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Water Ethics and Water Resource Management



Ethics and Climate Change in Asia and the Pacific (ECCAP) Project

Working Group 14 Report

Water Ethics and Water Resource Management

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PREFACE

The report is the product of international collaboration between members of Working Group 14 on “Water Ethics and Water Resource Management” established under the Chairship of the Center for Water Research, Peking University, China, under the framework of the Ethics and Climate Change in Asia and Pacific project (ECCAP), launched in September 2007 by the Regional Unit in Social and Human Sciences in Asia and the Pacific (RUSHSAP) at UNESCO Bangkok. In 2007 and 2008 some of the authors met at the Joint UNESCO-Peking University Conferences on Water Ethics, and working group sessions were also organized in other countries.

The Ethics and Climate Change in Asia and the Pacific (ECCAP) project aims to encourage science and value-based discussions on environmental ethics to produce substantive cross-cultural and multidisciplinary outputs for long-term policy making. The aim of the ECCAP project is not to formulate universal economic or political plans of how to deal with these issues. Rather, the working groups of the project aim to increase awareness and discussion of the complex ethical dilemmas related to energy and the environment, and to identify scientific data, and available ethical frameworks of values and principles for policy options that have proven useful in facing the challenges in certain communities and countries. The projects are ongoing, and the details of this report that extends the Asia-Pacific Perspectives on Bioethics series, can be found in the Executive Summary.

The reports were developed by working groups, whose members participate as individuals in the highest standards of intellectual vigour and integrity, integrating engineers, philosophers, policy makers, experts, youth, and persons of many different cultural backgrounds and experiences. The reports are subject to ongoing open peer review, and the principal authors are listed. The authors are all members of the working group 14, and thank Dr. Jayapaul Azariah, Dr. Fakrul Islam, Dr. Sultan Ismail, Ms. Anniken Celina Grinvoll, Ms. Lindsey McGraw, Dr. Salil Sen, Dr. Edward Spence, Dr. Ni Ni Thein, Professor Weiping Wang, and Dr. Feruza Zagirtdinova who all provided comments and assistance to the report. The WG chair, Jie Liu, and the ECCAP coordinator, Darryl Macer, appreciate all these contributions and comments during the conferences and dialogues over this report.

There is ongoing discussion of numerous reports on the yahoo group, unesco_eet@yahoogroups.com, that are in various stages of drafting. For all other reports, drafts and outline, and specific requests for further case studies and analyses, please examine the working group webpages which list the members, and the overall website, <http://www.unescobkk.org/rushsap/energyethics>. Feedback and comments are invited to Dr. Darryl Macer, Regional Advisor in Social and Human Sciences in Asia and the Pacific, Regional Unit for Social and Human Sciences in Asia and the Pacific (RUSHSAP) at UNESCO Bangkok, or email rushsap.bgk@unesco.org



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Executive Summary

This report examines ethical issues associated with water resource utilization and management, including its uses in energy and other domains. Under the “Ethics and Climate Change in Asia and the Pacific” (ECCAP) project, the Water Ethics working group has compiled a report with some case studies highlighting different ethical issues associated with water resource utilization and management. The report systematically discusses how water ethics can make a difference to water related practices and provides a cross-cultural review of the issues. The report reveals gaps in existing knowledge to researchers, policy makers and funders of research, which could be used to examine linkages between research and policy making, and presents areas of policy options to governments.

The work also feeds into considerations of the ethics of climate change that are being made by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST). The work builds upon some earlier COMEST reflections on water ethics and a growing body of discussion on the topics of water ethics. The ECCAP project¹ calls for developing dialogues within each participating country and between countries on the results of research, future research needs, policy lessons and policy recommendations in regard to the ethical issues of energy-related technologies and related environmental and human security issues. The conclusions of this report are applicable to all human uses of water, not only those related to direct use in energy production, or indirect use such as in energy intensive agricultural production systems.

Water is the most essential substance upon which all life depends. Water is a non-renewable resource, though it can be recycled. Climate change, rapid industrialization and urbanization, continuing population growth and mismanagement of water resources cause unprecedented water stresses. The access and use of water by humans and ecosystems is discussed in this report. Water is at the heart of many religions and culture. Cultural traditions, indigenous practices and societal values determine how people perceive and manage water, and provide useful references for water ethics construction.

The report examines some possible ethical principles to resolve moral dilemmas involving water. Existing problems in current water management practices are discussed in light of these principles. Transformation of human water ethics has the potential to be far more effective, cheaper and acceptable than some existing means of “regulation”, but transformation of personal and societal ethics need time because the changes to ethical values are slow.

Policy options are discussed with some examples, that are further explored in the appendices which include four case studies conducted by the members of the working group from perspectives of different fields, and they illustrate both theory and practical application of the ideas in the report more concretely. These include: The Need for a More Efficient Aquaculture Industry; Computer-Aided, Community-Based Water Planning: Gila-San Francisco Decision Support Tool; The South-to-North Water Diversion Project in China; A Review on Chinese Water Ethics.

The construction of water ethics needs joint efforts and interdisciplinary collaboration at all levels. By following certain general principles, adopting scientific methods and tools, arousing experts, stakeholders and decision makers’ responsibility, and conducting ethical education for young people, the construction of ethically acceptable water utilization and management system can be expected to occur in the near future.

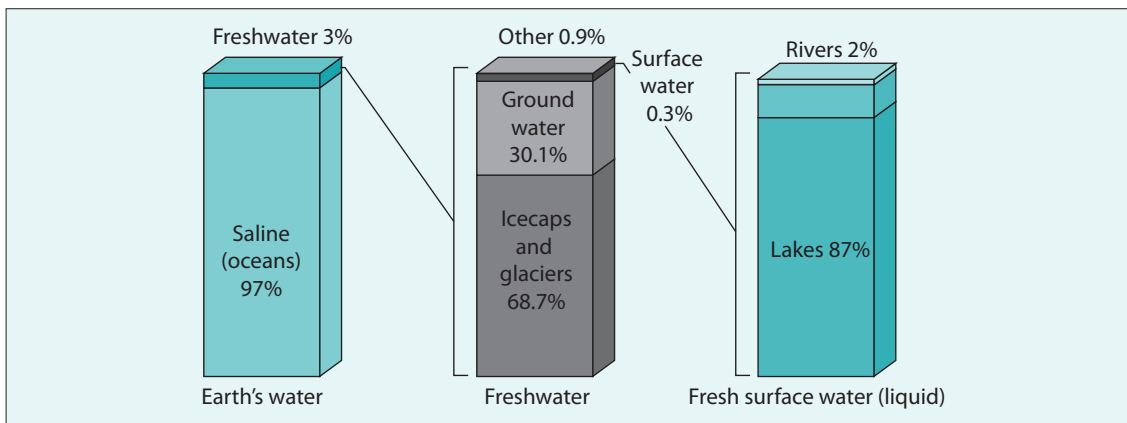
1 The formal launch to the EETAP (and ECCAP) project was the Conference on Ethics of Energy Technologies in Asia and the Pacific held in Bangkok, 26-28 September 2007.

1. Water and Life

1.1 Basics of Water

Water is an essential substance upon which all life depends. Where there is water there is life, and where water is scarce, life has to struggle. About 75% of the earth's surface is covered by water, as the saying goes "water, water, everywhere". The distribution of water on the Earth, based on human economic needs for freshwater, is represented in Figure 1. The left-side bar shows where the water on Earth exists; about 97% of all water is in the oceans. The middle bar shows the distribution of freshwater that is only 3% of all Earth's water. However, the physical state of water, including the freshwater, is not always liquid. Nearly 69% is locked up in glaciers, icecaps and permanent snow cover of both poles, mountainous regions and in Greenland. Land based glaciers affect stream flow quantity and provide water resources to the lowland regions. While 30% of freshwater comes from groundwater.² Only 0.3% of the freshwater on Earth is contained in river systems, lakes and reservoirs, which are the water we are most familiar with and the most accessible water source to satisfy human needs in our daily lives.

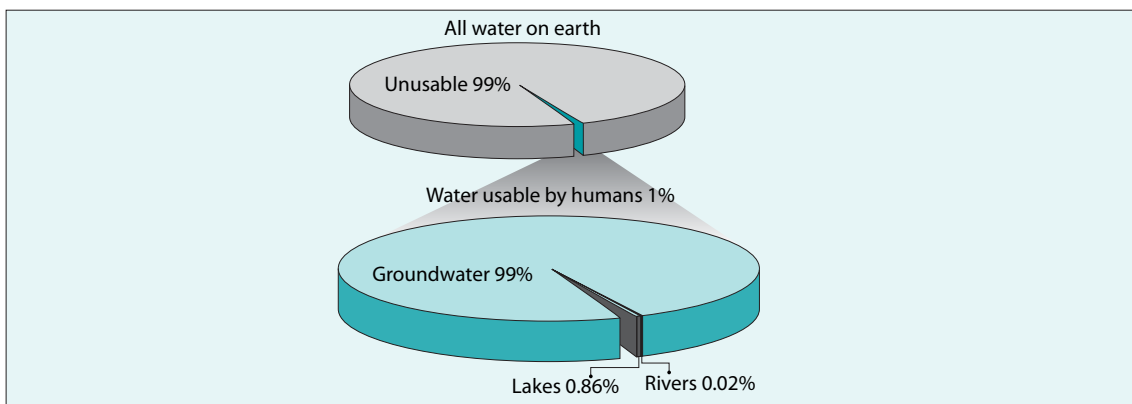
Figure 1: Distribution of Earth's Water



Source: USGS <http://ga.water.usgs.gov/edu/earthwherewater.html>

Even though three quarters of the earth's surface is covered by water, not all of that water is available for human uses. Figure 2 shows that more than 99% of all water (oceans, ice, most saline water and atmospheric water) is not available for our uses. Even of the remaining fraction of 1%, much of that is stored in the ground. Surface water sources (such as rivers and lakes) only constitute 0.0067% of the total water.

Figure 2: Earth's Water Available for Human Uses



Source: USGS <http://ga.water.usgs.gov/edu/earthwherewater.htm>

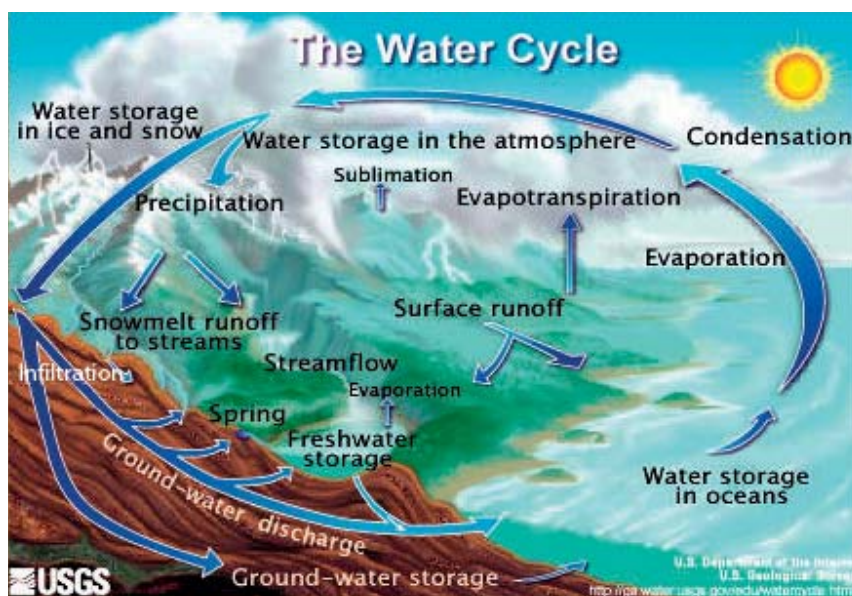
2 Including underground water such as deep aquifers rather than subsurface water, which is often included as surface water.

Here we can see that water is generally classified into surface water and groundwater. Surface water is water found in a river, lake or other surface impoundment. Surface water is exposed to many different contaminants, such as animal wastes, pesticides, insecticides, industrial wastes, and many organic materials. Groundwater is the part of precipitation that infiltrates down through the soil until it reaches rock material that is saturated with water. Water in the ground is stored in the spaces between rock particles, and slowly moves underground, generally at a downward angle, and may eventually seep into streams, lakes and oceans. Groundwater is not always accessible, and sometimes is difficult to locate or to measure and describe. Compared to surface water, groundwater is not as easily contaminated, but once it is contaminated, the full remediation and recovery is not easily achieved.

Surface water and groundwater are often correlated and can be transformed to each other within the water cycle, which is also known as the hydrological cycle.³ This is the continuous movement of water on, above and below the surface of the Earth (Figure 3). Surface and ground water cycles are only part of global cycle of water including the evaporation. There is no starting or ending point of the water cycle, and water can change states among liquid, vapor and ice at various places in the cycle.

Water is not in a static condition but there is a dynamic “exchange” of water among the ocean, land and atmosphere. The turnover of water involves water evaporation and precipitation processes. The turnover of the Earth’s water estimates as 577,000 cubic km per year (Shiklomanov, 1996) and about 40% of precipitation that falls on land comes from ocean derived evaporation and 60% from land surface (Figure 3). These large volumes of water illustrate the key role that precipitation plays in renewing water resources, especially recharging the ground water which is the main source of freshwater and supporting both rainfed agriculture and ecosystem.⁴ The dynamics and value of full renewal of water, full replenishment, depend on water volume and its dynamics. It is estimated that the full renewal time of the ocean may take 2,500 years, ground water 1,400 years, ground ice of the permafrost zone 10,000 years, polar ice 9,700 years, mountain glaciers 1,600 years, lakes 17 years and 8 days for atmospheric moisture (Shiklomanov, 1996). The times vary with climatic conditions, which are rapidly changing now.

Figure 3: The Water Cycle



Adapted from USGS, <http://ga.water.usgs.gov/edu/watercycle.html>

3 We note that “deep” or “fossil” aquifers are not usually linked with any of the surface water, unless they are extracted by humans for present uses.

4 Refer to the 2nd UNWorld Water Development Report: Water, a shared responsibility. 2006. pp. 123-125.

1.2 Uses of Water

1.2.1 Consumption and Utility

Although we use sea water and oceans in many ways ranging from transport, as a reservoir for dumping pollution, to recreation, this report focuses on freshwater. Uses of water can be classified as either consumptive and non-consumptive. A use of water is consumptive if that water is not immediately available for another use. The source and location of water are also measured in some schemes. Losses to sub-surface seepage and evaporation are considered consumptive, as the water is incorporated into a product. Water that can be treated and returned as surface water, such as sewage, is generally considered non-consumptive if that water can be put to additional use.⁵ A non-consumptive use is when water use does not diminish the source or impair the future water use.

Utility is the most common concept behind the different classifications of water use, though the actual meaning of “utility” and its scope have been changing over the last few decades. There is a growing recognition of indirect and non-use values when the benefits arising from ecological systems or potential future use of the water resources are considered. For example, wise use is the core concept of Ramsar Convention on Wetlands, while the Convention on the Law of the Non-Navigational Uses of International Watercourses (1997) encourages equitable and rational use of water. Indirect or non-use values are also regarded as an optional value to preserve environmental resources, though there is substantial difference in interpretation focused either on risk reduction or utility maximization, provided that any action is irreversible and its result is uncertain.⁶ In case of the International Watercourse Convention, no use could be perceived as utility maximization since the only qualifying condition for no use is uncertainty or no consensus about the preference between different uses of water.

The use of water and water services are often referred to as interchangeable categories (MEA, 2004; IWMI, 2006; FAO, 2008) which is another example of recognition of the multifunctional role of water. Based on this, the typology of water use is classified into: provisioning services (water for food production, plants and medicine), regulating services (flood protection, erosion control, natural treatment of water quality), and cultural and social services (cultural heritage, landscape, scientific research). The Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) is an example for protection of places based on their aesthetic, scientific or cultural values. The Yellowstone National Park, because of its outstanding scenic beauty, or the Ifugao Rice Terrace of Philippines, for its communal system of rice cultivation based on harvesting water from the forest clad mountain tops, are outstanding examples of harmonious interaction of people and nature.

Having identified the condition of water use set in international instruments we have reviewed water legislation of some selected countries including Cambodia, China, Indonesia, Kazakhstan, Democratic People’s Republic of Korea, Mongolia, Philippines, Viet Nam and Uzbekistan⁷ to assess whether and how these criteria are translated into the local legislation. Without any exception, the objectives and purpose of reviewed laws set a primary focus on meeting the needs of population and socio-economic development, through conservation and management of water resources with due regard of environmental requirements. Therefore, it is evident that water is treated as a natural resource, while the protection and conservation of the aquatic ecosystem per se is the subject of separate legislation, mainly the law on environmental protection. Except a minor variation, which is the case for China, the typology of water use is based on purpose and scale of utilization and classified into the domestic (household), industrial (including the hydropower) and agricultural use of water. Navigational use of water and utilization of hydraulic energy is included in the Water Law of China from 2002.

5 <http://www.waterresources.org/2008/07/23/uses-of-fresh-water>.

6 OECD 2007, *Assessing Environmental Policies* <http://www.oecd.org/dataoecd/52/15/38208236.pdf>

Please see also, Hanemann W. M. *On Reconciling Different Concepts of option Value* <http://escholarship.org/uc/item/81w7290x>

7 Based on availability of water legislation on FAO waterlex database <http://waterlex.fao.org/waterlex/srv/en/home>

With only the exception of Kazakhstan and Indonesia, the government regulation and intervention in water use enables the “beneficial and multiple use” since none of these countries allows any entitlement of water ownership. For example:

- Water Code of Philippines (31 December 1976), Article 18, “water permits granted shall be the subject of beneficial use”. Article 23, “Properties may be altered on grounds of greater beneficial use, multi-purpose use and other similar grounds...”
- Water Resources Law of Democratic People’s Republic of Korea (18 June 1997), Article 5, “...water resources are put into comprehensive and rational use”.
- Water Resources Law of Indonesia (Law No.7/2004), Article 5, “Use Water Right as intended under Article 6 Paragraph (4) consists of the beneficial use of water rights and the commercial use of water rights”.
- Water Law of China (amended in 2002), Article 4, “The development, utilization, saving and protection of water resources ... shall be carried out ... with emphasis on multi-purposes use and on achieving maximum benefits so as to give full advantage to the multiple functions of water resources.

1.2.2 Agricultural Water Use

Agricultural use of water for irrigation, livestock, fisheries and aquaculture⁸ is estimated as the cause of 71% of total water withdrawal. This number is higher in low and middle income countries (Figure 4). Between 15-35% of withdrawal of water for irrigation is unsustainable. The effective use of water is an ethical issue that could reduce the water usage related to crop and animal production (Appelgren, 2004). Compared to the increase of cultivated land by about 24% from 1961 to 2003 (CA 2006)⁹, the size of irrigated areas more than doubled from 1970 to 1995 (IWMI-FAO). About 70% of the world’s irrigated land is in Asia, where it accounts for 35% of cultivated land (CA 2006). The Democratic People’s Republic of Korea has the highest level, with 73% of cultivated land under irrigation, followed by Japan with 65% and China with 55%. Bangladesh, Nepal, Republic of Korea and Viet Nam have more than 40% of cultivated land under irrigation. Some tropical countries of south Asia and the Islands have an average between 20-25% of their cultivated land under irrigation (FAO Aquastat).

Cultivated crops, techniques and schemes of irrigation, sources of water used vary across the region. Overall, the surface water (lakes, rivers, wells) is the major source of irrigation, while the ground water is widely used in Bangladesh and India. Powered irrigation is common in dry season or in arid and semi arid zones. However, it is well documented that subsidies on energy prices are associated with extensive use of pumping and depletion of aquifers. It is reported that irrigation enables farmers to cultivate more diverse land areas, for example, Bangladesh’s powered irrigation accounts for 83% of its total irrigated area, 54% in India and 54% in China and these countries have balanced distribution of crop varieties, while in Southeast Asia (Bhutan, Nepal, Sri Lanka) rice is the most common crop representing 90% of crops.

According to FAO, the pressure on water resources is considered high if the withdrawal exceeds 25% of total renewable water resources: this threshold is already exceeded in India and the Republic of Korea with 34% and 26% respectively. Other countries like China, Japan, Democratic People’s Republic of Korea and Sri Lanka also have high values with 19%, 21%, 18% and 20% respectively (FAO, 2006).

In some areas of the world irrigation is necessary to grow any crop, in other areas it is focused on more profitable crops, or it is used to enhance crop yield. Various irrigation methods involve trade-offs between crop yield, water consumption and capital costs of equipment and structures. Irrigation methods such as most furrow and overhead sprinkler irrigation are usually less expensive but also less

8 Aquaculture as part of agricultural use of water is discussed in case study 1 of this report - “The need for a more efficient aquaculture industry”, There is a separate study in preparation on “Energy Flow, Environment and the Ethical Implications of Aquatic Meat Production” under the ECCAP project <http://www.unescobkk.org/rushsap/energyethics/eetwg13>

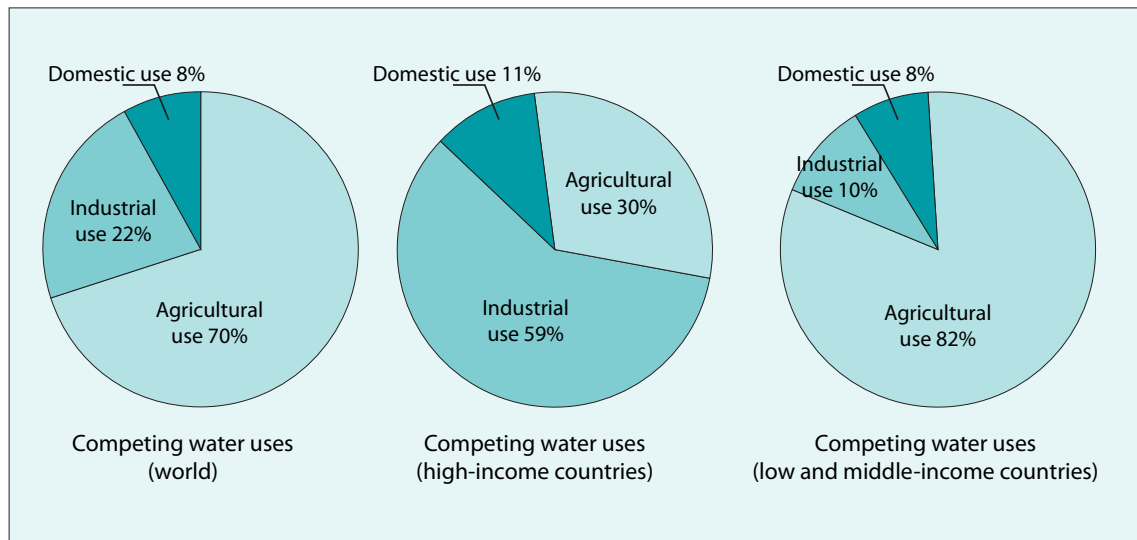
9 Water for Food, Water for Life: the Comprehensive Assessment of Water Management in Agriculture 2006 <http://www.iwmi.cgiar.org/Assessment/index.htm>

efficient, because much of the water evaporates or runs off. The ethical issues in the choices depend on how to balance the benefits and risks, and the needs of today versus investment in requirements for future generations. More efficient irrigation methods include drip or trickle irrigation, surge irrigation, and some types of sprinkler systems where the sprinklers are operated near ground level. These types of systems, while being more expensive, can minimise runoff and evaporation.¹⁰

Aquaculture is a small but growing agricultural use of water. Freshwater commercial fisheries may also be considered as agricultural uses of water, but have generally been assigned a lower priority than irrigation. As global populations grow and demands for food increase with a fixed water supply in the world, there are efforts underway to learn how to produce more food with less water, through improvements in irrigation methods and technologies, agricultural water management, crop types and water monitoring. For example, if we find synthetic materials require less water to produce (which is not usually the case now), there may be a shift from use of natural fibres such as cotton and wool.

The competing water uses for countries grouped according to their main sources of income are shown in Figure 4.

Figure 4: Competing Water Uses for Main Income Groups of Countries



Source: UNESCO, 2003.

1.2.3 Industrial Water Use

It is estimated that 15% of world-wide water use is for industrial purposes. A number of countries in Asia are developing their economies by industrial investment.¹¹ Some industrial users include power plants, which use water for cooling or as a power source (i.e. hydroelectricity plants, see section 1.3), ore mining,¹² oil refineries, which use water in chemical processes, and manufacturing plants, which use water as a solvent. The portion of industrial water usage that is consumptive varies widely, but as a whole it is lower than agricultural use.

10 More information is on Wikipedia http://en.wikipedia.org/wiki/Water_resources

11 For more information refer to ECCAP WG17.

12 Refer to the case study of Olympic Mine in South Australia in Boonlong R. et al. (2011).

1.2.4 Household Water Use

The world-wide water use for household purposes is around 15%. These include drinking water, bathing, cooking, sanitation and household gardening. Basic household water requirements have been estimated by Peter Gleick (2006) at around 50 litres per person per day, excluding water for gardens. Of these 50 litres, Gleick estimated 2L for drinking, 20L for sanitation services, 15L for bathing, and 10L for cooking and kitchen. However, if we examine the water consumption for food and energy in most countries, these exceed the direct consumption of water. (See further discussion in the section on valuing water).

1.2.5 Recreational Water Use

Recreational water use is a small but growing percentage of total water use. Recreational water use is often tied to reservoirs. If a reservoir is kept fuller than it would otherwise be for storage of water because of recreation functions, then the water retained could be categorized as recreational usage. Release of water from a few reservoirs is also timed to enhance whitewater boating, which also could be considered a recreational usage. Other examples are anglers, water skiers, nature enthusiasts and swimmers. There is significant use of the oceans for recreation also.

Recreational usage is usually non-consumptive. However sports fields could be considered consumptive. Golf courses are often targeted as using excessive amounts of water, especially in drier regions. Additionally, recreational usage may reduce the availability of water for other users at specific times and places. For example, water retained in a reservoir to allow boating in the late summer is not available to farmers during the spring planting season. Water released for whitewater rafting may not be available for hydroelectric generation during the time of peak electrical demand.

1.2.6 Environmental Water Use

Environmental water use is for the benefit of ecosystems or the environment, rather than for human benefit. Explicit environmental water use is a small but growing percentage of total water use, including artificial wetlands, artificial lakes intended to create wildlife habitat, fish ladders around dams, and water releases from reservoirs timed to help fish spawn. Like recreational usage, such environmental usage is generally non-consumptive but may reduce the availability of water for other users at specific times and places. We can expect an increase in this use as biocentric and ecocentric value systems are adopted more, so that water is provided to nature reserves and national parks away from competing human needs.

1.3 Water for Energy Production

Water is used in a number of energy production systems, from mining of oil and for oil extraction, to its use as a coolant, or driver of turbines. It is reported that hydropower shares 16% of world's electricity production (IEA 2009)¹³ and it remains the single largest means of renewable source of energy representing 92% of total renewable energy generated in the year 2000 (IHA 2000). Projection of price increase for primary energy sources, carbon accounting and incentives in clean energy technology are good stimulus for the renewable energy sector. For example, a study of 50 selected dams with installed power generation capacity of 39,000 MW found that they replaced the equivalent of 51 million tons of fuel in electric energy production annually.¹⁴ This is greater than other renewable energy sources like wind and solar power at present.

13 For the purpose of consistency and our reference in light of future projection, we refer to IEA data. According to the World Bank and International Hydropower Association, the share of hydropower refers to 19-20% of total electricity production.

14 World Bank Lending for Large Dams: A preliminary review of Impacts <http://www.worldbank.org/ieg>

Water is characterized as a stable source of energy and there is still much unexploited potential for hydropower, compared to oil and natural gas, widely spread around the globe.¹⁵ According to IHA, most of the remaining and technically feasible potential is in Asia, 6800 (TWh/year), which is higher than the total estimation of technically feasible potential for Africa, North and South America.¹⁶

Being amongst the biggest human made single structures and besides their economic importance, hydroelectricity generation and the dam building business have generated significant debate over the land use and modification of the natural environment (Thein, 2007). Traditionally, the engineering ethics in dam construction only focused on technical feasibility and financial accountability. The moral or ethical obligation of individual professionals and corporations towards society and environment was neglected. Moreover, the scope of the debate was not simply the divide into the pro-environmental groups against hydro industry business because of the negative environmental impacts of the large dams to local communities. The controversy over the distribution of burdens and benefits, concerns about accountability and participation of affected communities, neglected analysis of social costs including involuntary resettlement and doubts in long-term benefits have grown in parallel and embodied in several statements that called for moratorium or prohibition of large dam construction.¹⁷

The World Commission on Dams (WCD) was established in 1998 to provide guidance, and it declared that there are five core values: equity, sustainability, efficiency, participatory decision making and accountability. The report also outlined seven strategic principles, which may be appropriate to many energy production systems. These are (WCD, 2000):

- 1) Gaining Public Acceptance
- 2) Comprehensive Options Assessment
- 3) Addressing Existing Dams
- 4) Sustaining Rivers and Livelihoods
- 5) Recognizing Entitlements and Sharing Benefits
- 6) Ensuring Compliance
- 7) Sharing Rivers for Peace, Development and Security

Following the WCD a number of organizations have become involved in discussions including WWF, IUCN, World Bank, ADB, African Development Bank, WHO, and World Water Council. UNEP accepted to accommodate multi-stakeholders in follow-up action and to support dialogue on dam construction engaging stakeholders through its Dams and Development Project. HSBC Group also adopted the Equator Principles in 2003 and according to its policy,¹⁸ will offer no financial services to the energy sector to support operations in UNESCO World Heritage sites, Ramsar List of Wetlands of International Importance and in Tropical and High Value Conservation Forests.

A common recognition for basic principles, guidelines and recommendations has been reached on paper but there is no universal social consensus, and still there are numerous controversies especially over large hydropower schemes. A significant amount of arguments from different aspects, research materials, case studies and critical thoughts has been documented.¹⁹ Statistics from the International

15 World Bank estimates that 70% of hydro potential is yet exploited (World Bank. 2009. *Directions in Hydropower*).

16 IHA. 2000. *Hydropower and the World's Energy Future*. <http://www.ieahydro.org/reports/Hydrofut.pdf>

17 i) Manibeli Declaration from 1994 called for a moratorium on World Bank funding of large. <http://www.internationalrivers.org/en/follow-money/manibeli-declaration>. ii) Curitiba Declaration of people affected by dam, Brazil 1997. <http://www.internationalrivers.org/en/curitiba-declaration> and iii) San Jose Declaration on Dams and Wetlands, May 1999, to ban construction of new hydroelectric dams that affect wetlands and the people whose survival depends upon them. http://www.global500.org/feature_2.html. In 1996, Operations Evaluations Department, an independent unit within the World Bank, conducted its own evaluation focused on economic, social costs and benefits associated with 50 World Bank financed large dams built between 1956 and 1987, concluding that 90% of these dams were consistent with the standards applicable at the time of approval. And 74% of these dams are acceptable or potentially acceptable according to the World Bank's new standards. <http://www.pnud.ne/rense/Biblioth%E8que/BM05.pdf>

18 HSBC lending policy to socially and environmentally sensitive sectors: Energy Sector Policy. http://www.hsbc.com/1/PA_1_1_S5/content/assets/csr/080905_energy_sector_guidelines.pdf

19 Refer to case studies of dam construction in ECCAP WG4 (Boonlong et al., 2011) and WG5 reports.

Commission on Large Dams shows a significant decline of hydropower construction since the late 1980s. Multinational Financial Corporations have serious routine proceedings to answer to the question “whether or not to build dams”.

1.4 Water Resources, Availability and Stress

The permanent motion of water from liquid to solid, gaseous states (and vice versa) and its extensive and variable dynamics of turnover, make water resource assessment a complicated, time consuming and complex task. In the meantime, water resource assessment is not limited to physical or quantitative measures but also considers its qualitative values. Freshwater is not always renewable, like deep or fossil aquifers and not all freshwater is accessible for use. Therefore, it is important to distinguish available water resource from natural water resource, actual or manageable water resource, when freshwater flows out to the sea, from renewable water resources.

Clarifying these two definitions would help us figure out how much water can be really utilized by human beings. According to UNESCO and WMO, “Water resources” is defined as water available, or being made available, for use in sufficient quantity and quality at a location over a period of time appropriate for an identifiable demand. Here two definitions - “water storage” and “water resources amount” - should be differentiated: not all water stored on the Earth can be called “water resources”, and only those available with sufficient quantity and quality that can satisfy certain demands and uses can be called “water resources”.

The earliest comprehensive assessment of the global water resources dates back to the 1970s.²⁰ The First World Conference on Water Resources (Argentina, 1978) also contributed in global initiatives and cooperation, urging the international community to strengthen its coordination on global water resource assessment. Since then a number of initiatives have been taken to compile or compare existing data on water resource, among them most recent and often referred are FAO’s global information system on renewable water resources (Aquastat programme started from 1994) and the UNESCO-IHP project on water assessment (1991-1996).

FAO’s Aquastat is a database on water resources based on an accounting approach: the total renewable water resources (TRWR) of a country, which consist of the internal renewable water resources (IRWR), plus external water resources. The IRWR are the amount of water generated inside a country, and the ERWR are the amount of water generated in upstream countries. Shiklomanov’s data compilation on freshwater resource is based on a net balance approach, natural water resource minus demand of principal sectors of water use.

Overall, freshwater resources are sufficient to satisfy human needs. However, due to uneven distribution across the regions, countries and among the countries or across different sectors that use water, there is a conflicting and competing interest over the freshwater. Different indicators are used to estimate the distribution of freshwater resources and to define water stress. The European Environmental Agency’s definition of water stress is when the demand for water exceeds the available amount during a certain period or poor quality restricts its use. Water stress causes deterioration of freshwater resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.), and quality (eutrophication, organic matter pollution, saline intrusion, etc.).

The most widely used measure is the Falkenmark indicator or “water stress index” (Falkenmark, Lundqvist and Widstrand, 1989). They proposed 1,700 m³ of renewable water resources per capita per year as the threshold, based on estimates of water requirements in the household, agricultural, industrial and energy sectors, and the needs of the environment. Countries whose renewable water supplies cannot sustain this figure are said to experience water stress. When supply falls below 1,000 m³ a country experiences water scarcity, and below 500 m³ absolute scarcity.²¹

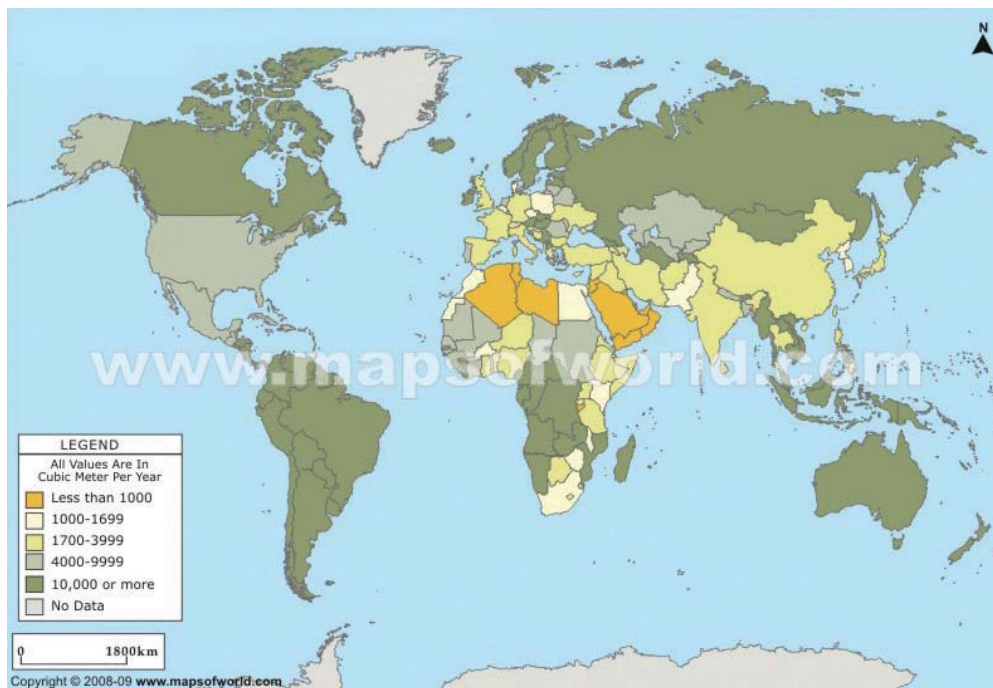
20 See State Hydrological Institute of the Soviet Union. 1974, *World Water Balance and Water Resources of the Earth*; L’vovitch. 1974. *World water resources and their future*. Baumgartner and Reichel’s. 1975. *World Water Balance*. Germany..

21 Rijsberman, F. R. 2005. *Water Scarcity: Fact or Fiction?* Proceeding of the 4th International Crop Science Congress, 26 September - 1 October 2004. Brisbane, Australia. Published in CD-Rom. Website: www.cropscience.org.au.

The freshwater resources per capita of the world are shown in Figure 5. According to the map, the freshwater resources per capita of the world are the maximum 10,000 m³ or more in South America, Russia, Australia and some parts of Africa. Algeria, Libya, Saudi Arabia, Yemen, Oman and Jordan are places where freshwater resources per capita are less than 1,000 m³.

Based on the IHP-UNESCO method of water resource calculation the net balance between natural water resource minus withdrawals for the demand of principal sectors of water use, developed a water resource vulnerability index. According to this index a country is in water scarcity if its annual withdrawals are between 20-40% of annual supply, and severely water scarce if this figure exceeds 40%. From Figure 5 it can be seen that freshwater distribution around the world is quite uneven. The Middle-East and some countries of Africa face acute water shortage (Wolf, 2001). Freshwater resources are finite and should be used properly to avoid its shortage in the future.

Figure 5: Freshwater Resources Per Capita of the World



Source: <http://www.mapsofworld.com/world-freshwater-resources.htm>

According to the World Business Council for Sustainable Development, water stress applies to situations where there is not enough water for all uses, whether agricultural, industrial or domestic. Defining thresholds for stress in terms of available water per capita is a complex process because it involves assumptions about water use and its efficiency. It has been proposed that when annual per capita renewable freshwater availability is less than 1,700 m³, countries begin to experience periodic or regular water stress. Below 1,000 m³, water scarcity begins to hamper economic development and human health and well-being.

A major factor behind this is fast growing populations. In 2000, the world population was 6.2 billion and in 2011 it will be 7 billion. The UN estimates that by 2050 there will be an additional 3 billion people with most of the growth in developing countries that already suffer water stress.²² Thus, water demand will increase unless there are corresponding increases in water conservation and recycling of this vital resource (Wolf, 2001).

The rate of poverty alleviation is increasing especially within the two population giants of China and India. However, increasing affluence inevitably means more water consumption: from needing clean freshwater and basic sanitation service, to demanding water for gardens, car washing or private swimming pools.

22 Asian Development Bank, 2007. *Asian Water Development Outlook*.

Business activity ranging from industrialization to services such as tourism and entertainment continues to expand rapidly. This expansion requires increased water services including both supply and sanitation, which can also lead to more pressure on water resources and natural ecosystems.

The trend towards urbanisation is accelerating. Small private wells and septic tanks that work well in low-density communities are not feasible within high-density urban areas. Urbanisation requires new investment in water infrastructure in order to deliver water to individuals and to process the concentrations of wastewater – both from individuals and from business. These polluted and contaminated waters must be treated as they pose unacceptable public health risks.

Climate change is having significant impacts on water resources around the world because of the close connections between the climate and hydrological cycle. Rising temperatures will increase evaporation and lead to increases in precipitation. Both droughts and floods may become more frequent in different regions at different times, and dramatic changes in snowfall and snowmelt are expected in mountainous areas. Climate change could also mean an increase in demand for irrigation, garden sprinkler and even swimming pools.

Due to expanding human population, competition for water is growing such that many of the world's major aquifers are becoming overdeveloped. This is due both to direct human consumption as well as agricultural irrigation by groundwater. Millions of pumps of all sizes are currently extracting groundwater throughout the world. Irrigation in dry areas such as Northern China and India is supplied by groundwater, and is being extracted at an unsustainable rate. Cities that have experienced aquifer decline between 10 to 50 meters include Mexico City, Bangkok, Manila, Beijing, Madras and Shanghai.²³ In many places of the world, groundwater is being used at a faster rate than it can be replenished. Even if some water remains available, it costs more and more to capture it.

Water pollution has been one of the main concerns of the past few decades, which aggravates water stress, and this issue will be revisited in the chapter on water management. The governments of many countries have striven to find solutions to reduce this problem through policy measures such as polluter pays²⁴ and fines, to overcome usage patterns underlying the pollution.

1.5 Water and Conflict

Discussion surrounding the linkages between the use of natural resources and conflicts, involves multiple focus areas and themes. There is increasing work on water and conflict studies²⁵ with strong emphasis on security and military threats. However, it is interesting to note that the environment was not considered as an independent factor in the traditional agenda of conflict studies²⁶ and therefore, databases on international conflictive interactions and events such as International Crisis Behavior Project, Conflict and Peace Data Bank or the Global Event Data System²⁷ do not contain categories that can indicate a relationship between water pressure and conflict. This is despite considerable historical reflections on how land and water access claims have been sources of colonialism and wars throughout time. Although, the Security Database on Water and Conflicts²⁸ from the Pacific Institute is a more specific resource that considers the environment from a geopolitical context and provides categories on water conflict, with events such as violent disputes of the two Sumerian city states of Lagash and

23 Foster, S.S.D. and Chilton, P.J. 2003. Groundwater – the processes and global significance of aquifer degradation. *Philos Trans R Soc Lond B Biol Sci*. Vol. 358, pp. 1957–1972.

24 Refer to an analysis of polluter pays in ECCAP WG7 report.

25 Green Cross International, Pacific Institute, Worldwatch Institute, Woodrow Wilson's Center, Trudeau Center for Peace and Conflict Studies of the University of Toronto, etc.

26 From the Latin for “to clash or engage in a fight”, a confrontation between one or more parties aspiring towards incompatible or competitive means or ends... UN University for Peace: 2005. *A Glossary of Terms and Concepts in Peace and Conflict Studies*.

27 Center for International Development and Conflict Management at the University of Maryland <http://www.cidcm.umd.edu>. Azar, Edward E. Inter-university Consortium for Political and Social Research <http://www.icpsr.umich.edu/icpsrweb/ICPSR>

28 Peter H.Gleick. 2008. *Water Conflict Chronology*. <http://worldwater.org/chronology.html>

Umma on diverted water dating back to 2500 BC, and the threat of a terrorist attack to the Warsak Dam, Pakistani's main water supply infrastructure, considered in similar vain. Though, in the first case water was the casual factor of conflict, in the latter, water is merely a tool of hostage situation in a milieu of existing conflict. It is established that "countries that cooperate in general also cooperate over water, while countries with overall unfriendly relations are also unfriendly over water issues" (Yoffe et al., 2009). Therefore, the question is whether and when water stress could cause a conflict.

Environmental security is critical for every society and this notion has been expanding.²⁹ If we refer to several authoritative reports and studies,³⁰ the concept of security is no longer the sole prerogative of interstate affairs and besides its traditional areas of focus, such as national security or integrity of political borders granted by military and diplomatic sources, but it considers human and environmental dimensions as well. For example, a recent Report of the UN Secretary-General on Climate Change and Its Possible Security Implications (A/64/350 from 11 September 2009) addressed this issue from a perspective of interdependence between human vulnerability (food security and human health) and national security (statelessness, domestic and international conflict on natural resources and inability to sustain stability), further indicating potential areas that could affect security. This redefined position on security as an aggregated per-capita based water resource calculation, accorded with more advanced approaches on estimation of water resource such as Water Resource Vulnerability Index (1991), Physical and Economic Scarcity Indicators (1998), Water Poverty Index (2003)³¹ and Index of Drinking Water Adequacy.³² Besides these indicators of human vulnerability,³³ there are two approaches are emerging, namely the River Basin Index and Minimum Environmental Flow to secure an environmental use of water.

A new register of transboundary river and lake basins³⁴ in the world, updated by the Oregon State University in 2002,³⁵ has listed 263 international river basins that cover 47% of the earth's land surface. "A total of 145 nations include territory within international basins. Twenty-one nations lie in their entirety within international basins, and a total of 33 countries have greater than 95% of their territory within these basins" (Wolf et al., 2003). Asia alone has 57³⁶ listed international river basins that cover 40% of the continent. Wherein, the Aral Sea, Ganges-Brahmaputra-Meghna, Indus, Mekong and Tarim flow across six and more countries each. Another 14 countries in this region also have a territorial share of three to four international river basins. The scope of competing interests over water include annually increasing demands from domestic, municipal, agricultural and economic users, socio-economic and political disparities between riparian countries, and the right to exploit natural resources within their own jurisdiction in relation to interests of lower riparian countries on natural flow of a river.

In the region there has not been a formal declaration of war over water, and no countries have voluntarily unified into one nation over water. For the years 1948-1999, cooperation over water, including the signing of treaties, outweighed overall conflict over water and violent conflict in particular. Out of 1,831 events, 28% were conflictive (507 events), 67% were cooperative (1,228), and the remaining 5% were neutral or non-significant. Of the total events, more than half (57%) represented verbal exchanges,

29 Refer to ECCAP WG7 report on Energy Equity and Environmental Security.

30 Brundland Commission. 1987. *Report on Environment and Human Development*. " True security cannot be achieved by mounting buildup of weapons (defense in a narrow sense), but only by providing basic conditions for solving non-military problems which threaten them. Our survival depends not only on military balance, but on global cooperation to ensure a sustainable environment." See also UN High-level Panel. 2004. Report on Threats, Challenges and Change. Also consider <http://www.iisd.org/ecp/es>

31 Rijsberman, F. R. 2005. *Water Scarcity: Fact or Fiction?* Proceeding of the 4th International Crop Science Congress, 26 September - 1 October 2004. Brisbane, Australia. Published on CD-Rom. Website: www.cropscience.org.au.

32 Asian Development Bank. 2007. *Asian Water Development Outlook*.

33 There is further general discussion of energy equity and environmental security in ECCAP WG7 report, See <http://www.unescobkk.org/rushsap/energyethics/eetwg7>

34 See reports for standard definitions of international river basins.

35 International Program on Water Conflict Management and Transformation <http://www.transboundarywaters.orst.edu/database/interriverbasinreg.html>

36 TWINBASIN: Promoting Twinning of River Basins for developing Integrated Water resources Management Practices <http://www.cawater-info.net/twinbasinxn/asia>

either mildly conflictive or cooperative. Yoffe (2009) identified six issues - water quantity, infrastructure, joint management and hydropower - as dominant. Cooperative events concerned a slightly wider range of issues than conflictive events, with a more dramatic difference at the extremes of the scale. They considered international freshwater treaties as the most cooperative event, with emphasis on water quality and quantity, hydropower, joint management and economic development. The extreme conflicts were extensive military acts, concerning quantity and infrastructure exclusively. No single indicator explained conflict/cooperation over water, including climate, water stress, government type, and dependence on freshwater resources for agriculture or energy. Yoffe found that even those indicators that showed a significant correlation with water conflict, such as high population density, low per capita GDP, and overall unfriendly international relations, explained only a small percentage of the variability in the data in their database. Overall, the most promising sets of indicators for water conflict were those associated with rapid or extreme changes in the institutional or physical systems within a basin (e.g., internationalization of a basin, large dams) and the key role of institutional mechanisms, such as international freshwater treaties, in mitigating such conflict.

The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes incorporates the right of equitable use of international watercourses with accountability via consideration of inter and intra-generational equity. The UN 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses (known as New York Convention)³⁷ set 'equitable and reasonable utilization and participation' as a general principle to be applied in non-navigational use of international watercourses, strongly emphasizing that mutual cooperation and participation among riparian states is a duty, which should be based on "sovereign equality, territorial integrity, mutual benefit and good faith in order to attain optimal utilization and adequate protection of an international watercourse" (Article 8.1). In determining what is a reasonable and equitable manner, the UN Convention provides a list of 'factors'³⁸ that must be considered and "the weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole" (Article 6.3). However, in case of conflicts between different factors and the "absence of agreement or custom to the contrary, no use of an international watercourse enjoys inherent priority over other uses" (Article 10.1) with due regard of vital human needs (Article 10.2).

Thomas R. Odhiambo, past president of the African Academy of Sciences, said that: "The art and practice of equitable distribution of and access to freshwater for all people in the 21st century, as a fundamental human right and international obligation, is the mother of all ethical questions of all transboundary natural resources of a finite nature" (Krimsky, 2005). Water rights have been discussed and assigned for millennia under different cultures (Barraque, 2004). The rights usually reflected the ethics of the day, which at times was inconsistent with our modern norms of ethics.

37 The UN 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses, Article 5.1: "Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse". Article 5.2: "Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to cooperate in the protection and development thereof, as provided in the present Convention". http://untreaty.un.org/ilc/texts/instruments/english/conventions/8_3_1997.pdf

38 Article 6: "Factors relevant to equitable and reasonable utilization":

- (a) Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character;
- (b) The social and economic needs of the watercourse States concerned;
- (c) The population dependent on the watercourse in each watercourse State;
- (d) The effects of the use or uses of the watercourses in one watercourse State on other watercourse States;
- (e) Existing and potential uses of the watercourse;
- (f) Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
- (g) The availability of alternatives, of comparable value, to a particular planned or existing use.

Conflicts and tensions over water are actually most likely to arise within national borders, such as in the downstream areas of distressed river basins. Areas such as the lower regions of China's Yellow River or the Chao Phraya River in Thailand, for example, have already been experiencing water stress for several years. Additionally, certain arid countries, which rely heavily on water for irrigation, such as China, India, Iran, and Pakistan, are particularly at risk of water-related conflicts.

Technology has allowed humans to exploit natural resources better in order to increase food production, however, there are a finite number of resources on the planet, therefore there is an upper bound to the amount of food that can be produced. Similarly, there is an upper bound to the amount of humans the planet can support as humans depend on food production, and the resources to sustain that. As societies get closer to these limits, we can expect more conflicts to emerge.

1.6 Water, Culture and Religion

The above sections review water basics, water uses and water stresses, mainly from a scientific aspect. The 2006 World Water Day (WWD) theme was "Water and Culture", which has drawn attention to the fact that there are as many ways of viewing, using and celebrating water according to different cultural traditions. Water is at the heart of many religions and is used in different rites and ceremonies – often being held sacred. Water has also been represented in art for centuries – in music, paintings, writing and film. Cultural traditions, indigenous practices and societal values determine how people perceive and manage water, and provide useful references for water ethics construction.

The UNESCO Water Portal Weekly Update No.122³⁹ published in December 2005 the following facts and figures about water religions and beliefs:

- 1) Water plays a central role in many religions and beliefs around the world: water is the source of life and represents (re)birth. Water cleans the body and by extension purifies it. These two main qualities confer a highly symbolic – even sacred – status to water. Water is therefore a key element in ceremonies and religious rites.
- 2) Water is often perceived as a god, goddess or divine agency in religions. Rivers, rain, ponds, lakes, glaciers, hailstorms or snow are some of the forms water may take when interpreted and incorporated in cultural and religious spheres.
- 3) Religious water is never neutral and passive. It is considered to have powers and capacities to transform this world, annihilate sins and create holiness. Water carries away pollution and purifies both in a physical and symbolical sense. Water is a living and spiritual matter, working as a mediator between humans and gods. It often represents the border between this world and the other.

In Buddhism, water is used in Buddhist funerals. It is poured and overflows into a bowl placed before the monks and the dead body. As it fills and pours over the edge, the monks recite "As the rains fill the rivers and overflow into the ocean, so likewise may what is given here reach the departed."

In Christianity, water is intrinsically linked to baptism, a public declaration of faith and a sign of welcome into the Christian church. When baptized, one is fully or partially immersed in water, or one's head may simply be sprinkled with a few drops of water. The sacrament has its roots in the Gospels, wherein it is written that Jesus was baptized by John the Baptist in the River Jordan. In baptism, water symbolizes purification, the rejection of the original sin.

In Hinduism, water is imbued with powers of spiritual purification for Hindus, for whom morning cleansing with water is an everyday obligation. All temples are located near a water source, and followers must bathe before entering the temple. Many pilgrimage sites are found on river banks; sites where two or even three rivers converge are considered particularly sacred. Hindu pilgrims travel thousands of miles to collect a bottle of water from the headwaters of the sacred Ganges River, and they proudly display the bottle in their homes for the rest of their lives. An important part of ritual purification in Hinduism is the bathing of the entire body, particularly in rivers considered holy. In Varanasi, India, 60,000 Hindus bathe in the Ganges River every day.

39 <http://www.unesco.org/water/news/newsletter/122.shtml>

In Islam, water serves above and beyond all for purification. The first and most important involves washing the whole body. It is obligatory after sex, and recommended before the Friday prayers and before touching the Koran. Before each of the five daily prayers, Muslims must bathe their heads, wash their hands, forearms and feet. All mosques provide a water source, usually a fountain, for this ablution. When water is scarce, followers of Islam use sand to cleanse themselves, and this is the third form of ablution.

In Judaism, Jews use water for ritual cleansing to restore or maintain a state of purity. Hand-washing before and after meals is obligatory. Although ritual baths, or mikveh, were once extremely important in Jewish communities, they are less so now. They remain, however, compulsory for converts. Men attend mikveh on Fridays and before large celebrations, women before their wedding, after giving birth and after menstruation. Water is a source of increasing conflict in Jerusalem region, because Israel controls water supplies for both the West Bank and the Jordan River.

Shinto is based on the veneration of the kami, innumerable deities believed to inhabit nature. Worship of the kami must always begin by a ritual of purification with water. This act restores order and balance between nature, humans and the deities. Waterfalls are considered sacred in Shinto (Smolan and Er Witt, 2006).⁴⁰

The culture of water use is under change, and human behaviour seems to be rapidly altered by commercial advertising, such as the increasing use of personal showers and bathing in certain countries, which is associated with shampoo commercials. Consumer goods marketing has also led to increased energy and resource use.

Culture could also be an avenue for change if a culture of conservation is more widely spread. Changes in ethical value are inherently slow in development and reactive in response, and takes time to construct. This is true for water ethics, especially when people have already gotten used to the approaches of “command and control” and “economic instruments”. Policy options that utilize culture as an agent of change will be discussed in chapter 4.

40 <http://www.worldwaterday.org/page/121>

2. Water Ethics

2.1 Roles of Water Ethics

The topic of water ethics is being increasingly discussed in policies and practices of water resource management. This report uses the term management rather than access to cover all aspects of water use: access to, utilization, allocation, quality, protection, etc. In this chapter, we explore different frameworks for water ethics referring also to knowledge gained through several case studies that illustrate uses of ethical models, and highlight ethical issues that are often ignored or undervalued in management of water resources, suggesting policy options that can be developed.

The application of ethical concepts has a direct practical relevance in water resource management. It can support the decision making process, which is a very complex issue involving a range of scientific domains (hydrology, groundwater, precipitation and runoff, water quality), and requires simultaneous consideration from different areas of water use, both from the supply and demand side (an integrated approach to water resource management), and their integration with socio-economic aspects. On the other hand, different tools and methodologies that are designed to support the knowledge base and decision making in the water sector are often technical. Review of state of the art and the application of these methodologies suggest that knowledge supporting tools and methodologies are not restricted to technical problems as they are also challenged by procedural items associated with stakeholder participation, especially at the level of communication with water managers and decision makers.⁴¹

In this complex environment with different variables, the role of ethics is to provide operational assistance and conceptualization of different perspectives while helping to keep a focus “whether on the action, the consequences, or the motives, which examine the concepts of rights and duties, or effects and outcomes.”⁴² From this perspective, the precautionary principle or cost benefit analysis for example, are useful.

Ethics can form both the source and normative content of a particular decision by providing reason and justification. From this perspective, there are several viewpoints of ethics: descriptive ethics is to describe the view that people have relating to ethical conduct (Macer, 1998), and the case studies and observations of people’s behaviour provide us a range of data to consider the world view of different persons. There is a need for more research on the gap between stated attitudes to environmental issues and behavior, however. From the perspective of prescriptive ethics, ethics is a socially accepted moral standard to define what you can do and what you cannot do (e.g. behavioral ethics) and/or a standard of what harm or pain, such as damage, loss, poverty, thirst, etc., can be inflicted upon other moral agents, including human beings (e.g. consequential ethics). In fact, our whole life as individuals, families and communities is regulated as a matter of course by tacit rules of behaviour and consequences.

2.2 Frameworks for Water Ethics

UNESCO previously examined the question of water ethics through working group meetings organized under the auspices of the World Commission on the Ethics of Science and Technology (COMEST) and the International Hydrology Programme (IHP) in 1998. This led to the publication of a series of 14 essays (Priscoli et al., 2004)⁴³ and the report Best Ethical Practice in Water Use (COMEST, 2004) which also included 5 case studies.

41 Refsgaard, J.C. (ed.) 2005. *State-of-the-Art Report on Quality Assurance in modelling related to river basin management. HarmoniQuA-report*, D-WP1-1 <http://www.HarmoniQuA.org>

42 Macer, D.R.J. 2006. *A Cross-Cultural Introduction to Bioethics*. Eubios Ethics Institute.

43 Delli Priscoli, J., Dooge, J. and Llamas, R. 2004. *Water and Ethics: Overview*. UNESCO International Hydrological Programme & World Commission on the Ethics of Scientific Knowledge and Technology. Series on Water and Ethics, Essay 1. Paris, UNESCO.

The sub-commission of COMEST argued that, rather than analyzing once more the ethical issues of water management, it should try to promote best ethical practices. They identified some fundamental principles, as follows:⁴⁴

Human dignity: for there is no life without water and those to whom it is denied are denied life;

Participation: for all individuals, especially the poor, must be involved in water planning and management with gender and poverty issues recognized in fostering this process;

Solidarity: for upstream and downstream interdependence within a watershed continually poses challenges for water management resulting in the need for an integrated water management approach;

Human equality: for all persons ought to be provided with the basic necessities of life on an equitable basis;

Common Good: for water is a common good, and without proper water management human potential and dignity diminishes;

Stewardship: for protection and careful use of water resources is needed for intergenerational and intra-generational equity and promotes the sustainable use of life-enabling ecosystems;

Transparency and universal access to information: for if data is not accessible in a form that can be understood, an opportunity will arise for an interested party to disadvantage others;

Inclusiveness: water management policies must address the interests of all who live in a water catchment area. Minority interests must be protected as well as those of the poor and other disadvantaged sectors. In the past few years the concept of Integrated Water Management (IWRM) has come to the fore and the means to ensure equitable, economically sound and environmentally sustainable management of water resources;

Empowerment: for the requirement to facilitate participation in planning and management means much more than to allow an opportunity for consultation. Best ethical practice will enable stakeholders to influence management.”

There has been considerable reflection on environmental ethics throughout the world. The adoption of the Universal Declaration of Bioethics and Human Rights (UDBHR) by all member countries of UNESCO in 2005 followed a series of consultation meetings. In these meetings a number of agencies and governments called for more formal codifications of environmental ethics principles that have been adopted in international treaties and texts (COMEST, 2010).

The UDBHR provides a universally agreed framework to describe bioethics, which brings together much of the previous scholarship and recommendations in environmental ethics by describing common ethical principles, and providing a framework which could be applied for normative ethical reflection. Although the UDBHR does not elaborate specific ethics for environmental application, it includes a number of consensus statements that can be applied to water ethics. The preamble of the UDBHR states that it is “addressed to States. As appropriate and relevant, it also provides guidance to decisions or practices of individuals, groups, communities, institutions and corporations, public and private”. The stated “aims of this Declaration” in Article 2 include:

“(g) to safeguard and promote the interests of the present and future generations;

(h) to underline the importance of biodiversity and its conservation as a common concern of humankind.”

44 World Commission on the Ethics of Science and Technology (COMEST) and the International Hydrology Programme (IHP). 2004. *Best Ethical Practice in Water Use*. UNESCO: Paris,.

2.3 Principle of Human Dignity and the Right to Water

The UDHR states:

“Article 3 Human dignity and human rights:

1. Human dignity, human rights and fundamental freedoms are to be fully respected.
2. The interests and welfare of the individual should have priority over the sole interest of science or society.”

The UDBHR specifically commits states to provide adequate water in:

“Article 14 on Social responsibility and health

1. The promotion of health and social development for their people is a central purpose of governments that all sectors of society share.
2. Taking into account that the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition, progress in science and technology should advance: ... access to adequate nutrition and water.”

This Article is based on the underlying ethical principle of human dignity, a principle which has emerged in many reports on ethics in general, reflected also in statements relating to the use of water. The question of how to balance the interests of individuals and society, and other non-human users of water is a fundamental challenge that is discussed in this report. In essence, since water is essential for human life the human right for water is a fundamental human right.

2.4 The Principle of Equity in Availability and Applicability of Water: The Right to Water

Equity in availability and applicability of water is an important ethical issue at all levels, from local community to the global scale. Article 2 of UDBHR means that one individual cannot have access to as much water as they like to the detriment of others. Further in the UDBHR we read:

“Article 10 Equality, justice and equity

The fundamental equality of all human beings in dignity and rights is to be respected so that they are treated justly and equitably.”

There is a need for equity of water rights to be promoted. On 11 December 2008, Mr. Koïchiro Matsuura, then Director-General of UNESCO, opened a session on the right to water during the 9th World Summit of the Nobel Peace Prize Laureates. Mr. Matsuura underscored that the right to water entitled access to sufficient, safe, acceptable, physically accessible and affordable water enjoyed without discrimination, and equally by women and men. In real life, the equity of water rights could be applied in policy as providing an equal amount of clean water required for human living. Extravagant consumption of water should not be included in this amount, however, there are greater than 10 fold differences in the current average water consumption figures between people living in different countries.

Water is one of the most essential resources for the human being: everyone has a right to water for various kinds of usage for living. Thus the human right to water is one part or one item of general human rights, accordingly the water right is a fundamental human right that cannot be deprived of by anyone or any kind of power. This principle is a postulation that evidently needs no argumentation here and from which we start our ethical consideration on water diversion and water usage. In actual life, this equality of water right can be formulated as the equal quantity of humans’ basic amount of water for living, which can be calculated into a concrete number. The equality of water right means that everyone has a right to possess the same basic amount, with (or without) an added amount for comfort. Extravagant consumption of water is inconsistent with this principle.

2.5 Ecosystem Requirements and a Healthy Environment

We have a deep and eternal relationship with water. The first relationship we have is biological dependence, and the fact that about 95% of our body weight is water. People may also have socio-biological fondness for water, as with other parts of the environment. It is an evolutionary advantage to like water, and an advantage to value nature. One of the common themes seen in the comments and pictures of nature and life in the International Bioethics Survey conducted in 1993 across a dozen countries in Asia and the Pacific (Macer, 1994) was water, especially rivers and ocean sunsets, with ponds containing birds, fish and other animals. Water has spiritual images of cleansing, purity, being used in most religions, which was also reflected in the survey responses. This data confirms that water is a common image of nature.

The UDBHR Article 17 on “Protection of the environment, the biosphere and biodiversity” specifically illustrates how relationships between different elements of the environment and biosphere, such as human beings, are important in environmental ethics:

“Article 17 Protection of the environment, the biosphere and biodiversity

Due regard is to be given to the interconnection between human beings and other forms of life, to the importance of appropriate access and utilization of biological and genetic resources, to traditional knowledge and to the role of human beings in the protection of the environment, the biosphere and biodiversity.”

Although many elements of a water ethic can be expressed as “principles” of water ethics, it does not mean that principlism as an ethical framework is the most appropriate for resolving water-related ethical dilemmas. There is further discussion of anthropocentric versus bio-centric and other world views in accompanying reports (Rai et al., 2010). The authors of this report urge policymakers to find appropriate models for the ecological communities that underpin human society in their nations and jurisdictions, and suggest that the principles outlined here could be useful.

Human beings are a part of nature, not isolated from or dichotomized from nature, so we should also make considerations for the nature side. Firstly nature and the ecosystems have the right to exist, evolve and develop by their own course steadily and smoothly from the present level to a future level; a right or rights to water. This right, here called an eco-right or nature-right, will lessen the disasters of nature and eventually to human beings, because some ecosystems have been killed due to diversion of water for human needs. Both humans’ and ecosystems’ rights to water are starting points for ethical considerations.

How can we balance the water needs between human beings and nature? In an ecocentric view, a human beings’ need is not more important than and takes no priority over the needs of other creatures and it subordinates to the whole ecosystem or nature. Therefore, at least the quantity of water usage in many industrialised countries should be reduced one fourth of the usual amount. It is an eco-mistake for us, as the offspring of the evolution of nature, to stand on the opposite of nature and use it just for survival without any consideration of other creatures. In this case, admitting ecosystems’ right to water, leaving enough water for degrading our living level by reducing the amount of our usage is a more appropriate option. Thus, the water that we can consider for human use would than be the remaining amount after water is taken away by the eco-system. Such a new ownership of water could be a precondition for ethical principles concerning water diversion and water usage

The relationship of ocean science to medical bioethics is suggested by the concept of the “health of the oceans”. This phrase was the title of a UNEP Regional Seas report (GESAMP, 1982), produced by the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). The idea of monitoring the See ECCAP Working Group 1 report on Universalism and Human Values. health of the oceans was found in several reports in the 1970s, and the concept is now well established. The “normal/natural” state of the ocean is difficult to define scientifically, as it will be changing with time, however, we can certainly find impacts in the ocean’s health and natural state caused by anthropogenic factors. What nations call healthy also is modified with changes in demands for particular resources and services, capital, knowledge, techniques, and political will.

The GESAMP group continues to act as an international group monitoring the health of the oceans, in addition to local groups, and national authorities. It is a constructive way of thinking to use the word health, and we could consider the committee to be among the “Bioethics Committees” of the world in their mandate (Macer, 1994b).

2.6 Principle of Vicinity

It is evident that distribution of freshwater resources is uneven, both spatially and seasonally, challenging the physical access to reliable freshwater resources. In addition, there could be a legal barrier to access when upstream land is privately owned or under the jurisdiction of other country, so that the water resource might be appropriated. The principle of vicinity means that when there is a need for water, the first choice is to use proximate water resources. This principle gives people who live closer to water the precedence in using it than those who live farther away. But it should be pointed out that this precedence is not a privilege, instead, it is merely due to their favorable situation.

Those who are closer to water and have the convenience of using it, also have a special duty to use water in a manner that it will not affect legitimate interest of other users. These include prevention from contamination and no destruction of natural flow. There are also special duties for those who use water upstream from others, both for surface and ground water resources, including the obligation not to cause significant harm. It is much more a responsibility than a right, that is to say, if one person lives closer to water and has more convenience using it than others who live further, he also has greater duty to prevent it from pollution and destruction.

2.7 Principle of Frugality

The principle of frugality means that people in the vicinity of water should not use water exceeding their actual needs. People should only use the amount for basic living needs, for comfort and for maintaining the local ecosystem, so that water that is not used can be used for the communities in the other places lacking water, and kept for future generations. To balance water utilization, the government may develop policy to adjust the levels between the places with water surplus and those with deficiency.

2.8 Principle of Transaction

This principle means that the saved and surplus water from the allocated amount can be traded as a commodity in the water market either through water banks, water exchanges or transfers: whereas users have a private right to the use and ownership of water resources.⁴⁵ In the vast majority of Asia-Pacific countries, water resources are regarded as public property and except for household purposes, appropriation and use of water is often achieved through temporary permit granted by the state. Often, beneficial or multi-purpose uses are the key enabling condition which may alter the right holders. Nevertheless, there are practices when spring and mineral water are excluded from models for the basic amount for living and are often sold for commercial uses.

45 The common law system attempts to “separate” water from the land so to secure the public intervention. Such proponents are successful due to the practice of “industrial agriculture”, profitable businesses support high monetary income via water trade and this is true for North America and the Western Europe (Spain, France), but has failed in Chile and Argentina (according to FAO and World Bank). In Roman-German legal systems, mineral resources are still public property and with “smallholder farming”, “groundwater based pastoralism” or “arid agriculture” (FAO) that are heavily dependent on aquifers across arid/semi-arid areas in Central and Eastern Asia, it is very controversial. It is also not a case for rainfed agriculture like in the Mekong basin plus Bangladesh, South-Eastern parts of India and Southern China, while in other parts of this region rural livelihood directly depends on water.

2.9 Principle of Multiple and Beneficial Use of Water

Important characteristics of these two key issues, multiple and beneficial use, is their supplementary role to each other and therefore, they should be considered in connection only. With the application of an integrated approach in managing water resources a multiple use is necessary. Except human biological dependence on water, none of other uses of water has any privilege but are considered equal. On this ground, the qualifying criteria of beneficial use should be the multiple uses across different sectors. Thus, for example, it is beneficial to construct multiuse hydropower, which supports both irrigation and electricity generation, instead of single purpose one.

On the other hand, if the multiuse hydropower is in conflict with vital human needs for water, satisfaction of the higher use of water should be the criteria of beneficial use. However, this principle does not imply any favour towards the greatest number if there is a conflict between the high uses of water, in other words, statistical minorities can not be sacrificed in favour to the majority when it is about the vital human needs for water. In this case, this principle should be applied in conjunction with the principles of frugality and vicinity.

A model of practical water usage is proposed in Table 1. The first column illustrates the categories of water; the second column suggests the order of importance for various water uses; the third one denotes the water uses and the fourth one shows the concrete usage of water. The number in this column indicates the order of importance.

Table 1: Categories of Water and Their Different Usage

Categories of water	Order of importance	Usage of water	Concrete usage
General kind of Water	I	Eco-usage	Human usage
	II	Local usage	1. for living 2. for agriculture 3. for industry 4. for commercial
	III	External usage and water diversion	1. for living 2. for agriculture 3. for industry 4. for commercial
	IV	Others	For emergency
Special kind of water	For commercial usage		

2.10 Principle of Mandatory Application of Quantity and Quality Measures

Quantitative and qualitative assessment of the water resources demands that supplies and allocation is taken as both a scientific and ethical task. Accurate, reliable and updated data on water bodies will allow us to monitor the surveillance status of all water bodies in order to define the long term strategic policy to achieve or sustain the desired status of water condition that supports healthy environment. It will also provide operational responses, and intervene against the negative trends and changes, whenever pollution or other problems emerge. The quantitative status of ground water may have an impact on the ecological quality of surface waters and terrestrial ecosystems associated with that groundwater body. Therefore, the monitoring and controlling of water quantity, to ensure the balance between the extraction and recharge of groundwater, is important and complementary in securing the water quality. This principle also requires a neutral interpretation of water status reports and the availability and accessibility of such reports to the public. Measures, standards and indicators should be established not only for the objectives of human health but also to protect terrestrial ecosystems, wetlands and their habitats and species.

2.11 Principle of Compensation and User Pays

As users of nature, we must compensate nature. As users of other region's resources, we must compensate those people whose living standards have been degraded because of resources being transferred away from them. How to compensate nature is a philosophical question.

User pays is an important principle in modern water ethics when water is shifted from a common property or good to a privatized resource. As users of nature, humans should pay a royalty or fee for using a natural resources on the grounds that it is a limited resource and belongs to nobody in particular but to the public, state, international community and so on, as appropriate. If someone is using another locality's resources, compensation must be paid to the people there.

For the purpose of sustainable and rational utilization of scarce water resources and to encourage environmentally friendly attitudes, relevant authorities must conduct incentive measures, including appropriate water pricing policy. While setting the price, operational costs for the water service and the resource costs may both be recovered (full cost recovery). However, in the European Water Directives, it was decided not to support full cost recovery. Amongst factors behind that decision is the undermining of a human right to water. In the meantime, the water pricing policy should ensure equitable and affordable access to the safe drinking water, as a basic human right.

2.12 Principle of Polluter Pays

An application of this principle has been gradually extended from its initial purpose to mitigate environmental damages as a preventive tool.⁴⁶ From its initial purpose to mitigate environmental damages by making the polluter pay, application of this principle has gradually extended to cover the costs of pollution prevention as well. From cost benefit analyses, expenses that water polluter's service operators must pay to mitigate the pollution are often greater than benefits they derive from the polluting activity. Therefore, the polluter pays principle is a preventive tool, encouraging investment in facilities and measures that prevent, control and monitor pollution.

2.13 Principle of Participation

Public participation in water resources management is also important so that the interests of all groups, especially the poor and under-represented groups, can be fully represented. Through education, open publication of water data, community hearings, and internet fora and discussions, individuals and groups can be involved in water using and managing processes and present their needs and concerns.⁴⁷

2.14 Principle of Equitable and Reasonable Utilization

This customary principle of public international law on shared waters is based on the doctrine of limited territorial sovereignty, recognizing the community of interest of riparian states in a navigable river and "... becomes the basis of a common legal right, the essential features of which are the perfect equality of all riparian States in the use of the whole course of the river and the exclusion of any preferential privilege of any one riparian State in relation to the others".⁴⁸ This principle was recognized and endorsed in two major normative documents on shared waters, the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention 1992)⁴⁹ and the UN Convention on the Law of the Non-navigational Uses of International Watercourses (1997).

46 Refer to ECCAP WG7 chapter on the Polluter Pays concept.

47 Refer to ECCAP WG5 on community engagement, and Boonlong et al. (2011) theWG4 report on Representation and Who Decides.

48 Case relating to the territorial jurisdiction of the International Commission of the River Oder. Permanent Court of International Justice, Judgement No.16, September 1929. Publication of PCIJ, Series A, No 23, p.27. http://www.icj-cij.org/pcij/serie_A/A_23/74_Commission_internationale_de_l'Oder_Arret.pdf

49 Refer to the section above on water and conflict in chapter 1, and to Boonlong et al. (2011).

To make this principle practicable there needs to be a principle of quantified allocation, i.e., there is a need to measure the amount of need. To calculate the total amount of water needed in a region for domestic, agricultural, industrial, and commercial uses, is both an ethical and scientific issue. The Yellow River Committee is a typical Chinese Governmental Department that does this every year, namely the allocation of Yellow River water for the provinces along it.

When looking beyond the boundary of a country and viewing things globally, how to allocate water among countries with water shortages would be the burden of UN, and how to articulate principles regarding global water allocation is politically difficult.

2.15 Future Reflections on Water Ethics

There is a growing number of studies on applied water ethics, and more can be developed. This report is intended to stimulate these debates, and there are a number of discussions that could be developed. Edward Spence brought forward a meta-ethical framework. One meta-ethical framework to apply to the analysis of water ethics is based on the ethical theory of the American philosopher Alan Gewirth (1978; 1996). Gewirth's ethical theory, based on the supreme principle of morality, the Principle of Generic Consistency (PGC), shows that by virtue of being purposive agents (sufficient condition) we have prima-facie universal rights to freedom and well-being and those rights, being universal, must be respected by everyone. Because of their universality those rights are global. Moreover, those rights can be extended to include animals and the natural environment generally, and in a word, the whole ecosphere (Spence, 2006).

Given how essential and indispensable water is to the basic well-being of everyone on earth, humans, animals and the natural environment generally, it follows that access and use of water itself is a basic universal moral right. The distribution of water among its users is therefore an important and crucial universal ethical issue. The definition of moral agents is important for many theories of ethics. We can see an expanding moral community, from human beings (anthropocentric), to sentient animals (sentience-centric), to living organisms (bio-centric), to the environment (eco-centric) (Rai et al., 2010). These entities may have their intrinsic rights respected.

Actually Aldo Leopold's (1949) "the Land Ethic" had already expressed this concept, to extend the concept of community to include not only humans but also animals and plants as well as the inanimate components of the environment such as soil, rocks and water. Leopold collectively refers to animals, plants, soil, rocks and water as "land" and states that the land has a "right to continued existence in a natural state", in at least some places. Given the realities of the global water stress crisis, we need to adapt acceptable frameworks of environmental ethics to water resources management.

The expansion of "ethical community" from a human dimension to include an ecological dimension increases the difficulty of resolving ethical dilemmas, because the aggravation of the water scarcity issue will increase the conflict between human and ecological concerns. However, Leopold (1949) was enough of a realist to appreciate "The Land Ethic" was a concept before its time, and he compromised by recommending that ethics be considered along with economics and aesthetics.

3. Problems in Current Water Management – The Need for Water Ethics

3.1 Overview

In the book “Blue Planet Run” by Rick Smolan and Jennifer Erwitte (2006), the following facts and numbers have been listed: 1.1 billion people worldwide – 1 in every 6 – do not have access to clean water; 1.8 million children die every year from waterborne diseases – one every 15 seconds; 40 billion hours have been spent each year in Africa due to the need to collect and haul water; 5.3 billion – two-thirds of the world’s population – will suffer from water shortages by 2025.

In terms of the Asia and the Pacific region, the situation also needs improving. Asia often seems to be a green place, with heavy seasonal monsoons, tropical forests and lush rice fields. Although the situation is not as dire as that in Africa with its massive water shortages, more than 100 million people in South East Asia and the Pacific lack access to safe water and 185 million are without access to safe sanitation. As a result, an estimated 80,000 children die in this region each year from diarrhea caused by drinking dirty water or ingesting toilet germs. The Asian Development Bank said in a report entitled “Asian Water Development Outlook”, “If the present unsatisfactory trends continue, in one or two decades, Asian developing countries are likely to face and cope with a crisis on water quality management that is unprecedented in human history.”

The reasons behind the water crisis are various: climate change, rapid industrialisation and urbanisation, continuing population growth, and mismanagement of water resources. The Asian Development Bank emphasized that mismanagement of water resources would be one of the most important reasons for the “unprecedented” water crisis in Asian developing countries. Future water crises will not come because of actual physical scarcity of water, as many predict at present, instead, it would likely be sparked by continuing neglect of proper wastewater management practices. Water resource management can be defined as the implementation of best practices for effective quantitative and qualitative planning, development, distribution and utilization of water. These management practices should ensure a long-term stable and flexible water supply capacity to meet multi-purpose water utilization, at the same time keep a stable relationship between water using practices and their associated environmental consequences. However, water resource management problems can be seen at every stage of the development, utilization and management of water resources.

1) Physical Problems

Physical problems still exist in Asia and the Pacific region, for example, poorly developed water supply and wastewater treatment facilities, and incomplete water metering/monitoring systems.

2) Water Pricing Problems

Low water prices are one of the leading factors contributing to excessive water use in agriculture. The methods of determining the water price should be sufficient to meet operation and maintenance costs. Take China as an example, water pricing is generally based on irrigated land area or only based on the electricity used. The water prices applied for industrial and domestic uses do not reflect the actual cost of water either.

3) Organisational Problems

Most of the water conflicts are caused by organisational problems. “Integrated Water Resources Management” has not been fully implemented in most of Asia and the Pacific. In the case study 2 “A Brief Introduction to the Trans-jurisdictional Water Quality Issues in China”, the overlapped and distributed institutional organisations will be introduced.

3.2 Pollution

Human activity is the main cause of ecosystem changes in the world. We can see the effects of human activity everywhere in the world, from atmosphere to oceans, from poles to the tropics and from the depths of the oceans to the highest mountains. The concept of stewardship is required to maintain a sustainable way of life, and a healthy world. Environmental problems may be able to be traced back to the beginning of civilization, but are getting worse with the global scale of air and water pollution, the introduction of new chemicals, and the still growing human population.

Much damage is unintended and unforeseen, such as the acidification of lakes in Scandinavia and Canada from the acid rain from the burning of carbon fuels. Restrictions on the release of sulfur and nitrous oxides have reduced the level of these acid residues, showing that pollution can be controlled. While sulfur dioxide emissions have fallen, the acidity of rain has actually remained high in polluted areas, due to parallel reduction in the basic cations (contributed by particulate matter) in the atmosphere that neutralize acid rain (Hedin et al., 1994). There still needs to be further reduction in pollution if acid rain is to be avoided. We can expect this issue to continue as more coal-based energy plants are used in countries with growing energy needs, and with concerns about other sources of energy and national energy security.

Pollution could be defined in many ways. One definition is that pollution is the appearance of some environmental quality for which the exposed community has inadequate information and is thus incapable of an appropriate response (Cairns and Lanza, 1972). Pollution can also be defined as the introduction by humans, directly or indirectly, of substances or energy into the environment resulting in deleterious effects as harm to living resources, hazards to human health, or hindrance to particular activities. The oldest method of pollution “control” that has been used is the principle of infinite dilution of wastes. Water is historically one of the substances in which wastes are diluted, perhaps why it has the associated spiritual meaning of holiness and purity. Increased industrialisation usually means increased production of wastes and potential pollutants. In the ocean, substances including carbon dioxide, cadmium, arsenic, lead and mercury are all disposed of in greater quantities than the natural fluxes can cope with. Under conditions of stress the species diversity of communities is greatly reduced, and the result is that the system becomes much less stable (Odum, 1971). The most effective control is to eliminate production of the pollution, at least to decrease the levels to what natural cycles can cope with. If it is not possible, treatment of the pollutants and/or the consequences is necessary in many cases before substances suitable for recycling or dilution can be released.

Many pollutants threaten water supplies, but the most widespread, especially in underdeveloped countries, is the discharge of raw sewage into natural waters; this method of sewage disposal is the most common method in underdeveloped countries, but also is prevalent in quasi-developed countries. Sewage, sludge, garbage and even toxic pollutants are all dumped into the water. Treated sewage forms sludge, which may be placed in landfills, spread out on land, incinerated or dumped at sea. In addition to sewage, nonpoint source pollution such as agricultural runoff is a significant source of pollution in some parts of the world, along with urban storm water runoff and chemical wastes dumped by industries. Wastes include municipal sewage, animal wastes and agricultural fertiliser runoff. To solve this problem these nutrients must be removed before such wastes are released into the water. In 1970, the animal population in the USA was estimated to be 564 million head, which produce the waste equivalent to 2 billion people. The animals in intensive animal production facilities are also associated with high energy use.⁵⁰ Water tends to be the ultimate sump for waste, and we are dependent upon the natural ability of ecosystems to cleanse waste and produce clean water. It is ironic that the economic benefits of natural actions are usually of no value in economic equations.

Eutrophication occurs in waters that have enriched nutrient content, which support excessive algal photosynthesis. Increased algae growth results in oxygen depleted water which is detrimental to the health of fish. Increased temperature due to climate change and waste water from industry or cooling water from energy power plants, lowers the oxygen concentration of water, which makes the ecosystem more susceptible to stress.

50 See ECCAP WG13 report.

The effects of pollution can be immediate, such as the sudden death of a large number of fish, or more prolonged such as defective development and reproduction. PCBs were widely used in many industries before their toxicity was understood, particularly as insulators in electricity systems. The level of PCBs in some marine animals exceeds the health standards set by some national authorities, but there are no known cases of human sickness from the consumption of animals and fish with these substances. However, seals may have suffered reproductive damage as a consequence of the level of PCBs (GESAMP, 1982, 1990).

At present, contamination of groundwater by arsenic is an important issue. Countries where arsenic contamination of groundwater has so far been reported include Poland, Hungary, Spain, Sweden, Finland, UK, Germany, Romania, Bulgaria, Greece, Switzerland (Europe), Taiwan, Sri Lanka, China, Bangladesh, India, Cambodia, Lao PDR, Thailand, Myanmar, Nepal, Iran, Viet Nam, Japan, Philippines, Afghanistan, Pakistan (Asia), Brazil, Argentina, Chile (S. America), USA, Canada, Mexico (N. America), Australia, New Zealand (Australasia), Egypt and Ghana (Africa). This list is regularly getting extended as newer areas with arsenic contamination are being identified all over the world.

Arsenic is a metalloid in the Group V A of the periodic table of elements. Besides being used to harden bronze in the Middle East around 3,000 years ago, as a dye by the Egyptians, Greeks and Romans, and as a potent poison to kill enemies at least since the days of the Roman Empire, arsenic compounds also found their use as pesticides since around the 15th century. 'Paris Green', the popular trade name of a copper-arsenic complex has been classified by WHO as a "Highly Hazardous" Pesticide of Class IB.

Arsenic was detected in groundwater, probably for the first time, as early as in 1917 in Argentina, although the first skin lesions and cancer linked to arsenic exposure were reported in 1955, again from the same country. Presence of this metalloid in groundwater was next detected in New Zealand in 1939 and subsequently in Chile and Mexico in 1950-'60s, in Canada and USA in the '70s, and in several European countries such as Finland, Romania, Greece and Switzerland in the '90s and in the present millennium. In Asia, the problem of arsenic contamination of groundwater first surfaced in Taiwan in 1961, followed by a host of nations such as India, Bangladesh, China (Inner Mongolia), Iran, Cambodia, Japan, Myanmar, Nepal, Viet Nam, Pakistan, Afghanistan and Sri Lanka.

In all these Asian countries, arsenic contamination originates from natural sources. Of the affected countries in Asia, arsenic contamination has assumed menacing proportions in the Bengal Basin or Ganga-Meghna-Brahmaputra Basin of India and Bangladesh, where more than 50 million people are at risk. It is now known that 50 out of 64 districts in Bangladesh and 9 out of 18 districts in West Bengal have groundwater arsenic levels higher than the Indian and Bangladesh national standards of 50 µg/l or more (Rahman et al., 2002). At this standard of safety, an estimated 27 million people in Bangladesh and 6 million in adjoining West Bengal state of India are at risk. The World Health Organization has described the situation in Bangladesh as "the largest poisoning of a population in history". Viet Nam also faces considerable arsenic threat as several million people may be at risk of consuming arsenic-contaminated groundwater in the Red River Basin near Hanoi (Mukherjee et al., 2006).

One of the earliest symptoms of arsenic poisoning is diffuse melanosis that is darkening of skin either throughout the body or on the palms of the hand. At a later stage, keratosis (thickening of skin) develops, which indicates moderate to severe toxicity. Most dangerous, of course, is the risk of suffering from cancer which has been estimated to be around 13 per 1,000 individuals for those consuming 1 litre of water per day with 50 µg/l arsenic or more (Anawar et al., 2002). The cancers include squamous and basal cell carcinoma, cancers of lung, uterus, bladder, gastrointestinal and genitourinary tract, and other sites. Arsenic can also cause neurotoxicity, can cross placental barrier, affecting the growing embryo, and has also been shown to be a genotoxic carcinogen.

The ethical issues pertaining to arsenic contamination in West Bengal, India, as well as Bangladesh pivot around the decision to access groundwater as a drinking water source in spite of the fact that this region experiences heavy rainfall and has ample surface water sources. The impact of arsenic poisoning in this area also brings to fore the ethical questions concerning public health ethics principles such as social utility, respect for human dignity, social justice and efficiency.

3.3 Water Governance⁵¹

3.3.1 General Principles

We should review the different instruments that constitute water regulation and management practice in Asia and the Pacific, including analysis of interaction and interdependence between the regulation and its impacts in uses of water.

An integrated water resource management (IWRM) is the most recognized approach in facilitating water resources, enabling both multiple uses of water for agricultural, irrigation and energy production purposes and ecosystem requirements. This is often referred to as a practical tool or process in water management, its multifunctional role is to sustain and support human health, ecosystem and socio-economic stability. Broader understanding of the multifunctional role of water, freshwater stress and its increasing value as a limited natural resource, and the multi-dimensional focus of the development agenda are underlying factors that have had a tremendous influence in institutional, legal and policy aspects of water management. Until the application of integrated water resource management (IWRM) a vertically hierarchical structure based on 'administrative-command' decision was the typical way in dealing with water sector. In addition to its vertical hierarchy, the structure was highly fragmented into the sectors (sanitation by health department, water quality by environmental department, irrigation by agricultural department, canals by the department of infrastructure, hydropower by energy department, etc., and as an outcome, fragmented and uncoordinated policies and regulations.

To some extent, this system was a reflection of mega programmes on engineering works to construct massive irrigation systems and large scale reservoirs, municipal and industrial water supply infrastructures. In Asia, large dam construction significantly increased in the 1960s and reached its peak in the 1970s and 1980s (ICOLD), similarly, the size of irrigated area more than doubled from 1970 to 1995 (IWMI-FAO). Irrigation has been a dominant theme in India's planning since the beginning of the era of five year plans. An area under irrigation increased at the rate of 0.7 million hectares per year during the first plan (1951-1956), and the rate accelerated to 2.5 million hectares per year during the sixth plan.⁵²

Despite differences of immediate goals and objectives, poverty reduction and food security, water supply and sanitation or support of rural livelihoods, the water sector regulation could be distinguished in two basic models: supply driven and demand driven.

Such a division works poorly for distributed water handling in agriculture, industry, and domestically, although it can be useful for big water projects and point sources of pollution. It is difficult to control diffuse sources, source abatement, cleaner production and cleaner products by centralised means. Historically, water regulation resources management, where it existed, was based on a "command and control" approach. More recently, "economic instruments" have been implemented. Equity in availability and applicability of water is the important ethical issue at all levels, from local community to the global scale.

According to Harremoes (1996, 1997), water resources management has developed to encompass more instruments and more philosophical issues, as illustrated by the following list:

- Command and control: laws, directives, standards, norms and codes
- Economic instruments: taxes, levies, subsidies
- Consensual approach: hearings, consensus conferences, stakeholder participation
- Ethical approaches: ethics, morals, attitudes

51 Water governance can be defined as the sum of organizations, policy instruments, financing mechanisms, rules, procedures and norms that regulate the water sector. Adopted from "Global Environmental Governance: A Reform Agenda," ISSD and Ministry of Foreign Affairs of Denmark at <http://www.iisd.org/pdf/2006/geg.pdf>

52 Venkatta Reddy, M. 1991. *Command area development-problems and prospects of irrigation in Malaphrabha Ayacut.*

That is where economic incentives have come into the picture. Environmental economics has become a discipline in its own right. However, for some values that cannot be measured by economic levers and numbered by price, this method loses its advantage. In fact, we all affect the environment by our daily behaviour. We have reached the stage in environmental abatement where the success of policies depends on daily decisions and activities of the individual, local communities and companies as much as on centralized rules and regulations. The ethical values and the associated attitude and behaviour are the foundation of a society that makes it work. Such values have to be addressed “at source”, by bottom-up approaches. Development of the ethical value of environment to the consumer, to public utilities and to industry has the potential as a far more effective, cheaper and acceptable means of “regulation”, as a supplement to a society. The difficulty is time. The driving forces and pressures on the environment change rapidly, while changes to ethical values are inherently slow in development and reactive in response, as opposed to a needed proactive paradigm. “Over-regulation” is an understandable response to rapidly developing conflicts and crises, but the long-term aspects of ethics and values should not be disregarded.

As we see the rise of mega-cities, some municipalities have more persons than entire countries. These cities tend to be able to buy water from the economically poorer rural areas, while also having the advantages of economy of scale to enhance water quality compared to smaller cities, leading to gaps in the water quality and quantity people can access.

3.3.2 Trans-jurisdictional water quality issues in China

Trans-jurisdictional water pollution has become a very serious issue in China. In some cases, it even caused disputes that had to go to the highest levels of the central government for resolution. Typical examples of trans-jurisdictional water pollution in China include: pollution from upstream administrative regions (e.g. provinces, municipalities and counties) deteriorates the water quality of the water bodies in the downstream ones; and several administrative regions discharge pollutants into one large lake.

The increasing trans-jurisdictional water quality issues in China are rooted in its legal and institutional framework for water governance. In addition, the lack of a good water ethics framework aggravates the problem. Thus, to tackle trans-jurisdictional water quality issues in China, an improved legal and institutional framework and new water ethic are necessary. Let us consider an example.

In mid 1990s, the printing and dyeing industries in Shengze (a town in Wujiang City, Jiangsu Province) began to boom. These industries generated a great amount of high-pollution wastewater. Due to the local protectionism, the effluents were not rigorously regulated, and severely contaminated rivers which drain into Jiaxing City (in Zhejiang Province). The pollution dramatically deteriorated the water quality in Jiaxing, which posed great health risk to its residents (more cancer cases had been reported among the population that accessed the contaminated water), and caused significant damage to its agriculture and fishery. Due to the lack of economic incentive, effective regulation enforcement and dispute resolution, the pollution as well as the dispute it caused continued.

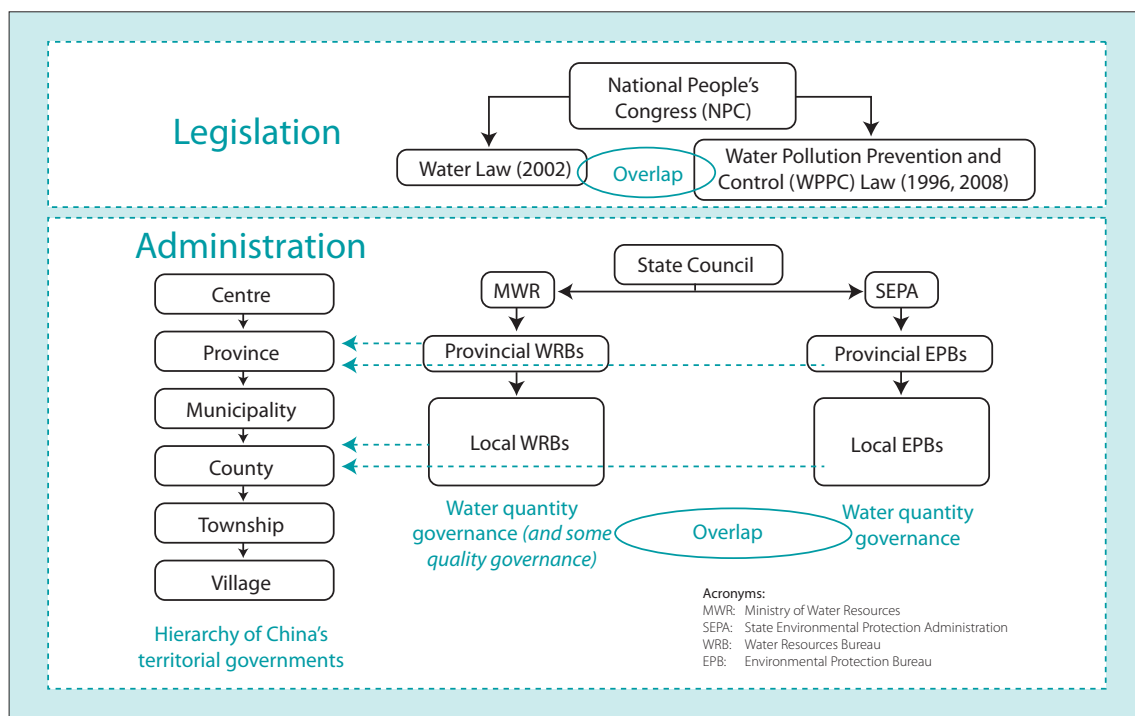
Eventually, the residents decided to protect themselves in their own way. On November 22, 2001, the furious residents in Jiaxing built a dam with sunken ships and blocked the water course of the Ma Xi Gang River. This action was in serious violation of multiple laws and regulations, and got immediate response from the State Council and the Ministry of Water Resources (MWR) and State Environmental Protection Administration (SEPA). With the coordination of the central government, an agreement was finally reached among the two municipalities, as well as the two ministries (MWR and SEPA). Significant efforts were made to persuade the residents, since they were not willing to remove the dam until they saw the water quality improvement. Measures of pollution control were started immediately after the coordination meeting, and water quality compliance first achieved on January 11, 2002.

This story has been reported in Chinese mass media. After the event, the effluent control was improved, but the water pollution remains a problem since illicit discharges occur from time to time, and no effective measures were available to fully address the trans-jurisdiction water quality issue.

As said before, trans-jurisdictional water quality issues in China are rooted in its legal and institutional system for water governance. Figure 6 depicts the system. On the legislation side, China's National People's Congress (NPC) established two major laws for water governance: Water Law (2002) and Water Pollution Prevention & Control (WPPC) Law (1984, amended twice in 1996 and 2008). Unfortunately, there are overlaps between these two laws, especially regarding water quality management, which causes many problems in regulatory practices.

On the administration side, China has a hierarchy system of territorial government. The State Council is the central administration unit which directs MWR and SEPA. MWR and SEPA work under the Water Law and WPPC Law, respectively. The overlaps of the two laws resulted in the conflicts of the two ministries in water governance, especially when water quality is concerned. At the province, municipality and county levels, water resources bureaus (WRBs) and environmental protection bureaus (EPBs) are counterparts of MWR and SEPA, respectively. However, as an institutional setting, a local bureau only reports its corresponding local government, not the bureaus or ministry above it. A higher bureau has no mandatory power over a lower one. Furthermore, a bureau is financially supported by the local government whose budget mostly depends on its local GDP. All these tend to promote local protectionism. In addition, WRBs and EPBs have the similar conflicts as those at the central level.

Figure 6: Water Governance System in China



According to international experience, River Basin Organizations (RBOs) are a general solution to addressing trans-jurisdictional water quality problems. In fact, China already has seven major RBOs, supervised by MWR, including: Yangtze River Conservancy Commission, Yellow River Conservancy Commission, Huaihe River Conservancy Commission, Haihe River Conservancy Commission, Pearl River Conservancy Commission, Songliao River Conservancy Commission and Taihu Lake Basin Authority. These organizations have been more or less effective in trans-jurisdiction water governance with regards to quantity, but not quality. We can use the Yellow River Conservancy Commission (YRCC) as an example, as briefly introduced below.

From the early 1970s to 1999, zero-flow events occurred almost every year in the downstream of the Yellow River. A centralized water allocation system was then started from 1999 for the Basin, administrated by YRCC. Some important measures include: integrated basin level water resources assessment and planning; water right allocation to provinces in the basin and downwards to municipality and county levels; and a strict monitoring system (e.g. monitors at water intakes, meters in the pipe system, etc.). These measures have been effectively enforced, and no zero-flow events occurred since 2000.

YRCC has a subdivision called Yellow River Basin Water Resources Protection Bureau (YRBWRPB) which connects YRCC with local WRBs and EPBs. YRCC's water quality management function is mainly in this subdivision. Nevertheless, in this basin, many trans-jurisdictional water quality problems remain unsolved. YRCC and its YRBWRPB are directly led by MWR. Although YRBWRPB takes advice from SEPA, it has little jurisdiction for pollution control or trans-jurisdictional pollution management. In addition, in YRCC and its YRBWRPB, there is no representation by basin stakeholders.

The main causes of significant trans-jurisdictional water quality issues in China can be summarized as below:

- The overlap of the WPPC Law and the Water Law leading to the overlap of institutional responsibilities of MWR and SEPA and their local counterparts;
- The failure to capture in the laws the necessity for integrated water quantity and quality management and control;
- The failure of local authorities to enforce the existing laws and to implement administrative decisions. Local protectionism is one of the major causes for trans-jurisdictional water quality problems;
- The lack of transparency in the decision-making process for water quality management, insufficient public participation and information disclosure, poor communication, and lack of involvement of stakeholders in river basin organizations;
- Improper basin-wide planning and management;
- Ad hoc measures for trans-jurisdictional water quality governance and dispute resolution.

To better address the trans-jurisdictional problems, the key is to create a mechanism, not to solve the problems case by case. General suggestions may include:

- Enforcing compliance;
- Improving monitoring system;
- Conducting legal and institutional reforms (legislation, administration system, judicial procedure, etc);
- Promoting data and information sharing;
- Performing integrated basin level management and planning;
- Utilizing market force;
- Establishing emergency response and reporting system.

In addition, original scientific studies are highly needed to provide adequate methodology and tools for trans-jurisdictional water quality management. Last but not least, a good water ethic should be established in China as one important supplement to regulations and economic incentives. Nevertheless, water ethics is a very new topic in China, further studies and discussions are in urgent need in this field.

3.3.3 Water Ethics Reflections in Eucalyptus Planting

Desertification and its consequence, famine, have already caused the death of millions of people in the world, including in Ethiopia. In India, starvation deaths owing to water scarcity are a recurrent phenomenon in Rajasthan, Madhya Pradesh, and Orissa. Since ancient times societies have known that forests are the best insurance against desertification and famine. However, a reductionist version of this response to desertification is itself a prescription for desertification.

There have been criticisms of the World Food Programme and FAO about planting eucalyptus.⁵³ Under the social forestry schemes for ecological repair, the World Bank, SIDA and USAID have persuaded India to putting some farmlands under eucalyptus. The ecological audit of eucalyptus plantations reveals that it involves heavy economic costs through the destruction of the hydrological stability and soil productivity in the following ways:

53 <http://unu.edu/unupress/unupbooks/uu05se/uu05se0i.htm>

First, in regions which have water scarcity, the high water intake of eucalyptus destroys the natural processes that replenish soil moisture and recharge the sources of underground water, turning the region into a completely arid zone. Moreover, eucalyptus damages the innate allelomorphous capacity of all other plants, seriously depleting the gene pool. The process initiated by large-scale cultivation of eucalyptus in water-scarce regions therefore leads inexorably to desertification.

Second, on fertile agricultural lands, eucalyptus, when planted and harvested in short rotation, heavily diminishes soil nutrients, destroying the soil's capacity for biological productivity. Moreover, eucalyptus destroys the environment for soil fauna that are at once 'factories' for reproducing soil fertility, and efficient 'machines' for maintaining the soil structure.

Eucalyptus emerged as a candidate for all kinds of afforestation programmes during the 1960s because it is a fast growing species. This belief was, however, challenged and it was shown that many indigenous species have higher growth rates than eucalyptus.

3.4 Access Rights to Water in Practice

In 1977, the UN Water Conference in Mar del Plata, Argentina, proclaimed that "All peoples... have the right to have access to drinking water in quantities and of a quality equal to their basic needs". Later in 1980, with reference to Mar del Plata Action Plan, 1981-1990 was proclaimed as an International Drinking Water and Sanitation Decade by UN Resolution 35/18. Those reflect a human-centric viewpoint, i.e., anthropocentric ethics.

Beside the dilemma on how to balance conflicting users of water,⁵⁴ which is the issue in international shared water, the domestic regulation of competing uses of water is another important ethical issue. Annually increasing demand of concurrent uses of water for the domestic, municipal, agricultural, industrial, recreational and environmental purposes are highly competitive by nature and contrary by character.

Inside nations there are growing disputes. By installing metering facilities and measuring the supplied/used water amounts, we can record and track water utilization, which is a prerequisite for scientific and ethical management of finite water resources. For example, the Yellow River Committee is a Chinese governmental department that is in charge of the quantification and allocation of the Yellow River's water for the adjacent provinces along it. This can check environmental "health" for better policy responses in addition to the safety and sanitation of the drinking water. Water metering is a system to collect service fees for the used water or to control individual behavior to minimize water use, while knowledge of actual water resource will provide us a clear indication of the socio-economic value of water.

In many developing countries the extraction of groundwater is as if it is part of the land and any land owner can extract groundwater inside his/her plot without permits or hindrances for domestic use, irrigation or for selling the drinking water. The development of this type of unregulated extraction of common resources must be discussed under ethical use of public property even though it is within one's own plot of land/town/division and/or country. The groundwater aquifers often transcend the political boundaries of the countries and it is in fact transboundary water in many areas.

The classical issues in water access rights such as the right to withdraw groundwater, the conflict among users at the upstream and downstream of rivers, the potential impact of mega water diversion projects, and transboundary water conflicts, were also discussed above in section 1.5⁵⁵. In 1966, the International Law Association approved a draft set of rules regarding equitable use of international river waters (Starke, 1987; Schachter, 1977). The following points are quite relevant (Islam, 2008):

- 1) Water utilisation of the river basin at present and in the past has to be considered;
- 2) The extent to which the population of each basin state is dependent on the river water has to be taken into account;

⁵⁴ Refer also to the section 1.5. on Water and Conflict.

⁵⁵ Refer also to the section 3.3.2

- 3) Research on the comparative costs of alternative means to meet the economic and social needs of the people of the basin states should be carried out;
- 4) Care must be taken to avoid unnecessary wastage when utilising river water;
- 5) Availability of other resources has to be considered;
- 6) The extent to which compensating one or more of the co-basin states for adjusting conflicting uses has to be evaluated;
- 7) The extent to which the necessities of a riparian state can be met without causing substantial harm to a co-basin state has to be taken into consideration (Schachter, 1977).

During the late 19th century, the Harmonie Doctrine, according to which a state has the absolute right to use the water of the rivers flowing through its territory as it wishes, without considering its effects on other states was quite influential. However, this doctrine has never been followed. Rather, there are hundreds of examples of peaceful water sharing between two or more riparian states through which a river flows, as discussed in section 1.5.

As an example, in 1909 the Boundary Water Treaty between the US and Canada was established. Article 2 of the treaty reserved for each side unrestricted territorial control over the boundary water within their territory and available legal remedies. However, under the 1961 Columbia River Treaty, both the US and Canada adhered to the principle of shared enjoyment and optimum utilisation of common waters through international cooperation. They have jointly undertaken comprehensive and integrated regional planning for the development of the Columbia watershed water resources (The UN L. Series, 1963). Even in extreme cases of common water disputes, accountability of claimants and recognition of mutual rights are apparent.⁵⁶

On the question of the use of international drainage basin water, there exists a persistent pattern of state practice and community expectations of shared competence and control. This pattern is reflected in the recurrence of identical provisions in a significant number of treaty practices of basin states all over the world. These treaties specify, in one way or other, the freedom of action of the signatory basin states.

The multiplicity of such treaties is the clear evidence that basin states have felt an obligation to work on the basis of mutuality and cooperation in the use of their common waters. The number of basin states which are parties to these treaties, their spread both over time and geography, and the fact that, "...in these treaties similar problems are resolved in similar ways, make of these treaties and negotiations persuasive evidence of law creating international practice" (Islam, 1987). There is therefore extensive experience that can be used for policy analysis, and to resolve outstanding conflicts, such as sovereignty claims over the Teesta River between India and Bangladesh.

China's current mega South-to-North Water Diversion Project will be discussed in the third case study and the ethical considerations will then be illustrated in the fourth case study. In some sense it is politically easier because the diversions lie within one country, but certainly bring many communities into potential conflict. In South East Asia the Mekong River Basin is the site of some ongoing international strategies for water management, given that the river is being used for hydroelectricity production and agricultural use.⁵⁷ In cases such as the Mekong, a number of different services are in competition with each other, such as electricity production, irrigation, flood production, fisheries and industrial uses (Resurrecion et al., 2008).

56 An example is the sharing of the Jordan River water between Jordan and Israel. Both parties had either implemented or taken initiatives to utilise the Jordan waters unilaterally. Although the initial efforts for negotiation by an envoy of President Eisenhower's Special Ambassador Eric Jonston had failed due to political reasons, eventually both parties came to recognize that each had rights to a reasonable share of the Jordan River water and that neither party should unilaterally interfere with its counterpart's share (Islam, 2008).

Through the treaty between Egypt and the Sudan (1926), Egypt got a reasonable share of the Nile water by cooperating in building a reservoir at the upstream, within the territory of Sudan. This case is an example, proving that "mutual confidence and cooperation in all matters concerning the river and its waters" are of much greater importance than that of arbitral tribunals, legal rules and expert commissions joined together (Smith, 1931).

57 Refer to ECCAP WG4 chapter 6 for an extensive analysis of the Yunnan Lancan cascade and hydroelectric electricity development.

The bioethical issue is not only providing access to water, but also we should try to avoid harm caused by pollution or reduced access to water. We need to understand the consequences of direct and indirect effects of our action in a complex ecosystem.

4. Policy Options and Construction of Practical Water Ethics

4.1 Lifestyle Change and Motivation

From the above review of the practices in water resource policy and management, we can conclude that neither scientific approaches alone nor legal regulation or economic incentives are able to fully address and respect an increasing demand among competing uses and users in access to water resources. Therefore, and in course of a growing preference in water policy regulation and management to the expansion of water infrastructure and supply, water ethics could be well suited both as an end and means in motivating and encouraging environmentally friendly behavior and ecological awareness, and also supporting policy making process and policy itself.

The distribution of water must, all things being equal, be made on the basis of an equitable division of water resources among all its relevant users. However, conflicts in the division of water resources will inevitably arise among the competing users. Those conflicts must be resolved within the relevant and particular contexts of sustainability, based on the basic principle that the rights of those for whom water is a matter of sustaining life itself (a primary right), as contrasted, for example, to sustaining a level of profitability for some industries (a secondary right), must be given priority. With no intention to contribute in meta-ethical discussion but to seek for a ground in practical water ethics and lifestyle change, which we believe is a long-term project, sustained efforts are needed at all levels, from the local community to the global scale as well as combined contribution from different views of value. Indeed, the anthropocentric view of nature's value, whatever the motivation or reason behind, is still instrumental in protection of aquatic ecosystem because we need to consider basic human rights to live in a healthy environment and to access drinking water.

4.2 Valuing Water

A prerequisite for sustainable water resource utilization and management is an objective assessment of the total amount of available (quantity) and accessible water. The available water here means the water with certain quality that can be utilized for a certain use, and various scientific methods are available for water resources assessment, including field survey, remote sensing, numerical models, etc. The information from the assessment could guide and form the basis in economic value of water and provide data for detailed planning and allocation of water resources as well as for transaction of water as a market commodity. Furthermore, and in light of growing concern over the climate change and its negative impacts on human well-being, the economic value of water and wetland ecosystems has been receiving more understanding and recognition. This provisional service of an ecosystem is well conceptualized in the Millennium Ecosystem Assessment report. However, we have to admit that the value of the water and aquatic ecosystem is predominantly based on scientific understanding of the ecosystem and its functions.

Due to its essential quality to sustain the human life, water in the majority of Asian and Pacific countries is something citizens are entitled to as a public or state property. As a public good, water consumption follows principles of non-rivalry and non-excludability in a sense that more consumption by one person in no way shall reduce the physical amount available for others (Hanemann, 2005). Legally, everybody and all should enjoy in common. However, in domestic laws there is no clear prescription regarding the quantitative value of water that could be considered as essential for human survival, instead, there is

a hierarchy among different uses of water wherein in some countries living use of water is treated as the highest priority. Article 10 of the UN Watercourses Convention requires that in the event of conflict between uses of an international watercourse, due regard should be given to the requirements of “vital human needs”.

A Statement of Understanding issued by the Working Group clarified that in determining vital human needs, “special attention is to be paid to providing sufficient water to sustain human life, including both drinking water and water required for production of food in order to prevent starvation” (Salman and Salman, 2003). From this perspective, considering the residential water supply and the ways in which the water is used, the notion of essentialness is not applicable at all.

In 1998 at the UNESCO Conference on World Water Resources at the Beginning of the 21st Century, some participants from Islamic countries rejected economic models of water that were adopted in the 1992 International Conference on Water and the Environment held in Dublin, citing the Koran that characterizes water as a free gift of God. For example in the Dublin conference the fourth guiding principle reads: “Water has an economic value in all its competing uses and should be recognized as an economic good. Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price.”

Further conferences attempted to resolve this issue, discussing Islamic perspectives, and concluding that the fourth principle was consistent with Islam (Priscolli et al., 2004). However, there is hot discussion regardless of religion about the privatization of water and its impact on economic scarcity. Policies need to be developed and institutionalized to take account of the ethics of financing models at all levels of water access (Teniere-Buchot, 2004).

The accounting and audit for water use needs to be transparent and open, and we could suggest people become aware of their “water fingerprint” in the same way as the term “carbon fingerprint” has become popular.

4.3 An Overlapping Kind of Water Ownership⁵⁸

Let us consider the case of water diversion in China, a situation not so different to that emerging in many cities in the world. The residents of Beijing drink water diverted and transferred from the Danjiangkou Reservoir in Henan and Hubei provinces, about 1,300 kilometers south of Beijing. The two provinces are not the region governed by Beijing municipal government, neither are the inhabitants close to the reservoir. Politically speaking, the local government of Beijing city does not have any legal power to divert and transfer water from a place other than its governing region, so the water diversion from South to North is a project at state level, planned by the Chinese central government and carried out by a special committee nominated by it. But ethically speaking, how can we do so? What ethical principles are involved in such kind of activity?

In modern political theory, a country’s boundary is also the confine of its inhabitants’ right. For example, we can’t make a claim to any property existing in another country except if we have paid for it properly. So a citizen of a country cannot use another country’s water except by paying money, by agreement or something like forceful occupation, just as what is happening now in the Middle East between Israel and Palestine, which is a much more complicated issue.

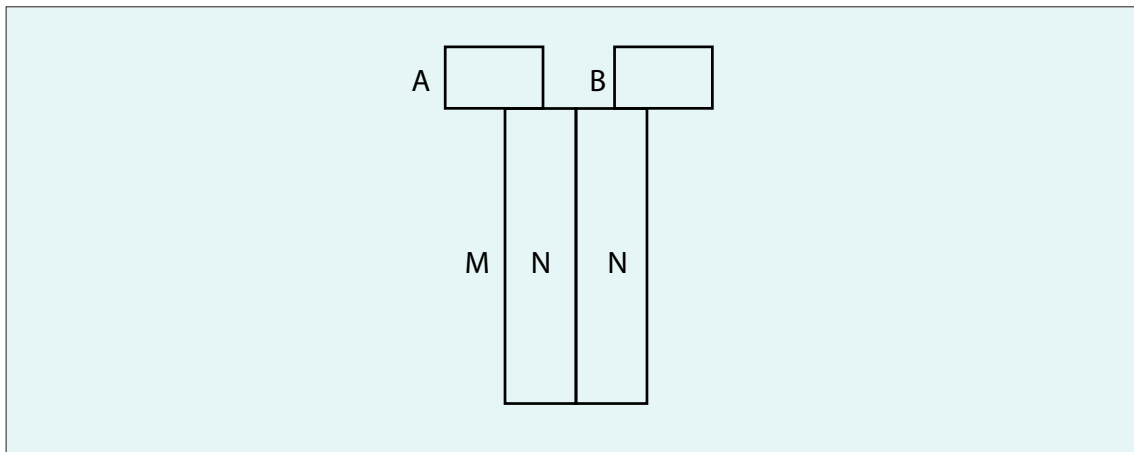
Just as any other kind of natural resources, water is not distributed geographically evenly within a country’s boundary. In some places, water, both surface water and groundwater, is in such an abundant state that their inhabitants are constantly being faced with the danger of flood; but on the contrary, there are also places that are in such an urgent scarcity of water that people cannot even maintain their daily life. Such is the real situation in contemporary China. Statistically, the average water possession per person in Northern China is just one third of that in Southern China, big northern cities such as Beijing,

58 This section was written by Qingju Qiao, Department of Philosophy, Nankai University, Tianjin, China.

Tianjin, etc. and a large number of northern rural areas are in serious shortage of water. Under the same sky and within the same boundary, such an uneven situation cannot be thought normal for a country's balancing development, especially of just and equal for every citizen. To divert water from one place to another we must ethically presume that a country's water is owned by all its citizens, every one of its citizens has an equal right to water in his country everywhere. This is the ethical justification for water diversion, consequently there emerge every kind of water adjust and diversion projects in China, of which the project of diverting water from south to north is the most famous one.

When saying that something is owned by a group of people, we would think that it can be divided into equal or unequal parts as many as the numbers in the group. For example, a company belongs to all its shareholders; everyone knows how many shares he owns, and can sell or buy others' shares. This kind of ownership can be called "shareholder's type of ownership". Contrarily, the type of water ownership is stemmed out from and is a part of one's fundamental human rights, it can't be divided into parts and be given to any one of the group, otherwise it would result in the deprivation of human rights. Thus, for understanding the human rights to water, a new kind of ownership model is brought forward. As shown in Figure 7, supposing that A and B are two persons or two family or juridical persons, M and N are one road or one property that can be divided into parts.

Figure 7: Diagram of a New Ownership Model⁵⁹



We assume A and B together own the road MN, which can be divided into part M and part N. By the shareholder's kind of ownership, A owns M, B owns N, A can buy or by any other means get N from B and vice versa. This will result in a situation that there is no road for B or contrarily no road for A, neither of the case could be called just and equal. Thus, we would look forward to a new kind of ownership, which is an overlap type of ownership. By this type of ownership, A's right is identified with M plus N ($A=M+N$) and so is B's right, therefore every inch of M and N is simultaneously owned both by A and B. Cutting any part of M or N would surely be a damage of right not only to A but also to B. If A and B stand for all the citizens of a country, including its future generation, and M and N are all the water resources of the country, this would become the model of an overlap type of water ownership. That is to say, everyone has the same right to all the water within the country's boundary. This model of right, based on the equality and justice, is the profound principle that makes water diversion ethically acceptable. It might be pointed out that as the most fundamental principle concerning human right to water, it can, in contemporary China, only be guaranteed by the central government. Furthermore, because it is an abstract concept, if making this take actual effect in real life, we must go a step further to solidify it by principles concerning actual water usage.

59 Source, Qingju Qiao, Department of Philosophy, Nankai University, Tianjin, China.

4.4 Ensuring Water Quality

There is an ethical obligation on water providers to ensure adequate water quality. The obligation to protect water from pollution is shared by all who contribute to pollution. Minimal water residue levels are one method to protect water quality, and WHO has set guidelines based on human health. Although one attitude that is displayed by some jurisdictions when faced with challenging standards is that countries and municipalities can give up on meeting these, therefore standards need to be based on a solid ethical framework for protection of both environment and human health, not only on pragmatism.

International agreements already include ethical principles to prevent pollution. Trondalen and Munasinghe (2004) argued that the Polluter Pays Principle, the Precautionary Principle, the Principle of national responsibility for transboundary pollution, and the Principle of institutionalized Environmental Impact Assessment are all embedded in international environmental conventions such as the Basel Convention and the United Nations Framework Convention on Climate Change.

While developing and/or applying certain standards, for the purpose of human health, sanitation or environmental status, we should note that they are defining the mandatory minimum requirements for constituents of water or indicators of water quality. Therefore, standard is the point of departure and its criteria or measurement should not be limited by the technical knowledge or specifications. Instead, it should be determined and led by quality values. For example, the Directive 2000/60/EC of the European Parliament and of the Council on “Establishing a framework for Community action in the field of water policy” set the water quality status as a “high, good, moderate, poor or bad” indicating its essential quality values⁶⁰ so that measurements are secondary to the values that the document wants to protect and preserve. The International Standards Organization (ISO) has issued a number of international standards related to water quality.⁶¹

4.5 Policies to Overcome Water Scarcity

Water scarcity can be categorized into economic and physical water scarcity. Economic water scarcity is where human, institutional, and financial capital limit access to water even though water in nature is available to meet local demands. Although physical scarcity of water is challenging to overcome through conservation and water resource management tools, economic policies can be modified to provide water to those who face scarcity despite presence of water resources. One of the contributing factors to provision of water in these areas of the world is privatization of water, which is a controversial strategy.

60 <http://www.wfd-info.org/Water%20framework%20directive%20UK.pdf>

61 Both methods and constituents of water are covered, in the lists available at:
http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_ics_browse.htm?ICS1=13&ICS2=60
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=52834

Selected examples include:

- ISO 9696:2007: Water quality – Measurement of gross alpha activity in non-saline water – Thick source method
- ISO 9697:2008: Water quality – Measurement of gross beta activity in non-saline water – Thick source method
- ISO 9698:1989: Water quality – Determination of tritium activity concentration – Liquid scintillation counting method
- ISO/CD 9698: Water quality – Determination of tritium activity concentration – Liquid scintillation counting method
- ISO 10703:2007: Water quality – Determination of the activity concentration of radionuclides – Method by high resolution gamma-ray spectrometry
- ISO/DIS 10704: Water quality – Measurement of gross alpha and gross beta activity in non-saline water – Thin source deposit method
- ISO/DIS 11704: Water quality – Measurement of gross alpha and beta activity concentration in non-saline water – Liquid scintillation counting method
- ISO/CD 13160: Water quality – Measurement of strontium 90 and strontium 89
- ISO/CD 13161: Water quality – Measurement of polonium 210 concentration activity in water by alpha spectrometry
- ISO/CD 13162: Water quality – Determination of carbon 14 activity – Liquid scintillation counting method
- ISO 15839:2003: Water quality – On-line sensors/analysing equipment for water – Specifications and performance tests
- ISO 17381:2003: Water quality – Selection and application of ready-to-use test kit methods in water analysis.

4.6 Modeling Method – A Useful Decision Support Tool

Natural resource planning spans orders of magnitude across spatial as well as temporal scales. Overlaying the natural processes, economic drivers and human demands further challenge the decision making process. Considerations of different management options that account for sustainable energy and water resources can be effectively tested using modeling and simulation. While models can be biased and oversimplify pertinent physics, the development process and the simulation outcome offer quantitative information, enhance insight, educate a broad audience, and reveal unexpected sensitivities or nonlinearity.

Nowadays, water resource models have been used to inform decisions about water supplies, ecological restoration, and water management in complex regional systems. Every single major water resource planning and management activity in the world today, whether focused on flooding problems, reservoir operation, groundwater development, water allocation, or aquatic ecosystem enhancement, includes models.⁶² A team at Sandia National Laboratories, USA, has developed models through stakeholder elicitation that can address a wide range of regional, national, and international challenges dealing with integrated resource planning. The second case study for computer-aided, community-based water planning: Gila-San Francisco decision support tool will be introduced to illustrate the application of modeling approach.

4.7 The Roles of Experts, Stakeholders and Decision Makers

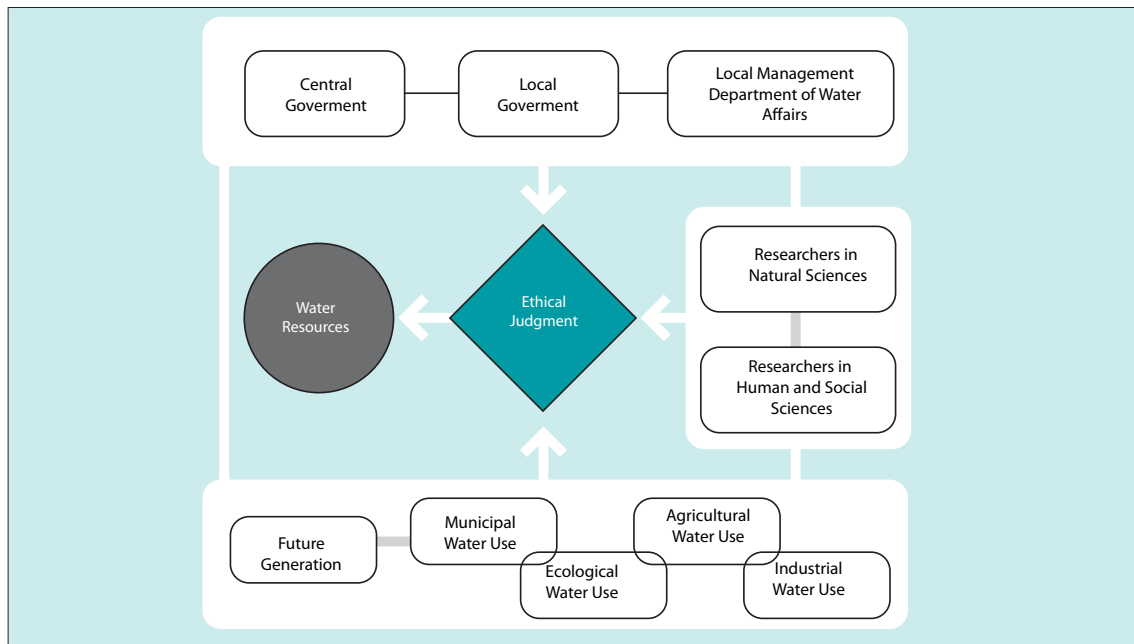
In the framework of water ethics construction, decision makers, stakeholders and experts should all take on corresponding responsibilities (Figure 8). This is true for both private and public sector experts.

Experts in the different roles as illustrated in Figure 8, no matter whether natural science or social science, should have stronger environmental concerns due to their deep understanding of the nature and water resources. Therefore, experts should take the responsibility to advocate, educate and propagate ethics, and help the decision makers and public build up the consciousness of protecting the environment (Zheng, 2005). One dilemma is that experts are often highly specialized, and the consequence is a narrow interpretation of what the issue is, a specialized terminology and a tacit understanding of concepts, problems and solutions within the expert community (Harremoes, 2001). For integrated water management, interdisciplinary collaboration is needed to bring all elements together. Experts in different water related fields should work jointly and combine social and human sciences with natural sciences during the constructing of water ethics.

All stakeholders play an important role in the construction of the actual water ethics and the ideal water ethics, especially the major water users. If they take their social and environmental responsibility, adopt water saving technologies, recycle water resources, follow and respect natural rules and protect the environment (water resources) self-consciously, then the construction of water ethics will be easier.

62 Ocean dumping of sewage sludge is prohibited in the United States by the Marine Protection, Research and Sanctuaries Act (MPRSA).

Figure 8: Construction of a Framework of Water Ethics (Liu, 2007)



The role of decision makers is essential in the design of water institutions and water policies. Decision makers have the responsibility to combine the ethical institutional considerations into the policy making, and design water institutions, which are both economically efficient and compatible with the ethical principles. Scientists, stakeholders and decision makers can play important roles in alleviating water scarcity based on ethical judgment, instead of being driven by economic benefits only.

4.8 Education

4.8.1 Water Education to Reduce Wastage

As discussed in section 4.1, a motivational change is required. As Harremos (2001) mentioned, “while the prospects (water ethics) may be grim, the hope may rest with education.” It is a feature of modern society that mass education has become feasible at a rate and to an extent never seen before. Water wastage is very common phenomena among teenagers. If you criticize them, they will tell you: “I admit water is very important in our lives, but I always waste water, which hasn’t caused any troubles. Why should we save water? There is a lot of water in our country, and the water is continuously flowing in the water pipe. When I am thirsty, I could buy the mineral water or the orange juice. You know, that’s not very expensive. I could pay for my waste.” This is just one typical case in the high school. They even don’t know that in the same part of their country, a lot of people cannot get enough nor clean water for their daily lives.

We must rely put a concerted effort in including water ethics in water education at all levels. In a traditional water education system, people are usually trained to use science and technology to fully develop and efficiently utilize water resources. However, the key problem concerning the ethics of water management is not just a problem of efficiency, and the ethics of water can never be reduced to certain skills and technologies. The most important thing is to create an equally communicating atmosphere so that all subjects (including nature itself) within the system have a chance to express their viewpoints about the reasonable utilization of water.

Professionals such as engineers or scientists who control the great power of knowledge must uphold highest standards of professional ethics as well as general virtue of human beings in order not to increase the risk of the world. As an example given by Liu (2007), “a boy who pisses into the source of drinking water once is not moral even though it is OK from the point view of science and technology, because the amount of his piss is trivial to pollute the water”, the limit of scientism should be broken through during education.

4.8.2 Teaching Plan on Water Crisis at High School⁶³

This example illustrates how to create awareness and education for young people. The High School Affiliated to Beijing Normal University, founded in 1901, is one of the well-known secondary schools in China. Bioethics has been chosen as an elective course for five years, which was introduced by Darryl Macer. The textbook used is *A Cross-Cultural Introduction to Bioethics*.⁶⁴ The water crisis is also one of the contents in this course. The “Water crisis” is a term that refers to the status of the world’s water resources relative to human demand. The major aspects of the water crisis are overall scarcity of usable water and water pollution.

The aim is to enhance the students’ consciousness to save water and their concern about the water resources.

The approaches used were:

- 1) Introduce basic knowledge about water resources in China, such as the quantity and quality of the water. According to the statistics, China’s per capita volume of water resources is only 2,300 m³, which is only 1/4 of the world’s average.
- 2) Describe some problems caused by water. There are several principal manifestations of the water crisis, such as inadequate access to safe drinking water in the west part of China; loss of groundwater leading to diminished agricultural yields; overuse and pollution of water resources harming biodiversity, and regional conflicts over scarce water resources sometimes resulting in warfare.

Here we take Taihu Lake as an example of water bloom. Located in the southern part of the Yangtze River delta, Taihu Lake is the third largest freshwater lake in China, and it is a famous scenic spot in China for its lake, its hills and its man-made scenery. There is a Chinese song, named the beauty of Taihu lake:

*The beauty of the Taihu Lake is for its water
where white sails give free chase
and red chestnuts grow underneath
and greenish reeds gather by the lakeshore
while plump fish and shrimps roam ashore
the lake water maps a network of irrigation
scented by ripe rice and fruits*

Such beautiful pictures in our mind, but things are different in June 2007. Taihu Lake suffered a serious pollution problem of blue algae. The waters give off a bad smell which makes people uncomfortable. Then the same thing happened in Dianchi Lake in Kunming, Yunnan province. Meteorological departments forecast that these lakes are still having the possibility of water bloom in the following years.

In fact, the students had learned this in the biology class. Nitrogen and phosphates are the culprit. So, some questions were designed to the students: “What caused the water bloom? Who dumped these compounds into the water? Who should take the responsibility for this event? Should they get punishment? What kind of measures should the government take? If you are a manager of the fertilizer company, what will you do? Have you ever thought about the bad result for the waste? Would you like to install a “Cyclator” to treat the waste water? Would you like to spend some money on it?”

Bioethics class is different to the biology or geography class. We hope the students could analyze this case, use the principle of water ethics, discuss with their partners, and find the right way to solve these problems.

63 This section is written by Jinhua Fu, the High School Affiliated to Beijing Normal University, China.

64 The book was supplied by Eubios Ethics Institute, including many chapters, such as genetic privacy and information, brain death, organ donation, HIV and ethics, genetically modified organisms, cloning, animal rights, assisted reproduction, hospice care, and sustainable development.

Another example is water pollution and the impact to health. Waterborne diseases and the absence of sanitary domestic water are one of the leading causes of death worldwide. For children under age five, waterborne diseases are the leading cause of death. At any given time, half of the world's hospital beds are occupied by patients suffering from waterborne diseases. According to the World Bank, 88 per cent of all diseases are caused by unsafe drinking water, inadequate sanitation and poor hygiene.

Biological concentration is also a serious problem, which means the process by which some contaminants, including heavy metals and herbicides or pesticides in environment are taken into in the body through the food chain. Since these contaminants are generally chemically stable, biological concentration will increase along the food chain, like DDT which was narrated in Rachel Carson's book *Silent Spring*. As we know, the heavy metals in the water also caused itai-itai disease and Minamata disease in Japan. Even in China, the incidence of intestinum cancer is increasing in the west part of China these years.

As learned in the biology class, water is an ecological factor to the creatures, and it is an integral aspect of agriculture and ecosystem services, but increasing demand has put serious pressures on its provision, availability and quality. 50 years ago, the world's population was fewer than half the people of today. In general, people consumed fewer calories, including meat, and thus required one third of the water we now use. Today, freshwater withdrawals from lakes and rivers doubled (since 1960) with 70% worldwide used for agriculture. Reduced availability of water in many areas constrains food production, exacerbating hunger and poverty, and reduces other ecosystem services provided by water. Poor water quality has serious effects on human health and biodiversity and hence on ecosystem services. Regulating services of wetlands includes nutrient cycling and flood and pollution control, essential services for healthy environments and productive agriculture.

After the class, one of the students wrote down a water song:

*Water is life,
She can help us, and she can kill us too.
If we haven't water, we will die quickly.
But, now water crisis is a big problem! The quality of water is worse and worse.
We don't want to be the last generation!
We must save water! We must use water economically.
Human being,
Save every cup of water, save every drop of water!
Heal the world, and heal the water!
This is our mission.*

Another student said: "Before the class, I thought the water crisis, like starvation and poverty, was seemingly far away from children in Beijing, especially us, who live in middle class families and think ourselves deserving good living conditions. I thought the water crisis just threatens the people in the poor places. By this lecture, I know some children are dying because they lack of clean water. How can someone with conscience and sympathy watch the tragedy going on and do nothing? I will share this information with my friends, relatives and families. We should strengthen the consciousness to protect water."

This course provided a good opportunity to carry out environmental education. The students are getting to understand the principle of water ethics, and human play a vital role in water issues which is relating to each of the Chinese people's lives and relating to a nation's future and destiny. From 14-21 October 2009, the Chinese Central TV News Channel launched a documentary "water cries", which also enhanced the teenager's and the citizens' responsibility to protect the water. The significance of that responsibility was nicely phrased by former Norwegian Prime Minister G.H. Brundtland: "We must consider our planet to be on loan from our children, rather than being a gift from our ancestors."

4.9 Balancing International Governance with National Sovereignty

For many countries water is not only an ethical issue but also a political problem. For example, the countries in Central Asia, like Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, have common rivers and great interest in water resources. The system of the fair sharing of water is absent. How should each country make decisions on the energy/resource technologies that they develop and which strategies to follow, given the environmental crisis and the variety of proposed benefits and potential risks of different technologies? As countries in the Asia-Pacific region face mounting external pressures to decide on their energy/resource policy, what are the values and questions that exist inside the region for ethical deliberation over the choices for energy/resources? There can be useful resolution of conflicts between cultures and communities in the shared use of common water, such as oceans and rivers, through international commissions, laws and treaties. At the same time nations wish to preserve their sovereignty.

Among the first major international laws protecting the environment is the Law of the Sea, which looks at the problem of protecting the global commons. This shows early recognition of the ethical principle of justice, applied in human responsibility to protect nature and the environment. The Law of the Sea became a forerunner to the more recent global conventions on protection of the ozone layer, biodiversity, and efforts to prevent increases in greenhouse gas emissions which contribute to global warming. While many national laws aim at reducing pollution, and preserving rivers, lakes and marine parks, and some regional blocks such as the European Union impose strict environmental standards, negotiations to apply international standards have been difficult (Islam, 2008).

How can we ethically control overuse of resources? Most maritime nations have declared 200 mile limits within which they claim prior rights to exploit marine resources, including fish. Therefore national policies are very important, but because most fish, and the water they live in, move over much greater areas, international fishing strategies are necessary. One way is to enact quotas, a given number of fish of each species that should be caught. Quotas were introduced to North Atlantic fishing since 1970.

Global influences are being recognized which require global bioethics. For example, natural variations in fish population are primarily related to the population of plankton on which they feed (and human action). The algal productivity varies greatly, with winds, sea currents, and climate - which itself affects the ocean currents. Increased fish catches of Atlantic cod, from the fifteenth century, have been associated with warmer climatic periods. Temperature also affects the biological organization of the ecosystem, and global warming can be expected to change not only these patterns but rainfall affecting the land, too. Unintentionally humans have begun global eco-engineering, and now considering intentional changes to combat these. For example, there have been experiments since the 1990s to add iron into the ocean to attempt to fertilize phytoplankton production.

5. Conclusions

The aim of this report is to illustrate how water ethics can make a difference to water related practices. The purpose is to reveal gaps in existing knowledge to researchers and funders of research, to examine linkages between research and policy making, to provide a cross-cultural review of the issue, to educate readers on water ethics, and to present policy options to governments at all levels.

The major focus of the report has been to study the ethical issues associated with water resource utilization and management, including its uses in energy and other domains in many countries. Water has deep meanings for people, and by exploring this relationship we may not only understand more the relationship between living organisms, people and the environment, for aquaculture, fishing, and enjoyment, but also we may understand more of ourselves. In the global age we live in, the question of the common oceans and the required diplomacy provides very important precedents and lessons for future global planning. It also provides a precedent for protecting biodiversity that is increasingly being recognized. We hope that the report can offer guidance to governments and people in decision-making that is necessary for our use of water and our very survival.

There is an accepted international ethical norm that human beings are entitled to access to water as a human right. Equity in availability and applicability of water is an important ethical issue, that has significant policy implications. Development of water ethics is an important supplement to the traditional “command and control” and “economic instruments” that are common in modern water resource management. There are several key principles listed in this report that can be applied in different cultures and circumstances. The principles of equity, vicinity, frugality, quantification, transaction, users pay and participation are guidelines for water ethics and construction of policy.

The world view varies from anthropocentric to eco-centric viewpoints across countries in Asia and the Pacific. Aggravation of water scarcity issues will increase the conflicts between human and the ecological concerns if an eco-centric view is adopted, however without such a view humankind will lose even more biodiversity and environment. There are existing precedents for international water-sharing including with primarily non-human environmental systems, and for protection of environmental resources, however, they need further development.

Conducting objective assessment of water resources and implementing modeling tools will provide a scientific basis for construction of practical water ethics. Experts, stakeholders and decision makers, all should play important roles in constructing water ethics. Education should be conducted, starting from young people, and including professionals in every sphere of decision-making.

More studies are needed to address existing gaps in our understanding and approaches to governance and ethics of water to link the extensive agreements on water sharing to change consumption patterns within and between countries. The authors also call for future research to better understand the complex foresight studies involving water use in various sectors including agriculture, energy and industry, under the framework of the ethics of climate change.

6. Case Studies

Four case studies conducted by the members of the WG14 have been used to illustrate ethical considerations in various fields. These include examples from aquaculture, water diversion, trans-jurisdictional water quality issues, modeling studies and education. These case studies provide real-world examples and good overviews of water challenges confronting human beings.⁶⁵

Case Study 1: The Need for a More Efficient Aquaculture Industry⁶⁶

Introduction

The technological revolution has supported the human population in terms of food production even as it continued to grow at an exponential rate. This seems to challenge the early prediction made by British political scientist Sir Thomas Richard Malthus. His famous quote is still used by geographers all around the world: "Food production will only grow at a numerical pace, while the human population continues to grow at an exponential rate. (Dorfman, 1989). However, when one studies the current state of food production and the energy usage associated with it, the scenario predicted by Sir Thomas Richard Malthus seems to be closer to becoming a reality.

This case study will illustrate how the current state of aquaculture came to be, using the collapse of the natural stocks of Atlantic cod to argue why aquaculture is a necessary alternative in terms of supplying a stable stock on the market. Details of the sushi boom and how the economic rise of Japan has started a trend of seafood consumption throughout the world will be discussed. Then how the current state of aquaculture is aimed at producing high-value products (shrimp, salmon, and tuna) and how that is producing many unfavorable environmental and sociological effects will be illustrated. Finally, a form of sustainable aquaculture (carp and oysters) is introduced, with the suggestion that we have a need to diversify our diets so we can protect marine ecosystems and preserve fishmeal resources for the future.

Seafood Growth Perspectives

Currently, Asia is both the greatest consumer and producer of all seafood products; this number is expected to continue to rise. According to data released in 2000, the Tsukiji market in Tokyo continues to be the basis for determining international seafood prices (although this might soon be surpassed by the seafood market in Shanghai), trading a total of \$6 billion USD worth of seafood on an annual basis. For comparison, the largest seafood market in the United States, the Fulton Fish Market in New York only trades \$1 billion USD on an annual basis.

In recent years, the influence that Japan once exerted on seafood markets has dwindled as other markets in Asia gain more influence. Growing seafood imports in ports of Pusan, Shanghai, and Taipei, are competing against each other to challenge the power currently held by the Tsukiji market (Tibbetts, 2001).

65 On 7 November 2007 and 22-23 October 2008, the 1st and 2nd Joint UNESCO-Peking University International Symposia on Water Ethics were held in Beijing, China, respectively. The symposia provided a platform for all participants to discuss water ethics and how more ethical water resource management could be constructed. This working group report started through building upon the major points that had been discussed during those two meetings and some of the case studies are based on the papers that were subsequently submitted by the working group members.

66 This case study is written by Keisuke Tachiyama, Japan.

The Evolution of Aquaculture

Aquaculture has evolved greatly in the past three decades. However, the beginnings of aquaculture can be traced back to more than 3000 years ago. In ancient China, carp were kept in artificial ponds and were later consumed by the residents of the local villages, resembling a subsistence-type system; leading to the conclusion that it was sustainable. For much of its history, aquaculture remained as a subsistence-based system. Even after globalization started changing how business was conducted, aquaculture continued to be a subsistence system that primarily fed the people in the villages of the developing world (Tibbetts, 2001).

During the same time period, natural fisheries around the world also supplied their catch to the people in the developing world while the people in the developed world primarily consumed poultry products (Bestor, 2000). However, this drastically changed in the last three decades of the 20th century, primarily due to three factors: the rise of the sushi boom; health consciousness that was born as a result of the Bovine Spongiform Encephalopathy (BSE or “Mad Cow Disease”); and the advancements in refrigeration technology that allowed seafood to travel greater distances without spoiling (Rosamond et al., 2000). These factors completely changed the flow of how the seafood market conducted business. From this point onwards, both naturally caught and cultured seafood products were produced in the less developed world, only to be consumed by the people of the developed world (Hannesson, 2002). The pattern of seafood consumption also shifted from marine organisms that were placed low on the food chain (carp) to those higher on the food chain (shrimp, salmon, and tuna)

The popularity of seafood has been attributed to the sushi boom that started towards the end of the 20th century (Hannesson, 2002). There have been various discussions of the way Eastern and Western cultures view cultural and economic exchanges.⁶⁷ There have been many studies of the relationships between Japan and the United States since the 1960s. The United States was the key player in the global economy and Japan was just starting to gain economic wealth. But as the 1970s progressed and as we entered the 1980s, Japan experienced the economic bubble and became the 2nd largest economy in the world.

The Sushi Boom and Rise of Aquaculture

During this time, large amounts of Japanese Foreign Direct Investment (FDI) started flowing into the United States, changing the previous flow of FDI (from the United States to Japan). Japanese sushi parlors started opening up in various areas of Manhattan and onto other North American cities. Japanese food was advertised in various magazines and television channels as being a healthy alternative to consuming meat products. Around the same time, refrigeration and freezing technologies improved; making it possible for seafood to be shipped from various ports around the world (primarily developing countries) to countries that were experiencing the sushi boom.

In addition, consumers in the United States also experienced a very interesting phenomenon at this time. Shrimp/prawn products were a popular food product amongst many North American consumers even before the sushi boom (Bestor, 2000). However, due to refrigeration technology and its limited biomass, the food product was considered a cuisine that could only be enjoyed along the banks of the Mississippi River. Prices also remained relatively high, reflecting its limited biomass. However, demand soon began to surge with the introduction of the sushi boom and new refrigeration technologies. Frozen shrimp/prawn products began to be sold in supermarkets across the entire North American continent and the prices soon started to drop as more and more of the natural stocks were extracted.

However due to the natural variability of the natural stock, the governments of the major consuming nations looked for an alternative. These were the beginnings of large scale shrimp farming in various areas of Latin America and Southeast Asia. The governments of developed countries specifically allocated FDI through various ODA organizations such as the World Bank and International Monetary Fund and promoted shrimp aquaculture to developing countries as a way of earning foreign currency. Due to these efforts that were enacted by various ODAs in the developing world, we (the citizens of the

67 Tibbetts J. 2004. The State of the Oceans, Part 2: Delving Deeper into the Sea's Bounty; Environmental Health Perspectives, Vol.112, No. 8. pp.472-481.

developed world) were and still are able to consume cultured shrimp/prawn products for a relatively low price. But the story of the ecological disasters that the shrimp farming industry has created is cited in many literature pieces. For instance, we have destroyed important mangrove forests that act as buffer zones during storm surges, and are changing the diet of the Southeast Asian people in that we are forcing these people to transform rice paddies into aquaculture sites, toxic materials used for shrimp aquaculture are polluting coastal areas, etc. In addition shrimp epidemics are frequently emerging in many Southeast Asian coastal areas (Hannesson, 2002). When this happens, there is no choice for the farmers but to kill off their entire stock and drain the water supplies in the pen to the adjacent coastal areas, leading to further pollution.

However, we simply cannot blame farmers in the developing countries that are producing cultured products. Some economists suggest that it is ultimately the consumers of the developed world who are responsible for this rapid change in aquaculture production systems. With a demand for products with better quality, greater variety (shipped from further areas), that are available all year round, for a cheaper price, aquaculture has continued to grow in importance over recent decades.

The Danger of Over-reliance on Natural Stocks

The destruction of the natural stocks of Atlantic Cod in Maritime Canada is perhaps the worst seafood disaster in recent history. This natural fishery was created in the late 1970s in Eastern Canada when the government decided to open up its coastal areas to earn foreign currency (Myers et al., 1997). This decision came from the fact that cod were widely consumed on the other side of the Atlantic (Norway and Portugal). Since the local residents of Atlantic Canada consumed a minimal amount and had such a large surplus, the government decided to exploit it and strengthen the economy of Eastern Canada. For the first few years after the fisheries opened up, the economy prospered, creating many new jobs for the local residents. However, the size of the operation was extremely unsustainable from the beginning. More than 300,000-800,000 tons of Atlantic Cod were caught on an annual basis and were processed at local plants. This created more than 40,000 jobs and the once barren cities of Atlantic Canada regained their vibrant atmosphere. However, the local fishermen continued to warn the government to implement restrictions on the catches since the local fishermen felt the effects by seeing fewer fish in coastal areas in the course of their daily operations. Marine biologists often cite this ignorance by the Canadian Government as being responsible for the tragedy that unfolded in the next few years. Soon catches started declining and the multinational corporations that were associated with cod operations started suggesting that the Canadian government implement some kind of restriction in order to protect the fisheries. However, when restrictions were finally implemented by the government on July 2nd, 1992, it was already too late. The stocks had diminished due to over-fishing and the natural habitat of the coast off Maritime Canada had been destroyed. The catches for 1992 were a mere 17,500 tons, opposed to 800,000 tons at its peak (Myers et al., 1997).

It is examples of fishery collapses such as this that worried governments throughout the world. Once thought to be an infinite resource, was exploited within two decades and still only marginally recovered in 2008. However, today the demand for cod in the European nations is being satisfied by aquaculture operations that are practiced off the coast of the Scandinavian Peninsula. Furthermore, the industry has expanded itself and today, large amounts of carp, catfish, clams, tilapia, milkfish, oysters, salmon and shrimp are farmed (Tibbetts, 2001). The argument of the governments of the developed country is that, aquaculture is a vital way of ensuring that many seafood stocks are supplied throughout the year since some migratory fish stocks have seasonal fluctuations of abundance and absence.

Effects of Aquaculture on Natural Stocks

The human induced ecosystem disasters have already been discussed in the section of farmed shrimp, but there are other unfavorable effects that aquaculture is known to potentially produce. Before discussing those in detail, statistics show that roughly 25% of all seafood products around the world are cultured products. But as we progress more into the 21st century, that number is expected to rise to 75%

by 2100 (Tibbetts, 2001). These statistics point in a direction that we have to be concerned about. The composition of the fish meal is as follows: body parts of the fish and fish oil, which are extracted from natural stocks of small fish, such as Peruvian anchoveta, Icelandic herring, men-haden from the Gulf of Mexico, Norwegian capelin, and sand eels from the North Sea. From the list above, one can visualize that fishmeal is produced in: Peru, Chile, Iceland, and Denmark (Tibbetts, 2001). These countries currently produce so much excess fishmeal that the surplus is used in other food producing sectors, such as the poultry industry. But this is made possible because only 25% of seafood around the world is cultured; and currently, there is a large surplus of fishmeal that is extracted from our oceans. However, if this number was to go up to 75% (expected to occur by 2100), then large amounts of fishmeal would be needed and the natural stocks might not be sufficient to sustain it. Thus this could point in the direction that we would have to culture the fish used for fish meal in the near future for the sole purpose of growing cultured fish.

If this happens, the meal that is currently used in the aquaculture industry could suffer crucially because at some point, the surplus of fish feed will be used up. As there is more demand for fish meal, we can expect prices to rise, and this would be reflected directly to consumers. Marine biologists/oceanographers are currently warning the multinational corporations and the governments of developed countries who are intensifying their operations, but the situation remains unresolved. This is because the aquaculture market is driven by market forces, short-term profits, and export earnings for the developing countries (Tibbetts, 2001). This means that unless there is a sudden drop in demand for cultured products, aquaculture will continue to gain its importance. At the same time, the diets of Asian people are also currently shifting to high value fish consumption. Furthermore, what is alarming is that currently many countries in Asia are gaining economic strength (such as India and China). As discussed earlier, many ponds in China currently rely on a subsistence system, culturing fish such as carp, which feed low on the ecologic food chain and are grown in ponds for consumption by the local people (Tibbetts, 2001).

Yet, if the economy of China continues to grow at its current rate, the middle class in the country would expand and they would start favoring carnivorous species of seafood such as shrimp, salmon, or tuna. If this becomes a reality, the sustainable polyculture system practiced in local villages in China (where many species exist together to maintain better water qualities) would fall apart and production in total has the risk of decreasing dramatically. As the farmers gained economic prosperity, they gradually shifted their operations from a natural type (carp feeding based on natural plants in the pond to using fishmeal and soya beans for feed). Articles written by Dr. Tibbetts shows that the current Chinese aquaculture market price trend resembles the prices of soya beans showing how correlated they have become. Currently, China is the largest aquaculture producing nation in the world, producing two thirds of total global consumption (Tibbetts, 2001).

Just to get an idea on how inefficient the practice of aquaculture is in other countries, we can view some of the numbers that have been cited. The data presented in an article by Rosamond et al. is alarming. According to his research, marine shrimp and salmon individually use more than 2000 wild fish as fish meal. This number translates into roughly 2.44 pounds of fishmeal to produce 1 pound of salmon and roughly the same number to produce a pound of shrimp. Both of these industries have surpassed natural fisheries and since the price of wild stocks has fallen dramatically, many fishermen who were working in wild salmon fishing sectors have been driven out of business and being displaced to aquaculture operations. (Hannesson , 2002). The salmon aquaculture industry in British Columbia of Western Canada has been studied extensively as an example of how aquaculture negatively affects the natural stocks at the same time. Since Canada is a developed country and has environmental regulations that are more rigid than those adopted in the Southeast Asian countries that culture shrimp, there are far less environmental catastrophes taking place, but the operation is dramatically affecting the ocean ecosystems of the region.

Salmon farming in British Columbia was introduced to the area in the 1970s as an alternative to natural stocks of salmon, which fluctuated on an annual basis (Shatzberg, 2002). However, the scale of operations increased dramatically when Norwegian capital flowed into the region starting in the late 1970s. Since then, most of the natural stocks have been replaced by cultured Atlantic farms (an exotic species introduced to the region due to their better growth rate). However, introducing a new exotic species into the region and having it compete alongside the native species of Pacific Salmon are thought to be

the reason leading to the dramatic decline of the native species. Salmon farming is a closed aquaculture system, meaning that the eggs were hatched in artificial hatcheries made at various parts of the river in incubation boxes so that they would never mingle with the wild stocks. These salmon would later be kept in closed pens that were usually located near the river delta. Although the operation has always remained a closed system, there have been large numbers of juveniles and mature salmon that have escaped into the river.⁶⁸ Since the introduction of the aquaculture system until 2001, it is estimated that a total of 255,000 farmed salmon have escaped into the wild and colonized the river systems throughout the province. Furthermore, there are reports that native populations have been wiped out in at least three rivers and the colonizers have settled in (Shatzberg, 2002). Even after knowing the detrimental effects that salmon farming causes, the industry continues to thrive, accounting for a total of USD130 million per year in revenue in 1990; accounting for half of the aquaculture sales in Canada (Marine Fisheries Review, 2000). This example shows that aquaculture and its unfavorable effects are not specific to developing countries, but the developed world as well. Salmon farming is currently practiced on a large scale in: Canada, United Kingdom, Norway, Chile, and Japan on a smaller scale. Four of the five countries listed above are developed countries (Hannesson, 2002).

Furthermore, an alarming piece of information is currently being studied in the salmon farms in Canada. The study conducted between 2007 and 2008 has found that wild salmon juveniles that swam down stream through salmon farms into the ocean contained higher amounts of sea lice (1.61-4.83 on average) than the juveniles in areas where salmon farms were absent (0.17 on average).⁶⁹ An article published recently by Fisheries and Oceans Canada scientist Kristina Miller has found a potential link between viral infection of the native sockeye salmon in this area and their mortality rate. If this study is accurate, this could mean that the wild salmon stocks can potentially dwindle not only in Canada but also in the United Kingdom, Chile, and Japan.

Aquaculture in Relation to Land Based Farming and Wildlife Systems

The source of feed that is currently used in the aquaculture system around the world and the feed that is being fed to land based organisms show an overlap. This has been discussed briefly in the section of how aquaculture products affect natural stocks, but in this section, some of the effects on the other food producing sectors will be examined in detail.

However, before going into the details of feed used for aquaculture and the poultry industry, it is important to take note of water resource interaction amongst these two sectors. As stated before, aquaculture facilities in coastal areas cause serious environmental effects to the surrounding terrestrial ecosystem. However, before this happens most of the aquaculture facilities are located in river deltas/coastal areas. This means that many farms that produce livestock are located in areas that are located upstream. In addition in some instances, factories and urban sewage contain excess nitrogen, which is the source of the water supplies used in some aquaculture farms. When this excess nitrogen water is used in fish farms, it can make the species in the farm contaminated and susceptible to disease. In addition to this, many shrimp farms in coastal areas were planned in an inappropriate manner and clustered too close to each other.⁷⁰ This puts extreme stress on the shrimp in one farm. Even when a single shrimp is affected with the White Spot Virus, a shrimp disease that creates white spots on the shrimp and eventually kills off the shrimp in a matter of a few days, it will rapidly spread through the farm.

In many instances, these sick shrimp were then consumed by ducks that were released into the particular farm in order to act as pest management agents and they would later travel to wetlands (Feare, 2006;

68 David Suzuki Foundation. 2008. Open Net Cage Fish Farming <http://www.davidsuzuki.org/Oceans/Aquaculture/Salmon/>. Date accessed: 20 January 2009.

69 Source: "Wild salmon sea lice linked to B.C. fish farms," (9 February 2011) CBC online <http://www.cbc.ca/news/technology/story/2011/02/09/science-sea-lice-sockeye-salmon.html>

70 Tibbetts, J. 2001. Aquaculture: Satisfying the Global Appetite; Environmental Health Perspectives, Vol.109, No.7, pp.318-323.

Tibbets, 2001). These ducks would travel long distances in some instances and contaminate wild bird species with one of the HPA1 or H5N1 viruses; which led some people to suspect that wild water birds were responsible for the spread of these viruses. In 2005-2006 alone, the H5N1 virus has spread from Southeast Asia to Northern China, Mongolia, Kazakhstan, Southern Russia, Eastern Europe, central parts of Europe, Middle East, Africa, and India. Furthermore, there is strong evidence that these viruses have been spread by wild water since 2005. In October of that year, outbreaks of HPA1 and H5N1 in Romania, Turkey, and Croatia have all been associated with wetlands. Located in other parts of the lake where the wetland was located were carp aquaculture sites. In this manner, the spread of the HPA1 and H5N1 virus currently is thought to be caused by water birds. These birds act as the agents who carry the virus to a particular wetland area, where infect migratory birds nest in the region.

However, this is not the only area where we can witness a strong relation between fish farming and poultry. These programs are usually called 'Integrated Fish Farming' or 'Integrated Agriculture Aquaculture' techniques. These programs make use of products of animal farming as food and fertilizers for fish farms. In some instances, pig pens are located directly above fish ponds, so that excreta and spilled food drop directly into the ponds and are consumed by the terrestrial organisms in the pond. In some other systems, fish pond usage is rotated between fish and crop production, and rice fields can also be flooded for fish rearing between rice crops (Feare, 2006).

What is then interesting is to note how fish aquaculture can affect water resources. In many fish farming operations, the water supply is fed by surface water running in from the adjacent river system or from ground-water supplies located in the aquifers underground. The pH in natural waters that are unaffected by pollution is in the 6.5-8.5 range. However because fish require oxygen supplies in the water system in order to grow in addition to the fish pellets, the water supply in these ponds is affected by the clustering of terrestrial organisms and excess bacteria. During the night, these factors can lead to the production of carbonic acid, bicarbonate HCO_3^- and H^+ ions. The H^+ ions eventually become abundant and can cause the pH levels to rise. In productive ponds (intense operations) the daytime pH can go as high as 10 which can be lethal to young fish. If this water is later used in the rice ponds, it can affect the growth of the crops in that pond as well.

A New Farming Attempt (Blue Fin Tuna)

It is a fact that blue fin tuna is known to be a special fish to the people of Japan. Throughout much of the 20th century, blue fin tuna around the world were caught, frozen, and sent to Japan and sold the following morning in the Tsukiji market. Ever since Japan started gaining economic strength in the 1970s, the demand for toro (fat taken from blue fin tuna) has continued to rise. In addition, as refrigeration techniques improved, blue fin tuna from countries further away were also imported and sold on the market (Bestor, 2000).

However with the rise of the sushi boom, the demand for blue fin tuna has also increased. Japanese consumers themselves were already stressing the supply of blue fin tuna around the world. Throughout the 1970s-1980s, Europe was a large supplier of blue fin tuna to Japan. However, there was a so called Gold Rush mentality amongst European fishermen and they have seriously depleted the natural stocks. In addition, during the last decade of the 20th century, demand for blue fin tuna rose world-wide. Many companies, knowing that many of the natural fisheries in the Atlantic and Pacific Ocean were about to be exhausted, started blue fin tuna farming. However, farming these highly migratory species is not easy since they favor different water temperatures. When the operation was in its initial stages, large numbers of blue fin tuna did not survive and died before they were consumed by human beings. The Japanese getting worried with depleting natural stocks invested heavily in the fisheries around the Strait of Gibraltar. These farms are owned by the Spanish, but in reality are comprised by technologies and funding from many developed countries. For instance, one farm relies on French purse seiners to retain tuna in their pens. The farms are joint ventures between Spanish/Japanese trading companies, using Spanish workers to carry out the operation using cultural techniques developed in Australia, fishmeal sent from various European countries, and computer technologies invented by the Japanese in order to monitor the tuna (Bestor, 2000). This might seem like a nice way of sustaining the fishery but the fact that captured tuna are carried to their pen shows the largest mistake of this operation. Since blue fin tuna, along with other types of tuna are highly migratory species, it is not known where they

spawn. Thus juvenile tuna from around the world that have not spawned when they are captured are brought into these pens. This would mean that the farming operation will decrease the stock in the long run because there are no juvenile tuna being born. Furthermore, as pointed out in the beginning of the tuna farming operations, many blue fin tuna do not survive until they are sent to seafood markets around the world (Rosamond et al., 2000).

Alternative to the Current Aquaculture System

Much of the discussion so far has been on the negative aspects of the aquaculture industry and how unsustainable it is. Therefore we turn our attention and think for a moment about how we can build an aquaculture system that is more sustainable for the fish stocks and for the people associated with it. According to the environmentalists who study the effect of aquaculture on the natural/social environment, there are several fisheries that improve the well being of the local people and do not largely impact the ecosystem of the surrounding areas. According to some environmentalists, pearl oysters are filter feeders and feed low on the food chain and produce a luxury product, pearls, at the same time as producing food (Tibbets, 2001). These products cost little to the environment and bring positive effect to the local and national economies.

As another example, we can highlight the traditional aquaculture system practiced in China as being another sustainable aquaculture system. As discussed before, carp feed low on the food chain and it has been cultured for 3,000 years. During that time, local knowledge has found it sustainable to culture several types of carp together and maintain a poly-culture system. By doing this, the farmer can avoid using any type of feed and the fish would provide the necessary nutrients for each other. In addition, the various species of carp would cooperate with each other and maintain the water quality of the pond that they are kept in. We need to diversify the types of operations of the aquaculture farms in order to take the pressure off the natural feeds. Currently the developed world is focusing only on producing high-value species (salmon, shrimp, and tuna), which are carnivorous species placed highly on the food chain. As natural stocks of fish keep decreasing in volume, we have to think of a viable way in order to make the aquaculture industry thriving.

Conclusion

Aquaculture if practiced correctly can lead to food security, while putting minimal pressure on terrestrial ecosystems. This is clearly illustrated in the example of the carp industry in China, which has been practiced for over 3,000 years. In this system, several types coexist in a single pond, cleaning waste and maintaining water quality amongst each other. As another example, pearl oysters are another good alternative for the people in the South Pacific countries. Culturing pearl oysters produce two goods at the same time; food and a luxury item, while providing minimal impact on the local terrestrial environment. This also protects the security of the people who are associated with its production. The local villages prosper economically and that gradually works itself up to the national level.

Yet, the reality is that we are making efforts to culture high-value products such as salmon, shrimp, and blue fin tuna. As illustrated in the paper, farming of shrimp and salmon is extremely inefficient. We currently use an average of 2.44 pounds of fishmeal to produce 1 pound of salmon/shrimp. This is currently made possible to the low prices of fishmeal which are extracted from natural stocks, but this is because natural fisheries supply more than 75% of our seafood supplies. In the future if aquaculture were to supply more than 75% of our seafood as we continue to deplete natural stocks, fishmeal could face severe inflation. In addition, currently there is a large surplus of fish meal, which allows us to use it as feed for the poultry industry or the chicken industry, but these sectors could face severe shortages in the future. We need to rethink the methods of how energy flows in this sector. In its current state, we can say that it is extremely inefficient.

The high-value seafood sector is also leading to many environmental/ethical problems for both the people associated in its operations; and for the local terrestrial ecosystems. The salmon that escape from the salmon farms are escaping into the wild, endangering the local populations that have existed

there for centuries. Shrimp farming leads to intensification and loss of mangrove forests that leads to increased vulnerability to wave erosion or storm surge. Also, the blue fin tuna industry is vulnerable despite its advanced operations involving many developed countries. Due to the nature of blue fin tuna, it is extremely hard to control water quality and many of the fish die before they are ready for consumption. In addition, aquaculture is rapidly getting integrated with agriculture, poultry, and even is affecting wildlife. In the section above, it was noted that the feed used for aquaculture is now being used to feed the poultry industry. However the opposite is currently taking place as aquaculture operations become increasingly correlated with the agriculture and poultry sectors. Waste that is generated from the livestock in some instances is fed to the terrestrial organisms and pond operations between aquaculture and agriculture become more common. This especially applies to the Asia Pacific region where more than 90% of the cultured products in the world are produced. In addition, wild birds that are released into aquaculture ponds are thought to be responsible for spreading viruses such as the HPA1 and H5N1 viruses. Furthermore, intense aquaculture production is putting immense stress on groundwater supplies and changing its pH levels, making it impossible to use in livestock and aquaculture operations as well.

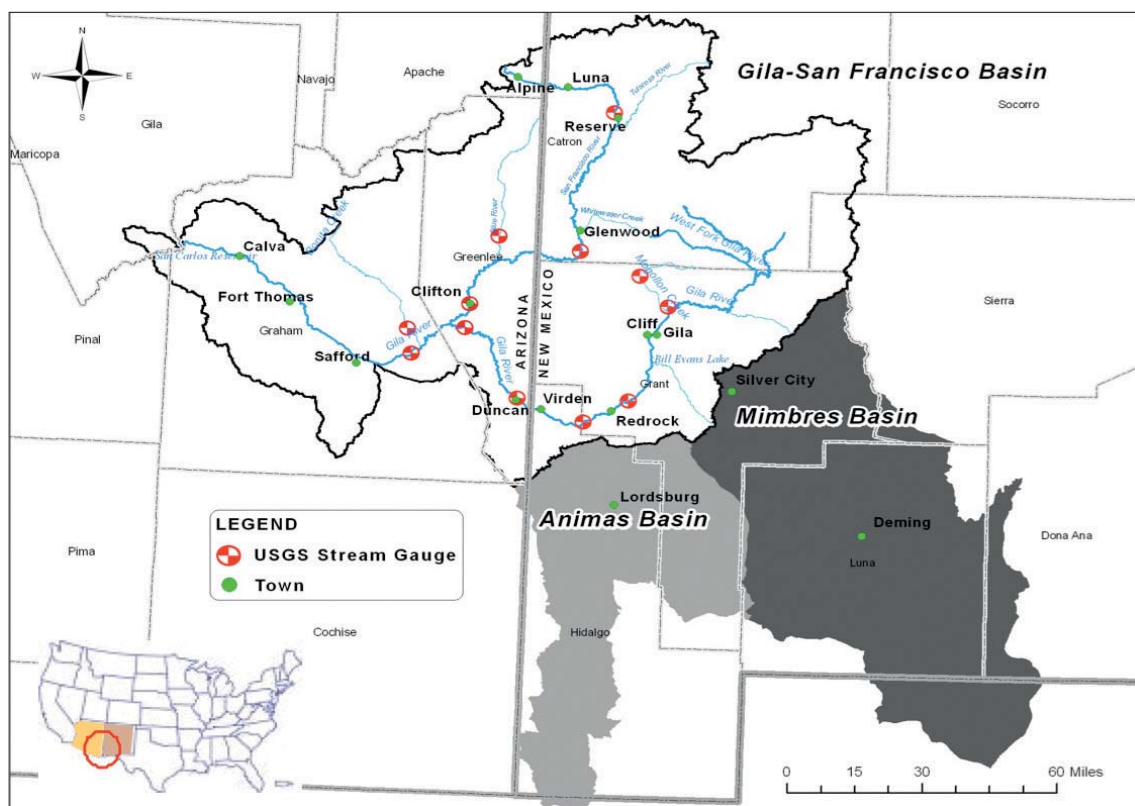
Indeed aquaculture is a viable alternative to the depletion of natural fisheries; but only if used correctly. We (consumers of the developed world) have to rethink our diets and understand that aquaculture will not be able to continue if it keeps on being practiced in its current way (producing high-value products). Yet as the ancient Chinese have proven, there are ways to make the aquaculture sustainable and we must do something to reverse the trend before it is too late.

Case Study 2: Computer-Aided, Community-Based Water Planning: Gila-San Francisco Decision Support Tool⁷¹

Introduction

There is a long history of struggle over access to water in the arid southwest, and water allocation conflicts in the Southwestern region of New Mexico are no exception. The legislation surrounding water management of the Gila River (pronounced “hee-la”) lasted almost fifty years. Figure 9 shows the map of the southwestern region of New Mexico surrounding the Gila River.

Figure 9: Upper Gila Region Spanning New Mexico and Arizona States. The Three Outlined Basins are Study Regions of the GSF Decision Support Tool. Red Circles Indicate USGS Gauges



The Gila river and its tributary San Francisco river begin in New Mexico, pass through the State of Arizona before merging into the Colorado River. The Gila-San Francisco Basin covers around 9,000 square miles of Southwestern New Mexico. The Gila Wilderness Area, the first designated Wilderness area in the United States, resides in the basin and houses several federally listed endangered species: Southwestern willow flycatcher; Loach minnow, and Spikedace.⁷² The agricultural communities that utilize the surface water for irrigation along Gila riparian region also date back to 1800s before New Mexico Statehood.⁷³

71 This case study is written by Amy Sun, Sandia National Laboratories, USA.

72 Endangered Species List of New Mexico.

73 Soles, E. S. 2003. Where the River Meets the Ditch: Human and Natural Impacts on the Gila River, New Mexico, 1880-2000. Master of Art Thesis, Rural Geography, Northern Arizona University.

Section 212 (d) of the Arizona Water Settlements Act of 2004 (henceforth 2004 AWSA) modified Section 304(f) to allow the Secretary of Interior to contract with water users in the State of New Mexico, with the approval of its Interstate Stream Commission (NMISC), or with the State, for water from the Gila River, its tributaries, and underground water sources in amounts that will permit consumptive use of water in New Mexico. As long as this does not exceed an annual average in any period of 10 consecutive years of 14,000 acre-feet, over and above the current legal maximal consumptive uses granted by article IV of the decree of the Supreme Court of the United States in *Arizona v. California*.⁷⁴ Such increased consumptive use can occur only as long as delivery of water does not diminish water supply for users in downstream Arizona. The stipulations within the 2004 AWSA for which additional consumptive use can occur for New Mexico are known as the Consumptive Use Forbearance Agreement (CUFA).⁷⁵

Table 2: Summary of CUFA Conditions Required for Additional Diversion of Gila-San Francisco River

Test	Type	Description
Annual Total < 64,000 AF (acre-feet)	Cumulative	Sum of Gila and San Francisco total consumptive use cannot exceed 64,000 AF per year.
Annual San Francisco Total < 4,000 AF (acre-feet)	Cumulative	San Francisco annual consumptive use cannot exceed 4,000 AF annually.
10-year running total < 140,000 AF (acre-feet)	Cumulative	Running 10-year total of Gila and San Francisco consumptive use cannot exceed 140,000 AF.
New Mexico CAP Water Bank < 70,000 AF (acre-feet)	Cumulative	The CAP Water Bank, as maintained by the federal agency, must never exceed 70,000 AF.
Gauged flow > Daily Diversion Basis (DDB)	Daily	DDB is the amount of water that the downstream users in Arizona are entitled to and must be satisfied before withdrawal is allowed.
Daily San Carlos Reservoir > 30,000 AF	Daily	San Carlos Reservoir provides water use to its downstream users. Minimum storage amount in the San Carlos reservoir is required before any consideration for withdrawal.
Sum of withdrawal < 350 cfs (cubic feet per second)	Daily	Combined withdrawal of rivers cannot exceed 350 cfs.
Gila Virden gauge > 120% of Duncan-Virden Valley call	Daily	Duncan-Virden valley straddles both New Mexico and Arizona and its daily irrigation requirement must be met. The USGS flow gauge near the town of Virden best indicates Gila River flow near the valley.
San Francisco gauges > Required flow for Phelps Dodge	Daily	This section of the CUFA focuses on the water available for the mining company Phelps Dodge throughout the year.
Gauged flow > Potential flow	Daily	This is a New Mexico mandate which requires a specified minimum flow imposed on the Gila and San Francisco rivers.

CUFA places several constraints under which the water can be diverted from the Gila river, none of which can be violated before water can be diverted. Table 2 summarizes the CUFA constraints. A cumulative constraint is defined as a constraint that does not limit a daily diversion quantity until it accumulates to its maximum legal limit. A daily constraint is a legal requirement that must be met on a daily basis. Understanding the current water supply scenario with added CUFA potential diversion is a major concern for the region.

74 Public Law 108-451, December 2004, Arizona Water Settlements Act.

75 New Mexico Consumptive Use and Forbearance Agreement Among The Gila River Indian Community, San Carlos Irrigation and Drainage District, The United States, Franklin Irrigation District, Gila Valley Irrigation District, Phelps Dodge Corporation, The Secretary of the Interior, and Other Parties Located in the Upper Valley of the Gila River.

More importantly, the 2004 AWSA provides between \$66 and \$128 million in non-reimbursable funds for New Mexico to develop water supply alternatives, including a New Mexico Unit of the Central Arizona Project 2. The NMISC has committed to a continuing process of public information and comment to help arrive at such determinations.

In considering any proposal for water utilization, NMISC will consider “the best available science to assess and mitigate the ecological impacts on Southwest New Mexico, the Gila River, its tributaries and associated riparian corridors, while also considering the historic uses of and future demands for water in the basin and the traditions, cultures and customs affecting those uses.”⁷⁶

Community-Driven Modeling

Prompted by the 2004 AWSA and awareness for collaborative solutions, local, state, federal governmental entities teamed with NGOs to form a collaborative modeling team that focuses on building decision support software for understanding water demand and supply in the Upper Gila region of New Mexico. The process of collaborative modeling has implications that extend beyond Southwestern New Mexico, beyond the borders of the United States, and beyond North America.

The team was formed in 2005 and has continued despite various political and funding shortfalls. The Team met bi-weekly between September 2005 and July 2007 via Web conferencing and conducted face-to-face meetings/workshops every quarter-year during that period. Due to a funding shortfall, the team only met four times between the fall of 2007 and the spring of 2008. Since the summer of 2008, the team resumed its virtual WebEx teleconferences and face-to-face meetings without a facilitator. Because of the lapsed time, the team make-up has decreased from fifteen representations to nine, as shown in Table 2. While it is difficult to pinpoint the cause of loss of memberships, the purpose of the meetings also transitioned from “model-construction” to “model-sensitivities” during those two periods.

One of the advantages of using Web conferencing is its ability to engage geographically diverse team members across this vast rural region. Participation in these meetings is central to understanding user needs, enhancing communication among users, and receiving feedback from team members.

In addition to modeling collaboratively, the team’s feedback on the process is captured in anonymous surveys. Three surveys have been conducted, one in 2006, one in 2007, and one in 2008. The results from these surveys indicate consistent satisfaction with the collaborative process over these years; nevertheless, the impression on the tool varies widely, and there is a general consensus that new membership is required to fully represent the interests in the region.⁷⁷

Gila-San Francisco Decision Support Tool

The Gila-San Francisco Basin is comprised of complex, highly interactive physical and social processes. These systems are continually evolving in response to changing climatic, ecological, and human conditions that span across multiple spatial and temporal scales. A modeling approach based on the principles of system dynamics has been applied to produce the GSF Decision Support Tool. System dynamics provides a unique framework for integrating the disparate physical and social systems important to water resources management, while providing an interactive environment for engaging the public.⁷⁸

Building models using system dynamics is based on a collaboration of ideas and inputs, as well as the feedback loops within each element of the system. “Model building should be a circular process of

76 Excerpt from the New Mexico Interstate Stream Commission Policy on Gila-San Francisco River Basin Planning and Decision Process.

77 Franky, C. E. 2008. Determining Model Robustness within a Collaborative User Framework: The Gila-San Francisco Decision Support Tool,” Master of Science Thesis, Water Resource Management, University of Nevada, Las Vegas.

78 Forrester, J. W. 1990. Principles of Systems. Productivity Press. Portland, Oregon.

creating a model structure, testing behavior of the model, comparing that behavior with knowledge about the real world being represented, and reconsidering structure".⁷⁹ The feedback loops for the GSF Decision Support Tool consider supply-side hydrologic units of surface water supply, and both shallow and deep aquifer supply. The demand side includes industry, agriculture (crop irrigation), cattle, population, and riparian growth.⁸⁰

The GSF Decision Support tool has been designed with the CUFA constraints, with the following goals in mind:

- Given various constraints, how much water is in demand from where, when, and to what purpose?
- What are the tradeoffs among various approaches to managing this water?

In May, 2006, at the face-to-face team meeting, the team then developed a list of variables that they felt would be most influenced by change, or that most reflected uncertainty:

- Demand by category (residential, agricultural, municipal, industrial)
- Instream flow targets
- Population change
- Weather/climate (temperature, precipitation, climate change).
- Vegetation composition (density, type land use change).

The team then selected five key metrics for output:

- River discharge by reach, as influenced by diversion and legal constraints
- Water appropriated versus actual use
- Water in storage
- Management effects on water supply/demand
- Effects on aquatic/riparian species and river ecology.

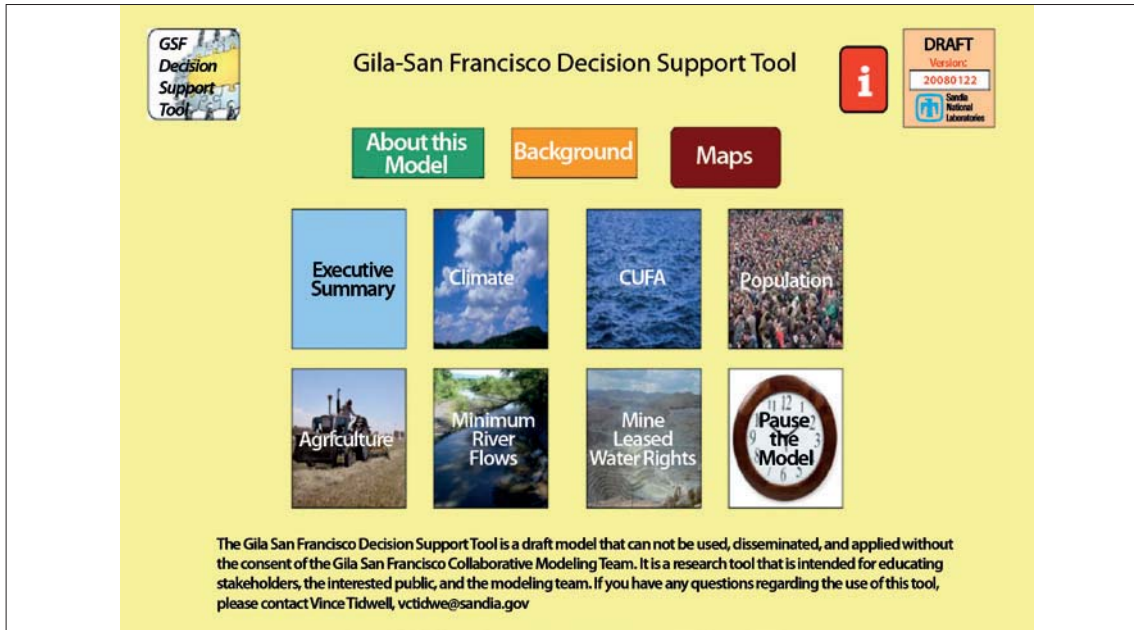
The model requirements and historical use data are painstakingly captured using the PowerSim software.⁸¹ There are several hydrologic components: groundwater, surface water, agricultural and riparian consumptive use, industrial and population demands, and terms of diversion based on New Mexico CUFA terms. Along with the model, the team created a desired list of schema that the stakeholders can evaluate using a user-friendly interface overlaying the model itself. The model homepage is the starting point from which users can select scenarios for Climate, CUFA, Population, Agriculture, Minimum River Flows, and Mine Leased Water Rights. Figure 10 shows the homepage of GSF Decision Support Tool.

79 Forrester, J. W. 1986. Lessons from System Dynamics Modeling. *System Dynamics Review* Vol. 3: pp.136-149.

80 Sun, A., Tidwell, V., Klise, G., Malczynski, L., Peplinski, W. and Brainard, J. 2008. System Dynamics Model of Southwestern New Mexico Hydrology to Assess Impact of the 2004 Arizona Water Settlements Act., pp 1-13. In: Proceedings of the International Conference on System Dynamics, Athens, Greece. 2008.

81 Powersim Software: www.powersim.com

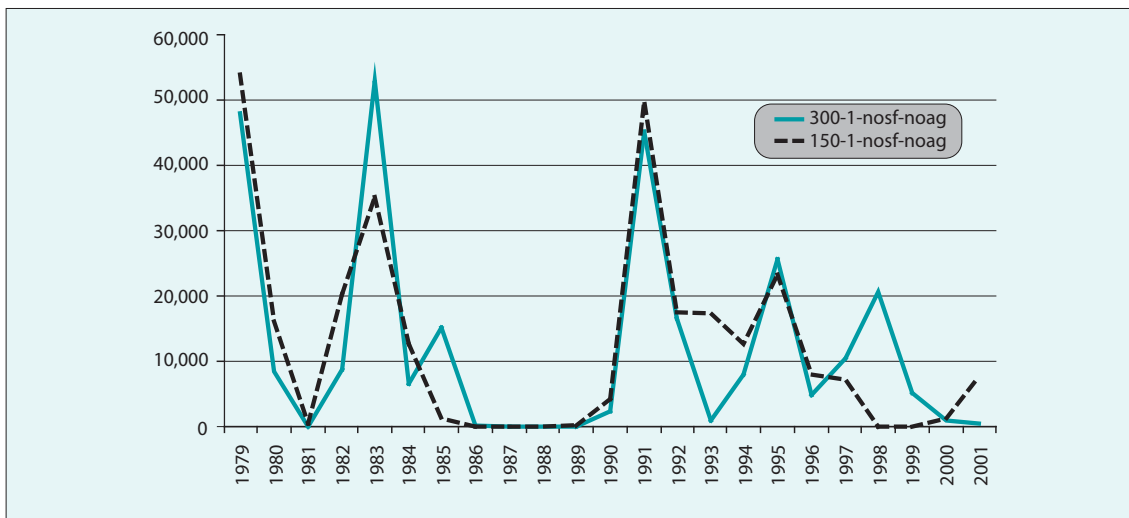
Figure 10: Homepage of GSF Decision Support Tool



Illustrative Result: CUFA Diversion Sensitivity to Minimum Flow.

Model calibration and quantification of water availability under the 2004 AWSA are currently being assessed by the team. As an illustration using historical hydrographs between 1979 and 2001, annual potential diversion from the Gila River is shown in Figure 11. The key insight from the dynamic simulation shows that large year-to-year fluctuations exist. More importantly, there are years where the potential water for diversion is larger even with larger minimum flow requirement. This is counterintuitive to what most stakeholders had envisioned. This is due to the constraints placed on the other CUFA constraints listed in Table 2. The interactions of all of the CUFA requirements restrained diversion potential beyond what the stakeholders had anticipated. Addressing the minimum flow requirement alone may not necessarily reduce the overall diversion potential for surface water diversion. This example demonstrates the often “unintended consequences” exhibited in water policy which only a combination of credible modeling and sound communication can lead to effective water management.

Figure 11: Gila River Water Availability Using 1979-2001 Historical Hydrograph of USGS Gila Gauge.



Blue indicates annual allowable CUFA diversion with 300 cfs minimum flow requirement, black indicates annual allowable CUFA diversion with 150 cfs

(This figure is only illustrative and cannot be reproduced without the permission of GSF modeling team).

Summary

Collaborative, consensus-driven community modeling process enhances the ethical quality while balancing human interests, ecological demand, and natural resources. Use of a computer-aided tool like the GSF Decision Support Tool provides a platform for productive and engaging dialogues. Sandia National Laboratories' technical expertise in providing decision support tools is well suited for creating a neutral, open, and inclusive environment.

The advantages of a collaborative modeling process of the Gila-San Francisco Decision Support Tool is that it provides an overall sense of ownership, integrated planning and enhanced insight. Nevertheless, the modeling process requires longer, iterative cycles that may not coincide with long-term funding. More importantly, the values associated with community learning and decision making are difficult to quantify.

Note: Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Case Study 3: The South-to-North Water Diversion Project in China⁸²

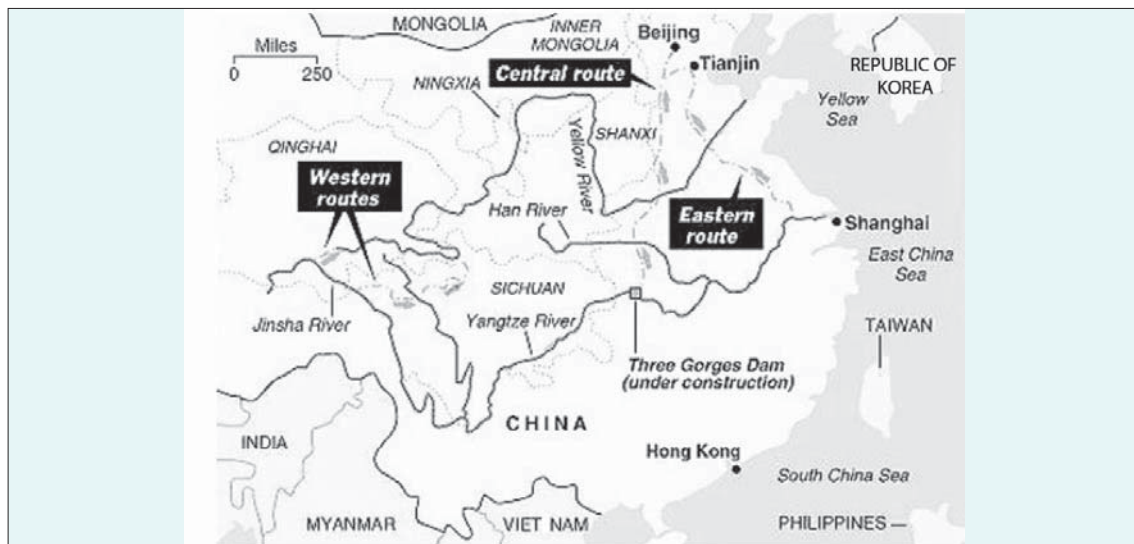
Introduction

China is short in water resources in general, with average per capita occupancy of water resources accounting for merely one fourth of the world's average. Worse still, the distribution of water resources is uneven in the country, which is rich in the south but deficient in the north.⁸³ The North China (Huang-Huai-Hai) Plain area contains about one-third of China's population producing one-third of its GDP and cultivating two-fifths of its farmland. This activity is supported only by less than 8% of the nation's water.⁸⁴

So schemes for large-scale diversions from the water-abundant Yangtze River (Chang Jiang) have been under consideration for over half a century, but because of their cost, complexity, and concerns over their adverse environmental effects, and the higher priority given to addressing flooding concerns on the Yangtze and Yellow River through large dam building, a full commitment to their construction has only recently begun.

The South to North Water Diversion Plan is composed of the Western Route Project, the Middle Route Project and the Eastern Route Project, and was launched in 2002. The project will become the largest civil engineering initiative in Chinese history in both scale and overall investment. It will make a great impact on the whole nation while facing a lot of problems. By 2050, the three-route project will channel 44.8 billion m³ of water from the Yangtze to the drought stricken north. The routes link together four of China's major rivers, the Yangtze, Yellow, Huai He, and Hai He. The four basins constitute one-third of China's landmass and are home to over 700 million people. The Eastern Route Project and Middle Route Project are under construction, and the Western Route Project is still under discussion because of many questions about water availability/deficiency and biological/environmental protection.

Figure 12: General Layout of South to North Water Diversion



82 This case study is written by Xiaohui Lei and Yanmin Huang, the Department of Water Resources, China Institute of Water Resources and Hydropower Research (DWR, IWHR), Beijing; Yu Tian School of Civil Engineering, Tianjin University, Tianjin; and Wei Bai Institute of Agro-Environment and Sustainable Development, Chinese Academy of Agriculture Sciences, and Key Laboratory for Agro-Environment & Climate Change, Ministry of Agriculture, Beijing.

83 http://www.yellowriver.gov.cn/eng/stnwnp/200612/t20061231_12736.htm

84 Nickum, J. E. 2006. The Status of the South to North Water Diversion Plans in China. Rep.No. International Relations, Tokyo Jogakkan College.

The History and Status of South to North Water Diversion Planning

History

The strategic concept of developing the gigantic water diversion project was first put forward by the late Chairman Mao Zedong in 1952, who said: "The south has a lot of water, the north little. If possible, it is ok to lend a little water." In 1958, in a Great Leap era Political Bureau directive, the terms (NanShuiBeiDiao) appeared. Then a project planning office was established in the Ministry of Water Resources in December 1979.⁸⁵ Feasibility and environmental impact studies were carried out in the early 1990s.⁸⁶ During the five decades, the Chinese government studied numerous potential locations and constructed a series of small diversions in six different provinces. Finally, on August 23, 2002 the Chinese State Council approved the three part South-to-North Water Diversion Project and created a limited liability company to oversee operations and management. The project's design integrates the efforts of numerous agencies, including the Haihe Water Resources Commission, Tianjin Hydroelectric Investigation, and the Design Institute (Eastern Route); Changjiang Water Resources Commission (Central Route); and the Yellow River Conservancy Commission (Western Route) (SNWDPT).

Status of South to North Water Diversion Planning

General Layout of South to North Water Diversion Planning

Since the earlier study on South-to-North Water Diversion started in 1950s, the following general layout of South-to-North Water Diversion has been worked out: three water transfer projects, i.e. Western Route Project (WRP) and Middle Route Project (MRP) and Eastern Route Project (ERP) will divert water from upper, middle, and lower reaches of Changjiang River respectively, to meet the developing requirements of Northwest and North China.⁸⁷

The layout is suited to three topographic terraces of the continent of China. The South-North Water Transfer refers to three sets of diversions, the Eastern, Middle and Western routes, each serving separate areas, with the exception of the coastal city of Tianjin, which will receive water from both the Eastern and Middle routes.⁸⁸ Situated in highest Qinghai-Tibet Plateau, WRP can control whole Northwest and North China, but only divert water for Northwest in upper and middle reaches of Huanghe River due to the limited water quantity in the upper reach of Changjiang River. Passing the west of the third terrace, MRP will divert water from middle reach of Changjiang River and its tributary, Hanjiang River, and the water can now travel by gravity to most parts of Huang-Huai-Hai plain. Passing the east of the third terrace, ERP will pump water north due to its lower diversion location.⁸⁹ The Service Areas of all three routes include Jiangsu, Anhui, Shandong, Hebei, Tianjin, Henan, Beijing, QingHai, Gansu, NingXia, Shanxi, Shaanxi, Inner Mongolia. The total diversion water will reach 44.8 bcm or more. The beneficial population will be over 400 million.

The South-to-North Water Diversion is an important strategic measure in the optimization of water resources distribution of China. As the specific geographic location and the limited water quantity of the water providing area, each of the West Route, the Middle Route and East Route has its own rational scope of irreplaceable water supply area, according to the requirement of relative regional economic development, the preparation of pre-construction and the ability of the state finance and other conditions. Portions of the eastern and central system are already under construction, while the western system remains in the early planning stages. The whole project has been carried out in 27 December 2002.

85 Zhang, Y. 2004. Nanshui beidiao shui ziyuan guanli zenma gai (How should we change our water resource management with South-North Diversion. Beijing Qingnian bao, March 2001, pp. 201-207.

86 Shao, X., Hong, W., and Wang Z. 2003. Interbasin transfer projects and their implications: A China case study, International Journal of River Basin Management, V. 1, no. 1, pp. 5-14.

87 <http://www.nsb.gov.cn/zx/english/20081114>

88 *Ibid.*

89 Liu, C. and Zheng, H. 2002. South-to-North Water Diversion Schemes for China. Water Resources Development Vol. 18. pp. 453-71.

Eastern Route Project

This project will divert water from the lower reach of Changjiang north to supply water for the eastern Huang-Huai-Hai Plain with the termination in Tianjin City by raising water in stages through the Beijing-Hangzhou Grand Canal.

There is plenty of water in the lower reach of Changjiang River, with mean annual water of 956 billion m³ entering sea, and more than 600 billion m³ even in an extremely dry year. Therefore, ERP will have enough water to be pumped north, and the water quantity to be diverted is based on the scale of ERP. The rational final engineering scale of ERP was considered in planning. The development level in 2020 was taken as the objective planning scale and the successful diversion of water into North China as the first-stage objective. The water quantities to be diverted in various stages are respectively 8.9 billion m³, 10.6 billion m³ and 14.8 billion m³.⁹⁰

Figure 13: Layout of Eastern Route Project



ERP will supply water for Jiangsu, Anhui, Shandong, Hebei Provinces and Tianjin Municipality. In detail, the receiving areas will include the plain on the lower Huaihe except the hinterland and its east of Lixiahe Region and the northern plateaus in Northern Jiangsu, the areas on both banks of lower Huaihe River from Bengbu City and on both banks of Xinbian River in the east of Huaibei City and parts of Tianchang County in Anhui Province; the areas along Nansi Lakes and Hanzhuang Canal and Liangji Canal, parts of eastern Jiaodong Peninsula, and the northern area which can not be irrigated by the water of Huanghe in Shandong Province, Hebei Province and Tianjin City and its suburbs.

Layout of ERP

ERP will be built on the basis of the existing water diversion project from Changjiang in Jiangsu Province, Beijing-Hangzhou Grand Canal, Huaihe harnessing projects and the other relative projects. ERP will consist of water conveyance system, impounding project, power supply system. Figure 13 shows the layout of this route. The main projects are the water conveyance and the impounding project.

90 <http://www.nsb.gov.cn/zh/english/erp.htm> Last assessed: 2008-10-11.

1. Water conveyance system

The water conveyance system will include the main diversion channel, pumping station, Huanghe-crossing project and the relative treatment projects.

a) Diversion channel

There will be two diversion locations, Sanjiangying where the Huaihe River enters Changjiang and Gaogang where the Beijing-Hangzhou Grand Canal crosses Changjiang. The diversion channel will be 1,156 km in total length from Changjiang to Tianjin trunk route, including a 646 km section in the south of Huanghe, a 17 km Huanghe-crossing section, and a 493 km section in the north of Huanghe. There will be 740 km in a total length of subsidiary routes including 665 km in the south of Huanghe. Ninety percent of the diversion channel will be made for use of the existing river channels. The Beijing-Hangzhou Grand Canal will be the trunk diversion channel. Some subsidiary diversion routes will be added to partial diversion channel sections.⁹¹

b) Pumping station

The topography along the Huanghe River means that the diversion spot will be lower than the surface near Huanghe by 36-37 m. 13 pumping stations are needed to pump water from Changjiang to the southern bank of Huanghe with the total lifting height of 65 m. The water crossing Huanghe can now be moved by gravity to Tianjin. In the south of Huanghe, there will be a stage for Nansi Lakes section, and three stages for each other section. There will be 67 pumping stations with the total installed capacity of 678 MW. 16 existing pumping stations with the installed capacity of 149 MW will be used.⁹²

In the first-stage engineering of 13 stages, 51 pumping stations with the installed capacity of 529 MW will be built. The characteristics of the pumping station of ERP will include low lifting height (2-6 m), large flow (15-40 m³/s for each unit), long operating time (5000 hours/year for the stations in the south of Huanghe). Some pumping stations responsible for water logging drainage will have to be of operating mobility and high efficiency.⁹³

c) Huanghe-crossing project

The alternative of tunneling under Huanghe between Dongping County and Dong'e County of Shandong Province was selected. On the basis of long-term geological investigation and the Huanghe-crossing exploratory tunnel excavation, the relative units have found out the foundation structure and the karst development in the river bed under Huanghe, and solved successfully the problem of leakage control for excavation under the riverbed.⁹⁴

The Huanghe-crossing section is 7.87 km in total length from the outlet of the Dongping Lake to the outlet gate of the north bank of the Yellow River, including a siphon section of 585.38 m. The two horizontal tunnels with the diameter of 9.3 m will be located 70 m under the riverbed of Huanghe. For the first stage of engineering, one of the two tunnels will be driven.

2. Impounding projects

The impounding projects are necessary measures for long-distance water transfer. Along ERP in the south of Huanghe, there are some lakes, such as Hongze Lake, Luoma Lake, Nansi Lakes, Dongping Lake, that can be used as the impounding projects for ERP with the total regulating storage capacity of 4.89 billion m³ through minor reinforcements and alterations. No new impounding project will be needed. In the north of Huanghe, Beidagang Reservoir in Tianjin City can be continuously used, and Tuanbowa in Tianjin City and Qianqingwa in Hebei Province will be extended for use, and Dalangdian and Langwa in Hebei Province will be newly built. So there will be 5 impounding projects with the total storage capacity of 1.49 billion m³ in the north of Huanghe.

91 *Ibid.*

92 *Ibid.*

93 *Ibid.*

94 Zhang, Y. 2004. Nanshui beidiao shui ziyuan guanli zenma gai, (How should we change our water resource management with South-North Diversion). Beijing, Qingnian bao, pp. 201-207..

In accordance with the price level in 2000, the total investment for ERP equals about 65 billion yuan. For the first stage engineering, some 32 billion yuan will be required. ERP will increase supply for Jiangsu, Anhui, Shandong, Hebei and Tianjin with 14.8 billion m³ of water. The ERP completed will basically solve the problems in shortage of water resources in Tianjin Municipality, Heilonggang and Yundong regions in Hebei Province, the north and southwest part of Jiaodong Peninsula of Shandong Province, and make the supplying water for Tianjin available, consequently prompting economic development of Bohai Sea area and eastern Hulang-Huai-Hai Plain, and improving the environment from deterioration caused by the shortage of water. ERP will ensure the annual navigation from Jining to Xuzhou on Beijing-Hangzhou Grand Canal, and make two commodity grain bases in Western Shandong and Northern Jiangsu strong and developed.⁹⁵

Present status

The first stage of the Yellow River Crossing engineering began on 28 December 2007. Figure 14 shows the construction scene.

Figure 14: Yellow River Crossing Project of Eastern Route Project



Source: Xiaohui Lei and Yanmin Huang.

Middle Route Project

The middle Route Project (MRP) for the South-to-North Water Diversion Project will divert water, in the near future, from Danjiangkou Reservoir on the Haijiang, a tributary of Changjiang River, to Beijing City through canals to be built along Funiu and Taihang Mountains. In the future, additional water is due to be obtained from the Three Gorges Reservoir or downstream from the dam on main Changjiang.⁹⁶ The advantages of this project lie mainly in the good quality of the water to be diverted, the greater water-supply coverage available, and that water can be conveyed by gravity. The project will be an important and basic facility for mitigating the existing crisis of water resources in North China.

95 <http://www.nsb.gov.cn/zx/english/erp.htm>

96 *Ibid.*

It has been already 40 years since the earlier stage study on the MRP started in the early 1950s. In these years, Changjiang Water Resources Commission, and other relative provinces, cities, and departments have performed a lot of investigations, plans, designs and research works. In January 1994, the Ministry of Water Resources examined and adopted the “Feasibility Study Report on MRP for South-to-North Water Diversion” conducted by Changjiang Water Resources Commission, and proposed to build this project to the State Planning Commission 8.

Transferable water quantity and scope of water supply

Based on the completion of the Danjiangkou Reservoir extension the annual water quantity to be diverted will be 12.0 -14.0 billion m³, and 6.2 billion m³ for the dry year (95% guarantee rate).⁹⁷ The normal water level of the Danjiangkou Reservoir will be 170.0 m. In accordance with the development level in 2020, some compensative projects will be built on the middle and lower Hanjiang to ensure the development of industry and agriculture, and the navigation and the environment of the water exporting region.

MRP will supply water for Tang Bai He Plain, middle and western parts of Huang-Huai-Hai Plain, with a total area of about 155,000 km². Due to the limitation of water quantity in Hanjiang River, MRP cannot meet all the requirements of planned water supply areas, but only provide water for municipal and industrial use in Beijing, Tianjing Municipalities, and Hebei, Henan, Hubei Provinces, and give consideration to the agriculture and other use of water in some areas.

Benefits of the project

MRP will mitigate the crisis of water resources in Beijing, Tianjin and North China, and increase the irrigated area by 0.6 million ha to 6.4 billion ha for municipal and industrial water supply, and to 3.0 billion m³ for agriculture, for Beijing, Tianjin, Hebei and Henan, and significantly improve the biological environment and investment environment of receiving areas, and boost the economic development in Middle China. Heightening Danjiangkou Dam will increase the ability for flood control of middle and lower Hanjiang and assure the safety of Wuhan City and the plain in the north of Hanjiang.⁹⁸

Table 3: Annual Mean of Water Diversion between Service Areas of MRP

Location	Water Supply (in billion m ³)
Beijing	1.02
Tianjin	1.24
Hebei	3.47
Henan	3.77
Sum	9.5

Layout of MRP

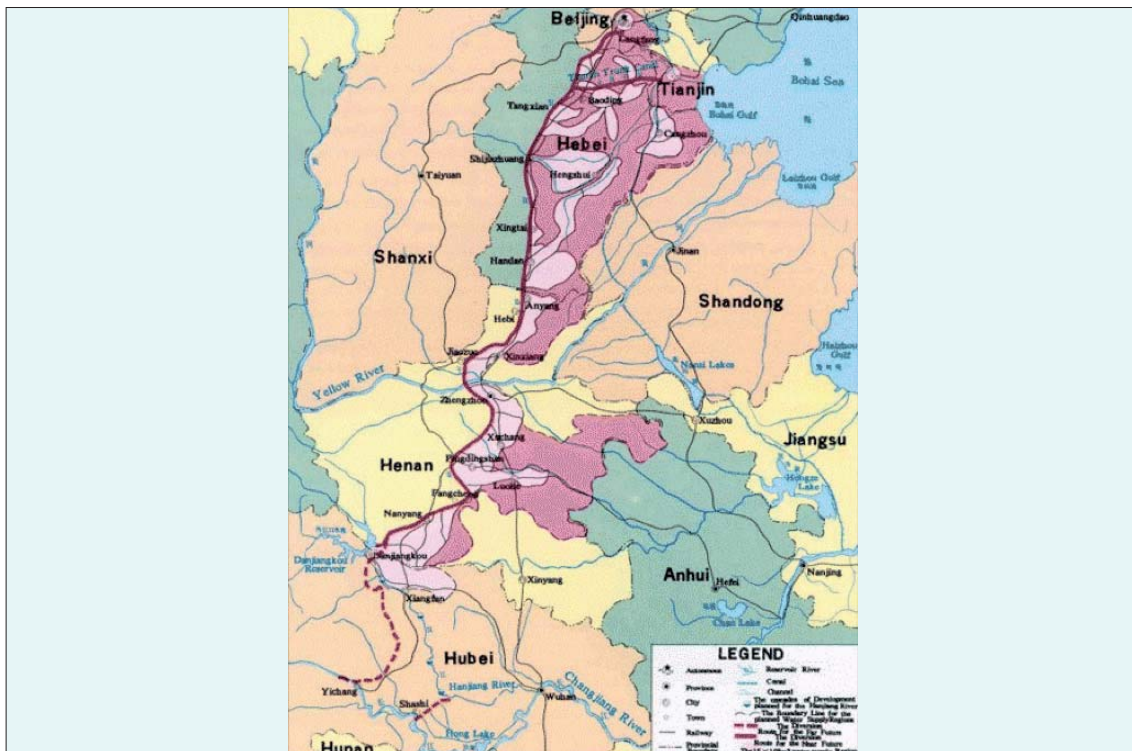
The main works of MRP will be composed of two major parts: the engineering structures in the water source region and the water conveyance systems. The former includes the Danjiangkou Dam Extension Project on the Hanjiang and compensative projects for its middle and lower reaches, and latter includes the main trunk canal for diverting Hanjiang and Tianjin’s main canal.⁹⁹ Figure 15 shows the layout of the Middle Route Project.

97 http://www.yellowriver.gov.cn/lib/top2/2005-08-02/jj_08100211834.html

98 <http://www.nsb.gov.cn/zx/english/mrp.htm>

99 *Ibid.*

Figure 15: Layout of the Middle Route Project



Source: www.maps-of-china.com

Engineering structures in water source region

1. Danjiangkou Dam Extension Project:

Controlling 60% of the total drainage area of Hanjiang River basin, Danjiangkou Reservoir has a mean annual natural runoff of 40.85 billion m³. Taking into account the development of the upper reach, the reservoir was expected to receive a mean annual inflow of 38.54 billion m³. Based on the engineering scale already in place, it is planned to continue to complete the Danjiangkou Project to its final scale, namely, to heighten the dam from its existing crest elevation of 162 m up to 176.6 m, with the design storage level raised from 157 m to 170 m and the total storage capacity consequently increased to 29.05 billion m³.¹⁰⁰ This means to gain, as against the initial figures, an additional reservoir storage capacity of 11.6 billion m³, an increased available regulation storage capacity of 8.8 billion m³ and an extra flood control storage capacity of 3.3 billion m³.¹⁰¹

The normal storage water level of the Danjiangkou Reservoir will be at 170 m in its final configuration, with the additional inundated area of 370 km². In accordance with the investigation in 1992, the main inundation indices are as follows: Earth excavation: 300,000 people; Houses: 7,086 million m²; Cultivated land: 0,01562 million ha.

2. Compensative projects for middle and lower Hanjiang:

To transfer water of more than 14 billion m³ in near future and avoid the available harmful effects on the water use for industry, agriculture and navigation in the middle and the lower Hanjiang Basin, it is required to construct Xinglong or NianpanShan Hydraulic Project on Hanjiang as part of the proposed main river canalization project and a water compensating project diverting water from Changjiang to Dongjianghe, and to modify or extend parts of either the existing sluices and pumping stations, or to build some additional navigation regulating works as well.

100 <http://www.nsb.gov.cn/zx/english/mrp.htm>

101 *Ibid.*

Water conveyance systems

1. Main trunk canal

Since the limitation of the location of the existing canal head at the Fangcheng Saddle on the watershed between the Changjiang and Huaihe Rivers, the range of passing Huanghe, the line of the main trunk canal of MRP in the south of Hulanghe, is clear. As to the main trunk canal in the north of Huanghe, two alternatives have been compared, utilizing the existing river channels or excavating new canals. In accordance with ensuring water quality and realizing of flowing by gravity in the whole route, the latter, excavating new canals, was selected.

The main trunk canal starts at the Taocha canal head, passing the 8 km of the existing channel, northeast along the south side of Funiu Mountain, going through NanYang City and crossing Bait1e River, and will enter the Huaihe Basin by passing the Fang Cheng saddle on the watershed. Then, through Baofeng County, Yuzhou County, and the west of Xinzheng, the main trunk canal will cross Huanghe at Gubaizui in the northwest of Zhengzhou City, the capital of Henan Province, and extend on the North China Plain between the eastern Taihang Mountain and the western Beijing-Guangzhou Railway, and enter the hilly area in Tangxian, and the Beijing Metropolis by crossing the northern Juma River, the Beijing urban district by crossing Yongding River, and terminate at Yuyuan Pool. The total length of the trunk canal is 1,273.72 km.

Tianjin main canal is 140.82 km in total length, from the diversion spot on the main trunk canal in the north of Xiheishan in Xushui County, Hebei Province, to Xihe Sluice of Tianjin. The designed water level at the head of the main trunk canal is 147.38 m, and that at termination is 48.57 m. The water diverted can flow by gravity along the whole main trunk canal.

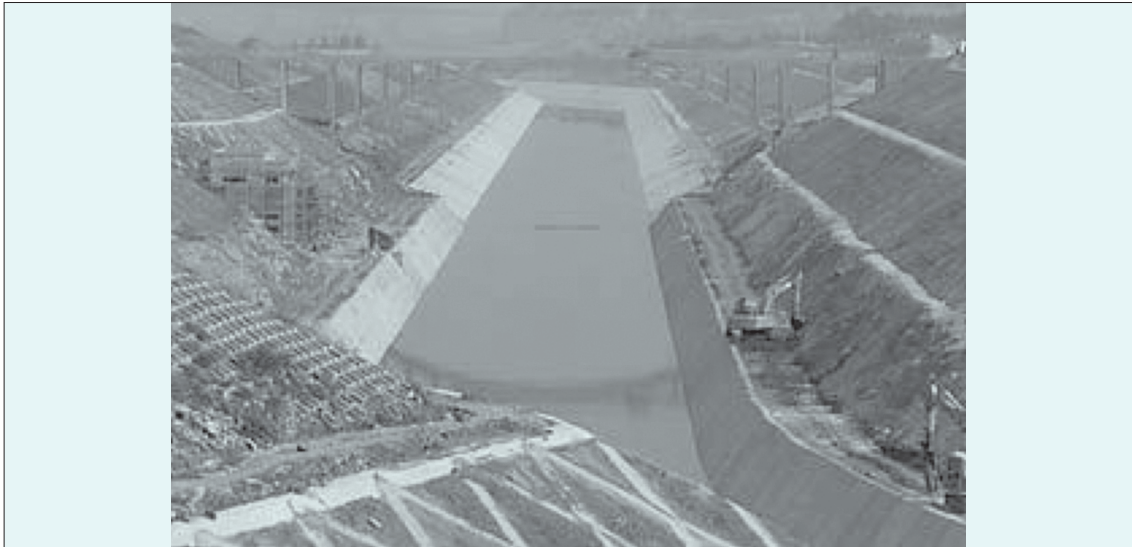
The longitudinal gradient of the canal is 1/25,000 for the sections in the south of Huanghe and 1/30,000-1/15,000 for those in the north of Huanghe. For the purpose of seepage control and roughness-reducing, the whole canal will be lined all along the route with concrete, cement-treated soil, shotcrete facing and the like in accordance with the foundation conditions. The design for the canal is progressively reduced from south to north, with water depth decreased from 9.5 m to 3.5 m, and bottom width changed in the range of 56.7 m.

The engineering geologic conditions and major geologic problems along the main trunk canal have been made clear. As for some local engineering geologic troubles related to bentonite and loess, such as canal slope stability, shock-induced liquefaction failure of sandy soils, earthquake resistance in a high earthquake intensity region, subsiding of underlying coal and mined hollow zones, they all can be readily solved and treated by adopting corresponding measures. Linking up four major river valleys, Changjiang, Huaihe, Huanghe and Haihe, the main trunk canal (including the Tianjin main canal) will have to run across 205 rivers, medium or small, each covering a drainage area of over 20 km², inclusive of the main Huanghe, and 42 railways. It is thus required to build, on the main trunk canal, various structures, small-size, totally 1,774, such as regulating, diversion and tailrace structures as well as tunnels and closed conduits, including 735 canal crossing highway bridges, the largest in scale of which is the Huanghe-crossing project.

2. Huanghe-crossing Project

The main trunk canal will cross Huanghe in Gubaizui under the comprehensive planning of Huanghe Basin. Since its complex problems, and large scale investment, the Huanghe-crossing project will be the most critical structure on the trunk canal. Based on the comprehensive study and comparison among the many alternatives, the aqueduct and the tunnel siphon are technically feasible. Tunneling methods have proven successful domestically and overseas, so it was recommended that the alternative of tunneling at Gubaizui would be adopted in accordance with the canals on both banks. The tunnels crossing Huanghe will be 7.2 km in total length. For it, the designed water diversion now is 500 m³/s. The project includes two tunnels with the internal diameter of 8.5 m.

Figure 16: Photo of Shijiazhong to Beijing Canal on October 2008



Source: CCTV.com.

Investment

There are two key factors controlling the construction schedule of MRP. These are the Danjiangkou Reservoir resettlement and the Huanghe-crossing project on the main trunk canal. In accordance with the price level by the end of 2000, the total static investment for MRP equals to about 117 billion RMB.

Present status

Work started in August 2005 on one of the key components of the middle route, excavating two 3.5 km long tunnels under the Yellow River and is expected to be finished in late 2009.¹⁰² The Shijiazhuang to Beijing section of MRP is finished. From the last golden week, 3 billion cubic meters water will be diverted from Hebei to Beijing by the canal in 2008.

Western Route Project

As the strategic project, WRP will divert water from the upper reach of Changjing River into Huang River to solve the problem of poorer water supply in Northwest and North China. Since 1952 when an investigation team was organized by the Yellow River Conservancy Commission (YRCC), the relative units have done a great number of investigation, planning and research works for more than 40 years. In 1987, the State Planning Commission classified WRP as a project of pre-earlier-stage study, and asked to make a 10-year study to assess the WRP. Since then, YRCC and other relative units have done a lot of basic work in nearby districts that are colder and more remote, with oxygen-lacking water, and submitted the "Preliminary Report on Western Route Project for South-to-North Water Diversion" and the "Findings Report on Yalongjiang Water Diversion Project" to the State Planning Commission and the Ministry of Water Resources for examination. Up to now, the findings on the Tongtianhe River and the Daduhe River Water Diversion Projects have almost been completed.¹⁰³

Transferable water quantity and scope of water supply

In the 1950s and 1960s, it was considered to divert water from Tongtianhe, Yalongjiang, Daduhe, Lancangjiang, Nujiang Rivers. In the last decade, YRCC has focused on studying water transfer from Tongtianhe, Yalongjiang and Daduhe Rivers. In accordance with the initial study results, from those three rivers, the maximum transferable water quantity about 20 billion m³, including 10 billion m³ from Tongtianhe River, upper reach of Changjiang River, and about 5 billion m³ from Yalongjiang, a tributary of Changjiang River, and 5 billion m³ from Daduhe River. The water diverted will be supplied for

102 http://english.peopledaily.com.cn/200411/26/eng20041126_165217.html

103 <http://www.nsb.gov.cn/zx/english/wrp.htm>

Qinghai, Gansu, Shanxi, Shanxi Provinces, and the Ningxia Hui Autonomous Region and the Nei Mongol Autonomous Region.¹⁰⁴

Layout of WRP

Bayankala Mountain lies between the Huanghe River and the Changjiang River. The elevation of the bed of the Huanghe River is higher than that of the correspondent section of Changjiang by 80-450 m. It is necessary for the water transfer project that a high dam will be constructed for damming water or some pumping stations be set up for lifting water, and some long tunnels will be driven through the Bayankala Mountain.

Two methods of water diversion, flowing by gravity and by pumping, were considered. But for each of them, a high dam in height of 200 m or so will have to be constructed and some long tunnels over 100 km in length to be driven.

The preliminary study on water diversion route is as follows.

1) Yalongjiang Diversion Route:

A diversion route by gravity was selected. The Hydraulic Project will be constructed on Changxu reach of Yalongjiang River, the water will be diverted from Changxu to Qiaqinong Ditch, a tributary of Huanghe River. The height of the dam is 175 m, the diversion route is a tunnel, which is 131 km in total length.

2) Tongtianhe Diversion Route:

This is a combining development scenario of the Yalongjiang and Tongtianhe diversion routes. The condition is that the Yalongjiang diversion route must be the priority construction. The Hydraulic Project will be constructed on Tongjia Reach of Tongtianhe, the water by gravity will be diverted from Tongtianhe Project to Yalongjiang River, then, to Qiaqinong Ditch. The Diversion Route is in fact a tunnel, 289 km in total length, including 158 km from Tongjia Dam to Yalongjiang River and 131 km from Yalongjiang River to Qiaqinong Ditch, a tributary of Huanghe.

3) Daduhe Diversion Route:

A diversion route by pumping was elected. The hydraulic project will be constructed on Xierga Reach of the Zumuzu River, a tributary of the upper reach of Daduhe, the height of the dam is 296 m. The water by pumping will be diverted from the Xierga Hydraulic Project to Jiaqu River, a tributary of Huanghe, the total length of the diversion route is 30 km, including a 28.5 km tunnel. The lifting height of the pumping station is 458 m, the mean annual power consumption is 7.1 billion kwh. Figure 17 shows the general map of water diversion route of WRP.

Benefits of project

20 billion m³ water from three rivers will be diverted by WRP to increase the irrigated area by 30 million ha and to supply living and industrial water by 9 billion m³ for Qinghai, Gansu, Shanxi, Shanxi Provinces, Ningxia Hui and Nei Mongol Autonomous Regions, consequently promoting the economic development of the Northwest and inland areas, and improving the biological environment of the Northwest Loess Plateau.

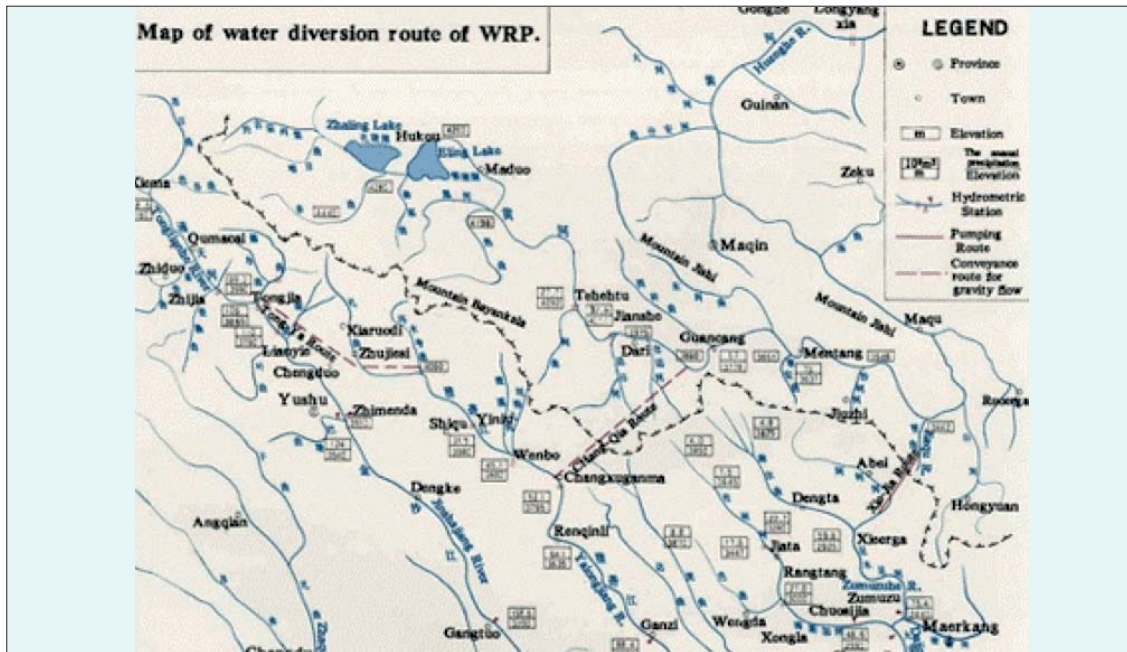
Technical feasibility

WRP will be located in Qinghai-Tibet Plateau, with an elevation of 3,000-5,000 m. For WRP, a high dam with the height of 200 m or so will be constructed, and some long tunnels over 100 km with the burden of hundreds meters will be driven in this very cold area which is also the one of areas with the most complex geological structure. The earthquake intensity of most parts of this area is over 6-7 degrees with the maximum intensity of 8-9 degrees on the modified-Mercalli scale. The construction of WRP with complex technology faces many difficulties of environment.

104 http://english.peopledaily.com.cn/200411/26/eng20041126_165217.html

Currently, since the western route involves the greatest level of uncertainties and complexities, it is required to strengthen earlier-stage studies and scientific research to solve the above problems. The construction is not likely to begin anytime in the near future.

Figure 17: Layout of the Western Route Project



Challenges of the Project and Related Research

The biggest challenges to the diversions are probably not ones of engineering or environment, but of institutions. These include the need to coordinate numerous provinces in an unprecedented way, the need to find an appropriate balance between public and private sectors while this is in flux nationwide, the politically charged nature of increases in water charges to cost recovery levels, ensuring adequate finance, and, more generally, the very real possibility of simultaneous market and government failures.¹⁰⁵

With good reasons, much of the research of the three-route project are focused on water resources management, hydraulic control, and gate/channel control, etc. The research contents of water resources management mainly includes:

- 1) Water resources evaluation, with the methods of traditional water balance or new developed distributed hydrology model that combines the effect of human activity;
- 2) Water resources operation, with the methods of mathematic programming, such as linear programming, nonlinear programming, dynamic programming, etc., or other rule-based methods to allocate the water resources between different water users, now and in the future;
- 3) Decision making support system, with the techniques of software engineering to utilize the models or experts knowledge to give decision support for water resources operation.

105 Nickum, J. E. 2006. The Status of the South to North Water Diversion Plans in China. Rep.No. International Relations, Tokyo Jogakkan College.

Case Study 4: Review on Chinese Water Ethics¹⁰⁶

Introduction

China has been suffering from water shortage since ages. The levels of total freshwater amount and the per capita value are relatively low. Moreover, the country also suffers from water waste, land subsidence due to over-exploitation of underground water, and severe water pollution. To solve freshwater-related conflicts, there have been various efforts from the government. However, big challenges still lie ahead as to how to share water resources between upstream and downstream regions, urban and rural areas and so on.

A case in point is the Yellow River region, where parties concerned are from different administrative areas with diversified geographical features. Different natural endowments and development levels have lead to different (even conflicting) priority schemes in dividing scarce water among domestic, industrial, agricultural, environmental and ecological use. In addition, water rights concern not only humans, but also non-humans. Especially, appropriate water schemes will contribute to poverty alleviation. Here the question of water ethics is raised.

Simply put, water ethics is the ethics towards water, including views people have on the object “water”, and practices people should embrace in managing water. In their effort to “stimulate the implementation of ethical principles in the field of Freshwater”, the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) published *“Best Ethical Practice in Water Use”* in 2004. The report identified several fundamental principles as essential components of best ethical practice in water management, and stated that: “Water management is fundamentally a question of social and environmental justice based on three essential concepts: equity, fairness and access between and across generations” (p.6). The report addressed especially the importance of involvement from locals in the decision making process and opinion formulating.

The significance of local (or traditional) environmental knowledge has been brought up by various scholars. Pena referred to it as a “particular form of place-based knowledge of the diversity and interactions among plant and animal species, landforms, watercourses, and other qualities of the biophysical environment in a given place” (Pena 2005, p.198). Primitive people depend heavily on nature and natural resources, and a harmonized relation with nature is mainly aimed for, and practiced towards. However, in many cases, such knowledge or ethics have been peripherized by mainstream discourse of environmental protection in the modern era. As we can see, unfortunately mainstream practices have not yet brought results in desired pace, as environmental degradation continues and poverty deepens. Could it be that locals, especially in poverty-stricken areas, have different sets of “social time” as opposed to classical “market time”, and that “local dwelling” and “mapping” should resets “outsider mapmaking” (Zhu 2007)?

This paper is based on the thesis that local traditional wisdoms could be of great inspiration to solve water problems we are facing now – above all, locals are most affected by local environmental changes and have established traditions that have brought them through generations after generations. The following section will be devoted to discussing ethics towards water and environmental ethics in a broader frame from more or less primitive people in China (Part 1). “More or less” because they are minorities in China but at the same time three of the largest groups with distinct traditions within China’s 55 minority groups: Tibetan, Mongolian and Muslim Hui groups. A comparison will also be made with Han traditional attitudes towards water. The second part discusses mainstream thoughts from Chinese professionals and experts in the field of ecological and environmental ethics. Part 3 is a further discussion on the dilemma ethnic people are encountering in the modern era. Part 4 will conclude the paper with possible solutions put forward by various academicians.

106 This case study was written by Lilin Yu, PhD student, University of Greifswald, Germany.

Traditional Attitudes Towards Water

As already said above, primitive people depend heavily on their natural environment for survival and flourishing. To them, the importance of water is self-evident. During the hundreds of years of social development, they developed religions and practices of worshiping water and of various ways to protect water resource.

Traditional Mongolian beliefs (Shamanism) said that everything has a soul, including water. In front of the Water God, one has to be humble, grateful and prostrated. Water is of critical importance to the prairie nomads, and many taboos have hence been practiced to protect water, for example ban on bathing or washing clothes in rivers; ban on urinating in water; ban on fetching with bare hands. (Ge, 1997, Jiang, 2004, Ma, 2007) As Tibetan Buddhism spread from the 12th century, they inherited many Buddhist beliefs on environmental protection. For example, according to Liu et al. (2007), Mongolians believe that one should use as little water as one could, because if one uses too much water while alive, he won't be able to cross a sea to reach heaven.

Among Plateau Tibetans – traditionally followers of Bon religion and later Buddhism – belief in the sanctity of water can be best reflected in their worshipping various lakes, like Lake Manasarovar, Lake Namtso, Qinghai Lake and so on. Due to reverence towards the Dragon God, controller of water-related natural forces, Plateau Tibetans dare not nuisance at the lake (spring, river) side, throw dirty things into lakes, or harm animals in water (Suo, 2007). During the period of the Bathing Festival, water in the lakes is believed to have eight advantages: sweet, cool, soft, light, clear, not smelly, good for the throat, and good for the stomach. Such water is also considered to be healing (Nan, 2007).

The Hui people are mostly Muslims. According to the Qur'an, the Prophet created all lives with water, and water is equalized as "sanctity". Many taboos have therefore been established for the sake of protecting water resource. Among them, one deserves special attention: forbidding doing more than twice Wudu and to wash the same body part more than three times before each ritual prayer (Nuerman and Yibulaxin, 2005, P. 367). That is important not only on theoretical but also practical level, especially in view that Ningxia Autonomous Region, which is mostly inhabited by Hui people, is one of the driest regions across China. Such hard natural condition imposes on the Hui people demanding requirements to carefully manage their relations with natural and things within. In a larger picture, wasting natural resources is considered unethical by the Muslims. To the Muslim Hui people, nature has its own laws of birth, development and changes, which human beings should obey (ibid, p. 368).

Water is also highly respected by the majority Hans. In the traditional Chinese theory of Wu Xing ("the Five Elements"), water is the 5th element, which represents inward energy, and is interpreted into "calmness" and "wisdom". From the emperor to local level, water worshipping is closely linked to both paying tribute to dragon and Fei Shui practices (Y. Wang 1995, 94-108). Taoism respects water. As Laozi's very famous saying goes: "上善若水，水善利万物而不争，处众人之所恶，故几于道。居善地，心善渊，与善仁，言善信，政善治，事善能，动善时。夫唯不争，故无尤"(Tao-Te Ching, Chapter Eight). Water is regarded as the embodiment of Dao, and the quiet character of water as the ideal state of life (Yang and Liu 2006). A long-lived life is the goal in Daoism, and the key to sustainable living is the balance of Yin and Yang in dealing with nature and natural resources as well as the harmonization among human, society and nature (Yang and Li, 2005, pp. 254-260). In Confucianism, water is deemed to assemble the characters of being humane, righteous, faithful, honest, fair, meekly, selfless for the public interest, sincere, brave, steadfast, and diligent in action (Y. Wang, 1995). Confucian ecological ethics can be summarized as: "respecting nature and fate, humane and sympathy towards humans and things, saving resources and protecting sources"¹⁰⁷ (Tu 2008). Such ethics is also central in Mencius thinking, which stresses "love for non-human beings", "harvest according to natural rules" and "frugality on utilizing" (Tian 2010).

Generally speaking, traditional beliefs and ritual practices see water as sacred, and primitive traditions are directed towards saving water. What kind of attitudes or positions, then, do professionals and experts hold in the subject matter?

107 "敬天畏命，仁人恤物，节资护源"

Mainstream Thinking on Water Ethics

The field of Environmental Ethics is relatively new in China – only since the 1990s, there have been increasingly translated Western works and works by Chinese scholars. Even since its birth in China, the field has been caught between Western and Eastern philosophical thoughts. Yu Mouchang and Ye Ping are regarded as among the pioneers and advocators of anti-anthropocentric thoughts. On the topic of water ethics, Yu proposed the idea of “river as life, water as partisan” (2006). He assented concepts by ancient philosophers, like those from Laozi, Confucius and Guanzi. He opposed modern industrial culture of “water as valueless”, and proposed a shift in viewing water, and a resulting new model of using water on frugal and recycling principles. Yu, Xu and Lu (2005) also hold that water is a living being, whose free character should be respected. Moreover, according to them, the water ecological system has the right to hold basic water amount – spatially as well as inter-generationally.

The discussion on water ethics is closely linked with that on river ethics. According to Li Guoying (2009), often credited as pioneering the field in China and currently director of the Yellow River Conservancy Commission (YRCC), river ethics has three key points: river is a living being; river has its own natural and inherited values; river has rights, the most foundational of which is the right to life that includes completeness, continuousness, cleanness, and finally holding of basic water amount. Agreeing with Li’s concepts and with a case study on water conservancy projects, Yu Mouchang (2009) put forward four doctrines: fairness, liability bearing, securing and risk avoiding, and interest compensating. From the perspective of water safety, Xing et al. (2006) suggested three principles: (1) water users should participate in water management; (2) deterioration of water environment should be reduced and controlled; and (3) it should be made sure that water supplies to urban and rural areas are save and well-served.

In 2007, YRCC published a series of seven books on river ethics. As introduced in their foreword by Li Guoying, the studies were carried out against the coming of a new concept to manage rivers that centers “maintaining the healthy life of the Yellow River”. “河流生命论” was written by Ye Ping, one of the pioneers alongside Yu Mouchang in the anti-anthropocentric school. In his thesis, a river’s nucleus is its water, the pulse being its flows, and the development being the coordinated evolution between human and nature. The resulting normative practical awareness comes that the health of a river’s natural life should be maintained, which includes:

“1. Construct safety awareness that respects a river’s natural life: “safety” means no danger and no harm [...] It embraces two layers: firstly the safety of the water in a river (including quantitative and qualitative requirements), and safety of the ecological system in a river; secondly safety of a river’s life as compared to that of other creatures, of human beings and of “水圈” system on earth [...]; 2. Respect fairness awareness during ecological process of a river’s natural life: [...], i.e. while making use of a river, the awareness should be established on inter-generational fairness between present and future generations [...], the fairness awareness should be established on resources of human and other creatures [...], the fairness awareness should be established on participation from different groups during the policy making process. 3. Respect the protection awareness of a river’s natural life: awareness of conservatism should be set up [...]; awareness of preservation should be set up [...]; awareness of restoration should be set up [...]; awareness of protection should be set up [...].”¹⁰⁸

“河流伦理与河流立法” (2007) by Cai is another book of the seven books published by YRCC, which focused on how principles of river ethics are reflected in river laws. He tracked the origin of concept of ‘law’ back to ancient Chinese people’s awareness that laws reflect relations between humans and the nature, that laws should be as flat as water and eliminate not straight things or acts. In Cai’s opinion, river ethics aims firstly at a harmonious relation between humans and water:

108 一、构建尊重河流自然生命的安全意识：所谓“安全”，无危为安，无损为安。……包括两个层面：一是河流之水的安全（包括量和质的要求）和河流生态系统的安全；二是河流自然生命相对其他生物的安全、相对人的安全，以及相对地球水圈系统的安全。……二、尊重河流自然生命生态过程的公正意识：……就是在利用河流时，要确立当代人与未来人的“代际”公正意识；……要确立人与其他生物的“资源”公正意识；……[在决策过程中]要确立不同群体的“参与”公证意识。三、尊重河流自然生命的保护意识：确立保持（conservationism）意识；确立保存（preservation）意识；确立恢复（restoration）意识；确立防护（protection）意识……(pp175-178).

“In traditional Chinese culture, “harmony” can be viewed as a “Dao” or “Shu”; it can be “Fa”, or form “Shi”. When harmonious Dao, Shu, Fa, and Shi are followed, governance will be smooth, people be peaceful, the nation be prosperous, and citizens be at ease. [...]. It is built on the concept of mutual prosperity and of a win-win situation between humans and nature, emphasizing the foundation of “human as basis, nature as root” and “human as leading force, nature as foundation”¹⁰⁹

The other three aspects dovetail the three key points by Li Guoying mentioned above. River ethics affects river laws in terms of river justice, river healthy life, water ecological security, distributional fairness, harmony between human and river, and so on (pp.154-158). Among others, “distributive fairness” has a couple of key meanings: fairness in the right to use water, in access to use water, in water amount being distributed, in humanism, in each species’ use of water, and in procedures to distribute water.

In general, mainstream Chinese scholars seem to have more or less unified ideas in the regard of basic water ethics, into which traditional ethics could fit quite well. For example, water as something alive should be respected and well treated. Water as a resource for life and development should be protected against getting polluted or harmed and should be used on the basis of frugality.

The Age of Water Shortage and Dilemma

It is surprising, with the above traditions toward protecting nature, how the environment was destructed to a life-threatening level. What went wrong?

That local traditions have been discarded or peripherized by mainstream practices and the impact of modernization on primitive communities and their traditional beliefs has been often brought up in works since recent times. “阿拉善生态环境的恶化与社会文化的变迁” (2007) was a case study of Min Qin Han people in Alxa, Inner Mongolia by Liu et al. Although acculturation existed bidirectionally between the two ethnic groups, the authors found the stronger Han culture led to the loss of core values of local Mongolians. In comparing the worsening ecological environment as the replay of the Tragedy of the Commons by Garret Hardin (1968), they proposed, above all the reconstruction of core values that favor environmental protection from national, local and personal levels.

There has also been challenge among Tibetans. Nan (2007, pp. 334-348) pointed out that Tibetan religion was being secularized, and attributed the lack of sense of social responsibility as one of the two reasons behind the rapid deterioration of the ecological system on the Qinghai-Tibet Plateau. Therefore, he advocated reviving traditions and renewing them through bilingual education and development of ethnic cultural industry.

Tian Song (2008) found the Naxi people of South China in a similar situation. In “神灵世界的余韵——纳西族：一个古老民族的变迁”, the author discussed in detail the Naxi people’s worshipping “Shu” – usually interpreted as the Nature God (p. 65), and the resulting sense of reverence towards the nature and non-human beings that are regarded as the property of Shu. However, the natural environment in Naxi region was dramatically destroyed. Upon looking at the reason behind the loss of traditional attitudes, the author came to the conclusion that the reason could lie in the loss of discursive right from locals, and that Dongba (or the man of Wisdom) was rendered to be against modern or post-modern discourse of sustainable development, environmental protection, and even deep ecology (pp. 168-172). In his opinion, road, electricity and school are key factors for lost of local traditions (pp. 144-149). To protect and maintain traditions, he suggested a parallel model: to add courses on local culture and knowledge in systemized education, so that traditions regain their discursive right in systemized education (pp. 182-184).

That local traditions could play an important role in environmental protection is also stressed by Zheng in his book “Globalization and Ethnic Cultures” (2005). According to him, in the heart of Dai people

109 在中国传统文化中，“和谐”可以说是一种“道”，也可以说是一种“术”；它既可以表现为“法”，也可以形成为“势”；奉和谐之道，行和谐之术，立和谐之法，造和谐之势，则政无不通，人无不和，国无不泰，民无不安。……它建立在人与自然共生共荣共发展、人与自然双赢的理念上，强调“以人为本，以自然为根”和“以人为本，以自然为基础”的基础上…

(also referred to as “Shui Dai” – Water Dai), water is seen as sacred, from which the sky and the land originated (pp. 181-194). They love and worship water because they believe water can bring them luck and protection in the face of danger. Till today, many villagers still prefer water from wells to that from running water system, because they believe well water, which comes from big forests, is cleaner and more tasty. However, Zheng noted that the devastation of the Dai living environment could be a result from losing traditions: the tradition of protecting the “Dragon Forest”, where water comes from. Believing that water tradition is important for sustainable development, he proposed advocacy of such water culture, recovery of traditional water conservancy system, and active participation of villagers in relevant management.

From the perspectives of local people, their attitudes were also found to be in favour of self-participation in the process. “Water Problems of China – A Sociological Study on Water Resource and Water Management” (Li, et al. 2005) is the result of a project consisted of three major interviews carried out respectively in 2000, 2001 and 2001-2002. On self-financing Irrigation and Drainage Districts in China (p.219-245), questionnaires on public involvement in water management were distributed to farmers of Ningxia, Sichuan, Gansu and Shandong. The researchers found that a new management model is inevitable that bases on autonomous organizations by farmers, and the farmers themselves were more than willing to participate in the process. In conclusion, the authors wrote that farmers needed official systemized management mode, not forced control; a cooperative mode seemed most promising that takes both the autonomous organizations by farmers and government authority into consideration.

In all, as there is much overlapping between traditions and mainstream thinking regarding correct environmental attitudes and practices, efforts should be encouraged to integrate both into legislative and daily practice. Since the establishment of China, various laws and legislations have been passed and put into force, including “水法” (1988, 2002), “水污染防治法” (1984, 1996), “水土保持法” (1991), “防洪法” (1997), “河道管理条例” (1988), “水行政许可实施法” (2005), “黄河水量调度条例” (2006). Although remarkable achievements have been made, there still lies much work ahead, for example, in solving conflicts between legislations, improving implementation, and so on. Also, as discussed above, reviewing relevant educational legislation is necessary.

Conclusion

To conclude, the significance of participation by locals in the decision-making process is not deniable. Such opinions are shared by professionals and experts in relevant fields as well. Only when the interests of parties concerned has been taken into account will the harmonization of human-nature relations be reached, and the environmental degradation be halted.

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