to the land.

Other than the above, a few youth mentioned mixed farming, crop rotation, the use of organic insecticide, and seed-saving as solutions for resolving land-related problems in their community.

Thus the answer to research question three is two-fold: The youth are aware and recommend certain practices based on indigenous knowledge to resolve issues related to water in

their community. They have learned about the majority of these practices in school. To summarize, the top two choices for water- and land-related solutions are offering are:

- Water-related: Planting native species of trees (indigenous knowledge) and keeping water source clean (indigenous knowledge).
- Land-related: Not cutting trees (indigenous knowledge) and stopping the pollution (exogenous knowledge).

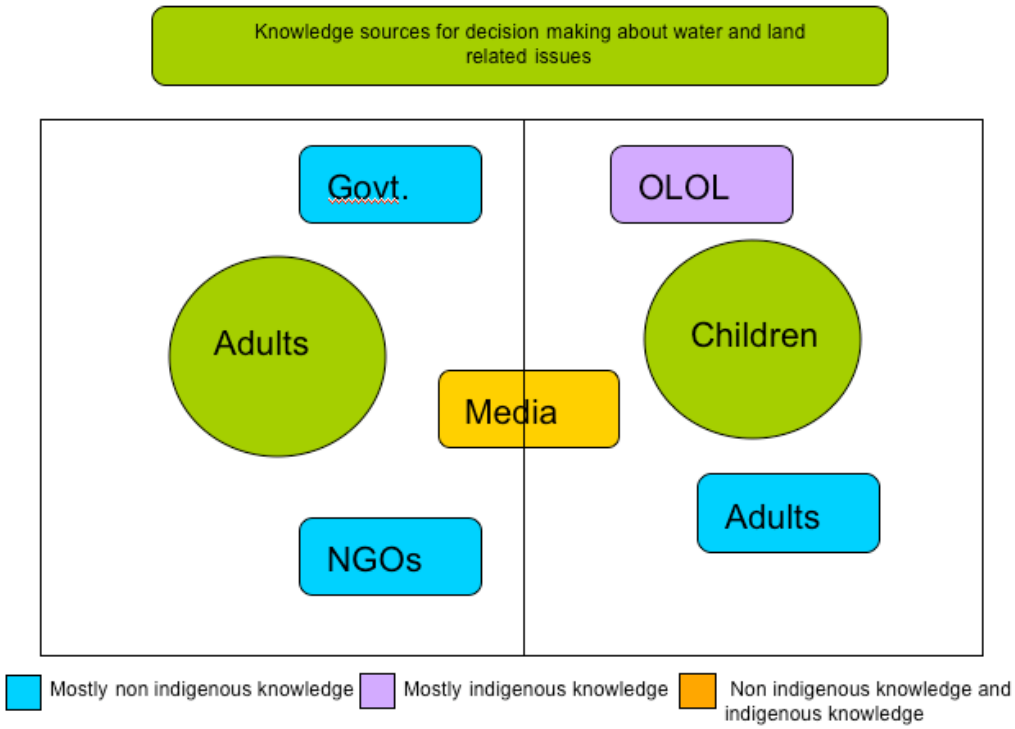
Question four: How do youth make use of indigenous knowledge in relation to exogenous knowledge while trying to negotiate issues related to their environment?

The answer to research question four is that most of the students indicated that currently, they would use practices based on indigenous knowledge to resolve some of the water- and land-related issues in their community.

Discussion for questions three and four

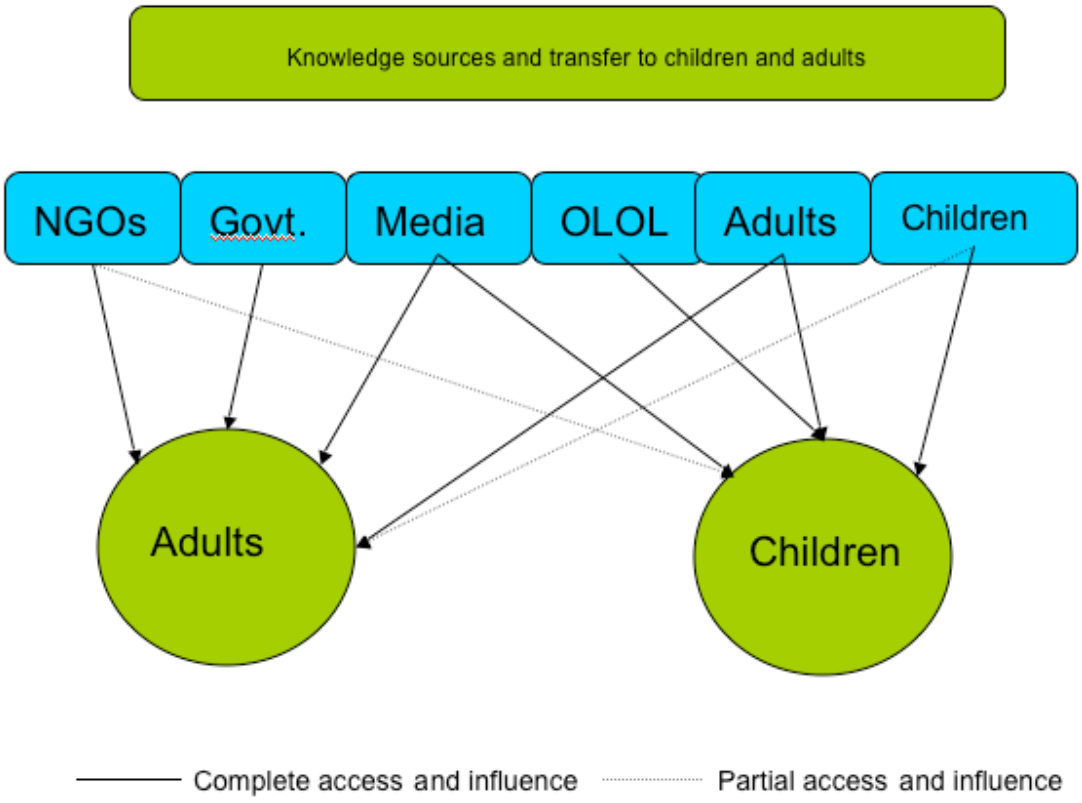
Based on these answers, there is no overlap between what the adults are saying and the solutions offered by the youth. Therefore, a question arises: Where are the youth getting their knowledge for making decisions about water and land related problems? The answer could be that since the methods of water and land conservation that the youth are suggesting are extensively discussed in their environmental education curriculum, *Our Land, Our Life*, that the curriculum could be a source of this knowledge. This is reflected in the data where 72.4% of students mentioned that they learned most of these practices in school, and 13.8% of students indicated that they learned some of the practices at home and some at school. The figure below tries to illustrate the knowledge influencing the youth and the adults. The figure also looks at possible sources for the knowledge held by the adults and youth.

Figure 5-1: Current knowledge sources for decision making about water and land related issues.



The above figure explains that the adults get most of their knowledge for environment decision making from government sources such as Vivekananda institute, non governmental organizations (NGOs) and the media. While the youth get most of their knowledge from the curriculum in school (OLOL), the adults, and the media. The diagram below shows which source most transfers knowledge to adults or youth:

Figure 5- 2: Knowledge sources and transfer to children and adults.



The above figure tells us which source has maximum influence on adults and youth. While NGOs, government, media and other adults influence the adults; youth are influenced most by media, adults, other youth and school curriculum. Therefore one can see that the community is dominated by non-indigenous knowledge sources and is most likely going to create some hybrid knowledge between the indigenous and non-indigenous knowledge that exists within the community.

Another observation that needs to be mentioned is that even though the youth mention that most of the practices that they will use in resolving water– and land-related issues are traditional practices, it is not completely guaranteed that they would use them to resolve these

issues in reality. This observation is supported by the data that indicates that when asked whether they prefer tap water or water from the naula, 95% of students said that they would prefer tap water. Jackson (2008) also addresses this issue of students not wanting to indulge in traditional practices, when he points out, "The young children in the village do not see compost as a resource for sustainable agriculture. In fact, they are ashamed of working on the land. The girls for aesthetic reasons (*nail paint would be spoiled* and the *compost stinks*- were some instant remarks from girls) and the boys for livelihood (*what will we do in the village? We go to the city, earn money and live comfortably*- the boys say). Several families in the village now complain of declining agricultural yields, so much so that food is not even enough for six months in a year." This quote implies that the students do not want to indulge in the traditional practices.

It is not surprising that the students are indicating that they have learned about resolving water and land related issues from their curriculum *Our Land, Our Life*. *Our Land, Our Life* is a powerful curriculum developed by the Uttarakhand Seva Nidhi Paryavaran Shikshan Sanstha, a non-governmental organization working in the Kumaon ranges of the Himalayas. The curriculum tries to link classroom with actual environmental problems, identifying links between issues that reflect real-world situations and relating environmental education to the local community. The curriculum addresses not only environmental science but also environmental education for sustainability more generally. The curriculum was developed in a unique partnership with local villages and has a focus on indigenous knowledge.

The data suggests a gap between the solutions the students are suggesting and the solutions the adults are suggesting. It may be possible that the curriculum *Our Land, Our Life* presents them with solutions that do not fit their reality. It also possible that the youth gave the answers they have learned in school since the interviews were conducted in the school.

This gap may also exist because of the changing nature of village communities themselves. The demographic of the village community has changed over time. The men in the

villages often go to the urban centers to seek better economic opportunities (Pande, 2001). There is a need within these communities to urbanize, as that is recognized as being developed (Agrawal, 2005). Thus indigenous knowledge practices are often times adapted to the needs of development and urbanization. However, in the school, the youth are learning about indigenous knowledge systems and about how these knowledge systems are sustainable because they fit the context. So on one hand at home there is a push toward being more urbanized while on the other hand at school there is a push toward indigenous practices. This struggle shows in the data as the youth and the adults have very little overlap in their answers.

Thus the school curriculum OLOL needs to fit the changing reality. The curriculum needs to recognize that people move through time and space and knowledge itself will evolve over a period of time. If the curriculum hopes to revive the traditional knowledge systems within the youth, I think there is a fair chance of it being rejected. Especially since the teachers (who come from an urban area) think of this curriculum as not 'up to date' (field observations, 2005, 2006, 2007, 2008). By not recognizing the changing landscape of the indigenous knowledge systems, the curriculum is working against the intergenerational knowledge transfer. Especially since the knowledge the youth are getting at home is different from the knowledge they are learning in school.

The other relevant observation is that the youth were much more confident in presenting solutions to resolve water problems. When it came to answering questions related to resolving land issues, most youth seemed like they did not know much about how to resolve them, and thus used the information from their curriculum *Our Land, Our Life* to answer the question. This could be because most of the youth who go to school do not go into the fields with their parents (or their parents are not farmers). However, they use water daily and are much more aware of water-related issues than land-related issues.

Thus, although *Our Land, Our Life* is a powerful curriculum that focuses on local

indigenous practices, it needs to take into consideration the evolving nature of indigenous knowledge and the applicability of this knowledge. For example, newer ecological problems have arisen during the past 20 years. Due to changes in the ecology of the region, the monkeys have started to raid the crops. This claim is supported by several ecological studies carried out on the Rhesus monkey population. Southwick and Siddiqi, 2001, point out, "In agricultural habitats, Rhesus obtain the great majority of their food from crop raiding and from other human sources, including direct handouts from people or thievery from roadside." The monkey population is certainly getting out of control due to several ecological as well as socio-religious reasons. Some of these reasons are listed below:

1. Lack of a predator: Pirta, Gadgil and Kharshikar (1995) point out that the land development strategies (for tourism and agriculture) in the Himalayas have reduced the number of big carnivores like leopards and tigers. These are the main predators for the Rhesus monkeys, and since the number of predators has reduced, the number of monkeys has risen.
2. Southwick and Siddiqi (2001) point to the fast reproductive ability of the Rhesus monkey as a reason for its population's increase.
3. Pirta, Gadgil and Kharshikar (1995) also explore the religious significance of the Rhesus monkey. They observe, "About 90% of participants considered the rhesus monkey as an incarnation of Hanuman, a Hindu deity." This implies the fact that they cannot be culled for management purposes.
4. Ecologist have also pointed out that due to forests being reduced in numbers, the animals have adapted to living near human habitats. The clearance of forests has also led to lessening of food resources for the wildlife, thus forcing the monkey population to raid the farms for food (Honwad, 1999).

Therefore, the village communities need to be made aware of all of these issues if this problem needs to be addressed. Currently they are dealing with this problem by employing a guard to chase the monkeys away. There is no indigenous knowledge that exists to deal with the monkey problem. More than looking for indigenous knowledge to resolve this problem, I believe, if the villagers understand the ecological processes behind why the monkeys are raiding their crops, they would be more empowered to resolve this issue. Thus the curriculum needs to keep up with the changing ecosystem to create solutions based on the evolution of indigenous knowledge.

In summary of the answers and discussion to research questions three and four, the data and observations suggest that the students are aware of the indigenous practices and some of the scientific reasons behind these practices but are less likely to use them in reality. There is evidence that youth are learning about different practices at the school and at home, but at this time they are unable to build bridges so as to carefully integrate the knowledge that they gain in all of these different settings. They seem to be thinking that the knowledge from home is not useful in school, and in school, they should only discuss things that they learn in the school curriculum.

It is important to bridge the gap between formal and informal learning as learners are constantly making sense of their environment in formal and as well as informal environments (Bransford et al 2006). Thus, if the students do not connect in-school (formal) learning to what they learn at home (informal), then the students are going to find it difficult to construct scientifically sound and meaningful knowledge (Hewson, 1992). The students' underdeveloped conceptual ecology with respect to environmental problem-solving solutions is certainly going to hamper the students' decision-making process. Thus, in order to close the gap between formal and informal learning and empower the students to make environmentally sound decisions about their local environment in the future, the designers of the curriculum *Our Land, Our Life* need to

restructure the content of this curriculum. The curriculum itself needs to be realigned with the current environmental situation of the Kumaon Himalayas. This can be achieved by:

1. Evaluating the current environmental situation in the villages: This has to be done as problems such as global warming are starting to create severe water problems in the Himalayas, and these new environmental problems need new strategies of adaptation and survival.
2. Restructuring the curriculum *Our Land, Our Life* based on the environmental evaluation.
3. Conducting long-term ethnographic research with students to assess long-term learning and application of knowledge.
4. Preparing iterations of the curriculum based on these long-term studies.
5. Connecting the curriculum to other subjects and making it a true interdisciplinary curriculum. This would also involve organizing teacher trainings to have subject teachers collaborate with each other.

As the climate changes, the water and land resources in the Himalayas are changing at a rapid rate. There need to be strategies in place to help people in the Kumaon region cope with these changing times. The recommendations above are just a start, and there is plenty of more research and action needed to help the mountain environment and the communities that reside in the Kumaon Himalayas cope and adapt to the changing ecology of the Himalayas.

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PhD Learning and Performance Systems,
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August 2009 to present
Research involves studying how middle school students make sense of complex systems using technology (Netlogo and Reptools) and a structure-behavior-function scaffolding approach.

Select Publications and Presentations:
Sinha S, Grey S, Hmelo-Silver C, Jordan, R, Honwad S & Eberbach C (2010) Appropriate Conceptual Representations: A Case of Transfer among Middle School Science Teachers. Accepted and to be presented at International Conference of Learning Sciences 2010.

Honwad S, Hoadley C, Scheinke E & Yarnal B (2009). Place as a construct in science teaching, learning, and curriculum design: implications for addressing culture and equity: Computer supported collaborative learning class between Penn State University, USA and Sherubste College, Bhutan for understanding the scientific and social implications of climate change (Carrie Tzou, organizer). Paper to be presented at the annual conference National Association of Research in Science Teaching (NARST).

Select Teaching:
Course Title and Description: Women in the Sciences and Engineering (WISE) Institute Camp (Summer 2009): The class focused on cross cultural learning about different cultural perceptions of climate change, between female high school students in India and the United States. The class used participatory video technology as a main tool to engage the students.

Course Number and Description: Geography 493/Society Science and Technology 433 (Fall Semester 2008): Cross Cultural collaborative learning class between University of Bhutan and Penn State University on Social and Ethical dimensions of climate change and global warming.