

Climate Change and Chinese Energy Policy

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Abstract

Stemming global climate change hinges in substantial part upon the success of economic and political reforms in the People's Republic of China. China, the world's most populous country, accounts for a large and growing share of global emissions of greenhouse gases. Without extensive industrial restructuring, there is little prospect for slowing the rate of growth of China's emissions. Many aspects of the necessary reforms are impeded by the Chinese government's lack of a strong source of political legitimacy. This paper will outline the link between the global environment and Chinese domestic policy considerations.

A variety of climate models predict that anthropogenic increases in greenhouse gases will result in a 1 to 1.5°C warming of average surface temperature over the next forty years (MacDonald 1988).¹ Unless emissions of these gases are limited, temperatures could increase even more dramatically over the longer term (Mintzer 1988). While the precise impact of temperature increases on the Earth's climate is still unknown, some of the possible outcomes of global warming will mean steep costs. The inundation of many islands and coastal areas, the widespread disruption of agriculture, and the loss of precious and unique ecosystems are among the most alarming and widely anticipated consequences.

About half the projected warming is due to increases in atmospheric carbon dioxide (CO₂).² Rising levels of atmospheric CO₂ are primarily a

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byproduct of energy production and use. The combustion of coal, natural gas, petroleum products, and biomass releases the carbon dioxide that can radically alter the natural order of the environment. Any serious attempt to limit global warming should include measures to cut CO₂ emissions by developing alternative sources of energy, and by promoting efficient energy production and use.

Developing alternative energy sources appears to be a hopeful long-term strategy for dealing with global warming. Energy sources that do not contribute to global warming, such as hydroelectric, geothermal, solar, wind, tidal, and nuclear power, while often presenting their own environmental complications, offer great promise. Shifting the global economy away from its current reliance on hydrocarbons for energy will take a great deal of time and investment, however. In the meantime, gains from greater efficiency of energy production and utilization must be fully exploited. Reducing current demand for energy directly limits emissions of greenhouse gases, and buys time for the development of new energy technologies to supply future demand.

Measures to promote energy efficiency often make economic sense independent of their impact on global warming. This is especially true for developing nations. According to a World Bank report, developing nations could save an estimated 6–10 percent of total industrial energy consumption per year through short term measures with payback periods of fifteen to twenty-three months and rates of return estimated in the range of 50–125 percent (Gamba 1986). Similarly, medium term measures with payback periods of two to six years and rates of return around 15–50 percent could save an additional 12–18 percent of yearly energy consumption. The total investment worldwide needed to accomplish these savings is estimated at US\$6.5–20 billion and US\$41–94 billion, respectively. This is only 2–6 percent of the estimated total energy sector investment required for developing nations during the period in which these savings could be realized (fifteen years). Total energy sector investment in developing nations is expected to reach US\$130 billion annually through the end of the century.³ Even without a concern for the long term implications of climate change, energy conservation is economically beneficial for developing nations.

Investment in energy efficiency in the developing world yields such high returns precisely because the current state of affairs is so dismal. Extreme variations in energy efficiency around the globe—particularly between developed and developing nations—indicate a potential for dramatic gains from more widespread use of the best existing technologies. As an extreme example, China's energy intensity of production—by far the highest in the world—is greater than that of its neighbor, Japan, by roughly a factor of four (Smil 1984, World Bank 1990, World Resources Institute 1990–91).

Despite the obvious advantages of conservation, progress in developing countries has been slow. Even assuming that nations like China have access to the latest technology and the resources to exploit it—often a specious assumption at present—their domestic producers typically lack economic incentives to invest in energy efficiency. Governments subsidize industrial development with low energy prices, so that the value of energy savings appears negligible when compared to the necessary investments in conservation. Such policies are by no means unique to developing countries, but at present they do play a much greater role than in wealthier economies.⁴ At the same time, developing nations are disadvantaged with respect to the resources necessary to cope with changes in these policies.

International Cooperation and Developing Nations

International cooperation to limit greenhouse gas emissions is necessitated by the global nature of their impact and the broad dispersal of their sources (Wirth and Lashof 1990). As a result, global warming will be one of the foremost issues of concern at the upcoming United Nations Conference on Environment and Development in Brazil in 1992. Many hope that the conference will lead to an international agreement to limit emissions of the gases believed to cause global warming, similar to the Vienna Convention and Montreal Protocol on Substances that Deplete the Ozone Layer. Such an agreement will be far more difficult to arrive at than was the Montreal Protocol. Unlike the gases controlled in the Montreal Protocol, whose production was concentrated in a small number of wealthy nations, greenhouse gases are produced in every nation. Developed nations account for 46 percent of global carbon emissions (Chandler 1989). Of the remainder, China alone emits 11 percent, the other developing countries produce 16 percent, and the former Soviet Bloc contributes the remaining 27 percent.⁵ Given the developing nations' rapid population growth and comparatively low per capita energy consumption, their carbon emissions are likely to see substantial growth. At the same time, reductions of 50-80 percent from current global CO₂ emissions levels are necessary to stabilize atmospheric concentrations of greenhouse gasses (National Research Council 1990). Developed nations would face unacceptably high burdens stabilizing global carbon emissions on their own.⁶ Clearly, limiting climate change requires the cooperation of all nations.

The essence of the Montreal Protocol is a bargain between rich and poor nations. Poor nations agree to forego future development of ozone-depleting technologies in exchange for compensation in the form of subsidized access to safer replacement technologies by the rich nations responsible for past and current ozone depletion. Efforts to limit global climate change must go much further—transforming developing nations' *current* economic structures in favor of conservation, often with far-

reaching ramifications for government revenue, corporate profits, and consumer income.

Unfortunately, while the scope of climate change is global, disparities in nations' capacity to bear its costs and the costs of its limitation, the likely uneven and unpredictable distribution of those costs, and the long delay before costs are felt will motivate many poorer nations to hitch a free ride on the efforts of the wealthy. Since the wealthiest nations are also primarily responsible for past emissions of greenhouse gases, it will not be difficult for poorer nations to rationalize inaction. As a result, an agreement on greenhouse gases will be far more difficult to achieve than was the agreement on ozone.

Chinese Cooperation

Chinese cooperation is crucial to the long term success of efforts to limit global warming. Home to one-fifth of the world's population, the People's Republic of China is at present responsible for more than one-tenth of annual global anthropogenic carbon dioxide emissions (Boxer 1989). Chinese emissions are certain to grow in the decades ahead, both in absolute and relative terms. *The Economist* predicts that by 2020 China's share of global CO₂ emissions will reach 20 percent. If China's billion-plus population continues to enjoy rapid economic growth under present conditions, the increase in China's contribution to global climate change could soon offset efforts to limit greenhouse gas emissions in other nations.

China is already the world's third largest energy consumer, but per capita energy consumption is very low—about one-third the global average (Xin 1988). China's per capita energy consumption is less than the average for all developing nations (Smil 1988), and less than one-twentieth that of the developed nations (Jia 1988). Obviously, there is great scope for a major increase in energy consumption during the course of China's economic development. Current plans to double GNP by the year 2000 call for a rapid expansion of energy production of anywhere from 50-100 percent (Smil 1988). Official forecasts into the twenty-first century, while of dubious reliability, anticipate continued rapid increases in energy demand, from 862 million tons coal equivalent (Mtce) in 1986 to 1,400 Mtce in 2000 and 4,000 Mtce in 2030 (Xin 1988, Smil 1988). As is often the case in Chinese economic planning, however, predictions of future economic growth and energy use levels are usually linear projections of current trends. Since it has been common to experience declining energy elasticities of economic growth in many countries, there is reason to hope that China's future energy needs may be more moderate than the Chinese government expects. This is especially true since China's energy efficiency is so far below current international standards. Still, China's extreme poverty and rapid growth rates suggest significant growth in energy

consumption, and China's massive size guarantees that its domestic changes will impact heavily upon the global scene.

Assuming continued, rapid economic growth in China, limiting China's CO₂ emissions will require greater energy conservation and the development of alternatives to fossil fuels. Of these two strategies, the former is the most promising in the near term. Developing alternative energy supplies—which are primarily comprised of nuclear, solar, hydropower, geothermal, and various biomass energy sources—remains a strategy for the longer term.

Development of nuclear energy requires the importation of expensive foreign capital equipment. Furthermore, while probably capable of running a few reactors—such as the new Jinshan reactor in East China—China lacks the skilled technical and managerial resources to safely maintain and operate an extensive nuclear power industry. These are not insurmountable barriers, but it will take time and considerably greater investment in education than is currently being undertaken before this is a viable option.

- Solar power is, at present, more expensive than conservation, and the areas best suited to solar power generation are those furthest from China's centers of industry and population. Generally, the far northwestern desert and the Tibetan plateau are the best sites for solar power generation, while the vast majority of China's population is located along the eastern seaboard.

- Hydroelectric power generation holds great untapped potential, but is threatened by heavy and increasing silt loads in China's major rivers. Extensive deforestation of the Huang He (Yellow River) and Chang Jiang (Yangtze River) basins in particular will have to be reversed before large scale investments in new hydroelectric capacity will be feasible. A good example is the Sanmenxia dam in Henan. Despite extensive protective measures, 60 percent of the reservoir's capacity was lost due to siltation between 1958 and 1973 (Smil 1984 and 1988, McDowell 1990). Environmental problems led to a re-engineering of the reservoir, cutting capacity from 1.1 GW to 200 MW (Smil 1984). According to McDowell (1990, citing Kinzelbach 1983), "Annual loss of reservoir volume in hydroelectric-generating stations owing to siltation is equivalent to a third of new reservoir volume excavated."

Development of small scale hydroelectric potential in China could reduce the rapidly growing rural industrial enterprises' reliance on low quality coal (McDowell 1990), but is unlikely to play a significant role supplying urban energy consumption.

As for geothermal resources, the majority of high-quality sites that have been identified are located in the far west in Tibet; again, far from centers of consumption. Overall, exploitation of all identified sites would add less than 5 percent of 1985 generating capacity (Smil 1988).

Finally, China lacks excess grain capacity to produce grain-based fuels,

and biomass stocks are already over-exploited as a fuel source (Ross 1988, Smil 1988). While forest stocks could be built up as a future energy source, this is definitely a long term measure. China's per capita timber reserves are among the lowest in the world, and extensive afforestation efforts have met with little success (Ross 1988, Smil 1988). Fossil fuels—in particular, coal, which supplies 75 percent of commercial energy—will remain the primary source of energy in China for some time to come.

While the greater part of China's energy supply will continue to come from coal, there is wide scope for conservation. Chinese energy intensity of production is more than double that of the OECD countries (World Resources Institute 1990). This is due both to the inefficiency of Chinese industry and to energy-intensive heavy industry's disproportionate share of gross material product.

Chinese Energy Policy

China has already embarked upon a conservation program. The record to date—particularly the reasons for the program's adoption, successes, and failures—is an important guide to the future of Chinese energy policy and to what, specifically, can be done to improve future performance.

At the end of the 1970s, implementation of the 1980–1990 Ten Year Plan's development program was stymied by an acute energy deficit. Prior to 1979, energy policy had focused solely on expanding output, without any attention to issues of efficiency. Overly ambitious plans for a fourfold increase in coal production and a fivefold increase in oil production in twenty years simply could not be realized (Smil 1988). Emphasis on inefficient, energy-intensive heavy industrial development using obsolete technologies and poor management meant that energy demand continually outstripped energy production; many factories were running at 50–70 percent of capacity due to insufficient energy supplies (Christoffersen 1987).

The energy deficit had, and continues to have, serious repercussions throughout the Chinese economy. While investment in energy production capacity accounts for one fifth of total capital investment and 36 percent of total industrial development, about 20 percent of industrial capacity is still idle nationwide (Xin 1988). Some 60 percent of coal produced is shipped by rail, tying up scarce transport capacity.⁷ Indeed, expanding coal production to meet China's energy needs is over-taxing an already severely straitened transport sector. In spite of the energy shortage, a significant portion of coal production is not delivered due to transport bottlenecks (Smil 1988).⁸

The government's inability to keep up with the huge investments in primary energy production and transport required by rapid, energy-intensive growth forced a new emphasis on energy conservation. The State

Planning Commission (SPC) saw energy conservation as a means to achieve economic growth targets despite the energy shortage (Christoffersen 1987). While production-oriented ministries might be expected to oppose a shift of resources from new development to conservation of energy, the powerful Ministry of Petroleum Industry was in fact a strong advocate of energy conservation as a means to free up petroleum supplies for export (Christoffersen 1987).

The result was an energy conservation policy that has gone through two distinct phases since its inception. In the first phase, extending roughly from 1979 to 1984, an emphasis was placed on industrial restructuring, shifting resources from old-style heavy industrial development to light industry and agriculture (Smil 1984). By 1985, energy intensity of production had fallen about one-third from 1980 levels (Christoffersen 1987). Approximately 100 Mtce were conserved, and annual declines in energy intensity were in the range of 2.6-3.5 percent (Smil 1988).

While China has by no means exhausted the potential for gains from sectoral restructuring, it has experienced rapidly declining returns to investment while pursuing this strategy. The average cost of saving one ton of coal equivalent energy under this strategy roughly doubled from 1981 to 1984, from RMB 160 (US\$42) to RMB 300-350 (US\$79-92) (Smil 1988).⁹ At the same time, the price of state-supplied coal in China is set extremely low, so that state enterprises lack financial incentives to conserve energy. In 1986, state coal prices averaged about RMB 34 (US\$9) per ton, or about one third the cost of production (World Bank 1991). State coal prices have risen since then, but have not kept pace with inflation. Market prices for Chinese coal are much higher, ranging around RMB 200 (US\$53) in 1989 (World Bank 1991).

By 1984, Chinese planners had already begun to shift to the second phase of conservation policy. The new emphasis is on the technical transformation of industry to improve efficiency. If appropriate resources can be directed toward this program, prospects for significant gains are bright. The World Bank estimates for conservation potential in developing countries discussed previously hold special relevance for China. According to the World Bank, the greatest potential for conservation lies in the modernization of heavy industries such as steel, petroleum refining, cement, pulp and paper, and chemicals (Gamba 1986).¹⁰ These sectors are all important in China, where heavy industry accounts for over half of output and energy consumption (Hartland 1989, Smil 1988).

Unfortunately, the new phase in conservation policy was damaged by the drop in world oil prices during the second half of the 1980s. Lower oil prices have had two major ramifications for the technical transformation policy. First, lower foreign exchange earnings from energy exports led to a curtailment of the funds available to enterprises for investment in efficiency, as the program is heavily dependent on imported technology

(Christoffersen 1987). Second, the export value of oil saved by technical upgrades is less than the cost of the required imported technology (Christoffersen 1987). The impact of lower oil prices is magnified by the lack of financial incentives to conserve energy other than those related to the export of energy. This is due to China's distorted price structure.

In the last few years, China has enjoyed great success in promoting exports. This, combined with domestic austerity, has resulted in a large trade surplus. For a nation at China's level of development to run large trade surpluses is unusual. In view of the gains to be had from investment in industrial energy efficiency, and the need for imported technology to enable these efficiencies, it would be logical to take advantage of China's strong export position to expand the conservation program. The prospects for an export-led conservation strategy are complicated by China's price structure, the state of economic reform, and certain political considerations.

Analysis

The key government organizations involved in adopting the conservation policy were the SPC and the Ministry of Petroleum Industry. The SPC has assumed greater responsibility for economic planning in recent years (Zhou 1991). The SPC's primary concern was the maintenance of economic growth given the constraints imposed by energy shortages. The SPC was essentially forced to adopt a conservation policy by the extremity of the energy crisis: new oil reserves could not be found. Exploitation of coal reserves was limited by insufficient growth in rail freight capacity. This bottleneck worsens as relatively accessible eastern coal reserves are increasingly depleted, forcing reliance on coal deposits ever further west, at a greater remove from demand centers. At the same time, China faces a rapidly growing labor force in an economy characterized by labor surpluses.

The Ministry of Petroleum Industry advocated investment in conservation (at the Ministry of Coal Industry's expense) to free up oil for export at high international market prices in order to maintain and expand its influence (Christoffersen 1987). The ministry's political influence is a function of its importance to the State Planning Commission's economic plan and the extent of the resources it controls—two closely related indices. Conserving energy helped free up petroleum for export,¹¹ generating higher income and,¹² more important, foreign exchange. State revenues come directly from profits of state enterprises, so profitable enterprises—and their ministries—tend to receive greater resources for expansion. As one of the central government's key earners of foreign exchange, the Ministry of Petroleum Industry would gain leverage as the linchpin of the government's modernization program. Access to foreign exchange

holds out the promise of improving the performance of current oil production and exploration as well. Finally, higher income and access to foreign exchange provide greater resources for expansion of bureaucratic patronage.

In addition, heavy industrial producers appear to have played a significant role in determining how the policy developed. From 1979 to 1984 these producers were hurt, as energy was "conserved" by limiting the growth of heavy industry and shifting resources to light industrial and commercial development. In the second phase, these same producers stood to gain as policy concentrated on improving efficiency in heavy industrial state enterprises by allocating them additional investment capital and foreign exchange to import capital equipment.

Heavy industrial enterprises were primarily concerned with obtaining resources for expansion. Industrial enterprises in China have an insatiable demand for investment. This is because they face what is known as a soft budget constraint: state-sector industrial firms that lose money have never been allowed to go bankrupt (Kornai 1980).¹³ Their credit is usually provided by banks controlled by an administrative unit (center, province, county, etc.) that receives its revenue from the enterprise's profits, so that strict accountability is often lacking. Governments want to protect their revenues and ensure full employment, so they have strong disincentives to force accountability.

At the same time, enterprises have strong incentives to grow. State enterprise managers are essentially members of the state bureaucracy. Their future careers are closely linked to the size of his or her enterprise. Enterprise status, and hence privilege, is based primarily on size. If a manager's enterprise increases in size, his or her status in the bureaucracy also rises. Larger firms gain greater leverage vis a vis local governments as well, resulting in lower tax rates, preferential allocation of resources, and cheap credit. Larger firms can buy the cooperation of their employees with greater benefits.¹⁴ The net result is a strong demand for investment resources—a demand that was thwarted when the SPC was forced to limit growth in heavy industry in favor of less energy-intensive development. Industrial enterprises soon found a way to reopen the spigot, however—investment in liberally defined efficiency projects.

Energy Pricing

The most important lesson to draw from Chinese conservation policy in the 1980s is the pervasive influence of distorted energy prices. Chinese state-sector energy prices are lower than prevailing world prices by a factor of four or more. In recent years, energy markets have been allowed to operate alongside the state-administered energy plan, with the result that market energy prices in China have at times even exceeded world prices.

Chinese heavy industrial enterprises, however, as a high-priority state sector, continue to receive most of their energy needs from state energy allocations at low, state-set prices. It has been argued that if these firms use the energy markets to make up differences between their energy requirements and their allocations, they will face a market-determined marginal price for energy that will motivate them to invest in efficiency as though all their energy was obtained at the higher price. It is unclear that this system can always be relied upon in practice. Enterprises can simply cut production rather than improve efficiency. Failure to meet production quotas may incur some penalty, but enterprises have been known to cut production in order to sell their supplies of state-subsidized fuel on the market (Christoffersen 1987).^{15,16} Furthermore, soft budget constraints, cheap or free credit, and the ability to regularly renegotiate their own tax rates leave firms with little incentive to invest in efficiency. Negotiating a small change in a firm's tax rate can more than compensate for higher energy prices at the margin.¹⁷

State-sector heavy industrial enterprises' current interest in efficiency is a function of the availability of state subsidies and incentives—particularly access to foreign exchange—for such investments. As a result, progress in energy efficiency is limited by the availability of state funds and foreign exchange reserves for these purposes. The former is increasingly limited by the steady decline in the state's share of national income (China in Statistics 1987). The latter has been curtailed first by the fall in both the quantity of oil available for export and the world oil price, and later by the government's severe austerity campaign. Only higher energy prices, coupled with a hard budget constraint, will generate internal incentives for enterprises to conserve energy. Only then will enterprises focus their managerial and technical resources on conservation, generating their own internal solutions rather than relying only on the importation of expensive equipment while ignoring essentially free managerial and process improvements.

Not only would price and economic reforms motivate firms to boost their energy efficiency on a continuing basis, but they would also result in immediate, substantial economic gains from more rational distribution of energy. Despite China's efforts at conservation, some 15–20 percent of industrial capacity remains idle due to lack of energy (Xin 1988). This proportion has remained remarkably stable over a variety of policy stances. If market prices prevailed, it is likely that, without further improvements in efficiency, some 15–20 percent of the least productive capacity in the economy would cease operation, reallocating energy to the most efficient enterprises. This would represent an immense economic gain for China.

Finally, the current price structure provides a powerful incentive for concentration on energy intensive production, especially for export. Low domestic energy prices give Chinese firms a significant cost advantage in

foreign markets. Higher exports are bought at a significant, yet hidden, cost to the economy. The government's adoption of a policy to divert petroleum from a shortage-plagued domestic economy for export is indicative of the distorting impact of artificially low energy prices.

Impediments to Reform

For more than ten years the Chinese government has acknowledged the need for comprehensive price reform, yet today stands little closer to the goal (Solinger 1991, Baum 1991, Zhou 1991). Premier Li Peng anticipates at least another ten years will be required before price reform can be completed (Zhou 1991). The painfully slow rate of progress reflects the substantial obstacles to reform. These obstacles are primarily related to the government's concerns for its revenue base and the need for political stability.

Government revenue is primarily derived from profits of state enterprises—particularly industrial enterprises. Profit margins are maintained by holding down input prices relative to the prices for finished goods. Profits in the state industrial sector are huge, though pressured by current reforms (Naughton 1992). Price reform would substantially shrink this revenue base. At the same time, implementing a broad-based tax system takes time. The timing of price reform depends in good part upon the government's ability to shift from a profit-based to a tax-based revenue structure.

The tenuousness of Chinese political stability is also an important obstacle to price reform. The regime has expended the large reservoir of good will with which it began. To prop itself up, the party increasingly depends on its ability to buy support from local leaders. The regime's inability to replace its early charismatic leaders such as Mao Zedong and Zhou Enlai have led it to depend on economic performance for legitimacy in the absence of other legal, democratic, or traditional sources (Tiewes 1984). This is manifested as pressure to sustain real economic growth, and to prevent urban unemployment and inflation.

The government fears that economic disruption from price reform could stall growth. The examples of the Soviet Union and Eastern Europe thus far do not encourage optimism in this regard. Similarly, there is widespread fear that price reform will lead, at least temporarily, to very high inflation. The hyperinflation China experienced during World War II seared the public memory, and is often cited as a reason for the Communist party's ability to triumph over the militarily superior Guomindang. Significantly, the unrest preceding the Tiananmen massacre of June, 1989, followed a rapid increase in urban inflation, and was cited in numerous public opinion polls as a source of deep dissatisfaction with the government's performance (Rosen 1991).

State-sector industrial enterprises are used to maintain as close to full urban employment as is possible. High profits based on price distortions allow industrial firms to support far more employees than they need. The government rightly fears further unrest if urban unemployment is allowed to rise. China's labor force is growing faster than the economy can absorb.¹⁸

Finally, urban workers' housing, health care, pensions and other social benefits are provided by their enterprises, financed by the same high profits. Price reforms will necessarily restrict enterprises' ability to provide social benefits, and the government currently lacks the resources to build up an alternative social infrastructure.

In the absence of greater political legitimacy, the government will not be able to inflict pain on consumers in a quick transition to a new price system without serious political repercussions. The need for a new, secure revenue base and an infrastructure for providing social benefits will also delay price reform for a long time to come.

Environmental Concerns

Another important aspect of China's experience with conservation policy in the 1980s is that environmental concerns played no apparent role in energy policy whatsoever. The key decision makers were all motivated by economic and political expediency. The new policy displayed continuity with the exclusively economic-motivated policy it replaced.¹⁹ The most radical feature of the policy change—the shift in investment from heavy to light industrial development—was dictated by crisis and was temporary. Members of China's fledgling environmental bureaucracy had no important, acknowledged decision making role.²⁰ Even the official summaries of the goals of the policy change made no mention of environmental concerns (Christoffersen 1987).

The short term economic orientation of Chinese energy policy holds both negative and positive implications for the future of China's response to global climate change. On the one hand, China's experience may make it that much easier to accept the links between economic and environmental issues, and the economic benefits of investments in energy efficiency. On the other hand, limiting climate change will eventually require raising the prices of fossil fuels far beyond what markets, unassisted, would accomplish by themselves. The Chinese conception of economic efficiency may not encompass environmental externalities.

The Chinese value the environment for its immediate economic uses. Land not currently employed in Chinese-style agriculture is usually referred to as *huangdi*, or "wasteland." The term connotes desolation and neglect, that the land thus specified was formerly agricultural land that has been returned (temporarily) to an uncultivated state. This implies that

"environmental" uses of land—such as habitat for undomesticated species—are accorded no value in China.

"Environment" even has a legal definition in the Peoples' Republic of China. According to Article 3 of the Environmental Protection Law,

The term environment...encompasses the air, water, land, mineral resources, forests, grasslands, wild plants and animals, aquatic life, places of historical interest, scenic spots, hot springs, resorts, and natural areas under special protection, as well as inhabited parts of the country (Environmental Protection Law, Article 3 1973).

Superficially, this is environment in the broadest possible sense—environment defined as everything. On a deeper level, this definition suggests a Chinese conception of environment as economic resources rather than habitat. Note that *forests* and *grasslands* are separate categories from the *wild plants and animals* that live in them. Note also that while forests and grasslands are included (along with resorts!), less economically useful ecosystems such as salt marshes and deserts are not mentioned.

When environment is defined as resources, environmental management means using resources efficiently. For example, environmental impact statements in China are primarily for urban construction projects (this is not surprising, since the Ministry of Environmental Protection is also the Ministry of Urban and Rural Construction) and they typically come after the plans have been drafted. Usually they do not ask "Is this an appropriate development given the constraints of this environment?" Instead they ask "How can this project be modified so as to reduce its [economic] costs" (Wengler, Wang, and Ma 1990)?

Subjective motives for investments for "environmental" reasons fall into two categories—luxury and efficiency. Environmental luxuries—usually resources whose immediate use is foregone—are a sign of status, and are strictly limited to what the leadership perceives is affordable. Environmental efficiencies are additional costs incurred to ensure a higher return on an investment. To the extent that Chinese cooperation in limiting CO₂ emissions is presented as an international duty, a service to mankind, China's fair share in a communal effort, it will be considered a luxury. The Chinese will then demand compensation for any actions beyond mere tokens.

Global warming could cost China a great deal. Already burdened by one of the world's lowest ratios of arable land per capita, China is likely to suffer losses in productivity and land it can ill afford. Despite significant scientific uncertainty, it seems likely that reduced rainfall and higher temperatures will make China's water-poor interior even dryer than it already is (Hafele 1981). At the same time, higher sea levels will lead to

flooding and salt intrusion in some of China's most productive farmland in the Huang, Hwai, Chang, and Zhu river deltas.

Changes in climate may well further speed China's already rapid deforestation. The loss of forest cover along the headwaters of the Huang river—and to a lesser extent along the Chang Jiang—is largely responsible for the heavy and increasing silt load borne by these rivers. A rapid increase in the silt load could lead to the siltation of irrigation canals and recently completed hydropower and flood control projects on both rivers, and to flooding along their fertile, densely populated lower reaches.

In addition to lost farmland, higher sea levels are expected to displace at least fifty million people (Daily Times 1990). Some of China's largest and most developed cities—including Shanghai, Guangzhou (Canton), and Xianggang (Hong Kong)—are at risk from flooding, loss of municipal water supplies to salt intrusion, and greater storm damage. In fact, most of China's modern and productive economic assets are concentrated in areas most likely to be adversely affected—coastal alluvial plains and deltas.

Given the potential for such severe losses, the Chinese government's emphasis on economic goals, and its tendency to define environment in terms of economics, could lead it to take actions to limit emissions of greenhouse gases. Unfortunately, these costs are difficult to predict, while the costs of raising energy prices beyond their short term economically efficient level (not considering externalities) will not appear so incalculable.

Conclusion

While the Chinese publicly acknowledge a pressing need for price reform and attendant economic reforms, their will to press forward on these fronts has been paralyzed by the economic and political risks they entail. In the absence of a new basis for regime legitimacy, the current regime is unlikely to risk short-term economic disruption from implementing price reform in the near future, preferring a long-term, gradual strategy instead. Developing the infrastructure necessary to collect taxes and provide social benefits will likely take precedence over comprehensive price reform. Continued rapid economic growth in this context necessarily leads to the conclusion that unless CO₂ emissions outside China are cut deeply, increases in China's emissions will eventually offset cuts elsewhere. The motivation for early action in China to limit climate change will have to come from the outside world.

Notes

1. See also Chamberlain et al. 1982, MacDonald 1982, Hafele et al. 1981, Seidel 1981, Schneider and Rosenberg 1989.

2. For a discussion of the role of energy production in climate change, see *National Research Council 1990*.

3. 1986 through 2000.

4. This is especially true in China and many other developing countries where the state plays a much greater role in the economy than is the norm in most developed nations. Energy prices for state firms in China are often less than one fourth the world average. At the same time, state intervention in distribution systems, pricing, and credit markets is so pervasive that negotiating small changes in government policy can have a far greater impact on profit margins than any investment in efficiency.

5. Data is for 1986.

6. The *Economist* (August 31, 1991) estimates that a carbon tax of US\$300 per ton of carbon within the nations of the Organization for Economic Cooperation and Development (OECD) and of US\$215 in the rest of the world could achieve a 20 percent reduction in CO₂ emissions by 2010, and subsequent stabilization of output levels. If, however, such a tax were assessed in the OECD nations only, it would need to total US\$2,200 per ton to achieve the same result.

7. Coal accounts for over 75 percent of China's commercial energy output.

8. According to Vaclav Smil in *Energy in China's Modernization*, this accounts for up to one third of coal production.

9. For purposes of comparison, the 1989 official exchange rate of 3.8 RMB/US\$ is used throughout this discussion.

10. "Chemical industry" here includes production of chemical fertilizer. China's chemical fertilizer production is based on recently imported technology and equipment, and is modern and reasonably efficient.

11. Despite the energy shortage, "surplus" petroleum was still available for export. At the same time that resources were being diverted from coal development to conservation, enterprises were encouraged to convert from oil to coal as a fuel. (It is common for Chinese factories to generate their own power by burning coal or oil, rather than purchasing electricity.) A greater emphasis was also placed on developing hydro-electric and other alternative energy sources. The policy of conservation was actually a policy of conservation and conversion, though the latter aspect of the policy was not particularly successful; some 85 percent of the funds allocated for conversion were instead spent on new electrical generation capacity (see Christoffersen 1987).

12. Most of the Ministry of Petroleum Industry's production is allocated to state enterprises at prices set at less than one fourth the world market price. While these prices allow many oil producing units to run at an operating profit, it is important to note that "China's definition of cost excludes capital interest and resource rent as well as all prospecting and exploration expenses" (Smil 1988). Under these conditions, the incentive to export rather than sell on the domestic market is very high. At the same time, state oil producers' (as well as state coal producers') incentives are to expand output at currently exploited fields rather than to prospect for new reserves (see Christoffersen 1987).

13. This may begin to change soon. There are indications that the Chinese government is beginning to close down or merge some of the most inefficient enterprises. So far the number of firms affected are very small, so that the impact on firms' decision-making is likely to be negligible. The government has been reluctant to close these firms down in the past, partly because employees and their families receive their housing, transportation, education, health care, and other social benefits through their work unit, and there is no infrastructure to provide them outside of the work place. Political organization is also based on the work unit.

14. Wages are usually set, workers are difficult to fire, and they have great difficulty changing jobs on their own initiative. Managers must resort to improving housing or offering better or new benefits to gain their cooperation.

15. While the profit from reselling subsidized inputs exceeds what the enterprise can get for its finished product, such transactions are not necessarily economically efficient, since profit margins on production do not reflect information about the real economy.

16. Of course, the (illegal) ability to resell state supplied coal on the market could also work to promote efficiency. Enterprises seeking to free up coal for resale might produce more efficiently instead of cutting production.

17. Tax rates are negotiated on a firm by firm basis in China.

18. Lynn White suggests that, while the official projections probably exaggerate the state sectors' employment growth potential, they may also underestimate that of the non-state sector.

19. As discussed above, previous government plans anticipated a key role for the petroleum industry, both as a rapidly growing supplier of energy, and as a key generator of foreign exchange earnings. When production peaked in 1979 after half a decade of rapid growth—oil exports averaged 55 percent growth a year—petroleum's role as an energy supply was necessarily downgraded, but the basic export strategy resisted change (Christoffersen 1987).

20. Indicative of the weakness of China's environmental bureaucracy, the State Bureau for Environmental Protection has been made a subordinate adjunct of the Ministry of Urban Construction.

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- Zhou Xiaochuan. In the Spring of 1991 I had an opportunity to discuss Chinese economic and environmental policy with an economist working for the Chinese government. Some of the conclusions herein reflect his views on Chinese policy.