China is a country poor in terms of water resources, with an annual storage capacity for fresh water of 2800 cubic km and 2300 cubic metres of water available per capita, which is far below the world average. Both water shortage and inefficient use make modern China thirsty. Table 11 shows there is a significant increase in demand for water, particularly for industry and for domestic use in East China. Furthermore, the loss of glaciers and wetlands from the western plateau where the headwaters of the major rivers of China are located will exacerbate this thirst in the future. Both scientists and decision-makers need to review the current water management schemes of linking climate change scenarios with water availability and allocation among different sectors. How to maintain environmental flow in China's rivers needs particular attention also.

With globalization, water becomes economic good through trade. The water that is used in the production process of a commodity is called the 'virtual water' contained in the commodity. The volume of virtual water flow can be quantified by quantity of international crop trade flow. The failure of food production in China or India has not only impacts on water consumption in food export country but also potential impacts other countries engaged in the food market through international food prices. China is already a net virtual water import country with net import volume of $20x10^9 m^3 yr^{-1}$ although India is a net virtual water export with volume of $32x10^9 m^3 yr^{-1}$ (Hoekstra, Hung, 2005). China, India and other countries in Asia will have a significant increasing water demand for producing more food in a decreased farmland (due to urbanization) for growing population.

Competing Use of Water for Hydroelectricity

China, India, and other Southeast Asian countries have become crucial parts of the economic powerhouse of the world after the slowdown in the American economy, and this has led to their increasing demands for water for hydroelectricity. The Ministry of Power, Government of India, has identified as many as 226 potential sites for large multipurpose dams on the rivers of Northeast India, most of them in the Brahmaputra basin. Some of these are presently in various stages of planning and development (Brahmaputra Board 2000). China is home to half the world's 40,000 large dams, including the largest which is the Three Gorges' Dam. Meanwhile a series of eight dam projects has been under way along the upper Mekong (Lancang) River and more along the upper Yangtze (Jinsha) River in Yunnan Province. The controversial 13-dam cascade plan on the upper Salween (Nu Jing) is still under government review. Yunnan, together with other parts of west China is becoming the 'powershed' of east China. Magee (2006) argues that the Western Development campaign in China paves the way to increasingly strong interprovincial linkage and regional integration between the water tower in the mountain region and the economic powerhouse in the coastal region. There is growing concern, however, about the possible negative impacts of proposed mega dams in terms of their viability and sustainability vis-à-vis the delicately poised geo-envi-

Table 11: Water Demand Forecast for China (2010-2050) (billion cubic metres)

	2010			2030			2050		
	West China	East China	Sum	West China	East China	Sum	West China	East China	Sum
Domestic	11.1	78.8	89.9	23.6	101.4	125	27	118	145
Industry	9.6	146	155.6	21.5	193.5	215	22.5	202.5	225
Agriculture	106	341.5	447.5	117.5	307.5	425	135	365	500
Environment	10	2	12	21.5	13.5	35	45.5	24.5	70
Total	136.7	568.3	705	184.1	615.9	800	230	710	940

Source: China Statistics Bureau 2007

ronmental base, ecological balance, ethnocultural heritage, and the extreme dynamism of geophysical processes in the region. The wisdom behind constructing a series of big dams in the mountain region raises more questions than can possibly be answered satisfactorily at the present stage of knowledge and development. The stakes seem to be too high and risks too great for such gigantic ventures which may have too many far-reaching consequences to justify making hasty decisions.

Similarly, in Bhutan most of its current power production is fed into the Indian power grid and therewith provides important revenue for the Government of Bhutan. Bhutan has a hydropower potential of 30,000 MW with an economically feasible potential of as high as 16,000 MW in terms of current technology. Currently only about 350MW are installed, but with the completion of the Tala hydropower project (expected to be completed in 2006), the total installed capacity will be about 1487MW. The revenue from hydropower accounted for about 42% of the total national revenue on the basis of the values from the year 1998/1999. With the increased installed capacity the hydropower sector will finance anything between 30 and 60% of the 9th Five-Year Plan from 2002 to 2007. Also, in Nepal this may become a substantial future source of revenue if power is sold to the adjacent states of India. Large-scale hydropower schemes that are so often found in mountainous regions are important on the national and regional scales, but also small-scale water - powered mills and small hydro plants are important on the local and community scale. In China 40% of the rural townships rely on small hydropower plants, while in Nepal about 800 plants of different sizes provide energy to about half a million people not connected to the national grid (Mountain Agenda 2001).

Along the Mekong river, hydropower potential varies from 31 200MW to at least 60 000MW. Values given for the different countries of the Mekong basin are: Yunnan Province of China 13 000 MW (42%), Laos 13 000 MW (42%), Cambodia 2200 MW (7%), Vietnam 2000MW (6%), and Thailand 1000MW (3%) (Bakker, 1999). Myanmar has no hydropower potential in this river system. Several projects are in the pipeline at different stages in different countries. The Salween River is one of the last untapped rivers, but several projects are in the pipeline in areas in both China and Myanmar. Myanmar has signed power sale agreements with Thailand for Thai state agencies to buy 1500MW of energy produced in the Salween river basin. In the Yangtze basin the technically feasible hydropower potential is about 197 000 MW or 52% of China's total potential (Kajander 2001). In addition another 23% of China's hydropower potential is in the Southwest rivers. The biggest project and probably the most controversial as well is the Three Gorges' Project. The dam site is situated in Hubei Province on the Yangtze River and has a dam, two powerhouses, and navigation facilities (Kajander 2001). The total installed capacity is 18 200 MW. In addition to positive impacts such as hydropower generation, improved navigation, flood control, and others others, there are also several negative aspects such as environmental impacts, resettlement of large numbers of people, and salinity problems in the estuary to mention a few

5. Asian Society at the Crossroads

Local Adaptation: the Social Capital

The Himalayan mountains promote cultural diversity (languages, belief systems, architecture, settlement patterns), land-use and livelihood practices (nomadic herding, agropastoralism, shifting cultivation, tea plantation, river paddy), niche products (tea, teak, medicinal plants, mushroom, spices), as well as merchants who connect peoples and market places, locally and regionally. Merchants from Yunnan in the eastern Himalayas travelled the Tibetan plateau, South-east Asia, and South Asia for a thousand years. Caravans served as market structures and formed a sociocultural network among mountain and lowland communities. Mountains were as much pathways of migration and trade as barriers between the highlands and lowlands. Mountains were productive and prosperous historically because of their microclimates which made a diversity of products possible, not to mention an environment free from malaria. Mountain regions used to be much more populated than the plains. The shift from the mountains as socioeconomic centres can be divided into the following periods: a) pre-colonial, b) colonial, c) post-colonial, and d) post-Cold War and economic liberalisation.

Equally critical are issues related to the form and flexibility of ecosystems and human adaptations to them; bearing in mind that ecosystems and humans are already stressed possibly by having to adapt to topoclimatic diversity. In general, local impacts of the climate do not follow single or simple paths, whether in terms of plant ecology, stream hydrology, erosion and sedimentation, extreme events, or human activities. Much of the mountain cryosphere is sensitive to sustained changes in atmospheric temperature. Already many Himalayan glaciers are shrinking, some extremely rapidly in the global context. The widespread consensus is that climate change is the main factor behind this.

Planting Trees, Caring for Water

Rivers from highland Asia rank among the top rivers in terms of suspended sediment load (Meybeck and Ragu 1995; see also figure 8). In terms of suspended sediment delivery the rivers originating from the Central Himalayas, such as the Karnali, Sethi Nadi, Tamur, Sun Khosi, Arun, and Marsyangdi,, have the highest amounts with values of more than 65 t/ha*y (Lauterburg 1993). In years with high intensity cloudburst, tributaries, such as those of the Kulekhani catchment in Nepal during the 1993 event, have had sediment loads of 500 t/ha*y (Schreier and Shah 1996). Over a period of 13 years, the sediment load is estimated to be about 53 t/ha*y. Western Himalayan rivers, such as the Jhelum, Chenab, and Indus, have low sediment delivery rates of below 15 t/ha*y. Locally these rivers may, however, have very high loads, as for example the rivers originating from the Karakoram draining into the upper Indus River. The Hunza and Gilgit rivers yield above global average sediment yields as shown in figure 8. The highest sediment loads are observed in the Yellow River (Milliman et al.)

Deforestation was one of the main issues in the 1970s and 1980s with the introduction of the Theory of Himalayan Environmental Degradation (THED) which asserted that anthropogenic or accelerated erosion is a serious

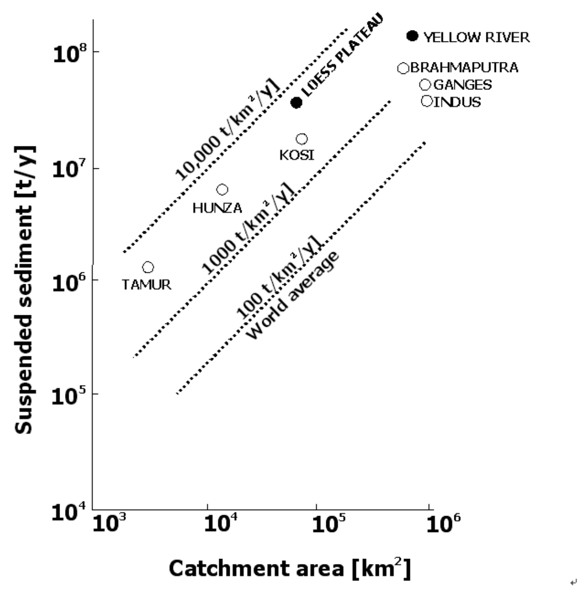

Figure 8: The sediment loads of selected South Asian rivers compared to the world average (Ferguson1984 in Alford 1992)

and general problem in the steep-sloped and fragile natural environments of the Himalayas. It is driven by human population growth and increasing numbers of livestock and the use by local people of agricultural technologies that are less than effective. Extension of cultivation onto steeper slopes, clearance of forests for agriculture and (subsequently) overgrazed pastures, and unsustainable collection of fuelwood and fodder from the forests have been identified as the major land-management practices which caused accelerated erosion, sedimentation of river beds, and increasingly severe flooding downstream (Blaikie and Muldavin 2003). Although deforestation has some effect on sediment transportation, erosional events of great magnitude occur for purely natural reasons in the Himalayas (Wasson et al. 2007).

In academic circles, the Theory of Himalayan Environmental Degradation (THED) has been refuted since the late 1980s, but this has not been reflected to any degree in the domestic policy agendas of the countries of the region. On 1 October 1998, after catastrophic flooding in the Yangtze basin, the Chinese state government implemented a total state logging ban policy, officially called the 'Natural Forest Protection Programme' (NFPP). The ban on logging was immediately followed in 1999 by a 'Sloping Land Conversion Programme' (SLCP) policy in all the headwater regions of major rivers. This programme was designed to address the problem of cultivation on hill slopes of upland watersheds, believed to be a key factor in soil erosion and flooding. According to this policy, any farmland with a gradient of more than 25 degrees must be converted to forest or grassland. To facilitate the conversions, farmers receive seedlings and the government provides 'grain for green'. Up to 2006, a total of 9 million ha of farmland had been planted with trees, of which more than two thirds, or 6.55 million, are located in West China (see table 12). Forest management and watershed conservation became part of the political agenda of government. Similar practices can be found in most regional countries from Bhutan to Nepal and from Thailand to Laos over the last two decades. Recent study shows the significant reforestation has taken place in recent years in the middle hills and Terai plains of Nepal (Nagendra 2007). According to a recent FAO report (2007), deforestation has been stabilized in Asia; in fact many countries have experienced good forest transition (recovery) in the past decade. In China, Vietnam, and India forest cover has increased overall, as a result of plantations (see table13), mainly in upland watershed areas.

China had an increase of more than 4 million hectares of trees per year from 2000-2005, mainly through plantation (FAO2007, also see table 14). It recently instituted the largest afforestation programme (and biggest in terms of funds) in the world. Forest transition in China, therefore, contributes to global carbon sequestration (Fang et al. 2001), biodiversity conservation (Xu and Melick 2007), and improvement of local and regional environments (Blaikie and Muldavin 2003). Given the potential of forest transitions for slowing down soil erosion, improving water quality, and slowing down climate change through carbon sequestration, can decision-makers and forest managers speed up the transitions or, once they have begun, ensure that the transitions continue? By establishing economic incentives and alternative livelihoods for conservation, Chinese policy practices might provide a political-economic impetus for afforestation in the region.

Table 12: Tree Planting on Farmland in China 2003-2005 (unit: ha)

	2003	2004	2005	SUBTOTAL
TAR	13,300	700	4,500	18,500
Xinjiang	249,500	97,200	73,100	419,800
Qinghai	88,200	43,700	38,200	170,100
Sichuan	478,900	101,200	113,600	693,700
Yunnan	336,600	111,200	85,400	533,200
Guizhou	346,600	143,700	113,300	603,600
Gansu	526,100	316,100	207,600	1,049,800
Shanxi	562,400	421,500	62,500	1,046,400
Ningxia	270,800	144,900	82,400	498,100
Guangxi	249,100	134,500	82,300	465,900
Inner Mongolia	340,200	442,500	265,600	1,048,300
Subtotal				6,547,400
China Total	8,262,800	5,188,100	3,431,400	30,178,900

Table 13: Forest Status in Regional Countries of the Asian Continent

COUNTRY	FOREST AREA 2005				ANNUAL CHANGE RATE			
	Total forest	% of land area	Area per capita	Forest plantations	1990-2000		2000-2005	
	(1000 ha)	(%)	(ha)	(1000 ha)	(1000 ha)	(%)	(1000 ha)	(%)
China	197,290	21.2	0.1	31,369	1,986	1.2	4,058	2.2
Bangladesh	871	6.7	0	279	n.s.	n.s.	-2	-0.3
Bhutan	3,195	68	3.6	2	11	0.3	11	0.3
India	67,701	22.8	0.1	3,226	362	0.6	29	n.s.
Nepal	3,636	25.4	0.1	53	-92	-2.1	-53	-1.4
Pakistan	1,902	2.5	0	318	-41	-1.8	-43	-2.1
Cambodia	10,447	59.2	0.8	59	-140	-1.1	-219	-2
Laos	16,142	69.9	2.8	224	-78	-0.5	-78	-0.5
Myanmar	32,222	49	0.6	849	-466	-1.3	-466	-1.4
Thailand	14,520	28.4	0.2	3,099	-115	-0.7	-59	-0.4
Viet Nam	12,931	39.7	0.2	2,695	236	2.3	241	2

Table 14: Forest Plantation in F=orestlands of China from 2000-2005 (unit: ha)

	2000	2001	2002	2003	2004	2005	SUBTOTAL	% OF CHINA TOTAL
TAR				23,233	24,803	13,488	61,524	0.17%
Xinjiang				352,328	206,001	163,053	721,382	1.99%
Qinghai				96,908	52,456	46,748	196,112	0.54%
Sichuan				723,215	370,130	241,883	1,335,228	3.69%
Yunnan				495,135	228,184	207,923	931,242	2.57%
Guizhou				377,939	177,109	135,597	690,645	1.91%
Gansu				582,243	367,916	247,601	1,197,760	3.31%
Shanxi				727,978	564,862	198,853	1,491,693	4.12%
Ningxia				319,625	162,594	112,924	595,143	1.64%
Guangxi				277,969	170,704	123,970	572,643	1.58%
Inner Mongolia				836,123	630,917	383,833	1,850,873	5.11%
Subtotal							9,644,245	26.65%
China Total	5,105,138	4,953,038	7,770,971	9,118,894	5,598,079	3,647,942	36,194,062	

With extensive forest plantation in mountain areas, the relationship between forests and water receives particular attention. These relationships have been studied for a period of time, but still send confusing messages and are, according to Calder (2002), based rather on myth than on scientific evidence. The question of whether forests increase average annual flows is negated on the basis of the literature consulted by Calder (2002) with a few exceptions (e.g. tropical montane cloud forests, Bruijnzeel and Hamilton 2000). Removing forest cover almost always results in increased runoff and stream flow, gradually returning to original levels if an area is left to revert back to forest (FAO and CIFO 2005). At the same time forests do not demonstrate a regulating mechanism between wet and dry seasons everywhere, but rather demonstrate very site-specific behaviour (Calder 2002). It is important to note that there are many competing mechanisms, e.g., it is not only the vegetation of both species and coverage (Fahey and Rowe 1992) that has an impact on hydrological properties, but also soil type and geology. Often geological conditions override the effect of land use or cover (Bruijnzeel and Bremmer 1989). In addition, the forest type and age are very important for all of the above considerations alhough natural forest is in many ways completely different from plantation or secondary forest.

Falkenmark (1999), on the basis of long-term research in Australia, argues that maintaining old forests will help to maximize water flows. It was estimated that water flows would recover to the original levels completely only after about 150 years post disturbance (harvesting or wildfire). Sweeney et al. (2004) have shown that changes in riparian forest and vegetation have a major impact on the biota in streams as well as on the pollutants entering the stream or river stretch therefore, for conservation, the entire watershed is required. The relationship between forests and the hydrological cycle is diverse. Information for policy makers, therefore, remains scarce and general predictions are at best approximate. On the basis of an account of the history of the forest and water debate, Andreassien (2004) identifies the following prerequisites to observe the actual impact of forests on the hydrology including on: a) the pedological condition. The soils need to be deep enough to allow deep-rooted trees to gain an advantage over shallow-rooted grass species. If this is not the case, the only difference between forests and grasslands are their different interception and evapotranspiration rates. The second prerequisite is b) climate condition. The climate needs to be such that there are periods of water deficiency and surplus in order for the soil to dry out and replenish soil moisture. The third prerequisite is c) physiological condition. Certain tree species have a big age dependency in terms of transpiration ability. In terms of sediment, forests are perceived widely to reduce surface erosion. As FAO and CIFOR (2005) point out, however, it is not the trees that provide this service, it is a benefit derived from the undergrowth and forest litter. A canopy of big trees, especially large-leafed trees, even increases the erosive potential of a rain storm by amalgamating rain drops of small size into large drops with higher kinetic energy and therefore higher erosive potential than small drops (Calder 1999). Soil erosion from forested areas is also closely associated with forest management practices.

Sharing Benefits and Rights

Asian society is becoming thirstier because of climate change and increasing demand for water. The increase in demand is based on the growing population, increased urbanization, and increased consumption amongst other factors. Additionally, inefficient water management and inadequate water governance play a major role. The vulnerability of people to natural hazards has increased in the past and is expected to increase even more in the future. One factor that has led to this increased vulnerability in the past is the continuing encroachment into potentially unsafe areas, e.g., flood plains. In future, the impact of climate change is expected to increase the number and magnitude of natural hazards.

In the context of Asian water towers that are intrinsically linked with the lowlands, it is important to accept the upstream-downstream linkages socioecologically. The literature shows, however, that information for policy makers remains scarce and general predictions are at best approximate. The main hurdle at present is to identify the impact of the main issues related to the hydrological cycle, climate change, and land-use or -cover change on both temporal as well as spatial scales. For the purpose of compensation for services, it is important to find mechanisms that provide incentives for both highland and upland populations which provide water services to downstream areas. These incentives, however, need to be based on clear identification of the role, of both the suppliers and beneficiaries.

Governance of water resources on all scales remains a big concern. This includes water management in the local community, interactions among watersheds, inter- and intra-basin water transfer, in particular, active participation of different stakeholders in dialogue. Herders in highland and farmers in upland watersheds can provide a direct environmental service in terms of water, as well as, what is equally important, reducing the risk of natural hazards from mountain ecosystems. As shown above, their impact through land use and management of upland resources, however, needs further discussion as their role is often unclear and sometimes based on myths rather than scientific evidence. This is particularly visible in the discussion on the impact of land use on the hydrological cycle. In years to come global climate change will add to the uncertainties of water supplies and the impact of this on both water supply and hazards. It is still too early to say in what direction water resources in a wider sense will be affected by global climate change. This is on one hand due to the still unclear development of climate warming as well as the very complex question of how the entire hydrological cycle is affected.

These uncertainties greatly affect water resource management, water access, and governance as well as the potential payment for environmental services' (PES) schemes (see figure 9). In addition to this, for all the issues mentioned above, scales, both temporal and spatial, play a major role. Scale is the biggest issue in hydrological science. While on the micro scale, processes are still not fully understood (e.g., hydrological processes in the soil), their translation to the meso and macro scales is a challenge in itself. When it comes to the question of governance, interaction between authorities at different levels needs to be addressed. For PES the appropriate scales for economic instruments need to be identified and the bigger the area under study, the more complex the question of service providers and beneficiaries will become.

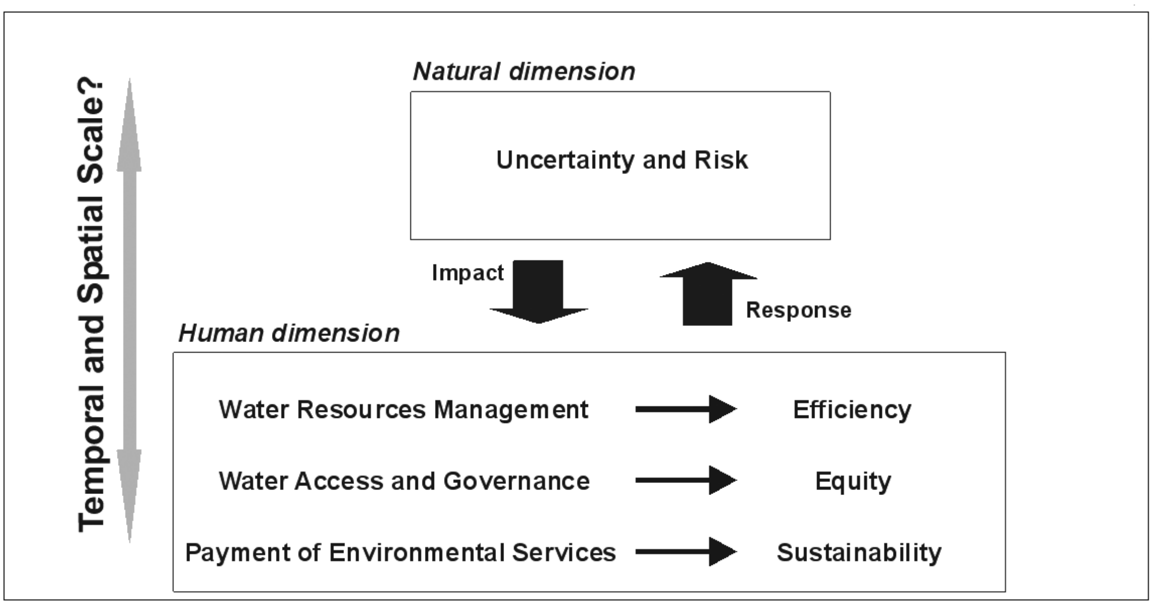

Figure 9: Possible framework for studying water resources

Pressure on the water resources of the Asian water tower has been considerable for a long time and it is likely to continue to increase in the future. As a result several of the rivers flowing across national boundaries have been sources of interstate disputes and conflicts. Similarly, it is often argued that water resources crossing boundaries would be a source of conflict, if not war. Generally history does not support these claims. Recent research and experience have shown that parties that share a water resource actually tend to find ways to cooperate in mutually beneficial ways. Historically, water, in general, and rivers, in particular, have been seen as a source of nation building. In fact, transboundary water resources that are cooperatively managed can make a significant contribution to global and regional peace and stability and to sustainable economic growth (Jägerskog et al. 2007). Examples of fruitful collaboration fostering economic and political stability, development, and growth can be drawn worldwide: the Nile Basin Initiative; the Okavango River Basin Commission; the Zambezi Watercourse Commission; the Mekong River Commission, the Rhine River Commission; and so on. In all these cases, countries have come together to discuss various opportunities to share the benefits of an existing resource. Mutual cooperation, therefore, is targeting development of resources in a joint collaborative manner in order to use water resources most effectively and maximize regional development. In other cases, transboundary cooperation and collaboration have been for the purpose of reducing hazards from floods and flash floods as well as mitigating drought.

The Himalayan river basin states are generally lacking this type of regional agreement for sharing benefits. Notwithstanding this lack, several bilateral treaties have been put into place since 1960 and have been of great importance for the bilateral relationships of the respective countries. The Indus treaty, signed in 1960, for instance, has survived and remained functional even during times of conflict and distrust, indicating the potential for using cooperation on water resources as an important take off point for regional sustainable development and economic growth. India and Bangladesh also signed an agreement for sharing the Ganges' waters in 1996. Signing of agreements on water sharing may be easy, but the real problem is how to keep the agreement working. Agreements need to stand the taste of time. An agreement can contribute positively to peace and cooperation in the basin by addressing the future water needs of riparian countries. Following the numerous treaties in the region for the appropriate and competent management of shared rivers, it is vital to build upon institutions at the basin level. By using large river basins as a unit for development of irrigation, hydropower, water diversion, or flood control projects, the countries of the Himalayan river basins can provide greater net benefits than they could provide through purely state-driven development. For such a development scenario, however, strong and independent river basin organisations (RBOs) are necessary to stipulate a set of clear rules and regulatory measures in each basin regarding water rights and environmental obligations. This phase of establishing RBOs is what large parts of Africa and Europe (as well as the Mekong in Asia) have gone through and are currently going through. The RBOs will form important platforms for continued development of the actual river basins. River basin organisations, moreover, are important mechanisms for sharing information, preventing conflict, and for purposes of management and early warning.

Fruitful and long-lasting cooperation on shared waters needs a comprehensive approach, for instance, in order to address issues of water scarcity as mentioned earlier. This comprehensive approach includes a series of measures to be taken at the basin level: 1) treating the river system as a single unit; 2) involvement of both state and non-state actors in water management; 3) recognition of the social and cultural contexts of water use; 4) clear appropriation rules for sharing water; and 5) networks for sharing information among the riparian countries. These basin-based initiatives have to be supported by the measures taken at the national (state) level: 1) effective management of 'virtual' water (trading of water intensive commodities) and 2) fair pricing of water.

What are the benefits, then, that can be realised and shared through basin-wide cooperation? Beginning with the river itself, joint regulations and agreements can realize environmental benefits **to** the river, such as improved water quality, river flow characteristics, soil and wetland conservation, sustained biodiversity and so forth. Widening the scope and looking at which economic benefits can be derived **from** the use of river resources; this would encompass improved water management for domestic use, irrigation, hydropower, navigation, and disaster risk reduction. In a wider context, increasing benefits **beyond** the river would facilitate improved integration of regional infrastructure, markets, and trade. Finally, joint collaboration would bring political benefits **because** of the river in the form of a policy shift towards cooperation and mutual understanding and away from conflicts and disputes (Sadoff and Grey 2002).

Emerging Regional Initiatives

There are billions of people in Asia who cannot afford to take no action; business as usual is not part of Asian cultures. The Mekong River Commission (MRC) is a good example of dealing with transboundary water governance. Even India and Pakistan have established a river commission for the Indus as per an agreement in 1960. The countries in the region have begun to form habits of regional consultation based on mutual respect, shared responsibility, and equitable access. These characteristics of good water governance at its best have become integral to the regional economy and local livelihoods through the active participation of different actors. Not only have states been mobilised into participation in the regional water dialogue, but also non-state water users and actors. Below are some of the emerging regional initiatives.

1.Himalayan wetlands' conservation initiative

The first 'Workshop on Conservation of High Altitude Wetlands and Lakes in the Himalayan Region', was held in Urumqi, China, from 4 to 8 August 2002. It shared information, reviewed the current situation related to wetlands and their role in cultural, spiritual, biological, economic aspects, and expressed the urgency for an 'Urumqi Call' by all Himalayan regional countries. This 'Urumqui Call to Action', as it is known, recognises the special need to conserve high-altitude wetlands in the light of climate change and its impact on water in the Himalayan rivers. The Indus, Ganges, and Brahmaputra originate from these high-altitude wetlands and lakes. This became a regional platform for joint efforts towards high altitude wetland conservation. In addition to regional governments, the Ramsar Wetland Convention, World Wildlife Fund (WWF)-International, International Union for the Conservation of Nature (IUCN), and the International Centre for Integrated Mountain Development (ICIMOD), and Wetland International provide technical support for such dialogues. This initiative aims to establish a regional database centre and secretariat for transboundary conservation of high-altitude wetlands.

2.Abu Dhabi dialogue on Himalayan waters

The Abu Dhabi dialogue stemmed from the '1st International Conference on Southern Asia Water Cooperation', a regional meeting of senior government, academic, and civil society members. Participants came from Afghanistan, Bangladesh, Bhutan, China, India, Nepal, and Pakistan and met in Abu Dhabi in September 2006. The International Institute of Strategic Studies convened the meeting with support from the United Kingdom's Foreign and Commonwealth Office. The conference followed an informal and non-attributable format and required no consensus outcome. Subsequently, key participants from the seven countries, with the support of the World Bank, agreed to sustain the momentum and continue the engagement on water cooperation in South Asia. They formed the 'Abu Dhabi Group', established the 'Abu Dhabi Dialogue' as an informal consultative process, and organized the '2nd Abu Dhabi Dialogue'. The theme for this 2nd meeting, selected from the recommendations of the 1st meeting, was 'the Rivers of the Greater Himalayas': the changing conditions in the headwaters, the pressures in the floodplains and deltas, and the challenges of, and opportunities for, regional cooperation.

3.Mekong biodiversity corridors

The 'Greater Mekong Subregion (GMS) Biodiversity Conservation Corridors' Initiative', endorsed by six

Mekong countries including Cambodia, China, Laos, Myanmar, Thailand and Vietnam, facilitated by the Asian Development Bank is minimize negative impacts of cross-border trade and regional economic integration as well as waterway, road and railway networks and dam construction in the GMS. Currently, there is concern that increasing development activities in the economic corridors may affect critical ecosystems and high value biodiversity areas adversely, resulting in fragmentation of natural landscapes. This would undermine the functioning and performance of the region's ecosystems, thereby threatening long-term socioeconomic development and environmental security in the GMS. The proposed GMS biodiversity conservation corridor initiative is to establish nine conservation corridors that restore connectivity between the existing national parks and wildlife sanctuaries.

4.Sino-India climate agreement

China and India are promoting sustainable growth while improving resource efficiency and reducing greenhouse gas emissions based on scientific and technological innovations. Together India and China have a population of more than 2.5 billion people to sustain, therefore, huge investments are necessary in the agricultural sector to improve food production and to cope with climate change. China is expecting that, throughout the country, agricultural production will drop by 10% due to climate change. In India the losses expected losses are in the same range at least. Mitigation and adaptation to climate change have become part of the political agenda for Chinese and India decision makers. In June 2007, during the G8 meeting in Heiligendamm, Germany, the Chinese President Hu Jintao, and the Indian Prime Minister, Manmohan Singh, agreed to increase cooperation on climate change. This proposed research and development project aims to make this pledge a reality with tangible outputs for poor farmers in India and China. Within the framework of this project, scoping studies on the most promising options for integrated climate change mitigation and adaptation will be investigated and pilot projects exploring and implementing new project methodologies and carbon finance mechanisms will be established.

5.SAARC disaster management centre

SAARC 'Disaster Management Centre' (SDMC) was established in October 2006, in New Delhi. The Centre has the mandate to serve the eight member countries of the South Asian Association for Regional Cooperation (SAARC) - Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka - by providing policy advice and facilitating capacity building services such as strategic learning, research, training, systems' development, and exchange of information for effective disaster risk reduction and management in South Asia.

6. Conclusions

The ecological health of highland Asia impacts about 1.5 billion people directly and 3 million indirectly in Asia, particularly in terms of freshwater supplies. Due to tectonic activity and high altitudes, such highlands are very vulnerable to global warming and increasing human activities. Uncertainties about the rate and magnitude of climate change and potential impacts prevail, but there is no question that it is gradually and powerfully changing the ecological and socioeconomic landscape in the region, particularly in relation to water. Business as usual is not an option. It is imperative to revisit and redesign research agendas, development policies, management and conservation practices, and appropriate technologies. Given the level of uncertainty in science and research about the Tibetan Plateau, policies should be 'adaptation friendly.

Mitigation of carbon emissions should be a responsibility shared among citizens and the private sector in the mountains as elsewhere. Adaptation and mitigation measures intended to cope with climate change can create opportunities as well as offsetting the dangers of a warming planet; but they must be identified and adopted ahead of, rather than in reaction to, dangerous trends.

Scientific uncertainty - We speak of uncertainty on a regional scale, in general, and in the highlands, in particular, in recognition of the fact that our science and information systems are no match for the complexity and diversity of regional contexts, quite apart from the lack of studies and basic data particularly about locations at high altitude. In no context is this more relevant than in predicting what climate change will involve. The physical manifestations of climate change in the mountains include locally, possibly regionally, extreme increases in temperature and in the frequency and duration of extreme events. It seems certain there will be appreciable changes in the volumes and/or timing of river flows and other sources of fresh water in critical ecological zones from highland plateaux to upland watersheds and from lowland plains down to coastal areas. There is also uncertainty about interaction of different interconnected zones and their feedback to regional and global environmental changes. Little is known about the dynamics of highland topoclimates and hydrological processes and their response to changing climatic inputs. The global circulation models used to model climates capture global warming on a broad scale, but do not have adequate predictive power even for large mountain drainage basins. To reduce uncertainty we need well-equipped baseline stations, long-term monitoring, networking, open data exchange, and cooperation between all the Asian regional countries.

Building resilience - Climate change is not new for mountain people. Tectonic uplift and Quaternary climate changes, including recovery from the last major glacial period and Little Ice Age, mean that every aspect of life has been adapted to, or stressed by, changing temperature regimes, water availability, and extreme events. Highland herders and upland farmers have a long history of adapting to these uncertainties, other related and unrelated environmental changes, and ecological surprises, whether through mobility of people and land uses, or flexibility in livelihood strategies and institutional arrangements. Mountain people have lived with and survived great hazards such as flash floods, avalanches, and droughts for millennia. Building the capacity to adapt and strengthen the socioecological system in the face of climate change is doubly important and is an important step towards achieving sustainable livelihoods. Supporting and being resilient and encouraging strategies to cope with surprises and long-term changes are the new adaptive mantras, unlike earlier notions of improving people's adaptations to relatively stable and known habitats. Climate change, as a public and global issue, has evolved from a narrow interest in the hydrometeorological sciences to a broad recognition that both the social consequences and policies in response have implications for all aspects of human development. Adaptive policies and major efforts to reverse the human drivers of climate change have to be incorporated into all sectors: land use, biodiversity conservation, water management, disaster management, energy consumption, and human health.

Linking science and policy to climate change - Good science with credible salient, legitimate knowledge can often lead to good policies in the context of climate change and mountain specificities or vice versa (Thompson and Gyawali 2007). By credible, we mean knowledge that has been derived from field observations and tested by local communities; salient information is immediately relevant and useful to policy makers; legitimate information is unbiased in its origins and creation and both fair and reasonably comprehensive in its treatment of opposing views and interests. Policy is a formula for the use of power and application of knowledge. The question then is who has the power and who the knowledge, scientific knowledge or local knowledge, or a combination of both? Scientific knowledge is useful but limited and full of uncertainties on a complex Himalayan scale; so then 'Nobody Knows Best' becomes the model (Lebel et al. 2004). Alternative perspectives carry their own set of values and perceptions about who should be making the rules, where the best knowledge lies to guide decisions, and about what further knowledge is needed about four contrasting perspectives – state, market, civil society and the greens, and locals– and merged together in decision-making processes. In such processes, scientists have to generate new knowledge with reduced uncertainty and facilitate the dialogue with balanced perspectives. The role of different actors in contributing to resolving scientific uncertainty, adaptation, mitigation, and public engagement through this approach can be summarised in the form of a matrix (table 15). In such processes, international cooperation is essential for transfer of technology from outsiders to locals, building regional cooperation into a global programme, and developing the capacity to downscale important results to highland Asia.

Table 15: Nobody knows best: policy matrix to cope with uncertainty in the highlands of Asia

	Scientific uncertainty	Adaptation	Mitigation	Public engagement
State	Regional cooperation, support long-term research, engaging in research processes	Intersectoral collaboration, poverty alleviation and environmental conservation	Commitment to international treaties, developing good policies	Transparency of information and support for public debates
Market	Partnership in research, new technology for monitoring	New technology, support for land and water management	Voluntary carbon marketing	Green certification, support for civil society
Civil society	Participatory vulnerability analysis, inventory of local knowledge	Community preparedness, participatory technology development	Social auditing, green watch and monitoring	Access to information, awareness campaign, social inclusion, intercultural dialogues
Local community	Local indicators and monitoring, local knowledge, innovations, and practices	Improved land/resource management, preparedness for surprises	Renewable energy, alternative livelihoods, sustainable land management	Representation in dialogues and decision making
ICRAF's Role	knowledge synthesis, knowledge for action	Local capacity building, pilot project for good practices and 'niche' products	Facilitating the clean development mechanism (CDM), toolkit for carbon assessments	Regional dialogue, debate at international forums, facilitate benefit sharing

Ten Critical Actions: Supporting Land-use Policies and Cooperation in River Basins based on Scientific Knowledge

Action 1: Integrated Himalayan transects

Credible, up-to-date scientific knowledge is essential for the development of climate policy. The current review finds a lacuna in the context of field observation networks because of the vast geographical area and its inaccessibility. Integrated Himalayan Transect Methods (IHTM) can become an effective platform for studies of environmental and climate change. Four transects along the major climatic and socioecological gradients of precipitation and land uses in the Himalayas have been established for research into how the availability of water contributes to land-use practices and production and how land use, water supplies, and local economies are influenced by climate change. As part of a methodology for multiscale socioecological characterization, the Integrated Himalayan Transect Method (IHTM) will generate both qualitative and quantitative data and bridge gaps between disciplines, scales, and socioecological zones. The method is illustrated by using meteorological stations, literature, remote sensing, and rapid field assessments. 'Himalayan climatic and socioecological diagrams' will facilitate easy presentation of the information collected about the variation and complexity of the Himalayan environment and its adaptation to climate change. Additionally, various quantified land-use and ecological characteristics will be used to scale up data from the level of the belt transect (50km width) to large climatic zones in the region. For example, the Dhaka-Almaty transect covers all the climatic zones of the world and is hence a perfect laboratory.

Action 2: Dryland development

Half of highland Asia is semi-arid or arid; almost half of the Chinese population lives in the drylands which include the poorest provinces in west China. Desertification and water stress are major socioeconomic challenges, particularly in northwest China from the alpine rangelands to lowland plains. Sustainable dryland development is crucial for achieving the Millennium Development Goals in the mountain region, as well as for bridging economic gaps between the uplands and lowlands. It is essential to test new technologies in the extreme fragile environment to find conservation and development pathways. Dryland agricultural technology and livelihood development are keys to adaptations to climate change.

Action 3: Alpine ecosystem conservation

Alpine ecosystems, defined as areas higher than the tree line and lower than the ice and snow of the nival zone, are found in mountain ranges around Asian water towers and constitute an important component of globally significant biodiversity hotspots. They provide critical ecosystem services and habitats for numerous species of animals and plants. The alpine ecosystems of the Himalayan region have been used regionally and locally by humans for thousands of years – primarily for ecosystem services such as livestock grazing, collection of medicinal plants, and water storage. These systems, which for the most part appear to have sustained such use, are now showing signs of the fragmentation and degradation often caused by exogenous forces such as climate change and economic development. There is an urgent need for a joint effort to assess the current status of alpine ecosystems throughout the mountain region and to create both broad-scale and community-based strategies for conserving these systems, their biodiversity, and water-related services over time. Threats to biodiversity and ecosystem services in alpine ecosystems have not been well quantified, perhaps due to a primary focus on forest threats. In contrast to most forests, however, common characteristics of alpine systems, such as cold temperatures, short growing seasons, and thin soils, render them less resilient and thus can hinder swift recovery from disturbance. This relatively low resiliency is coupled with a widespread increase in human disturbance and climate warming. Alpine ecosystems appear to be strongly affected by global climate changes. This calls for redesigning our current conservation strategy and actions in light of climate change. Through collaboration with communities, government, and other key partners, action should be taken to combine rigorous data collection with conservation planning, community conservation, and adaptive management; in other words, to support, through providing data and analysis as well as inclusive training, a dynamic decision-making process for both immediate and long-term actions related to sustainability of alpine ecosystems.

Action 4: The right tree in the right place

Water scarcity is an increasingly severe problem throughout the highlands, with many places among the Asian water towers already experiencing water shortages or severe water scarcity. Land scarcity is another problematic issue in a heavily populated Asian continent. The highlands have the greatest variation in predication from about ten millimetres to ten thousand millimetres. Certain trees that are integrated into agricultural systems can increase the efficiency of water use, control soil erosion, and mitigate natural hazards. Research on water use, water balance, and how their impacts effect trees in mountain watersheds has implications for water management, biodiversity conservation, watershed protection, carbon sequestration, climate regulation and mitigation, forestry, and agroforestry in water-scarce semi-arid and arid regions and water-rich monsoon regions. Although planting trees at mid and high altitudes is still controversial, improved land-use management can contribute to changes in precipitation and temperature patterns through atmospheric circulation, greenhouse gas emission, and changes in albedo on a global scale.

Action 5: Reducing emissions from deforestation and degradation (REDD)

Although deforestation in most countries in the region has been stabilized, ensuring local and international payments for carbon emission reductions is critical for sustainable management of forest resources, particularly in countries that are rich in forests such as Bhutan, Myanmar, and Laos. Incentives for reducing emissions from deforestation and degradation (REDD) are essential in order to support forest transition in both forest-rich and forest-poor countries and facilitate forest resource management and regeneration. The actions that should be taken include pilot demonstrations with outcome-based approaches that link rewards for environmental services to actual performance and negotiated baselines. Policies will need to be developed along with payment mechanisms, methods of payment, criteria and indicators for eligible projects/initiatives, a distribution mechanism, accountability measures, and a transparency policy. A full understanding of the prior land and natural resource rights in the forest areas in question and good overall forest governance are required to make payment and distribution transparent and an effective means of reducing emissions from deforestation and degradation.

Action 6: Development of agroforestry carbon offset

Agriculture accounts for estimated emissions of 5.1~6.1 GtCO2-eq/yr in 2005 (10-12% of total global anthropogenic emissions of greenhouse gases [GHGs]). The adoption of sustainable land-management activities, such as agroforestry and sustainable land management (mulching, zero tillage, cover crops, and residue management) in mountain watersheds can reduce GHG emissions on a large scale and will provide important linked benefits such as reduced soil erosion, improved water-holding capacity, biodiversity protection, and increased productivity and environmental integrity of agricultural ecosystems. Agroforestry and sustainable land- management activities are often adopted mainly for reasons other than GHG mitigation. A carbon offset project, however, can provide additional incentives required by farmers to adopt sustainable land-management activities that have a significant time lag before the benefits are tangible for farmers, e.g., planting fruit trees, controlling soil erosion control, and so on. Currently, activities to mitigate climate change in an agricultural context are not considered in the Kyoto protocol, but already are under the Chicago Climate Exchange (CCX). The CCX calls for development of a methodology, demonstration of partnership, assessment of local environmental benefits and risks, a baseline inventory, institutional development, and capacity building for such studies.

Action 7: Integrated water resource management (IWRM) for regulating blue, green and virtual water flows

The good practices of integrated water resource management (IWRM) should incorporate with two variables: a) multi-dimensional scientific methods of linking climate change scenarios with hydrologic response and ecosystem services for regulating blue, green and virtual water flows from mountain watersheds, b) adaptive institutions for integrated water management at watershed and river basin level under changing climate conditions. Disaster preparedness and risk reduction should be seen as an integral part of water resource management. IWRM is a political process and researchers should engage constructively with the relevant stakeholders in the public sector, private sector, and civil society. Water allocation for ecosystems and livelihoods deserves particular attention. Water storage based on local practices should be developed in the mountain regions to deal with the problem of too much water during monsoon and too little during the dry season.

Action 8: Payment for environmental services (PES)

As natural habitats shrink and human demands increase, environmental services previously provided for free are threatened. This emerging scarcity makes environmental services potentially tradable. The idea of payment for environmental services (PES) is that external beneficiaries of environmental services make direct contractual quid pro quo payments to local landowners and land users in return for their adopting land and resource uses that secure ecosystem services such as carbon sequestration. This calls for analysis and further development of existing PES schemes in China and other countries in the region to explore options to bundle together different environmental services, such as emission reductions, biodiversity, and water services, in different ecological zones.

Action 9: Supporting community-led adaptation

The best approach to vulnerability and uncertainty in the context of climate change is ‘bottom-up’ community-led adaptation built on local knowledge, innovation, and practices. The focus should be on empowering communities to monitor and take action to adapt to a changing climate and environment based on their own decision-making processes and participatory technology development with support from outsiders. For example, Tibetan nomads have already noticed the earlier spring and move yaks to alpine meadows much earlier than was the traditional practice. Farmers in the floodplains of Bangladesh build houses on stilts, and Nepali farmers store crop seeds for post-disaster recovery. Priority should be given to the most vulnerable groups such as women, the poor, and people living in fragile habitats such as those along riversides and on steep slopes.

Action 10: Dialogue towards the Kyoto protocol and beyond

With rapid regional economic growth, China and India, particularly, should accept equal, albeit differentiated, responsibilities from developed countries to control increasing carbon emissions. Himalayan regional countries should jointly develop a regional action plan for control of emissions. Participation of all countries has to be achieved by allowing them to interpret the mandates of international agreements according to their national interests and priorities.

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Who we are

The World Agroforestry Centre is the international leader in the science and practice of integrating 'working trees' on small farms and in rural landscapes. We have invigorated the ancient practice of growing trees on farms, using innovative science for development to transform lives and landscapes.

Our vision

Our Vision is an 'Agroforestry Transformation' in the developing world resulting in a massive increase in the use of working trees on working landscapes by smallholder rural households that helps ensure security in food, nutrition, income, health, shelter and energy and a regenerated environment.

Our mission

Our mission is to advance the science and practice of agroforestry to help realize an 'Agroforestry Transformation' throughout the developing world.

FUTURE HARVEST CGIAR

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