Forest Issues in China

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Ecologically, China's forests are extremely diverse, ranging from tropical moist forest to boreal taiga on permafrost. China's natural forest ecosystems span a wider array of environmental conditions than any other country on earth. Moreover, China is one of the world's most biologically diverse countries and ranks fifth in the world in total forest area (See Table 1). Despite this high ranking, China has had some of the most extensive historic forest losses in the world and is a relatively forest-poor country with only fourteen percent forest coverage. Overall, China has the highest or second highest rate (after Indonesia or India) of threatened species for each major group—e.g., mammals, birds, plants, amphibians, reptiles, and snakes. China's most important biodiversity hotspots are found in the forests of southern and central China. The most intact natural forest areas are concentrated in Yunnan and Sichuan provinces and in the Autonomous Region of Tibet. These forest areas are all considered highly threatened by agriculture, fuel wood collection, and logging by small-scale private timber companies.

On one hand, the degradation of forestry resources in China parallels trends in other developing countries. For example, the loss of natural forests stems from a large use of fuel wood and agricultural encroachment into forests. China's forest sector, however, differs from some trends in developing countries in that the Chinese government has organized mobilization campaigns of public and private resources for forestry and has promoted a high proportion of forestry cover in plantations (See Table 2). These policy actions have led to a reversal of overall forest loss in China, but, as will be discussed below, trends in consumption and production indicate that these past trends in afforestation will not continue.

Table 1. Comparative Forest Coverage Facts

	Percentage of World Forest Area	Percentage of Forested Land in Each Country	Natural Forest (Million Ha.)	Annual Change Rate (%) in Natural Forest (1990-1995)	Plantation (Million Ha.)	Percentage of Annual Increase in Plantations (1990-1995)
Russia	22.1	45	763[a]	n.a.	n.a.	n.a.
Brazil	15.9	65	546	-0.6[b]	4.9	7
Canada	7.1	27	244[a]	+0.1[b]	n.a.	n.a.
USA	6.2	26	212[a]	+0.3	n.a.	n.a.
China	3.9	14	99.5	-0.5	31	5
Indonesia	3.2	55	103	-1	6.1	8
Congo Dem. Rep.	3.1	48	109	-0.7	.04	10

[a]Indicates total forested area. [b]Indicates annual change in total forest.
Source: FAO. *State of World's Forests 1997*. Rome: United Nations Food and Agriculture Organization. 1997.

Table 2. Comparison of Forest Ecosystem and Protected Forest Areas

	Forests as Percentage of Original Forest	Percentage Intact Natural Forest Ecosystem Remaining	Percentage of Non-Tropical Forest Area Protected (Tropical Forests)
Russia	69	29	2 (0[a])
Brazil	66	42	7 (6.9)
Canada	91	57	7 (0[a])
USA	60	6.3	10 (6.7)
China	22	1.8	4 (13)
Indonesia	65	29	21 (21)
Congo Dem. Rep.	61	16	0[a] (7)

Source: World Resources Institute, UNEP, UNDP, and World Bank. *World Resources 1998-99: A Guide to the Global Environment*. New York: Oxford University Press. 1998.
[a]No such forests exist in this country.

Forestry Production and Consumption in China

The economic reforms introduced in 1978 have moved China towards a market economy and opened the country to foreign investment. Following these reforms, China has enjoyed one of the highest economic growth rates in the world with an average 8.9 percent annual GDP growth between 1983-1993. Throughout the reform era, international trade has become a major feature shaping China's forest sector. By 1995, China was the tenth largest importer of forest products and is currently a net importer for nearly all categories of forest products. However, China's overall influence on international forest product markets is still very modest. China's role is largely limited to a buyer in international markets. Currently, China imports less than two percent of its wood requirements, but as demand grows China will increasingly become dependent on imports for all categories of industrial wood products, particularly if the Chinese government drops import quotas on wood, pulp, and plywood if it is admitted to the World Trade Organization.

Although China is now the world's third largest paper producer after the United States and Japan, local production has been unable to keep up with demand. Therefore, paper and pulp board imports increased by 255 percent between 1981 and 1992. These imports come principally from the United States, Canada, and Japan. A majority of Chinese paper comes from non-wood fiber sources (eighty-five percent in 1992), however, higher incomes and recent changes in government trade policy are most likely going to lead to a sharp increase in demand for high quality paper from wood pulp.

Some estimates indicate that by 2010 China will consume as much wood fiber as the United States, although at much lower per capita levels. Paper and paperboard consumption have grown at twelve percent annually for the past forty years. China will have to import approximately one quarter of its wood to meet this growth in paper consumption and industrial wood demand. Nevertheless, China's per capita consumption is and will remain a small fraction of that of the OECD countries. For example, per capita consumption of paper in China in 1995 was about fifteen kilograms, which is approximately five percent of per capita consumption in the United States (285 kilograms). Per capita consumption of paper and wood-based panels in China is expected to increase by as much as seventy-five kilograms by 2010. It is the potential growth in industrial wood demand beyond 2010 that holds significant implications for international timber markets.

Key Forest-Related Environmental Issues in China

Natural forest habitat loss in China is approximately four to eight percent per year. Moreover, as Table 2 indicates, there is little protected forest area in China. The growing problem of deforestation is causing some notably serious environmental problems. For example, deforestation is creating growing problems of soil erosion that

degrades water quality and increases water siltation problems. Dams in China have a 1.5 percent sedimentation rate per year, which is due in great part to the lack of forest cover. High rates of species endangerment is also a directly linked to forest loss.

Like many developing economies, fuel wood and charcoal dominate wood use—China ranks first in the world just ahead of Brazil in this kind of wood consumption. The trends in fuel wood and charcoal use will have a major impact on how much of these products China will need to import to meet future demands. Aggressive plans to increase electricity generation from coal will likely lead to a decline in the use of fuel wood, but with significant adverse impacts on air pollution and greenhouse gas emissions.

Government Forestry and Biodiversity Policies

The Chinese government is taking a number of steps to expand supply and manage the demand of forest products, including extensive investment in a wide variety of afforestation programs and the promulgation of new regulations encouraging conservation and substitution. The PRC has a long history of tree-planting and is the world leader in investment in afforestation.

During the Mao era (1949-1976), short-term tree-planting campaigns "by the masses" was the dominant forestry policy strategy. Such campaigns led to a large number of trees planted, but most died due to lack of care and maintenance. In a similar vein, the post-Mao regime established the Obligatory Tree Planting Program in 1981, which calls on citizens to plant three to five trees per year. In 1994, 490 million people planted 2.5 billion trees, but survival rates are thought to be quite low. A more organized and better maintained tree planting campaign has been the Three Norths Shelterbelt Project. This project, also referred to as the Great Green Wall, is a vast network of shelterbelts designed to combat soil erosion and desertification from Heilongjiang to Xinjiang. This ecological screen against desertification in northwestern and north central China has led to the planting of approximately twenty-three million hectares of trees. Under another related project—the Desert Protection Project—2.2 million hectares of forest has been planted since 1992 in twenty-nine provinces. While these shelterbelts have stopped severe erosion problems, they are susceptible to insect infestation, for only one species of tree was used.

While the relative success of these programs is widely debated in the policy literature, in the reform era, the central Ministry for Forestry and the provincial forestry departments are increasingly effective technical agencies that have successfully implemented large-scale, complicated afforestation programs. The Chinese government expects to increase the forest cover from 13.6 percent to 15.3 percent of total land area by 2000. The current Chinese government development program for forestry is supported by a relatively sound policy framework—including more secure land tenure, market-based resource pricing for about ninety-five percent of all timber, and increased an emphasis on private sector activity. Much of the previously communal forests have been given to households with a fifty-year lease for land-use rights. Policies to encourage the substitution of metal and concrete for scarce wood resources combined with the official goals of planting an additional sixty million hectares of forest over the next twenty years may succeed in increasing the number of plantations, but would most likely be unable to keep up with consumption growth.

On a biophysical basis, there is considerable capacity to increase forest area in China. However, given that China already has one of the lowest agricultural land base per capita of any country, it is questionable whether expansion of forest areas accomplished during the past forty years can be sustained. Moreover, the overall positive trends in forest cover in tree plantations mask the continuing loss and degradation of rich natural forest ecosystems. Tree plantations cannot replace the biodiversity and ecosystem processes and functions of the natural forests. The rapid increase in demand for wood products has led to a decline in standing stock (timber volume) as mature trees are intensively harvested.

In light of these forestry losses and the huge demand for wild animal derived aphrodisiacs and pharmaceuticals, especially in southern China, a strong biodiversity policy is needed. In the international arena, China has not played a major role in shaping international forest-related policies such as the Convention on Biodiversity, CITES, and the International Panel on Forests. On such international accords, China tends to support the views of many developing countries, namely that industrialized countries should provide technology and financial support to developing countries in order to promote forestry conservation and biodiversity policies. Domestically, China has taken the Convention on Sustainable Development seriously and has already completed their Action Plan. While forestry policies fall clearly under the jurisdiction of the Ministry of Forestry, a clear mandate for a national biodiversity strategy does not yet exist, for State Environmental Protection Administration (SEPA), the National Academy of Sciences and other ministries have

all proposed competing biodiversity strategies.

In response to massive flooding problems, the Central government has periodically banned logging in various provinces. The increase in financial and administrative authority at the provincial level, however, limits the central government's power to enforce such bans. The provincial government in Heilongjiang has been apparently very strict in the forestry ban, for they have relocated 55,000 people who previously relied on these forests. Instead of totally banning logging, the central and provincial governments need to push better harvesting techniques on its forest industry and allow more non-governmental organizations to help monitor in this area.

World Bank Programs

The World Bank has provided five loans/credits totaling $804 million, one GEF grant of $18 million, and one Institutional Development Fund Grant over the 1990s to enhance forest productivity, resource-use efficiency, and institutional capacity for sustainable sectoral management. The China forestry program is the largest in the World Bank. It is also the largest forestry investment by any donor in one country. The specific World Bank operations during the 1980s-1990s include:

- The Forestry Development Project ($47 million IDA credit) approved in 1985 and closed in 1991;
- the Daxianganling Forest Fire Rehabilitation Project ($57 million IDA credit) approved in 1988 and closed in 1994;
- the National Afforestation Project ($300 million IDA credit) approved in 1990;
- the Forest Resource Development and Protection Project ($200 million IDA credit) approved in 1994;
- the Nature Reserves Management Project ($18 million GEF grant) approved in 1995; and,
- the Forestry Development in the Poor Areas Project ($100 million IDA credit and $100 million IBRD loan).

By the late 1990s the World Bank began to shift its lending rates for China's forestry sector to the commercial rate of seven percent with a twenty-year repayment period. Such terms will be very difficult for the Chinese government to finance and most likely signals a marked decrease in World Bank funded forestry projects in China. The Food and Agriculture Organization has been involved in a regional fuel wood project in China that is promoting higher efficiency fuel wood stoves.

There is a growing investment in wood processing by foreign private investment, mainly by overseas Chinese. Most of the $30-75 million in private wood processing investment has been done along the coasts, but it may not be promoting sound environmental techniques or new technology transfer.

China's Food Security

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Food security has long been a central concern of the Chinese government and citizens. To strengthen food security, the Chinese government has stressed the need to be self-sufficient in grain. Some western researchers, although hindered by a lack of data, have predicted that water scarcities in China represent a major obstacle to maintaining grain self-sufficiency. Scenarios for water scarcity range from predictions of a grain hungry China importing massive quantities of grain and causing world food prices to soar to predictions of China altering its food production patterns and importing moderately from the world grain market. Other challenges to expanding grain production include the diminishing returns and pollution from fertilizers and the government's inability to maintain grain subsidies. Gathering additional data on China's water consumption, land, and fertilizer use will help improve predictions of Chinese food security as well as highlight opportunities for U.S. cooperation.

Water scarcities in Northern China are the greatest in the country. For example, groundwater on the North China Plain has been dropping 1.5 meters for the last few years and if this speed of extraction continues, water conflicts will become a potentially explosive problem. In the Yellow River Basin a potential political conflict among provinces is also unfolding. The Yellow River, which flows through eight provinces as it winds to the sea, ran dry in 1972 and since 1985 it has been running dry for part of each year. The situation worsened in the 1990s and in 1997, the river failed to reach the sea for seven out of twelve months of the year. The long unresolved question has been how this river's water will be allocated among the provinces. Upriver provinces have plans to divert water for hydroelectric power and for fueling city growth. Building huge reservoirs for hydroelectric generation leads to a significant loss of water through evaporation. Beijing has decided to allow the upstream provinces to divert more water to enable them to develop industry in the country's interior and create as much employment as possible. The logic for this decision most likely stems from the fact that the central government no longer transfers as many resources from east coast provinces to fund development in the interior. This decision to favor upstream urban growth, however, has meant a sacrifice of irrigated agriculture in the lower reaches of the basin. It was a logical decision to make this choice to create jobs, but notably this action contradicts the government's longstanding "agriculture first" policy. The growing water shortages in the north have also led to a serious reconsideration for the construction of a gigantic water transfer project to bring water from the Yangtze River in Southern China.

In addition to regional water shortages, rapid economic growth in China over the past twenty years has increased competition for water among sectors. Specifically, the urban and industrial sectors are pulling water away from the agricultural sector. This trend will continue as China industrializes further, for it is increasingly uneconomic to use scarce water on agriculture. A hypothetical example illustrates this point: with 1000 tons of water one can produce one ton of wheat which can be sold for $200. If this same amount of water is used to expand industrial production one could earn $14,000. With a 70:1 ratio, it is clear that if a country is concerned about job creation and profits, water should not be put into agriculture.

Since economic reform began in 1978, agricultural production teams were broken apart and farmers were given long-term leases on their land. These institutional changes combined with chemical fertilizer use led to a rapid growth in grain productivity. Between 1978 and 1984, grain production grew from 199 million to 306 million tons, but in the 1990s this rise in land productivity slowed. When economically dynamic, water-scarce countries, such as Israel, Jordan, and Saudi Arabia, surpassed the limits of water supply necessary to produce self-sufficient agriculture and industrial growth, these countries began to import seventy to eighty percent of their grain. These imports allowed water to fuel the growth of cities and industry. Nonetheless, the size of China's population prevents it from following this model, for there is not sufficient grain on world markets to feed China.

While fertilizer has been an important factor in raising grain harvests, Chinese farmers are now reaching a point of diminishing returns in fertilizer use. Farmers in the United States hit this limit in the mid-1980s and since the mid-1990s, U.S. farmers have been using less fertilizer. China is using the same area of cropland as the United States, but significantly more land is irrigated in China. Every year, Chinese farmers use thirty-three million tons of fertilizer, while farmers in the United States use twenty-one million tons annually. In the United States each kilogram of fertilizer produces fourteen kilograms of grain, while Chinese farmers produce twelve kilograms for each

kilogram of fertilizer. Currently, most farmers in China use nitrogen-bicarbonate, which is a very inefficient fertilizer. Increasing effectiveness of fertilizer use in China is therefore quite limited. The principle gains in crop production will be achieved if China attains a better balance in chemical nutrients in fertilizer as opposed to simply putting more fertilizers on the crops.

Monsoon rain cycles have lessened even the most agriculturally productive areas. For example, Shandong Province has a very productive multi-cropping system with winter wheat followed by summer corn. In Shandong, wheat stays in the ground until June and corn is planted in July in order to be fed by monsoon rains. With such later planting of the second crop, it is difficult to produce large amounts of corn. In theory, crop yields could be increased by irrigating more areas, but this would be difficult, for in the water-rich south almost all available land has been irrigated and in the north there is insufficient water to expand irrigated area. In fact, without considerable conservation actions, there will be dramatic drops in irrigated area in some northern river basins, such as the Hai River Basin. Water from precipitation and ground water resources no longer meets demands in the Hai and the Yellow River Basins, which include some of China's most fertile wheat-growing lands.

Grain pricing is another key issue that will impact domestic grain yields in China. The central question is: what price level will be required to keep people on the land and to keep marginal lands in production? Grain prices were raised in late 1994 by forty-two percent in an effort to encourage production, which it succeeded in doing. These price supports, however, exacerbated the central government's fiscal debt. This led Beijing to create a tax law demanding more money from the provinces, as well as a push by the central government for provinces to support the grain prices. In an examination of Taiwan and Japan, the strain on state coffers is phenomenally high. Price supports in Taiwan have succeeded in keeping a balance between urban and rural incomes, but had occurred at a high cost to the state. The reform movement in China to cut subsidies and devolve fiscal authority raises the question whether the Chinese central government could even come close to sustaining such price supports.

The inability to maintain higher grain supports and the loss of irrigation levels caused by water scarcity are factors that will directly affect future grain productions in China. Some calculations by the U.S. government indicate that China will need to import 175-365 million metric tons by 2030. It is doubtful that China will ever import anywhere near that scale, for such a magnitude of grain will not be available on the world market. The principle grain exporting countries and regions (e.g., the United States, Argentina, and the European Union) exported sixty million tons in 1960 up to 200 million metric tons in 1980. Export rates have remained at approximately 200 million tons per year since 1980.This leveling of exports stems both from the fact that no strong growth in demand for grain has occurred in the 1990s and the inability for exporting countries to increase grain yields. The United States, for example, has not been able to increase their exports even during the last two years when U.S. farmers brought back into production land that been set aside. Some conservation land could be farmed sustainably to increase grain production, but there are no foreseeable technological changes that could increase these yields. In an examination of India and other countries facing severe limits on water supply, it is clear that projected growth on imported grain will increase considerably in the coming decades. It remains unclear, however, whether exporting nations can raise their exports to meet this potential demand from China. The last half century was dominated by falling grain prices and the next half century will most likely be dominated by scarcity of grain and falling grain supply.

Can China Feed Itself?

Lester Brown's 1995 book, *Who Will Feed China* (W.W. Norton 1995) was one of the catalysts for a group of U.S. federal agencies and the Harvard University China Project to conduct a study of the agricultural sector in China. The study examined only grain, so village gardens, forest agriculture and aquaculture, which are significant contributors to China's food supply, were not included. This study included work to estimate the quantity of arable land and freshwater availability and employed a United States Department of Agriculture (USDA) model to make projections and examine seven scenarios of agricultural supply and price in China. The analysis of these estimates and modeling highlighted some potential policy recommendations.

The major implication from this study was that there does not exist fundamental resource and technological constraints on China's ability to feed itself. Moreover, the study indicates that China's demand for grain will stretch, but not completely overwhelm the world grain markets. All the scenarios indicate that world food prices for grain will go up approximately five percent in real terms, which is not as great as some western analysts had originally assumed. Imaging satellites have estimated that China's

cultivated land area was between 133-147 million hectares (.95 confidence interval). This mean of 140 million hectares is forty-seven percent greater than the official Chinese statistics, which, notably, have been the statistics used previously by western analysts to apprise China's food security. This information underlines that yield per hectare in China is even lower than previously assumed.

The study also indicated that the need for additional grain to feed livestock may not be as great as initially predicted, for official Chinese government data on livestock appears to be overstated by twenty to forty percent. This has occurred because local government officials overstate their numbers to appear more successful than they actually are in order to receive awards from the central government. In light of the fact that fewer animals exist, the estimates for corn needs in China should be reduced significantly.

Implications of the Study for the United States and China

One recommendation from the study suggests that China shift its current requirement of achieving ninety-five percent grain self-sufficiency to one of food self-sufficiency. This could then lead to farmers who use more land to grow high value, labor intensive crops such as fruits and vegetables to sell on the world market and earn sufficient money to buy grain. Grain prices would then be lower and China would have sufficient food, which would promote social stability. Such a food strategy would be better for China's environment as well, for marginal lands would not have to be used for grain, which would decrease some erosion problems. Moreover, fruit and vegetable crops would conserve water, for they are less water intensive.

Every year, China and the United States consume 390 million and 240 million tons of grain, respectively. Both of these countries have the potential to effect the world food balance. Agriculture production can be a productive area for dialogue between the United States and China. Both the United States and China face similar agricultural problems, which means the two countries could hold a dialogue on this topic as equals. Discussions of research and development to solve agricultural problems in both countries could emerge as a building block in the U.S.-China relations. The food debate in China is changing, for there is an increasing openness and acceptance of foreign information and advice on this issue. For example, three years ago *Who Will Feed China* could not be legally sold in China and now it is being advertised on television. While agriculture is not as sensitive as topics such as human rights and carbon emissions, the Chinese government is sensitive about certain food issues. For example, suggestions for the central government to lower subsidies to grain markets and import our cheaper grain will raise tensions. The Chinese are concerned about the use of food as a weapon. Conversely, the United States also has a concern that Chinese demands on the world grain market would cause large fluctuations from year to year. Cooperation on water management issues could be one mutually beneficial area of cooperation, for both countries could improve their efficiency in water use. In China, water pricing policy reforms could produce significant savings in water, particularly in the dry north. Another common challenge for both countries is the loss of some of the most valuable cropland to urbanization.

Cooperation on agricultural research is another promising area for cooperation. In the United States, research is examining how to use biotechnology to increase yields and decrease the use of pesticides. For example, one solution might be breeding seeds with genes that enable plants to defend themselves. Chinese researchers and policymakers are interested in using non-pesticide necessary crops in order to lower the demand for pesticides, but the quality of Chinese research equipment is lacking in this area and they will need investment in order to make progress in using biotechnology to increase yields. China has one of the lowest agricultural research intensities in the world, below the quality of many less developed countries. If research and development in biotechnology and other areas could be increased, significant improvements in food yields in China could be made.

Conservation and Pollution of Water Resources in China

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The uneven distribution of water resources in China—a dry north and water-rich south—combined with growing water pollution problems are posing significant threats to economic development and quality of life in some regions of the country. Estimates by the Chinese Academy of Sciences place economic losses from water shortages in urban areas in northern China to be as high as U.S. $24 billion in 1997, which equals three percent of China's GDP. In light of these problems, Chinese policymakers are exploring a variety of conservation and pollution control strategies.

Water Shortages

In 1985, 236 cities in China had a daily shortage of twelve million cubic meters a day. A mere six years later in 1991, 300 of the existing 622 cities in China were suffering from water shortages by a total of sixteen million cubic meters a day. Although construction of water supply infrastructure to cities has grown considerably in the 1980s and 1990s, it is expected that by the year 2000 water shortages of twenty million cubic meters a day will be experienced in 450 cities. The current water shortages in urban areas adversely impact forty million city dwellers.

Exploitation and Conservation of Water Resources

Similar to early water development projects in the United States, the People's Republic of China has pursued a water supply strategy by building dams, particularly in the 1950s and 1960s. In the 1980s and 1990s, numerous water diversion projects have been constructed to provide water to the expanding northern cities, such as Tianjin, Qingdao (Shandong Province), and Shijiazhuang (Hebei Province). These water diversion projects, which divert water from rivers up to 200-300 kilometers away, were undertaken in order to halt the over pumping of local groundwater resources. Notably, the long-debated South Waters Northward diversion project, which would divert water from the Yangtze River in southern China to the dry north, has been recently approved.

Despite the continuing dependence on projects to increase water supply, demand management measures are increasingly being adopted in China, because new water resources have become more difficult to find. The fact that groundwater sources around cities have become severely depleted—groundwater sources near northern cities fell ten to thirty meters in the 1980s—has also prompted the push for water conservation and demand management. One very promising area for water conservation has been to improve water-use technology and equipment in certain high-use industries, such as steel, paper, and crude oil refining. These industries use 500-700 percent more water per ton of product produced than similar industries in developed countries. For example, steel industries in China use thirty to seventy cubic meters of water for every ton of steel while the rate is five to ten cubic meters per ton in developed countries. Efforts in the area of water recycling also represents a large potential saving of water. Currently, the average rate of water recycling in Chinese industries is only thirty percent nation-wide. Notably, some cities in the north have enforced a much higher rate (e.g., fifty percent in Beijing, Tianjin, and Xian; seventy percent in Qingdao; and seventy-five percent in Dalian). Efforts to increase wastewater recycling have also decreased wastewater discharge significantly. For example, in 1980 the production of 10,000 RMB worth of goods used to generate 470 m^3 of wastewater, while in 1995 this level of production only generated 130 m^3 of wastewater.

Water consumption in urban areas has grown as a result of growing population and prosperity. Some cities have also begun to install water meters and institute water charges for domestic water use. Not surprisingly, water consumption greatly drops in metered homes. Some cities, such as Beijing have instituted heavy water pricing and quota systems for industries and other organizations, for the city is so water short that the annual average water reserve per person is merely 460 cubic meters per person, which is one-fifth of the country's average. Per capita water resources available in Beijing are one-thirtieth of the world average for cities in the world. Since 1980, more cities have constructed water saving or water recycling projects and the water discharge rate has been reduced from 470 cubic meters in 1980 to 130 cubic meters in 1995.

Pollution of Water Resources

A survey conducted in 1984 indicated that of 1,200

rivers, 850 (seventy percent) were polluted. A total of 230 of these rivers were heavily polluted and unable to be used for irrigation, drinking or fishing. A more recent survey reveals even more serious pollution levels. In 1995, more than one-third of all rivers and over ninety percent of rivers surrounding urban areas were polluted. More than fifty percent of water sources did not meet the standards of potable source water quality. Table 1 presents an overview of low water quality of six major river systems in China. Levels I and II represent the cleanest quality of water sufficient for human consumption. Notably, fifty-eight percent of rivers near urban areas are severely polluted (level V and greater). Groundwater sources surrounding cities are also severely polluted. In addition to river pollution, groundwater pollution has also become quite severe. As early as 1983, a survey of eight cities found that all groundwater sources were polluted to some degree.

Strategies and Policies for Drinking Water in China

In light of the severe pollution of water and groundwater resources, the Chinese government has adopted a broad policy strategy to improve water quality. These strategies include:

- Expanding number and capacity of municipal wastewater treatment facilities;
- Controlling industrial pollution sources;
- Utilizing sewage irrigation projects, fish farming ponds, and wetland filtration systems;
- Developing effective river basin management; and,
- Controlling non-point pollution sources.

Municipal Wastewater Treatment Facilities

To protect drinking water sources, it is imperative for China to speed up the construction and operation of new municipal and industrial wastewater treatment plants. Chinese municipal planners have been focusing on the development of large-scale municipal wastewater treatment plants, which are more economic and efficient than the construction of many small treatment plants. The number of municipal waste treatment plants in China has grown from thirty-seven in 1978 to 135 in 1996. Despite the significant increase in the number of treatment plants, most municipal wastewater still is not treated—1.4 percent of wastewater was treated in 1978 and only 13.1 percent was treated in 1996.

Industrial Wastewater Treatment

Rules promoting industrial wastewater management strategies have increasingly been enforced in urban areas in order to eliminate wastes before entering municipal water treatment plants. The industries being targeted for wastewater management include food processing, textile

Table 1. Pollution Data of Surface Water Systems in China—1996

Class of Surface Water Quality	Yangtze River	Yellow River	Pearl River	Huai River	Hai River	Liao River	River Reaches in Urban Areas
I or II	32.2%	8.2%	49.5%	17.6%	39.7%	2.9%	0% (I)
III	28.9%	26.4%	31.2%	31.2%	19.2%	24.3%	23.3% (II and III)
IV or V	38.9%	65.4%	19.3%	51.2%	41.1%	72.8%	18.8% (IV), 19.6% (V)
Over V							38.4% (>V)
Main Pollutants	NH_4–N COD_{MN} Phenol	NH_4–N COD_{MN} BOD Phenol	NH_4–N COD_{MN} Arsenic	NH_4–N COD_{MN}	NH_4–N COD_{MN} BOD Phenol	NH_4–N COD_{MN} Phenol Cyanide Copper Mercury	Petroleum COD_{MN} TSS

Source: Wang Baozhen and Wang Lin. 1998. *Conservation and Pollution Control of Water Resources in China*. Unpublished Manuscript. Water Pollution Control Research Center, Harbin University of Architecture and Engineering. Harbin, China.

dying, printing, iron, steel, chemical, pulp, and paper plants. Approximately 40,000 industrial wastewater treatment facilities have been built and put into operation in the late 1990s. Most of these facilities have been constructed without foreign technology and equipment.

Natural Filtration Systems

Sewage irrigation projects have been increasing rapidly in China since the 1960s. In 1963, a total of 42,000 hectares were supplied by sewage irrigation projects, but by 1988 the amount of land irrigated by such projects leapt to 2.8 million hectares. Such projects use irrigated fields as a filter for wastes, which can improve soil quality and increase grain yields. As the amount of industrial wastewater has increased, however, sewage irrigation projects have increasingly led to the deterioration of farmland from toxins and to the contamination of groundwater resources. For non-industrial wastes, such as manure, China has used fish farming ponds and duck and geese ponds to process these wastes. There are approximately 100,000 such ponds in rural areas that receive and treat manure and sewage from nearby villages and towns. In urban areas and industrial districts there exist nearly 1,500 natural or artificial ponds to receive and treat municipal and industrial wastewater. Such ponds are used in conjunction with modern wastewater treatment plants or irrigation farmlands.

Because construction of wastewater treatment plants cannot keep pace with the growth of pollution, in the 1990s various municipalities and provinces have experimented with utilizing natural wetlands as sewage filtration systems. Such wetland systems (both natural and constructed) have proven effective in removing Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), as well as heavy metals, phenol, and cyanide. These wetlands are viewed as a promising and appropriate type of wastewater technology in China. Some examples include:

- Tianjin City uses a natural wetland area of 150,000 hectares, which should expand, for the Tianjin Environmental Protection Research Center has been conducting pilot studies on various types of wetland filtration systems.
- Heilongjiang Province contains a total natural wetland area of six million hectares.
- Shenzhen City (Guangdong Province) has built and operates a 140-hectare wetland system for treating domestic wastewater.
- Rongcheng City (Shandong Province) has been successful in utilizing a 200-hectare of semi-constructed wetland system to treat municipal sewage and pulp and paper mill effluent.
- Shouguang City (Shandong Province) built a 150-hectare wetland in 1996.
- Jiaonan City (Shandong Province) built a 120-hectare wetland in 1997 and has reached a capacity to treat 50,000 m^3 of municipal wastewater per day.

River Basin Management and Non-point Pollution Control

Since the 1980s, the Chinese Ministry of Water Resources has been expanding the administrative power of river basin commissions in order to better coordinate water conservation and pollution control work. The main functions of river basin management commissions has been to assess current and future water quality and resources, as well as set the priorities for comprehensive planning to manage water resources within the river basin. These commissions focus on the development of regional wastewater treatment plants, and large treatment and storage ponds to filter pollution within the basin. The greater empowerment of river basin commissions has led to the cleanup of ninety-nine rivers over the past decade.

In order to prevent non-point pollution, regulations, subsidies, and education programs have attempted to promote the controlled application of chemical fertilizers and pesticides and substitute low toxic pesticides for the highly toxic pesticides more commonly used.

Briefing on U.S.-PRC Environmental Initiatives

9 September 1998

One year after the creation of the U.S.-China Environment and Development Forum, questions regarding the results and benefits of environmental cooperation merit evaluation and discussion. The energy initiatives and water initiatives have been created to promote benefits for both countries. For example, access to U.S. expertise and technology could enable China to leapfrog into cleaner energy development. Conversely, China offers the United States huge markets for remediation, pollution control, and processed technology markets.

U.S.-China Energy Initiatives

The U.S.-PRC Environment and Energy Initiative owes its origin to the trip by Vice President Gore to China in 1997. After the visit, the Office of the Vice President convened an interagency group to examine ways in which the United States could connect the environment with key financial decisions in the energy sector. The details on the Environment and Energy Initiative were completed in October 1997. This initiative contains three central themes: 1) bringing clean energy technology to China, particularly focusing on clean coal and sulfur reduction technology; 2) rural electrification; and 3) air pollution.

In November 1997, an Oil and Gas Forum was also initiated to focus on the development of nitrogen monoxide (NO) policy, offshore and onshore drilling and joint venture oil and gas projects. Both of these energy initiatives are creating interagency cooperation both within and between the two countries. In China, the State Environmental Protection Agency, the State Development and Planning Commission, and the Ministry of Science and Technology are the main agencies engaged in the cooperative energy activities. On the U.S. side, the Department of Commerce, Department of State, Department of Energy, the White House Office of Science and Technology Policy and the Environmental Protection Agency are the key agencies participating in these energy initiatives.

To make progress in the focus areas of these energy initiatives, Chinese policymakers will need to make changes in financial markets and infrastructure planning in order to enhance China as an attractive market for energy investment. Nuclear agreement is mentioned in the Environment and Energy Initiative, but nuclear energy became a separate agreement, specifically a "letter of intent" for future cooperation. The Energy and Environment Initiative Forum is viewed as quite successful as a means for continuing engagement between the two countries. Moreover, the Oil and Gas Forum is attracting a high level of attention from U.S. companies.

China needs at least U.S. $50 billion a year in investment to meet its need for clean energy infrastructure. Ideally, to mitigate energy shortages and improve pollution problems, China will need considerable investment to leapfrog into high quality energy technology. One of China's greatest challenges in the energy sector will be to develop ways to bring capital from the private sector for new energy technology and renewable energy development. One opportunity for joint public and private investment would be in the development of coal bed methane and liquefied natural gas (LNG), for there exists considerable development potential for these energy types in China. Notably, in October of 1997 ARCO signed three contracts worth U.S. $30 million with the Chinese to explore for coal bed methane in Shanxi Province. The goal of the investment is to bring coal bed methane from this western province via pipeline to Beijing in order to replace urban coal burning.

In terms of financing, the Environment and Energy Initiative is setting up the financing seminars for Chinese administrators in the energy sector. Moreover, a U.S. government initiative to promote clean energy technology in China is being undertaken by the U.S. Export Import Bank. The Export Import Bank is in the process of creating a U.S. $50 million credit facility for renewable energy technologies with a goal to target small companies.

A working group on climate change met for the first time in August of 1998 and had productive discussions. An expansion in climate change discussions would create even greater opportunities for the United States and China to work together on energy issues. Although these talks and initiatives are promising, the United States must avoid becoming too naive about U.S.-China environmental relations, for there still exists the possibility of discord, especially over climate change. To continue the momentum in environmental agreements, the United States should avoid pressuring China and instead focus on creating mechanisms in which the Chinese are genuinely interested and which can solve severe local pollution and

Table 1. Framework for U.S.-China Joint Water Management Program

Discussion Areas	Infrastructure	Management	Assessment/Prediction
Agriculture/Forestry	Storage, distribution, erosion, pollution, quality and quantity (irrigation), crop production	Land use, pollution (non-point source), erosion, distribution, economics, water quality and quantity	Data sources, data archives, database management, remote sensing, prediction, modeling and simulation
Ecological Support	Availability of water, ecosystem health, quality and quantity of water, natural resource management	Biodiversity, technology and engineering, instream flow requirements, water availability	Data interpretation, satellite imagery, prediction, modeling and simulation
Domestic and Industrial Water Supply and Use	Treatment facilities, supply, industrial production, quantity and quality of water	Quantity and quality of water, human health, cost/price of water	Data-sharing systems, sensors, prediction, modeling and simulation
Flood and Drought Planning Mitigation	Hydropower development, instream flow	Economic and environmental impact of event	Remote sensing, prediction, modeling and simulation

energy problems. One ideal example of an initiative that has generated interest in both countries was the air quality monitoring agreement signed in June 1998. It must be acknowledged that the efforts by the United States to assist China in its energy goals continue to be hindered by the restrictions on U.S. Agency for International Development and Trade Development Agency funding.

The Water Resources Management Initiative

The Water Resources Management Initiative, which was begun in 1998, stemmed from an idea developed at the 1997 Environment and Development Forum held in Beijing. At this meeting, each of the Forum's four working groups addressed some aspect of water. For example, the Energy Working Group discussed small hydropower; the Science and Technology Working Group addressed water in its discussions on ecosystem protection; the Environment Working Group explored watershed research; and the Commerce Working Group explored the issue of water conservation and wastewater treatment. There was clearly a need to bring these interests together into a more holistic approach to water resources management and a more coordinated approach was needed to maximize the efficiency of the different efforts by the working groups. Since that meeting, a dedicated interagency group has been working to develop a proposal for the U.S. and Chinese governments to undertake a more coordinated approach to water management. A large workshop on Water Resource Management, which will include U.S. and Chinese government agencies and nongovernmental organizations, is being planned for early 1999. This workshop will examine issues related to assessment/prediction, infrastructure, and management using two different river basins in the United States and China. The framework that will guide the formation of this U.S.-China joint water management program is outlined in Table 1. This framework is the product of extensive consultations both inside and outside government.

[Editors Note: The Water Resource Management Workshop did take place in April 1999 and the workshop led to the creation of a U.S.-China Water Resource Management Program. Information on the program available at: http://www.lanl.gov/chinawater/procpres.html.]

Environmental Law in China

7 October 1998

In 1979, the first major environmental statute—the Environmental Protection Law—was enacted in the People's Republic of China. The nascent environmental law regime in China faces many challenges, for it is taking place in a country undergoing rapid economic, legal, and social reform. After nearly twenty years of development one can begin to systematically appraise the progress of China's emerging environmental law regime. In order to formulate strategies to strengthen the compliance of environmental laws, there are two key areas of the Chinese environmental law regime that merit examination: access to information and enforcement trends.

Access to Information

Information on the environment and environmental legislation in the developing world is rarely the quality necessary for making management decisions and promoting effective implementation. These problems are very acute in China, where resources devoted to environmental information are low due to financial limitations and the relatively recent focus on environmental issues. In addition to the paucity of information, institutional obstacles within the government and legal system in China also have created a very unequal distribution of information on laws, regulations, and enforcement mechanisms. This lack of information has led local governments to misinterpret laws and regulations and has prevented public comment on the content and implementation of environmental laws. Without clarity and transparency, environmental laws will not be effectively implemented.

Demands by local governments and citizens for better information on environmental quality and laws have been spurred by the growing severity of environmental damage in China. Roughly forty percent of river waters in China are completely unusable. Pollution damages—particularly from water and air pollution—cost China roughly $54 billion each year. The rising instances of pollution and disaster-related deaths have also heightened public concern and there is a notable increase in grassroots environmental organization activities. In addition, over the past decade, interaction among grassroots environmental groups in Hong Kong, Taiwan, and mainland China has flourished. These environmental groups are not necessarily playing an advocacy role in China, but they are giving citizens a way to voice their concerns and demand better information on environmental quality and implementation of environmental laws. This growing crisis orientation of citizens about environmental quality has pushed the central government to promulgate a wide range of environmental laws. Examples of key national statues include:

- Marine Environmental Protection Law (1982)
- Water and Soil Conservation Law (1991)
- Air Pollution Prevention and Control Law (1995)
- Solid Waste Law (1995)
- Mineral Resources Law (1996)
- Environmental Noise Pollution Law (1996)
- Water Pollution Prevention and Control Law (1996)
- Energy Conservation Law (1997)
- Criminal Law Amendment—includes section on environmental crimes (1997)
- Land Administration Law (1998)

Despite the wide range of new laws, there is no national requirement that these environmental laws be published or compiled in any one place. Therefore, at the sub-national level, many local agencies have difficulties gaining access to these laws and subsequent implementation regulations. Moreover, many of these laws place contradictory demands on local regulators. To overcome this problem, there is currently a proposal within the National People's Congress to integrate all the separate conservation laws into a single National Conservation Law. Alternately, the Congress is discussing whether to simply amend the separate conservation laws to eliminate contradictions. Other planned pieces of legislation for the next five-year period (1998-2003) include Clean Production Law, Environmental Impact Assessment Law, Renewable Energy Law, and Radioactive Pollution Prevention and Control Law. Planned laws that will complement the 1995 Solid Waste Law include laws for toxic chemicals management and industrial waste utilization. While this list for planned legislation may seem lengthy, it is significantly shorter than environmental laws proposed in the previous five-year plan, which highlighted fourteen environmental statutes to be created or revised. Li Peng, the head of the National People's Congress, has demanded that the Congress be realistic in its planning goals and promulgate fewer, higher quality laws.

One mechanism to promote information dissemination is the environmental impact assessment (EIA), which can engage the public and put pressure on polluters and developers. China's EIA law (1979) requires individual projects to conduct an EIA and have it approved by the local Environmental Protection Bureau. With this approval the builder can then take the project to the local planning commission for a permit. The main shortcoming of EIAs in China is that they only focus on individual projects, and EIAs are not applied to regional planning or government land-use and industrial policies. For example, in the early 1980s, the national government passed a policy that allocated forestland to individual farmers based on the assumption that those granted the right to use the forests would take care of them. Because farmers did not believe these land-use rights were secure, they quickly cut down most of the trees; an EIA could have helped better shape this land-use policy. Another shortcoming is that environmental impact assessments are not readily available for public viewing, which limits the possibilities of public input on land and industrial development.

To expand information access on environmental laws, China will need to promote and protect the freedom of information to its citizens. Newer environmental laws have notably included rules for notice and comment on regulations in order to encourage public participation. Greater internet access in China also represents another means for promoting greater circulation of environmental and legal information. The Asia Development Bank has been funding work to analyze existing environmental laws and disseminate this information to all regulators.

Enforcement Trends

Enforcement of environmental laws in China is much more difficult than in the United States, not only because of a lower amount of environmental awareness and economic development, but also due to a lack of enforcement capacity within the State Environmental Protection Agency (SEPA). In addition to the severe dearth of financial resources and personnel training within SEPA, the staff is very small, with only 200 people. As a comparison, the U.S. EPA has approximately 17,000 people in its agency.

Environmental laws, like most laws in China, tend to be very general and brief, which in practice grants considerable discretion to local governments. For example the Chinese Air Pollution Control Law is a mere ten pages long and allows local governments to adjust the law to fit local conditions. This has led to very inconsistent enforcement of air pollution control standards. More detailed and clearer environmental laws could help improve their implementation and enforcement.

The growing use of criminal law in environmental law enforcement is one major attempt to improve compliance. Notably, the Criminal Law, which was amended in 1997, now includes some environmental crimes, such as unauthorized waste import. Some new environmental laws also include criminal punishments and the death penalty is a possible punishment for extreme violations. Another change in new legislation meant to promote better enforcement, has been rules requiring more open reporting of waste generation and public access to implementation activities.

A considerable number of projects funded by the World Bank have been aimed at environmental education and capacity building, particularly to fund training programs for the drafters of laws. However, not many education or financing programs have been directed towards implementation and enforcement training of local officials. Training of judges is also an area that merits more attention and investment, for many judges are former military personnel who lack a substantive legal background. One promising trend for improving enforcement of environmental laws has been the work by nongovernmental organizations in China to raise public awareness of environmental problems and existing laws.

Policy Options for the 1999 U.S.—China Forum on Environment and Sustainable Development

30 October 1998

In preparation for the April 1999 U.S.-China Forum on Environment and Sustainable Development, a subset of the Working Group on Environment in U.S.-China Relations has developed the following ideas for cooperation between the two countries. These ideas and strategies are designed to be proposed at the Vice Presidential/Prime Ministerial level, and implemented by lower-level government agencies and/or nongovernmental institutions. The ideas listed below reflect the individual opinions of Working Group members, and do not represent the opinions of the Woodrow Wilson Center, a non-partisan, non-advocacy institute.

General Engagement Strategies

- Assistance and proposals for environmental activities should fit within the overall framework of the Chinese economic reform. Chinese Prime Minister Zhu Rongji is under heavy pressure to reform China's state owned enterprises (SOEs), financial markets, and government bureaucracy. Prime Minister Zhu is most interested in U.S. assistance on economic reform; U.S. support for his reform plans will provide him with renewed strength in China and a greater ability to press for environmental improvements both within and outside state owned enterprises.
- Mutual benefit in educational and scientific exchanges should be prioritized. Initiatives should not only consider Chinese environmental conditions, but also invite and create a mechanism for Chinese assessment of U.S. environmental performance and practices. Joint exchanges and research centers that emphasize the sharing of knowledge, information, and expertise will help develop U.S. and Chinese environmental improvements.
- Trade and investment opportunities for U.S. firms should be incorporated, as much as possible, into environmental improvement efforts. Emphasis should be placed on areas that are of high interest to the Chinese and to U.S. firms. Water conservation and treatment are potentially strong markets for U.S. firms in China, and the World Bank has demonstrated that commercial reforestation projects in China can be profitable.
- Local education efforts should be emphasized to improve overall environmental awareness and local-level environmental regulation implementation. Similar to the United States, local level environmental awareness in China increases pressure on local governments to enforce environmental regulations. Efforts to broaden the knowledge of Chinese citizens on environmental issues will play a large role in determining the success of China's environmental initiatives in the decades to come.
- Whenever possible, agreements and projects should be fashioned in such a way that they demonstrate China's willingness to combat climate change. A major barrier to support for global climate change action in the United States is the belief that developing countries, and especially China, are not taking action to reduce greenhouse gas emissions. If viewed in a different manner, energy efficiency, reforestation, and wetlands restoration projects, among others, can all be considered carbon reduction projects. Joint efforts in these areas would provide examples of Chinese action on climate change, and would demonstrate to the Chinese that the United States government is willing to move forward together on climate change issues.
- Efforts should be made to coordinate the initiatives of various U.S. and Chinese groups working on environmental issues in China. Many Chinese scholarly institutions and environmental NGOs are approached by various U.S. actors seeking partnerships on environmental issues in China. New initiatives should focus on coordinating the efforts of U.S. actors through umbrella agreements or consortia.

Optimal Areas for Engagement

- Energy Efficiency. In both production and consumption, China can vastly improve its already impressive energy efficiency efforts. Clean and efficient energy production and consumption decreases costs, improves ambient air quality, and reduces sulfur and greenhouse gas emissions.
- Wetlands Restoration and Protection. The loss of wetlands is a problem in both the United States and

China. Wetlands can reduce the severity of floods, decrease pollution from agricultural runoff into lakes and rivers, and maintain biodiversity. The wetlands issue is critical in many areas of the United States and China, and joint benefits could be gained from cooperation on this issue.

- The Energy-Climate-Health Nexus. Increased research on the health impacts of China's energy consumption—and the resulting health care costs of environment-related illnesses—would help demonstrate the social and economic need to address these issues. Reductions in total suspended particulates can create ancillary reductions in sulfur and greenhouse gas emissions.
- The Reforestation-Climate-Water Nexus. The connections between water, climate, and forests should be emphasized. China's planned reforestation efforts will create carbon sequestration benefits and improve flood control.
- Joint Research and Educational Consortia. Efforts to increase mutual understanding and knowledge about environmental issues will benefit both countries, while developing strengthened ties in the nongovernmental (NGO) and scientific sectors.
- Rule of Law and Environmental Enforcement. There are significant connections between the establishment of rule of law and environmental enforcement. Connections between these two issues will be imperative to improving compliance with environmental regulations at the township and village levels.
- Post-Disaster Ecological Restoration. Massive floods and storms in both the United States and China have caused the destruction of environmentally sensitive areas. Many opportunities exist for the joint study of the ecological restoration of these areas, and the methods by which restoration efforts can help reduce the severity of future natural disasters.

Specific Ideas for Proposals and Projects

Many of the ideas for specific proposals and projects cut across the four categories: acid rain, climate change, land use, and water resources. These four areas of emphasis have been grouped by focus rather than by environmental category.

Joint Research and Educational Initiatives

- Establishment of a loose consortium of universities to foster policy-linked research and educational exchange consistent with the Environment and Sustainable Development Forum's chosen themes. The aim of this government-sponsored consortium would be to provide high-level political impetus for expanding the existing abilities of U.S. universities to sponsor students, senior scholars, and visiting policymakers from China in pertinent areas. Hopefully, the high-level government involvement would also encourage Chinese universities and NGOs to sponsor a similar exchange of Americans to China to better understand Chinese policy conditions. Universities currently undertaking research projects in China (such as Harvard, Stanford, MIT, Yale, Berkeley, and others) could be joined in the consortium by equally prestigious Chinese universities (such as Tsinghua and Beijing University in the north, and Shanghai's Jiaotong and Fudan Universities). The governmental members of the Forum could shape the areas of focus for research activities conducted by the consortium members, perhaps resulting in a series of Sino-American conferences with both academic sessions and "executive summary" sessions for policymakers.
- Designation of at least one large and critical wetland site in each country to study the role of wetlands in water purification and flood relief. Wetland issues in China are critical in many areas, including the central/Yangtze region, the south (Pearl River delta), the southwest (headwaters of the Mekong and Irrawady), and the northeast (Three Rivers Plain along the two China-Russia border rivers). Many areas in the United States are facing similar wetland crises. Capitalizing on China's recently announced plans to restore wetlands in the upper Yangtze, a bi-national team could study wetlands restoration to help increase knowledge on the role of wetlands in flood protection and water pollution control, and in ecological restoration strategies. Bi-national teams could also study a sister U.S. site. Such sites could be managed jointly by government research laboratories, universities, or NGOs.
- Establishment of a U.S.-China Joint Center on Human Health. This Center, located within China, would provide an opportunity for U.S. scientists and researchers to work with their Chinese counterparts to increase knowledge in both countries about the effects of air and water pollution on human health. The Center could be jointly managed by government-sponsored research centers (such as the National Institutes of Health), or U.S. and Chinese medical

schools.

- Creation of a joint project to share environmental education materials and information via the Internet. There is a great need in China for improved environmental education materials for teachers. Chinese NGOs have developed environmental textbooks, but are facing difficulty in securing funding to print and distribute the millions of books it would take to educate the Chinese public on environmental issues. While Internet access in China is still very limited, it is growing rapidly. Environmental information placed on the Internet in both Chinese and English would help raise American understanding of China, as well as offering materials for Chinese teachers and students. Such an initiative could perhaps find support from U.S. computer and telecommunications firms.
- Creation of a bi-national working group to study post-disaster planning for ecological restoration. This working group would examine ecological restoration strategies and practices in the two countries and would establish a long-term policy research process to study the importance of ecological restoration in the aftermath of natural disasters.
- Creation of a joint task force, with participation from European countries and other developing nations, to study emissions trading. This task force would examine methods for establishing trading systems, how such systems work, and solutions to problems of parity within trading systems.
- Establishment of local environmental educational centers that specifically target village bureaucrats and local level officials. These centers could focus on agricultural extension, energy efficiency, green accounting, and environmental management systems. Centers could be established through sister city agreements that focus on common environmental problems and/or industries.
- Assistance in developing Chinese-language television shows and videos that describe U.S. environmental history, practices, and successes. These programs could be developed jointly between U.S. and Chinese NGOs, and broadcast on Chinese television. Such television shows would increase Chinese understanding of environmental issues, and of successful approaches to environmental problems in the United States.
- Joint support for the NGO Forum on U.S.-China Environmental Cooperation. This Forum, being planned for Fall 1999, will bring together environmental NGOs in China and the United States to discuss NGO development, management, and technical environmental issues. The goal of the NGO Forum is to increase cooperation and develop lasting partnerships between U.S. and Chinese NGOs.

Economic Reform and Sustainable Business Practices

- Creation of a U.S.-China Joint Center on Business Training and Sustainable Enterprise Development. This center could be established at the business school of Tsinghua University (headed by Zhu Rongji) in cooperation with a U.S. university. This business center would focus on increasing knowledge in China about environmental business practices such as environmental economics, risk assessment, environmental impact assessment, green accounting, tradable permits, and environmental management systems, while also providing expertise on more general financial and business topics such as mergers, privatization, and financial market restructuring. There is a strong need in China for assistance on enterprise and financial market reform. Packaging such information with expertise on sustainable business development and practices would most likely be very attractive to the Chinese.
- Establishment of a U.S.-China Joint Center on Environmental Technology Development and Management. In order to promote the development of its environmental industry, China is likely to relax regulations on joint ventures and foreign investment. The creation of a joint center on environmental technology development could give U.S. firms an advantage, especially in water conservation, treatment, and energy-saving agricultural technology in which the United States is a leader. Specific cooperation on water management and quality in paired regions of both countries—such as central California and the North China Plain—could potentially open doors for U.S. technologies and technical expertise.

Climate Change-Related Initiatives

- Expanding, a currently proposed, internal U.S. carbon emissions trading system to include projects undertaken in China could provide mutual benefits to the United States and China. Separate from the Kyoto Protocol and its Clean Development Mechanism, this program would reward U.S. firms with early credit for investing in Chinese carbon offset or reduction

projects. The program would demonstrate to the Chinese that the United States does not want to entrap them in future commitments, but rather is interested in creating a market for carbon emissions trading and in improving China's environmental conditions. Expanding the trading system to include Chinese projects would also provide an example of Chinese action on climate change issues.

- Assisting in developing sustainable forestry projects in the upper Yangtze region of China could become a promising climate-related initiative. The Chinese have announced extensive reforestation plans for a large portion of the upper Yangtze region to prevent soil erosion, assist with flood control, and achieve ecological restoration. The World Bank has demonstrated that forestry in parts of China can be profitable. For many commercial forestry projects, the cost of carbon sequestration is zero. Training on sustainable forestry in these regions of China could provide large carbon offsets for U.S. firms while also helping China meet its reforestation objectives.

Green Voice Environmental Solutions

Green Voice Environmental Solutions is a newly founded Chinese nongovernmental organization based in Beijing. The mission of Green Voice is to coordinate technically proficient teams of environmental professionals to bring sustainable solutions to complex environmental challenges. Operating as an autonomous NGO, Green Voice is able to constructively build partnerships among different Chinese government units for collaborative environmental initiatives, provide volunteer opportunities for environmental professionals to join multi-disciplinary teams, strengthen communications among China's growing environmental sector, and facilitate the involvement of international partners in model environmental projects.

Specific work areas for Green Voice include: 1) analysis and promotion of investment policies and procedures to stimulate the development of pollution prevention and energy conservation projects; 2) ecosystem management programs to conserve globally significant biodiversity in China's Yunnan, Sichuan, and Qinghai Provinces, the Tibet Autonomous Region, and the Tumen River region; 3) capacity building programs for national park management and publication of interpretive materials; 4) experiential environmental education program for Chinese youth, including development of vocational training on source reduction strategies and material handling protocols for hazardous materials; 5) strategic communications services to refine and amplify environmental messages to target audiences, from simple brochures to new streaming technologies via the Internet; 6) facilitation of environmental technology transfer to strengthen China's growing environmental protection industry; 7) building a coalition of government agencies, environmental organizations, industry associations, universities, and medical centers to reduce the public health threat of childhood lead poisoning; and 8) coordination of diverse training programs to build environmental management capacity of Chinese organizations.

Green Voice was founded by Mr. Leon Chen, who has supervised scores of environmental programs over the last ten years. In 1991, Mr. Chen was a consultant to U.S. EPA on China's country program of ozone protection and helped implement the U.S.-China Environmental Cooperation Protocol, including the evaluation of China's coal based energy sector. Since 1993, he has worked for the World Bank to help China implement the Montreal Protocol for ozone protection and most recently on the Bank's Iodine Deficiency Disorder Control project. Throughout his environmental career, Mr. Chen has compiled an impressive range of environmental experiences working for TRI (a U.S. environmental consulting firm), Waste Management International, U.S. Foreign Commercial Service, UNDP, UNEP, Getty Conservation Institute, EarthVoice, The Humane Society of the U.S., Fauna and Flora International, Phillips Petroleum Company, and the U.S.-China Environmental Fund. Mr. Leon Chen is also an author of *China Environment and Sustainable Development Resources Book* published by UNDP in August 1996.

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Population, Migration, and the Environment in China

4 November 1998

China constitutes the world's largest population with approximately 1.2 billion people. Today, one out of every five people in the world lives in China. This large population inevitably places intense demands on the natural environment and raises concern about sustainable development in China. It is not only the size of the population that causes concern, but the changing distribution of this population also poses great challenges to the Chinese government as the country strives to improve its economic growth. The interaction between environment and population occurs in a cyclical pattern with demographic behavior. For example, the destruction or depletion of natural resources in rural areas spurs urban migration, which increases the demand for natural resources by urbanites. This greater demand for natural resources is drawn from rural areas, which in turn increases rural poverty and induces more migration to urban areas.

Population Trends

The population in China is currently growing at a rate of about 1.4 percent annually. Through continuing efforts of family planning and enforcement of the one-child policy in urban areas, China has succeeded in slowing its rate of growth, which is predicted to level off at 1.5 billion by the year 2050. One notable population dynamic in China is the growing elderly proportion of the population. Since many of these elderly in rural areas do not have retirement pensions, their children will bear the burden of their care. This in turn will naturally impact growth and income patterns in China.

Migration Trends

The trickle of migration to cities in the 1980s has turned into a flood and Chinese demographers estimate that the country's floating population may be as high as 100 million, a population the size of Mexico's. Heavy migration continues despite attempts by interior provinces to limit the number of peasants heading for the coastal cities.

The speed and scale of change in the population movement from rural to urban areas in China is one that no country has ever dealt with before. Since 1990, the movement of millions of rural people into urban areas in China has become a growing problem for city governments. The overwhelming majority of migrants head the coastal cities and special economic zones which are the urban areas with the fastest economic growth rates. Most large coastal cities now have one to three million migrants living in shantytowns, overcrowded makeshift dormitories or public places, particularly railroad stations. Every night the main railway stations in Beijing, Shanghai, and Guangzhou are filled with poor migrants seeking work. Shanghai's population of seventeen million is now augmented by three million migrants attracted from all over the Yangtze River valley to the city's mammoth construction sites. One sign of the city's construction boom is the fact that Shanghai's new special tax-free zone on the east bank of the Huangpu River has eleven percent of the world's largest construction cranes.

Despite the country's encouraging economic prospects, China's State Planning Commission (SPC) has predicted massive unemployment problems in urban areas. According to its predictions, approximately forty-four million young people will enter the job market over the next five years and some twenty million workers in unprofitable state-run enterprises will lose their "iron rice bowl" jobs. Simultaneously, approximately 120 million surplus rural workers will head for coastal cities and other newly industrialized zones to seek work. The SPC has calculated that 180 million new urban jobs will have to be created to absorb all of these workers. If the economy continues to grow as it has since 1980, job creation may not be a problem. However, if China's explosive growth begins to slow, as it has over the past two years, millions of unemployed or underemployed people could be wandering the urban landscape.

Environmental Concerns

In addition to the joblessness and stability concerns created by a growing wave of migration, the larger population in cities has dramatically increased urban pollution problems. For example, urban wastewater pollution problems have been worsening throughout the reform era and scientists have estimated that along China's 18,000 kilometer-long continental coastline, municipal wastes flow into coastal waters at the rate of fifty to sixty million

metric tons per day, which amounts to seventeen to twenty-one billion metric tons a year. As of 1993, only sixteen percent of the total amount of wastes discharged received any form of treatment. That same year, the country's industries collectively pumped thirty-six billion tons of industrial effluents into rivers, streams, and coastal waters.

Over 100 million people live along China's Bo Hai Sea coast at a density of up to 1200 people per square kilometer, which has led to a significant increase in wastes dumped into coastal waters. Shanghai dumps 4.5 million metric tons of untreated wastes into coastal waters everyday. China's provinces along the Yellow Sea dump 744 million metric tons of untreated wastes into it every year. The industrial waste emissions from the thirteen large port cities flowing into the coastal waters total 200 million a year.

Untreated sewage is contaminating China's rivers severely as well. The fact that many of China's rivers are drying out on a regular basis due to overdrafts has exacerbated this pollution problem. For example, since the mid-1980s the Yellow River does not reach the sea for nearly 200 days a year.

The Liao River in northern China carries 1.3 billion tons of untreated industrial effluents into coastal waters annually. In the summer of 1986, nearly every aquatic organism was killed for hundreds of kilometers along the Liao River due to the massive amounts of pollution. This was the first instance of China's, now notorious, "stink rivers." In 1986, the Xiao River was overwhelmed with untreated sewage water, killing 100,000 metric tons of shellfish in the lower reaches of the river. The economic loss was estimated at 2.5 million dollars.

The high density of population in the urban areas raises not only concerns of pollution, but also increases in infectious diseases and social disorder. The difficulties in acquiring resources such as electricity and clean water have already led to the theft of these resources.

Environmental Impact and Population Density

There is no inherent relationship between population density and environmental impact. Thirty million people spread through small towns and villages can do as much damage to the natural environment through deforestation, as thirty million concentrated in one or two cities. Negative or unmanaged impacts are however more visible and *potentially* more harmful to human health when concentrated. It is possible that some technologies for treating wastes may be more effective in large cities where economies of scale are available.

Migration trends in China are creating the largest concentration of urban dwellers the world has ever known. The impact of such densely populated cities will depend on the kind of urban management that is put in place. To conquer the challenges of quickly growing and high-density cities, the urban management will have to be better than any other cities in the world have previously done. There are, however, no convenient technological or managerial fixes to China's urban population problems, for no other country has faced an urban migration at such a scale and speed. Chinese policymakers appear to favor high-tech, mega-project solutions to fulfill its growing demand for energy and other resources (e.g., the construction of large water diversion projects to bring water to northern China, the building of huge dams to mitigate flooding and supply electricity, the construction of large ring roads around cities to help alleviate traffic problems). The United States and other western countries could positively influence the urban environmental quality in China by promoting:

1) Mass transportation technology that offers a credible alternative to the automobile;
2) Water resource management that encourages efficiency for all uses, applying demand management through pricing policies that reflect costs for production and re-use;
3) The development of a "safety culture" for industry and urban service delivery. For example, safety standards that are linked with environmental standards;
4) The development of an effective insurance industry to raise standards in every sector—transportation, industry, housing, and health;
5) Training in environmental management;
6) Sister-City arrangements with foreign cities that contain an environmental agenda.
7) The growing greenbelt movement that designates tree planting in urban areas.

United States Environmental Priorities in China

10 February 1999

Purposes and Plans for the Second U.S.-China Forum on Environment and Development

In Vice President Gore's 1997 trip to Beijing, the simple objective was to pave the way for President Clinton's trip and work out a venue for discussion and cooperation on environmental issues at the most senior political level. The visit resulted in the creation of The U.S.-China Forum on Environment and Development (hereafter, the Forum). The Forum is co-chaired by the Vice President and the Premier of China—initially, Premier Li Peng.

The Forum's work is divided into four working groups: energy policy, environmental policy, science for sustainable development, and commercial cooperation. These groups are co-chaired by representatives of various government agencies and act as coordinating mechanisms for activities that take place under the Forum. The upcoming visit of Premier Zhu Rongji provides the first real opportunity for U.S. government agencies to focus energy on this Forum and to turn it into a productive working institution. Below is an outline of the four working groups of the Forum.

- The *Energy Policy Working Group* discusses issues of energy generation—including conventional, nuclear, renewable, and alternative energy sources—and major energy consumption activities in industrial, transportation, building, and utility sectors.
- The *Environmental Policy Working Group* focuses on two separate tracks. First, it consults and coordinates on multilateral environmental issues and negotiations. Second, it addresses pollution prevention and control, health impacts of pollution, as well as waste management and remediation, which includes hazardous waste.
- The *Science for Sustainable Development Working Group* examines the application of science and technology to better understand and foster sustainable development in China.
- The *Commercial Cooperation Working Group* examines trade, energy, environment, agriculture, and other aspects of U.S.-China environmental relations that pertain to sustainable development. This group has worked to identify areas in which opportunities for U.S. firms and China's environmental technology needs intersect.

Since the Forum was created, the participating Chinese officials have increased their interest in cooperation with the United States on environmental issues. At the early Forum meetings, the Chinese participants spoke supportively about the environment, but there was no clear indication that they truly intended to locate the resources to take action or make the tradeoffs in which the environment would be the driving factor. The Chinese government's change in attitude and more concrete actions on environmental protection stem from several sources:

- The massive flooding in China has demonstrated to senior political leaders how deforestation can severely impact river systems, as well as the economic, social, and health costs of land degradation.
- Acid rain and related health problems have also begun to impel the Chinese leadership to look for the sources of air pollution and to consider alternatives to the widespread use of coal for heating and industrial use.
- Air pollution and energy self-sufficiency concerns have propelled the Chinese leadership to explore such issues as the development of natural gas infrastructure, thus, opening up new avenues for U.S.-China cooperation.
- Growing demands by the Chinese public to mitigate pollution problems.

To elaborate on this last point, the general public in China is taking a greater interest in environmental issues along with politicians and bureaucrats. Evidence of this rising interest is apparent in a study conducted by the Chinese State Environmental Protection Agency, in which local hotlines were set up to allow citizens to identify the most serious problems in their communities. During the six-week period of the phone study, eighty to ninety percent of the calls cited urban air pollution as the largest problem. Information on air pollution levels is becoming more accessible in China, which in turn has increased people's awareness of the magnitude and possible health risks of air pollution. This rising public awareness could explain why Chinese officials have been talking more intensively with the U.S. Environmental Protection Agency on how China should address environmental problems, such as the impact of pollution on children's health. Cleaning up urban air pollution would not only solve a serious

local problem, but would mark another major step for China in addressing global climate change.

China's Energy Demand

Although the energy growth rate is increasing eight percent per year, China, with a population more than four times as large as the United States, still consumes only one-third the amount of energy that the United States does. More striking is the fact that per capita energy consumption in China is one-fifth that of the United States. Most of China's energy consumption has been driven by coal, which is a major source for local air pollution. Coal generates carbon dioxide, so decreasing coal use in China will have immense implications for lowering greenhouse gas emissions. There exist, however, numerous challenges to "greening" China's energy policy. For example, China shows accelerating rates of electrical energy consumption, as well as other forms of energy consumption. While China currently has sufficient energy, the country's needs will pick up quickly. In terms of clean energy possibilities, the Chinese leadership has initiated the development of natural gas resources in northern China. Through both bilateral and domestic investment, China is also pursuing the development of small-scale hydroelectric, wind power, and other alternative energy technologies. These technologies could create a network of scientific and commercial possibilities for cooperation between the United States and China.

One trillion dollars will need to be spent over the next twenty years in developing energy technology for China to meet the proper relationship between energy management and growth. How to mobilize capital, restructure energy pricing, and utilize existing technology are some of the major challenges China faces in its task of developing new energy technology. Some energy developments that represent opportunities for increased U.S.-China cooperation are listed below.

- Over the last two years there has been a shift in thinking in China over the relationship between the energy sector and economic growth. The Chinese recognize that their energy efficiency is much too low.
- The U.S.-China Oil and Gas Forum held in 1997 in Beijing opened the possibility of an inter-exchange of U.S. and Chinese companies and could result in symmetrical access to oil and gas resources.
- Chinese policymakers have agreed to import liquefied natural gas (LNG) to south China, for broader cost-benefit analyses have indicated that the costs of importing LNG are nearly equal to importing coal from northern China.
- The Chinese have directly asked the United States to help develop a natural gas policy.
- The United States and China signed a nuclear agreement regarding the procurement of U.S. nuclear reactors.
- For the past two years, China has tried unsuccessfully to obtain clean coal technology.
- The Chinese leadership has decided to actively develop the use of natural gas in public transport.

Government to government cooperation has increased, especially between the U.S. Environmental Protection Agency and the Chinese State Environmental Protection Agency. Work between the two countries on energy issues has focused predominantly on the following areas: 1) China's air quality monitoring network; 2) agreements on cooperation regarding wildlife and national park management; 3) energy finance seminars; 4) the Oil and Gas Forum; and 5) commercial contracts in the energy sector.

The Energy and Environment Cooperation Initiative

During President Jiang Zemin's 1997 visit to the United States, former U.S. Department of Energy Secretary Fredrico Peña and Chinese State Planning Commission Vice President Zeng Peiyan signed the Energy and Environment Cooperation Initiative. This Initiative expanded cooperative efforts between the two countries at the point where energy, environmental science, technology, and trade intersect. The Initiative has four focus areas: urban air quality, rural electrification, clean energy sources, and energy efficiency.

Future Prospects for U.S.-China Cooperation on Air Pollution

Pollution, particularly air pollution, is causing China to lose $50 billion per year due to environmental damage and human health problems. Overall, air pollution levels in China are well above the World Health Organization's acceptable emission standards. The long-term costs of pollution on economic growth are becoming clearer to Chinese policymakers. United States cooperation with China on sustainable development projects could help mitigate some of these pressing local pollu-

tion problems. Highlighting the nexus between air quality and human health should be central in U.S-China talks on cooperation on air pollution mitigation. A key question, however, is how should the common tools and approaches used in the United States for pollution control be translated into the Chinese political and economic system? Moreover, how can this newfound U.S.-China dialogue help improve the environment in both countries? Some specific areas for joint cooperation to alleviate air pollution problems in China are listed below.

- Sulfur dioxide (SO_2) emissions trading.
- Co-benefits studies taking steps to reduce emissions and to increase efficiency that produce both health and economic benefits.
- Air quality monitoring—China now has a network for air quality monitoring in eleven cities.
- Cleaner production, including zero waste and energy efficiency.
- Improved understanding of the private sector's role in bringing funding to energy efficiency projects.
- Clean coal technology.

Future Prospects for Cooperation on Climate Change

No global environmental problem can be solved without China's engagement and cooperation, whether the issue is deforestation, land degradation, biodiversity loss, or pollution. Climate change is one global environmental problem in which U.S.-China cooperation is critical. While the United States is the largest emitter of greenhouse gases, China is the second largest and fastest growing. It is imperative to recognize that if all the Kyoto Protocol targets were implemented and the fifty-two countries that assumed targets at Kyoto stayed on track over the next fifty years to reduce emissions, these actions would be insufficient if China and other developing countries do not also act to lower greenhouse gas emissions. The Chinese position in the global arena makes it critical for them to ratify the Kyoto Protocol, for its support of the Kyoto agreement will impact the positions of other developing countries. The United States must improve its dialogue with China on the issue of climate change in an incremental way. One climate change related issue that the United States could stress is the market approach to decreasing greenhouse gas emissions. For example, the flexible market-based mechanisms adopted in the Kyoto agreement are constructed so as to provide incentives for private investment and private sector solutions. Many countries in the world do see the Chinese market as an opportunity for long-term sales of clean energy technology. Despite the promise of foreign investment in this area, it will not occur unless the Chinese government considers a full-scale investment in a variety of new energy technologies and related infrastructure.

Future Prospects for Cooperation on Water Resources and Land Use

The U.S.–China Water Resources Management Program was initiated as a result of the U.S.-China Environment and Development Forum. Water resources management was identified as a critical issue that crossed the core interests of the different working areas of the Forum (Energy, Environment, Science and Technology, and Commerce). It was recognized that water resources management is among the most difficult of all sustainable development problems yet one that crosses the interests of a variety of governmental and nongovernmental organizations. Thus, the initial focus was to identify and prioritize common problems associated with water resources, both quantity and quality. Four activities regarding water are currently underway: 1) identifying programs for bilateral cooperation; 2) reaching out to the private sector; 3) finding common problems; and 4) developing a joint framework.

The water, energy, and other cooperative initiatives created under the umbrella of the Forum hold promise for mutual benefit on environmental activities in both countries. The U.S. government could improve its environmental work with China by understanding the experience and extent of environmental work done by major aid organizations (e.g., UNDP), multilateral financial institutions (e.g., World Bank and the Asian Development Bank), and other countries. Examining these multilateral and bilateral environmental projects could inform the U.S. approach to environmental cooperation in China. Foundation support and activities by nongovernmental organizations in China also hold lessons for U.S. government environmental work. To date, activities and funding by foundations and nongovernmental organizations in China have centered on sustainable agriculture, green building and ecological design, organic fertilizers, environmental conservation, renewable energy programs, low carbon development paths, and transportation. Ultimately, for the United States to expand and deepen its cooperation with China on environmental issues, the U.S. government will need support from Congress, particularly backed by the financing of bilateral initiatives.

Twenty Years of U.S.-China Cooperation in Atmospheric and Oceanic Science

29 October 1999

A delegation from the U.S. National Oceanic and Atmospheric Administration (NOAA) visited China 12-30 September 1999, to attend two working group meetings and a special symposium and workshop on climate change. The delegation included scientists from NOAA, NASA, and several U.S. universities. During their time in China, members of the delegation also attended various meetings to sign new cooperative scientific work plans between the United States and China. The Chinese and U.S. scientists and officials also held celebrations to commemorate twenty years of Sino-U.S. scientific cooperation in oceans and atmosphere.

In 1979, Jimmy Carter and Deng Xiaoping signed the first Sino-U.S. cooperative scientific agreement. This umbrella agreement was based on mutual benefit for the two countries and led to the signing of thirty protocols on scientific cooperation between NOAA and the two corresponding agencies in China: the Chinese Meteorological Administration and the State Oceanic Administration. The most significant protocols for NOAA include the Atmospheric Science and Technology Protocol and the Marine and Fishery Science and Technology Protocol. During the past twenty years, scientists from both countries have held thirteen working conferences on oceanic and atmospheric research. This long-term science and technology partnership has also led to regular workshops and an ever-growing number of cooperative projects between the two countries.

The NOAA delegation's trip, co-hosted by the Chinese Meteorological Administration (CMA) and the State Oceanic Administration, began with meetings in Beijing, where the new agreement on Climate, Oceans, and Atmosphere was signed. In attendance at the conference were one hundred high-ranking officials, as well as top scientists from both countries—including Chinese Vice-Minister of Science and Technology, Deng Nan, and U.S. Under-Secretary of Commerce, Dr. James Baker. Agreements on Marine and Fishery Science and Technology Protocols were signed later in Hangzhou City, Zhejiang Province. At the ceremony celebrating twenty years of cooperation, Jack Kelly, Assistant Administrator for NOAA's National Weather Service, and Wen Kegang, Administrator of the CMA, signed the Twelfth Atmospheric Science Joint Working Group Report, which is a work plan for the next two years. In each of these formal signing ceremonies, the two sides agreed they would continue joint projects and exchange of scientists and data. The atmospheric agreement promotes cooperation in the following areas:

- Research on climate and monsoons;
- Mesoscale meteorology;
- Satellite meteorology;
- Atmospheric chemistry;
- Meteorological modernization; and,
- Training and participation.

After the first signing ceremony a regular meeting of the Joint Working Group—created by the Atmosphere and Science and Technology Protocol—took place in Beijing on September 15-16. The twelfth meeting of the Atmospheric Protocol's Joint Working Group took place in Beijing on September 15-16. Signing of the two-year work plan and celebration of the Atmospheric Protocols twentieth year Anniversary took place at the Great Hall of the People.

This meeting was followed by another event on September 23 celebrating the twentieth anniversary of the signing of the Protocol of Sino-U.S. Marine and Fishery Science and Technology Cooperation. This Protocol has encompassed cooperation in five broad areas:

- Data and information exchange;
- Marine environmental services—tides and currents;
- Role of oceans in global climate change;
- Living marine resources; and,
- Integrated coastal management.

These areas of cooperation cover topics that hold considerable practical application in China. For example, integrated coastal management is one topic that particularly concerns Chinese scientists and policymakers, for much of China's population lives along the coast, approximately 520 million people. Cooperation on such scientific agreements is strongly supported in China, for they promote sustainable development and improvements in technology to monitor potentially dangerous natural disasters. Notably, the Marine and Fishery Science and Tech-

nology Agreement has been one of the most successful data exchange agreements that NOAA has signed with any country. Many valuable data have been exchanged and NOAA has gained access to rich, long-term data sets, particularly on climate. For example, some Chinese records on climate and temperature fluctuation extend back 5000 years, which scientists in the United States view as invaluable in climate change studies. In Hangzhou, NOAA officials also signed the Fourteenth Joint Working Group Report to the Marine and Fishery Protocol that outlined cooperative activities for the 1999-2001 period. The Joint Working Group for this Protocol, which meets every two years, met most recently in Hangzhou September 26-27.

In addition to the anniversary and signing ceremonies, the U.S. and Chinese participants held two meetings: a symposium addressing climate and environmental change and a workshop focusing on the role of oceans in climate change.

The PRC-U.S.A Symposium on Climate, Environmental Change and Regional Impacts (21-22 September 1999) was co-hosted by the Chinese Meteorological Administration and the U.S. National Oceanic and Atmospheric Administration. The participants provided overviews of national climate programs in the United States and China, which represent efforts in our two countries to improve understanding of how the climate system works. One key goal of this exchange is to create a shared understanding on predicting El Niño and monsoons. Of particular interest to U.S. scientists has been exploring the complex impacts the Asian monsoons have on El Niño and Chinese data are invaluable in this pursuit. At this meeting they also discussed the impact of climate on weather.

At **The Symposium and Workshop on Climate Change and the Ocean's Role** the Chinese and U.S. participants shared data from their own studies and agreed to protocols to continue exchanging climate and ocean data and modeling results. Moreover they decided to explore establishing a jointly-managed virtual laboratory. This virtual co-laboratory would enable Chinese and American scientists to exchange data and ideas over the Internet in real time. It should be noted that both U.S. and Chinese scientists have been engaged in climate change and assessment of impacts of climate change for many years. The Chinese Meteorological Administration has been a principal agency in developing a Chinese response to the Kyoto Protocol.

The China-U.S. Workshop on the Impacts of Ocean Variability on Climate (23-24 September 1999) was a meeting co-sponsored by the Chinese State Oceanic Administration and the U.S. National Oceanic and Atmospheric Administration. In this workshop the Chinese scientists discussed the results of their South China Sea Monsoon Experiment, which aims to predict rainfall over the Yangtze River basin—the highly populated, breadbasket region in south-central China. The participants also discussed the following topics:

- Oceans as drivers of climate variability;
- Ocean monitoring and application of satellite remote sensing data;
- Prediction modeling and real time forecasting;
- Theoretical study on the interaction of monsoon and El Niño;
- Global ocean observations for the next 20 years; and,
- Impact of a dipole mode in the Indian Ocean on climate in Asia and Africa.

During the workshop, U.S. and Chinese scientists examined ways to coordinate efforts in improved ocean observations as a key to advancing climate forecasting services. U.S. scientists presented an overview of the developing ARGO program to deploy new technologies and improve climate data integration and management. The ARGO program promises to be an important multilateral, global effort to develop a new generation of reliable climate services. The Chinese interests in participating in this program are being pursued in light of the discussions at the Workshop.

The U.S. delegation ended their visit with tours of numerous key atmospheric and marine research centers, such as the National Marine Data and Information Service in Tianjin, which is one of the three world data centers for oceanography. The other two such centers are located in Washington, D.C., and Moscow. All three of these centers were set up the 1960s. This center in China maintains a very active Website (http://www.nmdis.gov.cn/eindex.html) that provides tide and current data.

Other site visits included various centers operated by the Chinese Meteorological Administration (CMA), specifically the operational forecasting center, the climate center, a television broadcasting center, and a modeling center. In contrasting the United States and China in terms of atmospheric agencies, it is notable that while the NOAA has 5000 employees engaged in atmospheric work, its sister organization in China has 63,000 employees. Moreover, while NOAA is a federal agency, the CMA is administered under a dual leadership arrangement between central and provincial governments. The CMA has offices in all thirty provinces and works directly with local governments.

The China-U.S. Center for Sustainable Development

On the occasion of Premier Zhu Rongji's visit to the United States on 9 April 1999, China's Ministry of Science and Technology and the State of Oregon, USA signed a Memorandum of Understanding to form the *China—U.S. Center for Sustainable Development* (the *Center*). The National Academy of Sciences graciously hosted the signing ceremony at their headquarters in Washington, D.C, immediately following the Second U.S.—China Forum on Environment and Development chaired by Premier Zhu Rongji and Vice President Gore. China's Ambassador Li Zhaoxing and the office of the Vice President were instrumental in bringing all parties together for the event.

The mission of the *Center* is to advance new forms of sustainable development cooperation between China and the United States in "land use planning; sustainable agriculture and rural development; sustainable forestry; environmental technology and cleaner production practices; sustainable cities; energy; marine environment; water resources; and capacity building for sustainable development." The Ministry of Science and Technology has a central role in coordinating China's sustainable development agenda. The state of Oregon is a leader in the United States in the application of sustainable development practices both in government and with the private sector. The organization of the *Center* is moving forward on several fronts.

Co-secretariats have been designated to administer the activities of the *Center*. China's Secretariat is the Administrative Center for China's Agenda 21 (ACCA21). The ACCA21 is responsible for coordinating the implementation of China's Agenda 21 and provides technical and advisory services related to sustainable development in China. The United States Secretariat is the International Sustainable Development Foundation (ISDF). The ISDF is a 501(c) 3 non-profit corporation with its headquarters in Portland, Oregon. Oregon's Governor John Kitzhaber approved start-up funding for the operations of the U.S. Secretariat.

China and the United States agree that the *Center* will focus its resources on demonstration projects and breakthrough opportunities to demonstrate the feasibility and benefits of sustainable development. A key objective of the *Center* is to engage the business sector in trade and investment activities that advance sustainable development practices and generate market return. The *Center* will work closely with China and U.S. government agencies and will forge partnerships with the private sector, higher education, nongovernmental and multi-lateral organizations. The explicit goals of the *Center* are to leverage resources, steadily accelerate the pace of sustainable development cooperation and achieve innovative results.

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Another tour took the U.S. delegates through a satellite briefing. The CMA operates polar orbit satellites, and in 1997 it launched its first geo-stationary satellites. Chinese satellites capture pictures of typhoons, monitor floods and forest fires, and provide mud and river outflow information in large coastal bays, such as Bohai Bay. The three receiving stations for satellite data are located in Beijing, Urumqi, and Guangzhou. With a larger number of functioning satellites the current satellite programs have been very successful. In the 1960s, Chinese satellite programs benefited a great deal from access to meteorological satellite data provided by the United States. Consistent with the United States, China has always maintained a policy of sharing meteorological satellite data, the Chinese Meteorological Satellite Program is now also sharing its data and contributing to global environmental satellite systems. Sharing such information with the international community is a significant shift from past policy in China. In fact, Chinese satellite data are now available on the Internet.

NOAA and the Chinese Meteorological Administration administrators also discussed the possibility of a joint modernization of radar systems. In the past year NOAA has completed a modernization of the National Weather Service with new radar, satellite, and communication systems. In a move to upgrade their system, the CMA has recently signed a joint venture agreement with Lockheed Martin. Under this agreement they developed an improved Doppler meteorological radar system. Over the next few years a 103 Doppler radar system will be deployed. Under the new atmospheric science and technology work plan, NOAA will interact with the Chinese as

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As an important step to achieve these goals, Oregon's Governor John Kitzhaber is pleased to announce that the renowned architect and sustainable development leader, William McDonough, has agreed to be the founding Chair of the U.S. Board of Directors for the *Center*. In 1992 the city of Hannover, Germany selected him to write *The Hannover Principles/Design for Sustainability* to guide the design of EXPO 2000, the World's Fair. In 1996, Mr. McDonough received the Presidential Award for Sustainable Development, the nation's highest environmental honor, presented in a White House ceremony. He is founding principal of William McDonough and Partners, an internationally recognized firm practicing ecologically, socially, and economically intelligent architecture and planning in the U.S. and abroad. He is also a founder of McDonough Braungart Design Chemistry, a product and systems development firm which assists companies to profitably implement their unique sustaining design protocol. Mr. McDonough is the former dean of the School of Architecture at the University of Virginia where he is now professor of architecture and professor of business administration at the Darden School of Business Administration. He is also the founder of the University's Institute for Sustainable Design and Commerce. Mr. McDonough has been called a "hero for the planet" by *Time Magazine*, which hailed his "unified theory that, in demonstrable and practical ways, is changing the design of the world." He is currently engaged in breakthrough initiatives to advance sustainable practices for such global corporations as Ford and Nike. Mr. McDonough was born and raised in Asia.

The other members of the U.S. Board of Directors are now in the process of being appointed. China's Board of Directors is being formed and a search for the Executive Director of the U.S. Secretariat is now underway. For additional information on the Board or U.S. Executive Director search, please contact the International Sustainable Development Foundation.

Even as the Board is being formed, initial delegations have been exchanged between China and the U.S. to chart the future course of the *Center.* The *Center* was also called upon to lead a discussion on state and provincial level land use cooperation at the third U.S.—China Forum on the Environment and Development held in January 2000. Several potential projects are currently being considered for early implementation. The International Sustainable Development Foundation welcomes inquiries, expressions of interest, and support for the work of the *China—U.S. Center for Sustainable Development*.

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they upgrade their radar system NOAA and collaborate on technology and data analysis.

In addition to the direct agreements under protocols negotiated with its sister organizations in China, NOAA has also increased its cooperative activities in China under *The U.S.–China Forum on Environment and Development*. This Forum was established by Vice President Gore and Premier Li Peng in 1997 and is currently co-chaired by the Vice President and Premier Zhu Rongji. The most recent meeting was held in April 1999 and the next meeting will be held in January 2000. The approach taken by the both parties on this Forum has changed significantly over the course of two years since its inception. Specifically, in the first Forum on Environment and Development, the U.S. side spoke predominantly about the environment, while the Chinese delegation stressed issues of development and economic growth. In the April 1999 meeting the two sides became more unified in the goals of the Forum. Notably, Zhu Rongji spent considerable time at the April meeting talking about environmental issues and problems that China faces and stressed areas in which the United States and China could cooperate to promote environmental concerns. Issues concerning NOAA that are encompassed by this Forum include cooperation on natural disaster reduction and seasonal-to-inter-annual climate variability (El Niño), and integrated coastal management. Additional projects undertaken by NOAA in China are listed in the Inventory of this publication.