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# **ECONOMICS, ECOLOGY AND THE ENVIRONMENT**

**Working paper No. 7**

**Poverty and Its Alleviation in Yunnan Province China:  
Sources, Policies and Solutions**

**Ren Zhuge and Clement A. Tisdell**

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**WORKING PAPERS ON  
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**Working Paper No. 10**

**China's Environmental Problems  
with Particular Attention to  
its Energy Supply and  
Air Quality\***

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April 1997

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\* A background paper for a seminar to be given at the University of Duisburg, Germany 16 April, 1997.

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# **CHINA'S ENVIRONMENTAL PROBLEMS WITH PARTICULAR ATTENTION TO ITS ENERGY SUPPLY AND AIR QUALITY**

## **1. Introduction**

China's outstanding growth in recent decades and its open-door policies have made it a growth pole in the Western Pacific. Higher income countries, experiencing sluggish economic growth, have been vying to share in China's economic growth. They are seeking to gain from this growth through increased trade with China and greater investment opportunities in China. Consequently, along with China's economic reforms, this growth has been welcomed in Western countries. On the other hand, less attention has been given in Western countries to the environmental problems and costs involved in China's economic growth, except in a few academic circles. Furthermore, it must be noted that China's improving economic strength has implications for its military power and its position in international political bargaining. China's advancing economic position, increases its international strategic position because economic power and political power are closely intertwined. This is capable of producing some fear in Western countries as underlined by reactions to China's missile firings in the vicinity of Taiwan during Taiwan's elections in 1996. There are, therefore, two sides to the coin as far as the economic growth of China is concerned. This essay, however, concentrates only on the environmental aspects of China's economic growth.

Considerable debate exists in the literature about the relationship between economic growth and the state of the environment. The most optimistic view sees economic growth as leading to an improved environment whereas the most pessimistic view sees these two aspects as antagonistic. Differences of opinion exist both on the empirical and the theoretical plane. Using cross-sectional data, The World Bank (1992) for instance, suggests that with economic growth (or more particularly transition from low-income to high-income status) a country's environment at first deteriorates then improves. Economic growth is therefore seen as ultimately resulting in significant environmental improvement. Where is China currently placed on this U-shaped environmental quality curve? Is it still on its downward path and how much further will its environment deteriorate and in what ways? There is probably no easy answer to these questions.

One of the reasons why there is no easy answer to these questions is that environmental quality consists of multiple characteristics, so it consists of a number of variables. Some characteristics may improve with economic growth whereas others may decline and so it can be difficult to evaluate the resulting combination. Furthermore, very long-term environmental impacts may differ from short and medium-term ones and global environmental impacts may diverge from country-specific ones (cf. Tisdell, 1993a, Arrow *et al.*, 1995).

On the theoretical level, most economists appear to agree that it is *possible* for economic growth to occur and for improved environmental quality to be achieved in the short to medium term, although some particular policy measures may be needed to make this a reality. However, there is considerable theoretical disagreement about the extent to which economic growth is sustainable in the long run. One school of thought sees economic growth as ultimately reducing the natural environmental stock and lowering it to a level where income can no longer be sustained. Advocates of this point of view argue that strong policy measures must be adopted to conserve the natural environmental stock if sustainable development is to be achieved. They are said to advocate strong sustainability conditions. (These conditions are outlined in Tisdell, 1995b.)

On the other side of the spectrum are those who advocate weak sustainability conditions. They see man-made capital as an adequate substitute for natural environmental capital. Basically, they are supporters of traditional recipes for economic growth, whereas the strong sustainability school sees these recipes as leading ultimately to economic disaster. It should not, however, be concluded that the strong sustainability school opposes all economic growth. It merely rejects the view that man-made capital is always a suitable substitute for natural environmental capital and advocates a cautious approach to reducing the stock of natural environmental capital. It is unclear where Chinese policy-makers stand in relation to this issue, but the general importance of sustainability issues in development have been officially recognized in *China's Agenda 21 - White Paper on China's Population, Environment and Development in the 21st Century* (State Council, 1994) and this document is discussed below.

This White Paper indicates that as a result of China's economic reforms, there is now more scope for using market-related instruments (such as taxes, tradeable permits) as a means



of exerting environmental control in China. While up to a point these instruments are likely to be useful in balancing economic activities in a way which takes account of their environmental externalities, they may be of little value in addressing the level of environmental impacts from the scale of economic activity and on their own, may fail to conserve the natural environmental resource stock adequately. Price mechanisms do, it seems, have limitations in relation to environmental issues even when they operate extensively to take account of externalities (cf. Tisdell, 1990, Ch.2).

China's environmental effects are not purely China's concern (Tisdell, 1993b). Environmental developments in China are capable of having global impacts, for example, its increasing use of fossil fuels is likely to accelerate global warming and loss of biodiversity in China is to some extent a global loss. Furthermore, environmental changes in China can have international regional environmental impacts. Rivers from China flow into many nearby countries, and air bodies from China also circulate over nearby countries. Both have the potential of transporting pollutants to nearby countries. Such transboundary effects will be discussed later. Furthermore, given its eagerness to attract foreign investment, China has the potential to attract polluting economic activities which would not be tolerated in many higher income countries. Let us consider China's environmental problems with this background in mind.

## **2. The State of China's Environment and the Supply of its Natural Resources**

Compared to the world as a whole, China seems to be a country relatively poor in natural resources in relation to its population. This is highlighted by Table 1. In terms of availability of land and water resources in proportion to its population, China is at a serious disadvantage compared to the world as a whole.

In relation to water resources, the World Bank (1992) considers that countries with less than 2,000 cubic metres per capita have serious problems especially in drought periods and those with less than 1,000 cubic metres per capita face chronic water problems. Given predicted population changes, freshwater resources per capita in China are predicted to fall to less than 1,500 cubic metres by 2025 (World Bank, 1992). China's water availability problem will undoubtedly worsen. Furthermore increasing industrial production and higher income levels will add to the demand for water. The geographical distribution of water

resources in China combined with seasonal variation in water availability is already causing severe problems in China especially in parts of its northeast, for example, in the Beijing-Tianjin area. It might also be noted that given the high value placed on China's limited freshwater resources, pollution of these can be expected to impose a heavy economic cost on China.

Table 1: Availability of Selected Natural Resources of China Compared on a Per Capita Basis with those of the World in the early 1990s		
	World	China
Population (person/km <sup>2</sup> )	39	117
Arable land (ha/person)	0.26	0.08
Forest (ha/person)	0.77	0.13
Grassland (ha/person)	0.62	0.20
Fresh water (m <sup>3</sup> /person)	7744	2484

Source: Based on Wu and Flynn (1995, Table 2)

Unfortunately many of China's water resources have become polluted. Some lakes are reported to contain unacceptable levels of heavy metals released from industry, for example, those in the Wuhan area. The organic levels and sediments carried in most rivers have increased significantly. Furthermore high rates of artificial fertilizers used in agriculture and inadequate treatment of sewage has significantly added to the nitrate and phosphorous levels in rivers. It has been suggested that the discharge of these nutrient-rich waters into the China Sea is a prime factor making for the periodic occurrence of red tides which kill fish *en masse* and/or make them poisonous for human consumption. It ought to be noted that all these types of water pollution threaten China's aquaculture industry which in terms of volume of production, is by far the largest in the world and a significant source of animal protein for China's population. Of course, the economic costs of water pollution are much wider than this example indicates and its health consequences and its impact in reducing biodiversity should not be ignored.

Air quality in China has deteriorated seriously with its economic growth. Excluding township enterprises (considered by some to be a source of serious pollution), sulphur dioxide remissions in China increased by more than one-third in the period 1982-1992 and other gases contaminating the air more than doubled (estimates from figures supplied by Wu and Flynn, 1995, p.4). Most of China's large cities have air quality much lower than the standards set by the World Health Organization. For example, the air in Shenyang is heavily polluted and this has been proposed as a source of the high incidence of cancer amongst its population. Air pollution is responsible for a high incidence of respiratory illness in many of China's cities.

In fact because air quality is so poor, 26 per cent of all deaths in China are attributed to it, five times the U.S. level of such deaths (Bingham, 1993, p.12). Respiratory disease is the biggest single source of death in China. Acid rains are a serious problem and sometimes cause pH levels in rivers south of the Yangtze to fall below 5.6 even though alkaline loess dust helps to reduce this acidity. Inefficient boilers and small power stations are a major source of this pollution (Bingham, 1993).

China is relatively rich in coal resources, and the burning of coal in China is a serious source of local air pollution. Furthermore, the burning of fossil fuels in China is adding significantly to greenhouse gases and China's emissions of such gases is predicted to rise significantly. In 1989, China ranked third in the world in terms of greenhouse gas emissions; after the U.S. and the Soviet Union. "However by 2020, China would be the world's largest producer of carbon dioxide, releasing three times as much as the US." (Bingham, 1993, p.12).

Solid wastes create serious problems. About 55,000 ha of land is covered with untreated solid waste, most of it industrial and much of it contains heavy metals and toxic substances. Leaching from such waste dumps threatens aquifers and groundwater (Bingham, 1993, p.14).

Loss of forests in China has occurred on a significant scale. Estimates of the World Resources Institute *et al.*, (1994, Table 17.1) indicate that the area of forest and woodland in China decreased by 6.5% between 1979 and 1991. Consequently, in 1992 only 13.6% of China's area was covered in forest and woodland. This is one of the lowest percentages for Asian countries and is slightly less than the estimated percentage forest cover for Bangladesh (cf. Tisdell, 1995b).

While forest loss is not the only source of biodiversity loss, it can be a significant source. Like several countries in Asia, China has a large number of threatened species of mammals, birds and higher order plants. These are reported by the World Resources Institute *et al.*, (1994, Table 20.4) to be 40, 83 and 3,340 respectively, and many of these species are unique to China.

Taking the situation overall, Chinese authorities estimate that almost 7% of China's GDP is lost due to environmental pollution, about twice the estimated percentage in high income countries (Bingham, 1993, p.10). Chinese estimates put the annual economic costs of pollution (to China) at about 90 billion yuan, 40 billion of which is attributed to water pollution, 30 billion to air pollution and around 25 billion to pollution from solid wastes and pesticides. However, actual economic costs may be much higher than this when, for example, full account is taken of the adverse impact of pollution on human health.

### **3. Environmental and Natural Resource Constraints on China's Economic Growth**

In attempting to raise the income levels of its population to that of medium income countries in the 21st century, China faces many environmental and natural resource constraints. The question has certainly occurred to some Chinese policy-makers of whether these constraints will prevent China from achieving its goals for increasing incomes.

According to Wu and Flynn (1995, p.5), who rely on statements in ZHN, 1992, p.305, some policy-makers in the central government believe that it would be unwise or impossible for China to repeat the Western pattern of economic development involving in the first stage economic growth and environmental degradation and in the next stage, comprehensive 'clean-up' of the environment. The reason is said to be "... China does not have sufficient natural resources and environmental capacity to absorb industrial pollution. It is also impossible for China to select the 'high technology' route to control and treat industrial pollution due to its limited funding sources and great pressure for economic growth from population expansion. The best choice for China is to harmonize economic development and environmental protection to develop its economy as fast as possible under the condition of environmental stability (ZHN, 1992, p.305)" (Wu and Flynn, 1995, p.5).

Elsewhere Wu and Flynn (1995, p.3) state that "... the relative shortage of natural resources constrains China's ability to copy the Western pattern of high-energy/resource

consumption. Thus China must explore a new kind of development path to harmonize economic growth with environmental protection". This must be one that pays more attention to protecting the environment initially.

This basic policy is repeated in the preamble to *China's Agenda 21*, and has been contrasted with the approach of Taiwan to economic development. Taiwan has basically followed the Western pattern mentioned above (Tisdell, 1995a).

If the above is correct, then at least in principle major Chinese policy advisers lean more towards strong conditions for sustainable development in China rather than weak ones. However, in practice, China unfortunately does not have policies in place to enforce strong conditions effectively. There are many political reasons why practice differs from principles. These include the inability of central government to enforce central policies effectively at the local level. Politically China is very decentralised and provinces and localities compete with one another for investment sometimes resulting in considerable environmental concessions being made to investors at the local level. Furthermore, laws are often not enforced. In some cases this is due to bribery and corruption and in some other cases due to lack of application by administrators. As pointed out below, some pollution control measures are only put into effect in a few locations in China. Furthermore politicians are often keen to show quick economic results and are prepared to sacrifice environmental quality to achieve this, even though this might result in a worsened economic position in the long run. Political myopia is by no means peculiar to democratic systems. Hence, practice and principles of policy can diverge significantly.

The question should be pursued of whether China's situation is so different that it cannot follow the pattern of Western development which seems to have been imitated by Japan and is in the process of being copied by Taiwan and South Korea. The latter three countries, like China, might also be considered to be natural resource poor countries in relation to their population. However, like European countries, these countries have been able to overcome their natural resource constraints mainly by reliance on international trade. Japan has made considerable progress in improving its environment and Taiwan is now undertaking considerable investment with this aim in mind.

It is possible that China faces greater problems. It is a relative latecomer in international trade and it is a very large country which means that the expansion of its trade

can bring adverse reactions from trading partners. Nevertheless, seeing that China is so short of arable land, it still has the option of importing food if it can export say manufactured products. It does not have to be self-sufficient in food. To some extent international trade can moderate China's environmental and natural resource constraints. Yet, its water shortage will continue and become more severe, and its air pollution and solid waste disposal problem will not be solved by international trade.

The global consequences of China's creation of pollution, for example, its contribution to greenhouse gas emissions, may also place it in a different category to South Korea and Taiwan. Thus for environmental reasons, it may not be able to initiate blindly the economic growth strategies used by other Asian countries which have significantly improved their economic lot.

#### **4. China's Agenda 21**

In 1994, the Executive of the State Council of China adopted *China's Agenda 21 - White Paper on China's Population, Environment and Development in the 21st Century*. This is a wide-ranging document which, in English, consists of some 20 Chapters and is 244 pages in length. It is China's response to the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 which called on all nations to develop and put into effect their own strategies for sustainable development.

The preamble to this document states that

“traditional ideas of considering economic growth solely in quantitative terms and the traditional development mode of ‘polluting first and treating later’ are no longer appropriate when considering present and future requirements for development. It is now necessary to find a path for development, wherein consideration of population, economy, society, natural resources, and the environment are coordinated as a whole, so that a path for non-threatening development can be found which will meet current needs without compromising the ability of future generations to meet their needs” (State Council, 1994, p.1).

The document goes on to elaborate on this theme.

The white paper points out that China's economic growth is hampered by its large population, relatively inadequate natural resources and fragile environment as well as its low

capabilities in science and technology. It suggests that this requires holistic co-ordination of China's economic growth. At the same time as China adopts growth measures to become a middle-income country in the 21st century, China's Agenda 21 states that "it will be necessary [for it] to conserve natural resources and to improve the environment, so the country will see long-term, stable development." Consequently, the development principles outlined above are articulated in China's Agenda 21.

Continuing market reforms and opening to the outside world are seen as an important part of China's Agenda 21 presumably because these can result in more efficient use of natural resources. Maintenance of population control is regarded as essential and measures to introduce technologies that are more environmental friendly than current ones are seen as desirable. Institution building and improvements in China's legal system are desired targets, as is continuing international cooperation. All of these factors are expected to contribute to China's sustainable development. The main policies recommended for China's sustainable development have been summarised as follows:

- “● Carry forward reform and expand opening to the outside, and accelerate the establishment of the socialist market economy system, with the economic development as the central focus;
- Enhance capacity building for sustainable development, particularly standardize the establishment of the systems of policies, laws and regulations, and indicators of the strategic objectives. It is also important to set up a management system of resources, biological monitoring system, statistical system of social and economic development, and related system of information services, and to improve the public awareness of sustainable development and the implementation of China's Agenda 21;
- Control population growth, enhance population quality, and improve population make-up;
- Popularize sustainable agricultural technology that suit local conditions;
- Develop clean coal technology, and other forms of clean and renewable energy sources;

- Adjust industrial structure and distribution, improve the rational utilization of resources, and reduce pressures on transportation and communication due to industrial development;
- Popularize cleaner production techniques, minimize the output of waste, encourage the conservation of resources and energy, and enhance the utilization efficiency;
- Speed up the construction of 'better-off building', and improve residential environment;
- Develop and popularize key technology for environmental pollution control;
- Strengthen the protection of water resources and sewage treatment, protect and expand vegetation cover, rationally utilize biological resources to safeguard biodiversity, improve regional environmental quality, increase land productivity and mitigate natural disasters."

(Administrative Centre for China's Agenda 21, 1994, pp.6-7)

The white paper (State Council, 1994) itself, however, gives little attention to possible conflicts between objectives and how these might be best resolved. Hence, it is doubtful if it provides a workable blueprint for development. To some extent this is understandable. However, it should be observed that if a holistic approval to economic development is adopted then trade-offs between objectives will be unavoidable. To a considerable extent, the various chapters of the white paper dealing with different sectors and spheres of development read as independent entities. There is therefore some concern that much of the white paper consists of 'motherhood' statements and window-dressing. Furthermore, some may wonder if the English version of the white paper presented to promote China as an environmental leader of less developed countries and to allay the concerns of some Westerners about the environmental consequences of China's economic growth.

On the other hand, the positive side should not be forgotten. At least China's policy leaders do recognize that an economic growth dilemma may exist which calls for positive measures to conserve China's environmental resources even in its present economic growth stage. Recognition, while not sufficient, is necessary if concrete policy actions are to be taken to address the matter. Secondly, China appears to be one of the few countries to have followed up the UNCED resolution on Agenda 21 in a concrete manner. It is possible that



China's Agenda 21 will become a catalyst for more workable policies for sustainable development in the future, and that China could become a leader in that regard.

In the past China was well known for its use of integrated diversified productive systems at the village level. These systems produced virtually no waste. Even today some of its integrated agriculture-aquaculture systems may be of this nature. Such systems basically incorporate balance, stability and harmony. In reality, however, China has increasingly abandoned such naturally balanced systems and has moved towards monocultures increasingly dependent on high energy inputs typical of Western productive systems. China has been moving towards productive systems dependant on high levels of external inputs typical of those in western countries. I have, for example, seen non-integrated aquaculture systems in China which involve the raising of a single species, for example, white eels, using imported fish meal. Furthermore, it must be a matter for environmental concern that China's consumption of artificial fertilizer is now the largest in the world (Wu and Flynn, 1995, p.4). Its application of manufactured fertilizer per hectare is now more than twice that in high income countries (Wu and Flynn, 1995, p.4). Thus it seems that China has or is adopting production methods copied from the West which may be inappropriate to its environmental situation.

Economists who advocate market-making as the solution to society's ills will be pleased to learn that special mention is made in China's Agenda 21 of the desirability of making effective use of economic instruments and market mechanisms for promoting sustainable development. The Administration Centre for China's Agenda 21 (1994, p.16) summarises the main points in this regard as:

- “● Reform the unreasonable pricing system, and establish the paid use system for all kinds of resources and energy;
- Employ the taxation, financial and credit policies in promoting sustainable development;
- Endorse studies on economic policies to maintain sustainable development.”

Despite this statement, reading of China's Agenda 21 white paper as a whole indicates a high degree of reliance on administrative measures rather than price-related strategies for environmental control.

## 5. China's Environmental Policies in Practice

As mentioned earlier, principles and practice often diverge, sometimes sharply. China is continuing to lose natural resources and in several respects its environmental deterioration continues as its economic growth proceeds. The types of dilemmas that China faces are seen by its decision to proceed with the Three Gorges Dam. The dam will undoubtedly change the environment in the Yangtze Valley considerably even though it will bring economic advantages, at least in the short to medium term. However, it is hard to believe that the natural resource stock of this region will not be reduced and so one could say that China in making this decision is not acting in accordance with strong sustainability conditions said to be desirable in the preamble to its Agenda 21.

Possibly the first major moves by China to protect its environment in recent times began with the Second National Environmental Protection Work Conference in 1983. In 1984, following this conference, the Environmental Protection Commission was established under the State Council "to co-ordinate all ministries and agencies whose activities affect the environment. Similar organizations and institutions were set up at the local level" (Wu and Flynn, 1995, p.5). Thus a relatively comprehensive administrative system for environmental management was established in China.

In the 1980s policy makers appear to have reached widespread agreement on:

- (1) use of the *precautionary principle*, that is avoiding environmental problems by means of prior planning and when necessary incorporating defensive environmental elements into projects.
- (2) The importance of imposing greater responsibility and liability on polluters by using the 'polluter pays' principle to internalize pollution costs which would otherwise be external to organizations.
- (3) *Strengthening government administration* of environmental controls. Qu and Li (1994) claim that in fact strengthening of administrative management of the environment has been the main focus of the new policy.

China has considerably increased the number of persons employed in environmental protection. In 1981 only 22,000 were employed in this way but in 1992 the number was 74,898. Comparatively, however, it is still a low number and the number has failed to increase proportionately with China's GDP because the growth in this employment has been

linear rather than logarithmic (see Wu and Flynn, 1995, Table 2, p.5). Nevertheless, in 1991 China is estimated to have spent 1 percent of its GNP on environmental improvement compared to 0.7 percent of GNP in the 7th Five Year Plan (1985-1990). The National Environmental Protection Agency's target is to increase this to 1.5 percent (Bingham, 1993, p.10) which for a less developed country is a substantial investment in environmental protection.

Coming to China's practice in using economic instruments to control pollution, there can be little doubt that China has made great progress in this regard, although much still has to be done. Discharge fees on pollutants were first imposed in one form or another and with varying degrees of coverage beginning in the late 1970s - basically at the same time as China's economic reform began. They have been widened in coverage and strengthened since then. Pollutants of water and air, solid wastes and noise creation incur discharge fees. However, discharge fees on sulphur dioxide and sewage have only been levied since 1992 in nine cities in two provinces on a trial basis.

In 1994, pollution discharge fees (including fines and related items) amounted to 3.097 billion yuan. Of this 2.355 billion yuan was obtained from regular pollution charges and 0.742 billion yuan from fines, penalties and related items (Mao, 1996, p.1). Charges on emissions of water pollutants other than sewage were the major source of revenue, followed by charges on emissions of air pollutants, those on solid wastes, noise, and sewage.

Nearly all the revenue obtained from pollution charges was spent on treatment of pollutants and on administration. In 1994, 2.49 billion yuan was spent on the treatment of pollution and 0.54 billion yuan on government administration of pollution regulations. None of the income collected was used to compensate victims of pollution for damages caused. Nevertheless, in some cases victims can claim damages from polluters and this even when they are not fully compensated for its damage by the pollutor, the payment is often sufficient to moderate the behaviour of the polluter. Take the example of a non-ferrous smelter which was once a serious source of cadmium poisoning.

This plant located in Daye County emitted large quantities of cadmium into the air resulting in cadmium poisoning among nearby villagers. In the later part of the 1980s, it was required to compensate victims for their medical expenses. This was sufficient to cause the enterprise to install technology which reduced contamination of the air by cadmium. This

extra investment in technology showed a substantial positive rate of social return (Zhiyong *et al.*, 1991).

In relation to compensation of victims for environmental damage, there is still scope for strengthening China's laws and their application. There is still some doubts about whether China's discharge fees are fairly determined and consistently applied to individual enterprise in practice.

The National Environmental Protection Agency is intending to increase the level of pollution emission fees and to apply fees to emissions at all levels rather than to those exceeding some threshold quantity as is the case for a number of pollutants at present. Some of these extra funds will be used to provide loans to enterprises for environmental protection and for treatment of pollutants.

Overall China's performance in relation to protection of natural resources and environmental protection is mixed. Even in relation to pollution control, it seems that at least up to now less attention has been given to pollution prevention than to pollution treatment. So principles and practice still have yet to be brought fully into line.

## **6. China's Environment and the Outside World**

Today the environment of most countries is not solely their own business. This is particularly so in China's case because of its immense size both in terms of population and land area. The main reason why a country's environment concerns the rest of the world is the presence of externalities from the state of its environment.

China's potential level of economic activity and its possible environmental impacts are so large that they cannot be ignored by the rest of the world. Some of its impacts are global. Its possible global impacts are not restricted to its large (and potentially much larger) addition to greenhouse gases. A recent additional example was its emissions of CFCs, a threat to the ozone layer. As a result of the Montreal Agreement and subsequent international meetings, arrangements have been made to phase out the use of CFCs in countries like China and an international fund has been set up to provide financial assistance for the phase-out (Litfin, 1994). China is one of the recipients of such aid.

Regionally China's environmental change has transboundary effects. It is the source of major rivers which are to a large extent the economic life-blood of Indo-China, Burma and

Bangladesh. Environmental actions by China which pollute these rivers, reduce their waterflows, increase their sediment loads and vary the erratic nature of their flows can be expected to have considerable economic and environmental impact in China's neighbouring countries. Again, China's economic activity generates a considerable amount of acid rain. Some of this is transported to neighbouring countries. There have, for example, been complaints in parts of Japan that acid rains are responsible for the deaths of some trees in the vicinity of Hiroshima.

While not directly involving an international externality element, the environmental policies of a country can influence the international location of polluting industries and international trading. Countries which have low environmental standards may attract polluting industries from abroad and have an advantage in exporting goods the production of which generates pollution. The fact that those in polluting industries do not pay the full social costs of their economic activities means that in effect they are granted a subsidy. The 'concession' benefits special economic interests but often imposes greater costs on the community than the benefits received by these special interests. Therefore, extreme care is needed in making environmental concessions to particular businesses or industries. Some Taiwanese economic activities have, it is claimed, been located in China for environmental reasons. In a relatively decentralised system particularly as in China, it is very difficult to prevent local authorities competing with one another by making environmental concessions to attract foreign investment. Increased central control may, however, be exerted as the National Environment Protection Agency becomes stronger.

## **7. Energy Supply and Air Quality**

Modern societies depend heavily on non-renewable natural resources for their energy requirements. There can be no doubt that use of such sources of energy has made human life easier, has provided humans with greater control over nature and has significantly contributed to economic abundance in high income countries. Nevertheless, combustion of such fuels is a considerable source of air pollution in large urban areas and in several regions in Asia. In addition, according to the greenhouse gas thesis, this combustion is a major source of atmospheric warming. As is well known, developing countries in Asia such as India and China are predicted to increase their consumption of fossil fuels substantially, thereby

becoming major contributors to greenhouse gas emissions. How best to deal with the threat of the greenhouse problem still remains a major issue (Tisdell, 1995a). It is one that will require both regional and global co-operation. At the same time, industrial activities in cities emit air pollutants affecting human health. Air pollution in many of Asia's cities, such as Shenyang, Beijing and Calcutta, is a serious and increasing problem. As Asian countries become more urbanised and expand their industrial activity, their air quality must be expected to deteriorate further unless countermeasures are adopted.

The importance of China's case will serve to illustrate the problems of energy supplies and the impact of their use on air quality. In the next century China is expected to become the world's major user of fossil fuels, overtaking the USA. According to Haugland and Roland (1994, p.212), 'China faces two main challenges in its energy policy: (1) to provide adequate energy supplies to foster economic growth, and (2) to limit environmental damage from energy production and consumption'. China is now the world's leading coal producer, having overtaken the United States in 1983. Both China's GDP and energy production and consumption have increased remarkably since the establishment of the People's Republic. Between 1953 and 1980 China's GDP grew at an average rate of 6 per cent p.a. and its energy use expanded at 9.8 per cent p.a. After China's market reforms, its GDP grew at an even faster rate averaging 9 per cent p.a. in the 1980s, but its energy use expanded at only 5.5 per cent p.a. in the 1980s.

In other words, it is clear that China's intensity of energy use in relation to its GDP rose in the 27-year period prior to 1980, but declined during the 1980s. This reflects both restructuring of China's economy and China's improving economic efficiency. Consequently, although absolute emission of pollutants increased in China in the 1980s, the intensity of this emission in relation to GDP may have declined. Nevertheless, because aggregate pollution levels in China have continued to rise, dangers to human health from pollutants have grown.

Although the intensity of China's use of energy has fallen, it is very high by world standards. In 1989, it was almost three times that of a comparable country, India, more than twice that of Japan and more than four times that of the United States (Haugland and Roland 1994, p.217). There may be many reasons for this: (1) China's GDP may be underestimated.

(2) The economy may not have fully restructured following its forced emphasis on high-energy using industries during the pre-reform era (Tisdell, 1993c). (3) Technology used in its power generation industry and technology employed in industry using energy may be relatively inefficient. (4) Proper procedures may not be in place to encourage users to economize in energy.

China still has a long way to go to reach the levels of per capita energy consumption of high income countries. Its energy consumption would need to increase more than five times to reach per capita levels comparable to those of Japan and more than twelve times to reach a similar per capita level to the United States. In many parts of China electricity is still considered to be in very short supply by local communities.

The high sulphur content of Chinese coal constitutes an environmental problem. Sulphur dioxide emissions, with other compounds such as nitrogen oxides, from coal combustion are a serious source of air pollution in China and result in acid rains in several parts of the country. The effects are pervasive. They are not confined to the locality or province where fuel combustion occurs but extend internationally. For example, prevailing winds from China's industrial Northwest bring acid rains to Japan (cf. Foe11, 1994, p.229, Fig. 2; Bleck, 1996) and to and from Korea (Kim, 1996). As growth in use of coal and other fossil fuels increases in Asia, India's emissions of SO<sub>2</sub> are also rising. Acid rain problems can be expected to become more serious, and will call for greater interregional co-operation to deal with the problems. The interregional dimensions of this problem (and many other environmental problems) in Asia should not be neglected.

As is well known, developing countries in Asia, such as India and China, are predicted to increase substantially their consumption of fossil fuels (Drysda1e and Huang, 1995; Fesharaki and Wu, 1992), thereby becoming major contributors to greenhouse gas emissions. How best to deal with the threat of the greenhouse problem still remains a major issue (Tisdell, 1995a). It is one that will require both regional and global co-operation (ABARE, 1995). The potential of hydroelectricity to substitute economically for fossil fuels in electricity production and reduce greenhouse gas emissions appears to be limited, but, as discussed below, nuclear energy shows promise. Alternative energy sources can also play a larger role (Byrne and Shen, 1996), but can only be expected to supply a very small fraction of Asia's energy requirements. From a social point of view, the choice of energy sources

should be influenced by the externalities associated with the alternatives. The size of these is still difficult to quantify, particularly in relation to greenhouse gases. ABARE (1995, p.139) states that “while there are considerable uncertainties associated with the science of global change, the potential risk covered by global warming are sufficient to justify some abatement action”.

Naturally, China has considered the question of whether it can use ‘cleaner’ means of generating electricity than from coal. In its *Agenda 21 - White Paper on China's Population, Environment and Development in the 21st Century* (State Council, 1994) alternatives to using coal for energy generation, especially hydro-electricity, are discussed. While China has significant potential for expanding its production of hydro-electricity, there are some problems. The greatest potential is in the southern inland of China. This area is not well located for supplying northern and coastal areas of China which have the largest concentration of population and industry and therefore demand for electricity. Large amounts of investment are required. Furthermore, dams associated with hydro-electricity generation are not without environmental costs and risks. They may inundate areas of value for biodiversity conservation and tourism, they may flood productive farmlands, interfere with waterflows (especially if there is associated irrigation) and result in increased salting of rivers and in navigation problems. The list could be extended.

In Xishuangbanna Prefecture of Yunnan, for example, there is a perceived shortage of electricity. Some local authorities favour the construction of a dam on the Lancang (Mekong) river to generate electricity and provide for irrigation. However, the dam would flood a large portion of Xishuangbanna State Nature Reserve and would reduce water supplies to Thailand, Laos, Cambodia and Vietnam.

The Three Gorges Dam to be completed in the Yangtze (Changjiang) River provides another example. On the one hand, it will add significantly to electricity generation, provide for irrigation and flood control. On the other hand, it involves loss of cultural and natural assets, massive relocation of communities due to flooding from the water body, deterioration in important wetlands below the dam, and loss of valuable additions to silt on agricultural land below the dam. There is some concern about the risks to the dam from earthquakes. In addition, disease-patterns in environments affected by the dam are liable to alter. The parasitic disease schistosomiasis (Mahmoud, 1987; Sleight and Mott, 1986), for which water



snails are an important host (Sobhon and Upatham, 1990) may well increase, as has occurred in parts of Africa following the construction of large dams. The economic costs of the disease are as yet poorly known (Huang and Manderson, 1992).

Nuclear energy is probably still not an economic alternative for China to the generation of electricity by the use of coal. Furthermore, while nuclear power stations avoid many of the pollution problems associated with the use of coal for electricity generation, there are still concerns about the environmental radiation hazards associated with nuclear plants.

In 1985 it was thought that China might embark on a substantial programme to increase its electricity production by 2000 by building nuclear plants and both the United States and Europe were hopeful of selling it reactors, but China's ambitious plans in this regard were shelved in 1986. In fact, China only has two plants under construction. Owen and Neal (1988, p.28) believe that the principal reason for China's change in policy was probably the stress placed on China's relatively meagre stock of foreign exchange by the high initial cost of imported nuclear plants, although there was also scepticism regarding nuclear power's purported cost advantage over coal.

The comparative cost of generating electricity from coal or other sources compared to nuclear varies by country and location. The Nuclear Energy Agency (1992, p.43) of the OECD claims that in many OECD countries electricity from nuclear energy will be at least 10 per cent cheaper than from coal for plants commissioned in 2000. However, it points out that this will not be so in the cheap coal regions of the United States, Canada, Brazil and China.

Yoda *et al.* (1994) suggest that in Japan the cost of electricity generation from coal and LNG was higher than from nuclear up to the mid-1980s, but from 1986 onwards the position reversed. Nevertheless, in 1994 Japan generated 28 per cent of its electricity from nuclear (Akiyama, 1994) and is planning in the longer term to generate 60 per cent of its electricity from this source, but for the time being will still build more coal-fired and LNG power stations. According to Akiyama (1994, p.220), who is President of Kansai Electric Power Co. Inc.,

“utilities put aside reserve funds to cover high level radioactive costs, decommissioning costs and internalise them into revenue requirements. Electricity production is calculated at 13 yen per kilowatt hour by hydro power, at 10 to 11 yen

by fossil fuels and at 9 yen by nuclear. Therefore, nuclear energy proves [to be] cost competitive”.

These figures differ slightly from those of Yoda *et al.* (1994) but may refer to plants to be commissioned around 2000. It should be noted that in Japan much of the cost of using fossil fuels is internalised as a result of the emission standards set, which increases the cost of generating electricity from fossil fuels.

Akiyama (1994) notes that nuclear power plants are in operation in Asia, in Japan, Korea, Taiwan, India and in China a trial plant is operating and two are under construction. Furthermore, Indonesia is planning to construct 12 reactors over the next 15 years with Japanese advice. However, The World Bank (1994, p.265) claims that compared to coal based generation, nuclear is a high cost option for Indonesia. It concludes “the nuclear option does not appear to be competitive with coal fired generation unless there is a willingness to pay a premium equivalent to about \$37-64 per ton of carbon abatement”.

Differences of opinion exist about the comparative costs of generating electricity from nuclear compared to coal and about the size of the environmental externalities associated with each and how these should be monetised. While nuclear appears to be an economic option for some Asian countries, for example, Japan, it is by no means clear that it is the most economic option for all. Furthermore, nuclear is only suitable for supplying base-load electricity requirements and non-nuclear sources are needed to supply the remainder. Much depends on technological progress. While further progress in nuclear technology is to be expected, there is also a possibility of coal-fired stations recovering many of their present emissions, processing these and selling them as by-products. Given Asia's large coal reserves, particularly China's, the option of cleaner coal-fired power stations needs to be vigorously pursued, especially since it is predicted that fossil fuels will still be supplying 90 per cent of the world's energy consumption in 2010 (OECD, 1994, p.14).

## **8. Concluding Comments**

China's growing importance in the world should not be judged purely in terms of its rapid and economic growth and the spin-off of economic benefits to the rest of the world. The environmental and social consequences of its economic growth must be considered including the sustainability of its growth. China does face considerable difficulties in achieving

sustainable development. The Chinese themselves have posed the question of whether it is sensible for them to follow the Western and Japanese pattern of economic development which involves economic growth first and environmental clean-up later.

Although the Chinese have expressed doubts about the desirability of such a pattern of growth for China, there is little evidence that they have to date been following a different pattern. On the other hand, there are some signs that this could change. Consider the position outlined in *China's Agenda 21* and the increasing control of pollution by the National Environment Protection Agency. Nevertheless, politically and especially taking into account the influence of local politics, China will find it difficult to pursue an environmentally friendly development path. In addition, in order to follow this alternative path effectively, China may need new production techniques which are environmentally appropriate and must be careful to only transfer techniques from abroad which have suitable environmental and sustainability characteristics. Otherwise, articulation of China's *new development path* may amount to no more than lip service. On the other hand if the new path is earnestly sought and found, China's economic resurgence may not only be sustainable but China will re-emerge as a world leader, in technology and in intellectual thought, as it was in the Tang period.

It might be noted that the introduction of the market system in China seems to have helped in reducing pollution intensities in relation to its GDP. It also provides scope for the use of market-related instruments as a means to control pollution and China has made a cautious start in applying such instruments. Furthermore, politically, it seems easier to control pollution in a market system than in a centrally planned economy. Social pressure towards environmental ends is, however, likely to be even greater in a democratic society with freedom of the press and of expression. How far China will proceed down the latter path following the death of Deng Xiaoping remains to be seen. Social stability is likely to remain a permanent goal for China and democratic change will need to be assessed in relation to this goal.

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