Sustainable natural resources policy and management in relation to water diversions with special reference to the south-to-north water transfer project in China.

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SUSTAINABLE NATURAL RESOURCES POLICY AND MANAGEMENT IN RELATION TO WATER DIVERSIONS WITH SPECIAL REFERENCE TO THE SOUTH-TO-NORTH WATER TRANSFER PROJECT IN CHINA

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ABSTRACT

China has undertaken a vast engineering project: the large-scale transfer of water from the south of the country to the north, the intention being to alleviate flooding in the south and water shortages in the north. It may take up to fifty years to complete. This thesis examines the broad outline of the scheme, the planning that has gone into it, its historical and political background, and the political, social, and ecological problems that it has encountered and may be likely to cause in the future. The political context of a 'pro-technology' policy amongst today's Chinese leaders is highlighted.

The Chinese study is made in the light of water-transfer schemes that have been implemented, or proposed, in other countries; and also ideas about sustainable development, policy processes, and natural resource management.

Five case studies are considered: the Aral Sea (Central Asia), the Snowy Mountain Scheme (Australia), the National Hydrological Plan (Spain), the Central Arizona Project (the United States) and the South-to-North Water Transfer Project (China). They are examined as a basis for understanding policy problems and processes in water resource management, and also to make some suggestions for their resolution in the Chinese case—though finding a permanent or definitive solution lies beyond the scope of the present inquiry.

The difficulties for traditional policy processes to manage uncertainty and complexity are particularly acute in the area of natural resource management. For example, climate change issues challenge present water management systems and diversion projects. Therefore, uncertainty and complexity issues, beyond the 'ideal' policy cycle, are considered, particularly in relation to climate change, but also the water diversion schemes themselves. Climate change presents a particularly important challenge to the Chinese Project.

Given the cultural and political background in China, the South-to-North Water Transfer Project, which is already under construction, will likely be completed, despite its potential risks. However, suggestions are made as to policies that should also be given consideration, such as restraints on water consumption, water recycling, and improved water harvesting.

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"Doing PhD is like marathon. The important thing is to keep momentum going." That is what my supervisor, Dr John Merson, told me on the first day of my PhD life. He was right. I thank him sincerely for his guidance, support, and inspiration.

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ABBREVIATIONS

APEC	Asia Pacific Economic Cooperation
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CPC	Communist Party of China
CPCCC	Communist Party of China's Central Committee (China)
EEB	European Environmental Bureau
EPB	Environmental Protection Bureau (Local Level) in China
GDP	Gross Domestic Product
ICOLD	International Commission on Large Dams
IPCC	Intergovernmental Panel of Climate Change
KGB	Committee for State Security
MWR	Ministry of Water Resource (China)
NCNPCC	National Political Consultative Conference (China)
NHP	National Hydrological Plan
NPC	National People's Congress (China)
NSW	New South Wales
OCCSTNWTP	Office of Construction Commission of the South-to-North Water Transfer Project
OECD	Organisation for Economic Co-operation and Development
SCPCPCCC	Standing Committee of the Politburo of the Communist Party of China's Central Committee
SDPC	State Development Planning Commission (China)
SEPA	State Environmental Protection Authority in China
SMHA	Snowy Mountain Hydro-electric Authority
SMS	Snowy Mountain Scheme
STNWTP	South-to-North Water Transfer Project
TIHSD	Tianjin Institution of Hydropower Survey and Design

TST	Tagus–Segura Transfer
UNDP	United Nations Development Programme
UNEP	United National Environment Programme
UNIDO	United Nations Industrial Development Organization
USSR	Union of Soviet Socialist Republics
WCD	World Commission on Dams
WWF	World Wildlife Fund

CHAPTER ONE

INTRODUCTION

1.1 Overview

My research aims at integrating the idea of sustainable development into water resource management through a comparison of water diversion case studies from China, Australia, and other countries. It will discuss conceptual, practical, economic, and political difficulties in water resource management and possible counter-measures in the light of the notion of sustainable development. The case studies are intended to provide a basis for understanding policy problems and processes for dealing with them in water resource management, and also to make some suggestions for their resolution in the Chinese case, though finding a complete and satisfactory solution lies beyond the scope of the present inquiry. Nevertheless, the comparative study may provide information useful for the better management strategies of water problems in general.

There are five case studies in this thesis: the South-to-North Water Transfer Project in China (STNWTP hereafter); the Snowy Mountain Scheme in Australia; the well-known water diversion project and its aftermath in the Aral Sea region; the abandoned National Hydrological Plan in Spain; and the Central Arizona Project in America. These five cases are all important for forming a broad perspective. However, they function at different dimensions and levels in this thesis. The STNWTP is the leading case. Although the other four cases are useful for the discussion of policy processes, my investigation does not try to find answers for each of those cases. The main goal of this thesis is to adapt the experiences and lessons from the past and from other countries to provide precautionary principles (or cautionary examples) for the Chinese case, which is still in the development phase (or words to this effect).

1.2 Starting Points

It is universally acknowledged that a man of good fortune needs water. But someone with little fortune or none also must be in need of water. Water is a critical substance for life and it should be used wisely and sustainably. However, even with the great efforts that have already been made by governments, NGOs, environmental professionals, communities, and the general public, the water crisis issue is getting more and more serious. As stated by UNDP (United Nations Development Programme, 2004, 9):

> [T]this water crisis is largely our own making. It has resulted not from the natural limitations of the water supply or lack of financing and appropriate technologies, even though these are important factors, but rather from profound failures in water governance.

Water governance has been defined by the UNDP as a range of political, social, economic, and administrative systems that are in place to regulate the development and management of water resources and the provision of water services at different levels of society (UNDP web-page). On the one hand, globalisation brings the world closer together than ever before: so that no one can live wholly independently from others. It necessitates the ‘sharing’ of resources. International corporations and the world market are good examples. On the other hand, competition for resources, especially natural resources, enforces the idea of ‘boundary’, which requires management to be localised. Therefore, research on the management of a natural resource such as water should take that fact into consideration and calls for work in the area of comparative policy studies.

Connor (1999, 30) sees nine drivers for water demand: population growth, economic growth, *per capita* energy consumption, technological development, land-use change, rate of environmental degradation, environmental awareness, government programs, and climate change. The first two are the main causes for driving the water demand up. For other drivers, it is hard to tell whether the driving force pulls the demand up or down, except for climate change, which, currently, is generally regarded as a negative influence for changing water cycle (Sophocleous, 2004, 70–72).

The dramatic increase of population in the last fifty years and worldwide economic development have stimulated an increase of water use in a short period of time. According to evidence given by the Population Reference Bureau, world population reaches 6.1 billion, and this number could rise to more than 9 billion. Compared with the trend in the past fifty years, world population is now multiplying more rapidly than ever before. Between 2000 and 2030, nearly all the annual world population growth will occur in the less developed countries in Africa, Asia, and Latin America, whose population growth rates are much higher than those in more developed countries. Meanwhile, Asia's share of world population may continue to hover around 55 percent while Europe's portion is declining sharply and could drop even more during the 21st century, Africa and Latin America each would gain part of Europe's portion (Population Reference Bureau, 2006).

Economic growth is an influential driving force for the sharp increase of water use. In the past ten years, world economic growth rate hovered around 3–4%. In the meaning time, economic growth in Asia, especially northeastern Asia remains a robust at 6.7% (Japanese Cabinet Office, 2005).

Water issues are becoming more and more important for the future of life on earth, and it is the responsibility of environmental researchers in each and every country to work on water management problems in relation to political, economic, and social perspectives. There is, of course, no single principle for the whole world. Water management is not an exception. Comparative case studies in water management among different countries could provide a basis for better understanding of the roots of problems and also chances of collaborative actions to address difficulties encountered.

From 1949 to 2005, the population of China doubled from 0.6 billion to 1.3 billion. About one third of the country is desolate or mountainous and uninhabitable [land]. A third of land has soil erosion problems, and only about 3 million square kilometers are inhabited and supports 1.3 billion people. On the basis of the world average, China's environment only can maintain a population of around 0.32 billion considering its fresh water supply; and 0.26 billion on the basis of agricultural land. Obviously, the ecosystem is already well stretched beyond its natural capacity to sustain the population in China. Moreover, persistent high economic performance has been accompanied by heavy pollution and high consumption of resources, which damage the natural resource reserves. Waste emission per unit is more than ten times the world average. At the same time, labour efficiency rate is one tenth of the rate in developed countries. As estimated by the World Bank, the losses caused by air and water pollution are equal to 8% of annual GDP in the country (CHEN Zhong, and CHEN Chuyue, 2005, 12–13).

The average water availability is 2812 billion cubic metres per year, which is the sixth in the world after Brazil, former Soviet Union, Canada, America, and Indonesia. However, divided between 1.3 billion people, the average *per capita* water availability is only 2163 cubic metres, one fourth of the world average, which is around 7000 cubic metres. According to an estimate from the Ministry of Water Resources in China, up to 2030, the national population will reach its peak, and the *per capita* water availability will then be only 1760 cubic metres annually (SUO Lisheng[1], 2002, 8).

Because precipitation and flows decrease from the southeast coast to the inland northwest, water resource distribution in China is highly uneven. In Northern China (north of the Yangtze River Catchment area), where population accounts for 47.4 % of national population, cultivated land and GDP separately occupy 61.1%, and 41.2% of national levels, water availability is only 19.6% of total water availability in the whole country CHEN, Zhikai[2], 2000, 9).

Water scarcity in North China has already not only held back the economic growth in the region, but also struck the residents' normal life. For example, in Hebei province, 1.94 million people, and 350 thousand livestock suffered from seasonal drinking water problem in 2002 (Department of Water Resources in Hebei Province, 20 April, 2004). NIU Maosheng, the former Minister of Water Resources in China, has stated that water scarcity has become the major restriction for China's economic and social development. He comments that without food, people cannot live; without water, it is even harder to survive. Once the natural environment is destroyed, lack of water will soon result in

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1 SUO Lisheng, Vice-minister of Ministry of Water Resources in China, graduated from University of Michigan, USA with a doctoral degree in civil engineering.

2 CHEN Zhikai, Academician of Chinese Academy of Engineering.

there being no food to eat (YI Zheng, 2001, 79). This is obvious to all, but it is noteworthy that a politician/bureaucrat should have made this remark.

Facing such a daunting challenge for water management, solving the water shortage problem becomes the most urgent task. It has already been recognised that extracting water from the natural environment without restraint will be likely to result in environmental degradation and be economically unattractive (Boutkan and Stikker, 2004, 151). However, governments have invested, and continue to invest, large amounts of money in water-related infrastructures, such as water diversion projects. But flood control, and water supply for irrigation, drinking and recreation needs cannot rely solely on infrastructure (Enderlein and Bernardini, 2005, 253). There is a paradox that if water diversion projects are considered to be an ineffective, inefficient and uneconomical method for dealing with a water crisis, why is it nevertheless applied? To expose the 'secrets' behind water diversion projects, and the motivations and incentives for planning such projects from a policy perspective, is a question my thesis will endeavour to address.

A water diversion project is commonly considered as an engineering work: thus particular attention is focused on its engineering design. Even though Biswas (1983, 9–10), in the book *Long-Distance Water Transfer: A Chinese Case Study and International Experiences*, mentions that social and environmental factors should be given attention as well as engineering and economic factors, his analysis does not go further to the political and policy research areas.

For the Chinese case, there are only a few articles that discuss the STNWTP from a policy perspective, because:

a. Under the present political system and environment in China, some issues can be hardly explored, or are too sensitive to discuss openly.
b. Decisions about the Project have been and are made by top leaders, without involving public opinion to any significant degree.
c. Information offered by the Government for academic research has been very limited.

d. For the majority of the public, the Project is just an enormous engineering project that should be looked after by government. Public concerns about water prices and other aspects, which will affect their daily life, but most people do not have much interest in participating in the political discussions about the topic.

Although these four points indicate the difficulties in analysing the STNWTP from the perspective of policy theory, they also show the close correlation between the Project and the role played by governments (particularly the Central Government). This goes to show the necessity of doing policy analysis of the Project.

Fifty years ago, when the Project was first put forward, the concept of 'sustainable development' had not been developed and was not widely accepted in the world. Thus there was little initial thought given to the principles of 'sustainable development'. The purpose of the Project was to control the water system of China by connecting the four main rivers in the country, and implement a unified management of water resources. The nature of the idea is 'control'. This was understandable in the context of the planned economy that was dominant in society at that time. However, fifty years later, the Project is still based on the assumption that water shortages should be solved by altering the geographical distribution of water. But such changes may lead to unsustainable ecosystems even though sustainable development is now one of the tenets of the country's national policy. In any case, knowing the concept of 'sustainable development' is different from understanding it and is far from applying it in an already existing institutional system. Therefore, learning experiences from other cases may help the Project to apply precautionary principles, and promote the incentives needed to make changes from outside of the system.

1.3 Terminology

The water diversion projects that I have selected for discussion are long-distance, and large-scale ones. A water diversion project is not only a piece of engineering work, but also a systematic and dynamic decision-making process and a 'piece of art' for policy. My reasons for choosing long-distance water-diversion projects as objects of study are as follows:

a. Long-distance water diversion projects, as an important method, are still commonly put forward as solutions for water shortage problems in large areas, and are quite common in water management.
b. Long-distance water diversion projects often cross internal political boundaries or geographical boundaries. Thus they can be extremely complicated and usually take a long time to plan, and implement.
c. Long-distance water diversion projects are intended to be used for a long time and will influence water allocation between different generations. Thus inter-generational equity needs to be taken into account in water allocation.
d. Long-distance water diversion projects have strong impact on local, regional, or even national economic development, and can involve considerable social and environmental changes.
e. Long-distance water diversion project requires firm support from government, especially in China.
g. Long-distance water diversion projects are often operated by non-profit corporations or groups. But without strong market forces in operation, the management of such projects may be more risky and complex than are ordinary development projects.
h. Long-distance water diversion is often a result of interactions among interest groups at different levels. The personal values (or ambitions) of decision makers may greatly affect technical options and other areas.

Therefore, policy research for long-distance water diversion projects is important both in terms of sustainable development, and also in natural resource management.

The essence of the concept of 'sustainable development' is the establishment of a lasting condition for human beings to exist on the planet, not only for the present generation but also for future generations. The importance of the concept is well known. The key point is how to apply this concept in the real world, leading to two main questions: whether it is possible to embrace the concept, which indicates the feasibility of the idea; and what are the fundamental elements of successful 'sustainable development'. Resources provide the power essential for the functioning of a society.

Only if there is a sufficient supply of resources can the world support present and future generations with respect to 'sustainable development'.

Resources can be of various kinds: for example, human resources, natural resources, and social resources such as those that operate with in a particular political system. Natural resources are the most vulnerable as many of them are finite. Many natural resources are renewable, but take hundreds, thousands, or millions of years to finish the chemical and physical processes of renewal, which makes them effectively non-renewable. It does not mean other forms of resources (such as human resources) are not important or can be ignored. However, considering the reality that natural resources can be a bottleneck of modern development if no efforts are put into changing present practices, which rely on the consumption of natural raw materials, without which human beings cannot survive.

In order to be sustainable in the future, and even today in some areas of the world, natural resources should be a fundamental consideration. Sustainable development requires, sound natural resource management, which can maintain a society's development indefinitely (including economic growth and social development), while at the same time maintaining a healthy natural environment. In brief, the core of sustainable development is good natural resource management; or, in another words, the major obstacle to achieving 'sustainable development' is natural resource limitations.

Owing to the present uncontrolled demands of human beings, natural resource shortages spread through the entire world under the impact of economic growth. However, it can be argued that the main problems are not natural resources themselves, but malfunctioning social systems. Ohlsson has contended in *Water and Social Scarcity* (1998, 10) that not being able to mobilise a sufficient amount of resources to manage a new way of life required by increasing environmental scarcities and ought to be recognised as a particular kind of social resource scarcity.[3] He (1998, 23) explained further by generalizing the argument into three levels:

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[3] Social resources include such factors as appropriate social behavior(s), governance, education and training, legal systems, taxation systems, etc.

a. The problems encountered by societies attempting to manage environmental scarcities quickly will emerge, not simply as a scarcity of natural resources, but more particularly as a scarcity of the social resources required for adaptation to natural resource scarcities.

b. Social resources, which constitute the adaptive capacity of society, may become diminished by the necessary attempts at managing natural resource scarcities.

c. An important mechanism whereby this occurs is the new kind of conflict, caused by social resource scarcity. A maladaptive capacity thus will work in a vicious circle to further diminish the adaptive capacity of society.

Ohlsson further considers that in most occasions the stress or shortage of natural resource results from faulty social and political policies, which block society's capacity to adapt to natural resource stress or shortage, discourage the institutional innovation, and trigger more pressures on scarce natural resources. He calls this 'second-order scarcity', natural resource scarcity being 'first-order'. He concludes that the idea of 'social resource scarcity' is a huge challenge to conventional thinking, which only seeks to acquire or use more, rather than adjusting to scarcity. There can be doubt that more should be done in the political and social spheres than exploring for and exploiting ever more resources to meet resource consumption; and that is why a change from only supply-side management to demand-side management is required.

However, the concept of 'social resource scarcity' is too vague to apply in many practical cases. It can be interpreted as almost anything, according to the definition of 'ingenuity gap'.[4] Although introducing and emphasizing the idea of 'social resource scarcity' can assist, by emphasizing greater adaptive capability of society rather than more plunder of the natural environment, the concept can lead to misguided efforts in attempting to solve social problems, rather than considering the natural environment, thereby missing the opportunity to reduce environmental pressures. Its broad meaning may only raise confusion and uncertainty.

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[4] Homer-Dixon's term.

The first outcome is what Ohlsson described as a ‘vicious circle’ of natural resource scarcity or social resource scarcity (a kind of ‘chicken and egg’ situation), which is perhaps why Ohlsson wanted to reformulated the concept of ‘social resource scarcity’ in his book to avoid such a state of affairs. Without denying the essential importance of social resources in alleviating the natural resource crisis, priority should be given to the natural environment. Hence the fundamental point is how to manage natural resources wisely; and social resource scarcity should be considered as a segment of the larger problem. Simply linking natural resource stresses to social resource scarcity, shifts the focus of the problem from the ‘requirements’[5] for natural resources to a confusion of time-consuming social debates, which fail to provide worthwhile solutions. Therefore, in order to make the concept more manageable, and not omit important factors, the idea of ‘sustainable development’ should be built upon well-formulated natural-resource management, which I characterise as having:

a. a flexible system that can adapt to natural resource stresses and alter itself through social and economic changes to meet any natural resource pressure;
b. a natural environment conservation policy as a fundamental consideration for resource management;
c. the interaction of social and natural resources (on a planet of finite size) being recognised and taken into account.

1.4 Methodology

a. Case-studies

The main case examined in the present thesis is the ongoing South-to-North Water Transfer Project in China, which has taken fifty years for preliminary feasibility study and planning, and may take another fifty years of construction. It is worthy of study because of the very uncertainty of the future of the Project and the complexity of the interaction between social, political and economic factors within the Project.

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5 Certainly, nature itself cannot require anything, but here the words used as if nature were a person and rules are made by nature.

b. Comparative Study

Besides the Chinese case, the water diversion project in the Aral Sea region (former Soviet Union), the Snowy Mountain Project (Australia), the Colorado River Project (USA), and the abandoned National Hydrological Plan (Spain) are included in examining the characteristics and policy problems and possible countermeasures of long-distance water diversion projects. Among the more than 200 long-distance water projects in the world that I might have considered, the cases I examine have not been chosen at random, but for the purposes of comparison with the main case that I address in the present thesis, i.e. the STNWTP. The Russian case exemplifies what may happen when a project is imposed from the above for the political and economic reasons without due regard to ecological and social consequences. The Australian case illustrates the problems involved when a transfer scheme operates across political boundaries and does not foresee future ecological consequences. The American case is an example in which insufficient attention was given to economic considerations. The Spanish case exemplifies what may happen when powerful economic and political forces seek to override local interests and also the wellbeing of the environment.

Some of these schemes were completed a few decades ago, and the results of these projects have already become apparent, which can help the STNWTP to forecast its possible future problems. Certainly, because of differences in the natural environments, the political and economic systems, and the cultural backgrounds, these problems may not necessarily apply in the Chinese case. Even so, if that turns out to be the case, knowing what makes the difference and why is still an issue worth studying. For example, the Snowy Mountain Scheme was completed in 1974. Thirty years later, salination and dying of the Snowy River are two major environmental aftermaths. Will salination attack the water- receiving areas in China? How it will happen, and can any precautionary measures will be adopted? What is the impact of the Project likely to be for the downstream region of the Han River?[6]

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[6] One of the main tributaries of the Yangtze River, and the water source for the Central Route of the STNWTP.

c. Interviews and On-the-spot Investigations

Through a trip along the Central Route of the STNWTP in 2004, I interviewed government officials, both at the Central and local levels, and collected first-hand information relevant to the present study.

d. Policy theory in the Context of Natural Resource Management (Policy Cycle)

My research has adopted an ‘in-and-out’ model. It started by asking broad questions, then figured out what are the main issues under that question, taking each main issue into account and returning to a more informed view of the broad picture, with improved understanding of the relevant factors, and so on. It is a kind of iterative process of analysis and synthesis. Finally, there comes the stage when specific cases can be examined in the light of the broad context. This kind of research process is described in Clark’s work, as two ‘lenses’—selectivity and comprehensiveness, in applying policy science to the study of natural resource management (Clark, 2002, 11).

My major tools of analysis are taken from policy science theories, particularly in the area of public policy. About 90% of the world’s water is still supplied by the public sector (Reyes, 2006). As Sterner has observed: “the public sector has the natural role in providing (or at least monitoring) water supply because this vital ‘goods’ has many special characteristics” (2003, 345). Sterner’s analysis is based on economic assumptions that consider water as a ‘public goods’. Thus in his view, the appropriate policy instruments for natural resource management are market mechanisms, such as pricing and tariff policies. He also acknowledges that market force can fail for some cases, in which case public policy must intervene (2003, 346, 348–350, 352). Therefore, public policy only plays a role as backup. In my thesis, however, policy instruments are not only involved in natural resource management as the final product, like rules or formulae, although these are crucial points for policy making. More importantly, I focus on the process of the policymaking: why and how to respond to certain problems in water diversion projects. Therefore, I apply the so-called ‘policy cycle’ as an analytical framework for my case studies. Although the words for describing the policy cycle or policy stages are slightly different in different books, the core of the concept has been well defined. Jones (1977, 9) summarised the cycle as follows:

> Public problems exist in society as a result of the perception of needs by people, some people have problems in common, some of these organize and make demands or demands are made by those who seek to represent people, demands are perceived and judged by those with authority to make decisions, decisions are made and enforced, public problems are affected by these decisions, people react to the decisions, some people have common reactions, demands are made, and so forth.

A policy cycle for public problems in Nature is necessarily a dynamic process involving interactions between Nature itself, the authorities/policy makers, and the public. It includes agenda setting, policy formation, policy implementation, policy evaluation, and policy modification (Colebatch, 2002, 50). (I give a diagrammatic representation of the cycle and further discussion in Chapter 3.)

My research does not provide a ‘yes’ or ‘no’ answer to the STNWTP through engineering or economic analysis, but tries to use the Project as an example to show how governments act, and why they act as they do, in natural resource management. Hence suggestions can be made for improving natural resource management. (See next page.)

Note on Sources

In several cases, while interviewing people in China, I was requested to undertake to treat the information provided as the private views of the interviewees. Therefore, I am not able to provide full details of the names of people I spoke to, or the names of their institutions.

1.5 Thesis Structure

This thesis is structured around the five stages of policymaking process, which provides the connection of argument used for the five case studies (see Figure 1.1):

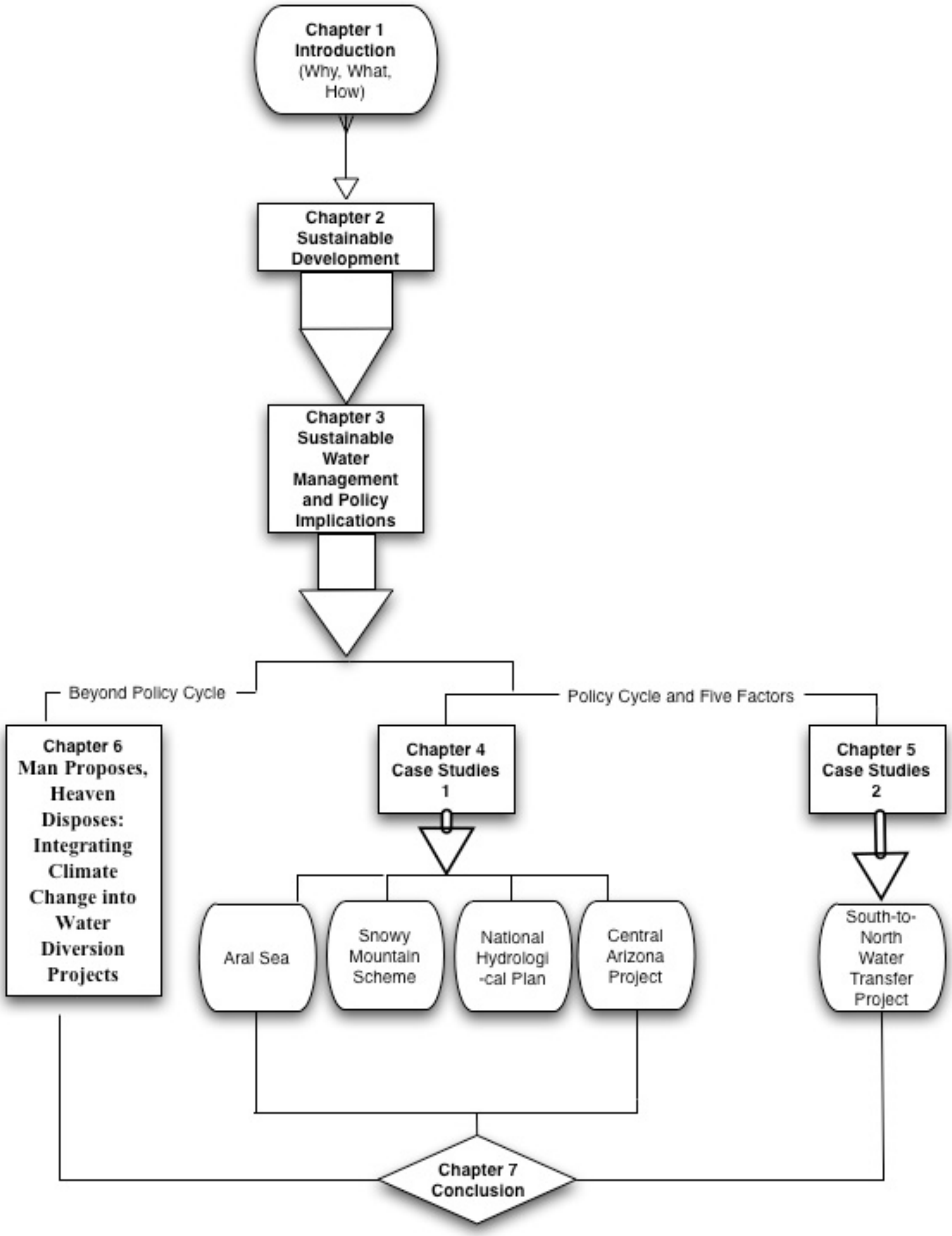

Figure 1.1 Schematic Representation of the Thesis Structure

Chapter One: Introduction

Chapter 1 tries to explain what this thesis is about (what), why I chose this topic (why), and the methodologies applied and definition of terms (how).

Chapter Two: Waving a Flag: Sustainable Development

This chapter discusses how the term ‘sustainable development’ originated and developed, what are main arguments or problems about the idea, and its implication in natural resource management. In this chapter, sustainable development in China is also discussed to provide a general background for further argument in later chapters.

Chapter Three: Water Crisis and Public Policy in terms of Water Resource Management

How may one apply Sustainable Development concepts to water resource management? What are the key problems that hamper action regarding water management? This chapter follows the discussions on policy theories and their links to water resource management in Chapter 1. It includes a discussion of policy cycles, and explains why they may usefully be applied for water diversion cases studies in this thesis and elsewhere.

Chapter Four: Case Studies 1 (Aral Sea case; Snowy Mountain Scheme; National Hydrological Plan; Central Arizona Project)

Traditional thoughts about water management follow a simple logic: that is necessary to seek for more water supplies. Thus, from that point of view, water diversion projects have been taken to be the predominant solution to water crises. Even today, they are still popular as engineering fixes to situations of water stress. Four water diversion cases (the Aral Sea in Central Asia, the Snowy Mountain Scheme in Australia, the National Hydrological Plan in Spain, and the Central Arizona Project in America) demonstrate that technological fixes may be unsound shortcuts to solve problems in water management. All cases are linked by the five-stage policy cycle and Clark’s natural resource management model.

Chapter Five: Case Studies 2 (South-to-North Water Transfer Project, China)

Based on the results from the previous chapter, the STNWTP in China is examined using the same analytical structure as that used in Chapter 4, but giving more consideration to the public policy domain because of the leading role taken by the Chinese Government. The analysis includes the decision-making processes from the beginning to the present (construction now having already begun). In order to have an overall picture of the policy cycle in the policy evaluation section, another Chinese water transfer project, the Luan River Scheme, already completed and in operation nearly thirty years, is introduced to demonstrate the possible unforeseen adverse outcomes of a large water transfer projects in China. In Chapter 5, the interactions between, within, and among the Central Government, local governments, technocrats, and the general public are examined in some detail, which is the driving force to shape and modify the STNWTP.

Chapter Six: Man Proposes, Heaven Disposes: Integrating Climate Change into Water Diversion Projects

The main subject for this chapter is to bring problems of uncertainty and complexity into discussions about water management. Climate change is a substantial issue that should be taken into account in the management. Problems like climate change, with great uncertainties and complexities, should be integrated into policy cycle for to try to achieve better water management results.

Chapter Seven: Conclusion

The last chapter reviews the major issues discussed in the previous chapters about water diversion projects and water management. Further discussions of how to deal with the water crisis, and recommendations regarding the STNWTP and water management in China, are given.

CHAPTER TWO

WAVING A FLAG: SUSTAINABLE DEVELOPMENT

2.1 Sustainable Development: a Common Ground for Natural Resource Management

Even before the concept of 'sustainable development' became a commonplace, the interpretation and discussion of the word, sustainability had been spread in Western post-industrial societies; especially where economic structural changes are associated with the decline of the agricultural and manufacturing sectors and the growth of the service sector (Jones, 1982, 4–5). While more people would be employed in the service area, which is not directly attached to natural resources, at the same time the conflict between economic growth and the limits of natural resources has increased and gradually been recognised; and the overuse of natural resources and pollution have started to impede economic growth. Under such circumstances, there was a need for new thinking that would form different conceptual foundations for the social transformation, which would (somehow) prevent environmental degradation and social deterioration.

2.2 The Concept of Sustainable Development—A Timeline

The publication of *Silent Spring*, written by the American biologist Rachel Carson in 1962 about the negative impacts caused by the spread of use of chemical pesticides in agriculture, was the landmark for first raising a general awareness of pollution problems and which paved the way for the introduction of the concept of 'sustainable development'. This also led to several influential international environmental organisations being established, such as Friends of the Earth (1969), and Greenpeace (1971), with the purpose of safeguarding the natural environment.

Since that time, discussions about how human activities influence the natural environment in a harmful way became a topic, not only for scientists but also for economists. Gradually, the focus of the discussions widened in relation to the problems of rapid economic growth and restricted resources on our planet. This led to two opposite attitudes towards the issue. For instance, ten years after *Silent Spring*, in *Only One Earth*, Dubos and Ward (1972) took an optimistic view, namely that a shared concern for the future could create a brighter common future. By contrast, the Club of Rome published *Limits to Growth* (1972), which predicted dire consequences if growth were not slowed down.

The same year, the UN Conference on Human Environment was held in Stockholm, which was another milestone in forming of the idea of 'sustainable development'. It was the first time that collaborative actions were taken for figuring out environmental problems at the international level. Two actions that followed the conference were the establishment of World Environmental Day (5 June), and the birth of the UNEP (United National Environment Programme) (UN Conference on Human Environment, 1972).

An important document, *Our Common Future*, was produced by the World Commission on Environment and Development in 1987, which sought to give a definition of the notion of 'Sustainable development'. The phrase means different things to different people, but the most frequently quoted or widely accepted definition is from this report (1987, 43):

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Changes in the concept of sustainable development have continued since the 1980s and has become a popular mantra. In 1992, the leaders at the Earth Summit built upon the framework of the Brundtland Report to create conventions on critical issues such as climate change, desertification, and deforestation and also a broad action strategy was drafted—*Agenda 21*—as the work-plan for environmental and developmental issues in the coming decades. Most significantly, *Agenda 21* developed the concept into a three-dimension model: social, economic and environmental, which was adopted by UNIDO

(United Nations Industrial Development Organization) (UNIDO, 1998, 4–5).

Dixon and Fallon (1989, 76) also refined the concept by identifying three different connotations:

> [F]irst, sustainability as a purely physical concept with respect to a national resource; secondly, sustainability as a broader physical-biological concept with respect to the regenerative capacity of resource-systems or whole ecosystems; and thirdly, sustainability as a physical-biological-social concept, where the notion of ongoing 'maintainability' attaches to the relationship between nature, human welfare, and society.

The reshaping of the concept was the starting point for the arguments about sustainable economic development and sustainable environmental development, natural capital, and social and cultural values.

Throughout the rest of the 1990s, regional and sectoral sustainability plans were developed. A wide variety of groups, ranging from businesses to municipal governments to international organizations all gave the term their own preferred interpretations. These interpretations increased understanding of what sustainable development might mean in different contexts. Unfortunately, however, as the Rio de Janeiro Earth Summit review process demonstrated in 1997, progress on implementing sustainable development plans has been slow (or negative).

At the time of writing, the latest major document related to sustainable development is that of the 2002 World Summit on Sustainable Development, held in Johannesburg, South Africa. World governments, concerned citizens, UN agencies, multilateral financial institutions, and other major groups participated and assessed global changes since 1992, when the United Nations Conference on Environment and Development was held. A shift to governmental cooperation at the international level can be recognised as the result of the recognition that environmental problems are not just a problem in one particular country and cannot be solved by individual countries alone.

2.3 The Evolution of the Concept of Sustainable Development

There have been two stages in the evolution of the sustainable development concept: from an emphasis on the idea of growth to that of development; and from development to sustainable development. At the moment, the second stage is nowhere near complete.

The theory of sustainable development has relatively deep historical roots. From the 1950s to the beginning of the 1960s, under the pressure of economic growth, urbanisation, population growth, scarce resources, etc., people began to doubt whether economic 'growth' was equivalent to the term 'development' and discussed this topic extensively.

Two major eras of economic growth were the Industrial Revolution and the Post War II period. The former took mechanisation as a fundamental drive, which led to a sharp increase in productivity. The latter followed the restoration from the damage of war and focused on the development of Bretton Woods institution to encourage international trade and economic development. The common high economic growth has attracted extensive attention from scholars. Discussing what was the cause of the development, how economic growth was promoted, and what were the possible results brought about by development, the modern pioneers of development economics were interested in 'making the pie bigger'. They thought that development in itself could solve all problems. Even some later neoclassical development theorists, took the view that "economic development [w]as a growth process that require[d] the systematic reallocation of factors of production" (Adelman and Morris, 1997, 831). That is 'development' could be equated with 'growth'.

But what is the difference between the two terms? An answer by Daly (1990, 2) is pertinent:

> [G]rowth is [a] quantitative increase in physical scale while development is qualitative *improvement* or unfolding of potentiality. An economy can grow without developing, or develop without growing, or do both, or neither [emphasis added].

Daly's analysis gave an answer to the question about the difference between 'growth' and 'development', but his explanation of the relationship between 'growth' and 'development' was not adequate because it placed too much emphasis on the difference between the two terms. To understand 'growing without developing' is easy and there are many examples in reality to illustrate this (such as the increase in size of a waste heap). If the quantity argument is not accompanied by any real improvement in quality, then it can be viewed as economic growth but not development. Massive production not only increases the quantity of products, but also leads to pollution, if qualitative aspects have not been considered and no preventive measures are taken. However, 'developing without growing' in commerce is incomprehensible. Although 'economic growth' is not equal to 'development', they still share some characteristics and they should not be taken as two separate matters. One region or one country cannot develop without any economic growth, just by improving the quality of its products. Even if it can happen, the whole process must be accompanied by growth to some extent; otherwise one has a static condition, not a dynamic situation as occurs in the real world.

Therefore, I consider that 'development' can be represented by two dimensions: one is on quantitative side; the other is on the qualitative side, and includes 'growth' (Figure 2.1).

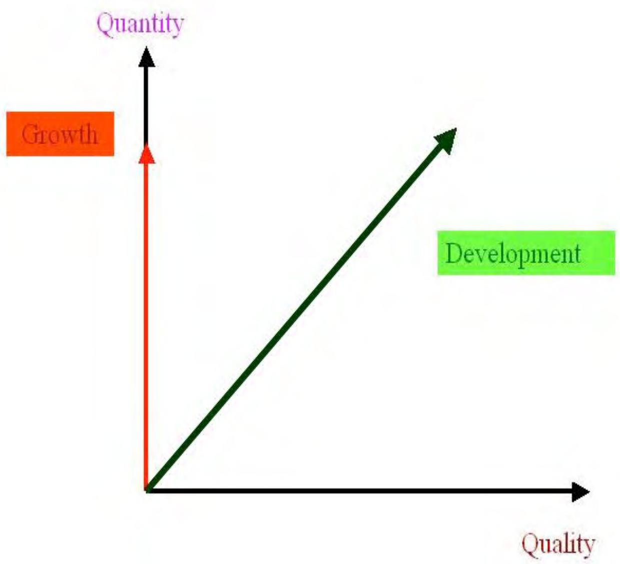

Figure 2.1 Two-Dimensional Idea of Development

To be sure, the foregoing figure simply shows the idea of development, but at least it indicates two points:

a. Development involves increase in two dimensions. Either increase in quantity alone, or quality alone can’t make any sense to ‘development’.
b. ‘Growth’ is a part of ‘development’.

However, growth may not lead to development. By contrast, development is always accompanied by growth. Therefore, to understand development, a close look needs to be taken at growth.

The theoretical root of growth is derived from development economics. However, the expectation that economic growth was the same as ‘wealth’ and would bring ‘happiness’ to both individual life and overall welfare of the society (‘a rising tide will lift all boats’) was mistaken. On the contrary, research indicates that people with increasing wealth are often less happy than before (Ackerman, *et al*., 2000, 95).

Hamilton (2003, 33–53, 58) comments that the logic of modern capitalism is about the “rationality of money”, but this cannot ensure an increase in happiness or improve social wellbeing, since the economic methods of evaluating ‘happiness’ are imperfect, and ignore social and psychological aspects that money cannot buy.

In any case, economic growth does not necessarily eliminate poverty. The economic growth that has occurred worldwide over the last twenty years has not decrease the poverty even within developed nations; and the richest nations in the world still accommodate some of the poorest people (Beder, 1996, 20). And the increase of wealth of some nations has been accompanied by increasing poverty in others.

Globalisation spreads capitalism and consumerism to every corner in the world, which results in a unifying lifestyle in developing countries. Every new large city in every country is similar. Stiglitz (2002, 248) comments on globalisation, people are not better off. They are actually “worse off, as they have seen their jobs destroyed and their lives become more insecure. They have felt increasingly powerless against force beyond their control. They have seen their democracies undermined, [and] their cultures eroded". This kind of 'development' has never touched people who live in lower class or in rural areas. Ordinary public's life is getting far away from so-called 'development'.

Moreover, Tietenberg (2000, 6) has argued that:

> we . . . [should] care not only about the value of resources, (the size of the pie), but how this value is shared as well (the size of each piece to all recipients). In other words fairness or justice concerns should accompany efficiency consideration.

And inequity does not only exist within one generation, but also between different generations. Yet any serious attempt at reducing poverty requires sustained economic growth in order to increase productivity and income in developing countries. But there is more to development than just economic growth—much more.

The Brundtland Report can be considered as the turning point for forming the concept of 'sustainable development', which involves social factors and brings the concept formally into policy discourse. And it indicates that human development history is moving towards a new era, from the attention to growth (quantity) and development (quantity and quality in a material sense) to concerns about social and environmental factors (quality in both material and immaterial senses).

2.4 Different Standpoints of Sustainable Development: Ecological or Economic?

The relationship between the economy and the environment became the main issue when the discussion of sustainable development intensified in the 1980s. Economists held that economic growth was crucial for sustainability since it could create the possibility of achieving environmental protection by (for example) appropriate financial and technical supports. Economic growth could provide the conditions in which protection of the environment could be achieved, in balance with other human goals, as was necessary to achieve sustainable growth.

Therefore, in spite of acknowledging the importance of the natural environment, proponents of sustainable economic development still consider the economic system as having priority over the ecosystem, which is counted as a part of the economic system.

> [However], the natural environment is an important component of the economic system, and without the natural environment the economic system would not be able to function. Hence, we need to treat the natural environment in the same way as we treat labour and capital; that is, as an asset and a resource (Beder, 1996, 11).

So economists commonly consider that the natural environment *serves* economic growth, for the ultimate purpose is economic growth. And they take environmental factors into account because the ecosystem can hinder the economic growth if human beings ignore the interactions between economic growth and the ecosystem.

By contrast, environmentalists believe that too much emphasis on economic growth will inevitably lead to greater negative results. They argue that what economists expect has not happened. For instance, economic growth cannot eliminate poverty and market signals cannot solve pollution problems automatically.

Thus the classical economic approach to environmental protection fails to take into account the biophysical laws, which are fundamental to ecology. “It attempts to treat the environment as a set of goods and services that are sold in actual or hypothetical competitive markets. It ignores the roles of social institutions other than firms and households in determining outcomes. And it is based on an ethical standpoint that works against ecological sustainability and social equity” (Diesendorf and Hamilton, 1997, xviii–xix). These authors doubt the extent to which economic growth can maintain sustainability. Furthermore, the more radical environmentalists are not satisfied with the idea that the natural environment is simply a ‘tool’ for the purpose of increasing economic prosperity. However, environmentalists and economists can agree about the significance of sustainable development and realise that economic growth and the natural environment are interlocked. But they take different attitudes as to how to achieve sustainable development.

Diesendorf and Hamilton have distinguished four different approaches towards sustainable development. They put those who think that economic growth is the key thing at one end of spectrum and those who give priority to environmental issues at the other end. Then they divide those people in between into two groups.

They explained that some proponents of first group tend to “regard economic sustainability as one element of well being, while others regard economic sustainability as a separate, secondary matter. On the other hand, economists tend to see sustainability as being the maintenance of consumption at some constant level forever. Some economists assume that if this can be achieved then the environment will also be sustained, while others consider the environment to be a separate, secondary matter” (Diesendorf and Hamilton, 1997, 64–65).

As we have seen, in the 1960s, scientists and some industrialists and politicians began to be concerned about the environmental problems caused by pollution and the overuse of natural resources. At that time, environmentalists took an antagonistic attitude towards economic growth. The core item they considered was the old Malthusian idea that population increased exponentially, while economic resources increase arithmetically. Economic growth could not meet the needs of the increasing population. Additionally, endless and unlimited economic growth (trying to catch up with population growth) would result in severe environmental problems. At the time, this thinking did not belong to the mainstream and was regarded as excessively pessimistic. One good example was the argument given in *Limits to Growth* (1972). This Malthusian argument reached its peak in the 1970s and was called the first wave of environmentalism. It was the same period, mentioned previously, when the idea of growth gave way to the concept of development.

Beder has described the ‘first wave’ of environmentalism as a trend that was associated with the counter-culture movement of the 1960s and 1970s. It rooted from “traditional concerns with nature conservation into awareness of the potential for a global ecological crisis and was clearly a protest movement” (Beder, 1994, 37).

During the first wave, governments scarcely recognized the importance of environmental problems and refused to acknowledge the global environmental issues. However, under the pressure of community-based activities, they did have to deal with local pollution problems and establish appropriate legislation. But overall, governmental actions did not achieve significant changes. Moreover, in spite of the fact that some participants in the first wave were industrialists themselves, such as the leading members of the Club of Roman, the first wave failed to bring environmental problems to businessmen's attention.

In this new climate of opinion, government departments and agencies found it extremely difficult to administer the legislation that had been put in place at the height of the first wave of environmentalism, and businesses did their best to ignore the laws or get round them. After the 1970s, there were few backers for the two extreme ends. The majority took the view that the natural environment and economic growth could (somehow) be reconciled.

The 'second wave' of environmentalism started in the late 1980s. The first and second waves differed in two important aspects. The second wave received more comprehensive support from governments, businesses and economists, as well as scientists. The second wave also took a more optimistic view towards the relationship between economic growth and environmental problems. It believed that technological innovations could, in principle, handle such problems. The main evils of economic growth—pollution and over consumption of natural resources—could supposedly be changed by technological methods, for example, using waste control and developing substitutes for non-renewable resources. Sustainable development could be achieved with both economic growth and improvements in social aspect and environmental issues.

Even though the Brundtland Report's definition of 'sustainable development' was not totally satisfactory for understanding the concept, nevertheless in practice it has been an important milestone in the development of the notion of sustainable development, because it pushed people to think about the lives of their children and their children's children, and it gave this idea greater and more comprehensive scope. After all it was in the Brundtland Report that the ethical and economic principles of "intergenerational equity' first emerged.

For more conservative environmentalists and for economists, politicians, business people, and others, the concept of sustainable development offers the opportunity to overcome previous differences and conflicts and work together towards achieving common goals, rather than confronting each other about whether economic growth should be encouraged or discouraged (Dryzek and Scholsberg, 1999, xiv).

Besides building a foundation for further discussion and finding practical ways to achieve sustainable development, the second wave of environmentalism did make some progress. In fact, the advent of the idea of sustainable development could be regarded as a shift from pessimism to optimism. Unqualified condemnation of industrialisation and globalisation gave way to a consensus about the desirability of sustainability. However, it did not please everyone. First, it was claimed that the idea of sustainable development was a 'camouflage' for achieving the real goal of economic growth. Even though businesses admitted theoretically the significance of protecting the environment, the idea of sustainable development failed to change the fundamentals of egotistically-based classical economic theory. After the intimate interconnection between economic growth and ecosystems was recognized, no one could deny that economic growth could only be promoted within a sound ecological system.

However, the second wave did not originate from a new idea or a fundamental change in social structure. Moreover, the discussions of sustainable development emphasized economic perspectives so that sustainable *economic* development remained the core of the concept. Therefore, sustainable development is a money-centred concept, which evaluates everything according to its economic cost, and seeks to avoid damage to the natural environment by financial inducements or penalties.

There are uncertainties as to whether or not sustainable development is a human-centred development. Consider the question of whether it is more important to build a new waste-control system for a city or preserve grassland for a rare kind of antelope. Usually, short-term benefit takes precedence over long-term considerations. The antelopes are sacrificed!

Indeed some scholars think too much attention is paid to biodiversity. Dumanoski argued at the Harvard Seminar on Environmental Values on 15 December in 1999, for example, has argued that:

> environmental campaigns that have captured public imagination—such as the worthy battles to save wilderness, rainforests, and dolphins have helped foster the impression that th[e] crisis is primarily about distant places and creatures rather than about the natural systems that support our communities and the larger human civilization. This focus on a “nature” remote from our daily lives has reinforced a dualism within our culture, which imagines a nature separate from the places where we live our lives and makes it difficult to perceive our situation clearly.

In fact, ordinary people generally chiefly consider their ‘nearest interest’ or that which gives them the most quick and direct benefit. ‘Nearest interests’ can be measured according to three dimensions (see Figure 2.2).

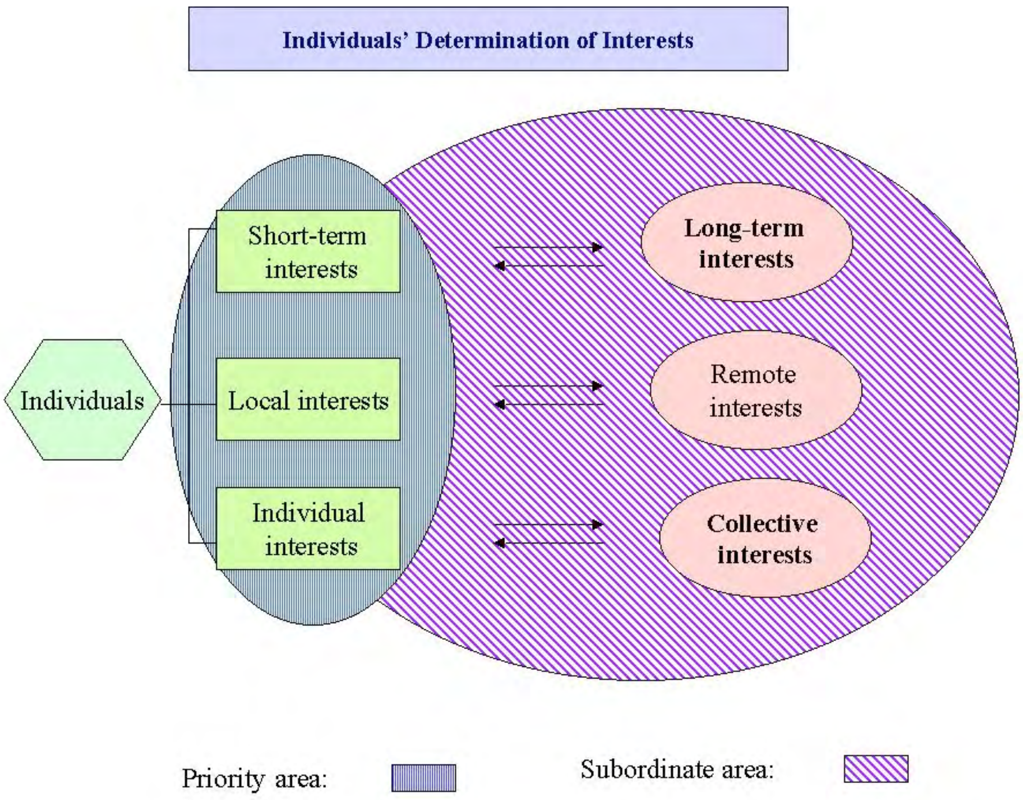

Figure 2.2 Individuals' Determination of Interests

a. Considering the temporal dimension, people prefer short-term interests rather than long-term ones, because of future uncertainties.

b. The spatial dimension has to do with the fact that the interest of a local community is always considered first, rather than the related interest about what happens elsewhere (the principle of 'propinquity').

c. The last dimension is concerned with the tension between individual and collective interests.

These are the three categories of interest-relationship that reflect what most people consider when making their decisions (in terms of self-interest). To some extent, this is an instinctive pattern for human decision-making. However, this model is not fixed and universal. Under some conditions, the short-term interest can be changed into long-term interest, and influential factors elsewhere become the main issue. Or in a particular local area the collective interest is as substantial as, or even more important than, the individual interest. For example, in the short-term, cutting trees in a tropical rain forest maybe unrelated to city residents who live in the North Temperate Zone. However, cutting quickly decreases the number of trees that are key components of the ecosystem in rainforest areas and their destruction finally causes global environmental deterioration, which results in adverse climate change in the cities of the North Temperate Zone. Thus the long-term considerations of seemingly irrelevant factors need to be pondered seriously at the beginning (*before* cutting the trees!). Consequently, for second-wave environmentalism, neither long-term nor short-term aims can be disregarded; neither remote nor local; and neither collective nor individual concerns.

These kinds of problems have been discussed by, among others, Daniel Bromley of the University of Wisconsin-Madison (Bromley, 2004). He takes a line of argument standing in the tradition of American pragmatism. He contends, rightly I think, that consequentialist economic theory as applied to environmental problems is incoherent in that it is impossible to do cost-benefit calculations that provide useful, reliable, or even intelligible guides to action. He commends the use of abductive reasoning. That is if one has a problem, one should try to hypothesise a policy that will provide a solution to the problem rather than calculating the basis of a policy according to some consequentialist algorithm. In this context, the use of abduction would presumably involve hypothesising a policy and trying to gauge its practical consequences, and give the "reasons for the decision reached". The policy decisions must "share wide agreement within the interpretive community" or be "warranted" (Bromley, 2004, 93). However, he states that:

> [The] theory will require explicit recognition of the concepts of impression, expression, and created imaginings. That theory will require recognition that joint action in the policy arena entails the working out of contending expressions and contending created imaginings. It will require recognition that human agents cannot possibly articulate coherent and salient wants in isolation from the specific context of choice in which they learn about those wants as they learn about what they can have.
>
> . . .
>
> Policy is simply choice and action in which groups of individuals work out what seems better (what seems reasonable), at the moment, to do. The

> citizenry does not need, nor does it appear to want, environmental economists telling it which of those plausible futures is socially preferred. They will figure that out for themselves as they go about figuring out how to reconcile their contending expressions and imaginings. Pragmatism helps us by offering reassurance that it is perfectly acceptable to be unsure about what seems better to want and to do (Bromley, 2004, 94).

This is hardly a policy prescription. It merely tells us that environmental problems are complex! However, one might say that the recent election in Australia (24 November, 2007) was a collective expression of a nation's decision to alter its environmental policies—a decision reached by millions of individual, only partly informed, imaginings. But the decision to change governments and policies was made with no pragmatic certainty as to the eventual outcome.

2.5 Finding the key to sustainable development

After the term 'sustainable development' reached general acceptance and usage, there have been two trends in the development of this concept, stretching it to wider scope and deepening its clarity, which have involved redefining and re-examining the concept. Following the Brundtland Report, the term began to appear much more widely, and was popularised by giving sub-definitions in the light of the needs or interests of particular groups of people, such as the World Wildlife Fund,[1] the UK Department of Environment,[2] Transport and Regions, and the World Business Council for Sustainable Development (Mawhinney, 2002, 3–4).[3] Although the term was generally approved as a formula to interpret and understand sustainable development according to particular and different interests, background, and knowledge, the insufficiency of the term opened spaces for more research as to ultimate principles, and *what* should be sustained.

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1 Sustainable development means improving the quality of life while living within the carrying capacity of supporting systems.

2 Social Progress that recognises the needs of everyone; Effective protection of the environment; Prudent use of natural resources; Maintenance of high and stable level of economic growth and employment.

3 Sustainable business practice requires 'Business leadership as a catalyst for change toward sustainable development, and to promote the role of eco-efficiency, innovation, and corporate social responsibility toward sustainable development.

As mentioned, the best-known definition of ‘sustainable development’ is that given in the Brundtland Report. This definition is quite neutral, neither giving too much focus to economic perspective nor to environmental protection. However, the definition has been criticized for making use of vague concepts such as ‘need’ and ‘development’, which entail personal judgment, which in turn results from different personal experiences, knowledge, and social status.

The Report only defines ‘need’ as the core concept or standard for weighing whether the development is sustainable or not. ‘Need ’ as described in the Report is a general term lacking specific limits. Unquestionably, ‘needs’ for people in developed countries and ‘needs’ in developing countries are different in both quality and quantity. Hence there is no uniform standard as to what ‘need’ is and how to meet ‘needs’. Furthermore, the definition supposes that future generations will have the same value judgments as we have today, which means that people in the present are deciding what will be ‘needed’ by people in the future.

The term ‘development’ has similar problems in that there is no consensus about its meaning and how it may be measured, if indeed it can be measured at all. Despite such problems, economists can offer various indices (e.g. GDP) to quantify ‘development’. But none of them provide a reliable and precise standard for measuring ‘development’. GDP, for example, can only reveal the economic growth rate, which chiefly considers the quantity of goods and services, not their quality or social happiness and wellbeing.

The ‘needs’ of different generations are different because ‘development’ at different levels shapes the differentia. Redclift (2005, 213) has observed the internal link between ‘need’ and ‘development’ and he raises two questions: as whether in this case ‘development’ is the primary determinant; and how changes in ‘need’ affect the way needs are met. The two questions lead to a logical predicament that is ‘development’ structures the ‘need’; and ‘need’ (both for present and future generations) becomes wrapped into the notion of ‘sustainable development’. Furthermore, for Redclift, the term ‘development’ is equal to ‘economic growth’, since economic growth is the driving force for changing ‘need’. This may be true but it will not do much towards helping achieve sustainable development in the long run.

The cultural aspect is seldom noticed in works that discuss sustainable development though Diesendorf and Hamilton (1997, 74) mention the importance of the conservation of cultural diversity in their *Human Ecology and Human Economy*, pointing out that cultural loss has been extensive in languages, social structures, economic and political systems, and spiritual beliefs.

Redclift (2005, 213–214) has also found this missing part of the definition of sustainable development from the Brundtland Report, which is the cultural implication. The notion of sustainable development is rooted and embedded in its capitalist background. With globalisation and the spread of capitalism and consumerism, cultural differences are ignored in pursing sustainable development, which leads to an assumption that ethics, economy, political structure and civic society in the capitalist world are basic requirements for achieving sustainable development, even though there are still insuperable difficulties in reconciling 'expansive' capitalism and finite natural resources.

The other trend of discussion about sustainable development has been to go further with the concept itself, and find words to define 'need', which are clear and concise. In short, the effort in this field has been to try to answer the question, *what should be sustained*? Should it be 'physical throughput' (Daly, 1990, 1), utility or welfare (Pearce and Warford, 1993, 49), or something else? However, while those terms maybe theoretically meaningfully, in the real world, there is still difficulty in practice. Although the concept was born as a result of concern with and for the environment, discussion still inclines towards the economic perspective. As stated by Beder (1994, 8):

> Sustainable development is not about giving priority to environmental concerns, it is about incorporating environmental assets into the economic system to ensure the sustainability of the economic system.

The confidence in economic growth contributes to the faith in advanced technologies and the belief that a 'bigger pie' can eliminate poverty. The optimism about the power of economic growth calmed the worries in the 1970s when it seemed that the world was running out resources. However, in the long run, natural resources will undoubtedly be depleted. Applying the concept of living within limits is paramount even today. As mentioned before, the (necessary) fate of capitalism and consumerism is to grow bigger, like a swelling balloon. Without restriction, it will continue growing until there is a blow-out. However, if the balloon is put in a limited space it will remain in a condition such that only moderate quantities of resources are used.

What is the brake for growth to stop it before explosion or crash? Robert, K.H., the founder of the concept of 'The Natural Step', considers that the major message given by sustainable development should be recognition of the limit of natural resources. He describes it as a tunnel with four walls being four restrictions to development: "[d]oes an action cause a decrease in the use of metals, fuels and minerals? Does an action increase dependence on unnatural substances? Does an activity encroach on productive parts of nature? Does an activity result in the use of unnecessarily large amounts of resources?" (Robert, 1997, 81; Mawhinney, 2002, 4). If so, the tunnel is shrinking (or, so to speak, becoming a funnel) due to natural resource depletion.

The four conditions are not *negotiable*. They are very difficult to achieve. If the 'conditions' can be replaced by 'restraints', then the understanding of 'funnel theory' can be improved. Four restraints instead of conditions are more likely to be accomplished in the real world. For instance, mining and petroleum industries are not required to close but being aware of the concept of limit, adaptive measures should be taken, either so as to reduce total output of resources, or by paying more attention to the efficiency of the production process, and the quality of products (long-life and more effective products), etc.

However, Sathiendrakumar (1996, 7–19) takes the view that sustainable development should secure the welfare of the current generation, in such a way that future generations will not be worse. Thus he concludes that "Reducing optimal depletion of non-renewable resources; Optimal depletion of renewable but exhaustible resources; Preventing environmental degradation; Improving energy efficiency" are conditions for sustainable development. The core of this concept of sustainable development is natural resources seen from the economists' point of view.

Natural resources are vital to development, and whether our society can be sustained or not depends on whether natural resources can be used wisely. Taking care of natural resources is like holding a bunch of grapes, which represents population growth, urbanisation, water management, economic growth, public health, and cultural evolution. Holding the bunch by the stalk allows all the grapes to be retained. If it is held by one or two grapes, the bunch will fall and all the grapes will be damaged. By analogy, environment should be given equal importance to the economy. The market can encourage the efficient use of natural resources, innovations and substitutes of rare resources if proper steps are taken. But that only happens when the idea has been accepted that the sustainable management of natural resources is critical to achieving sustainable economic growth.

2.6 The Market Force and Sustainable Development

2.6.1 Elementary features of the market

The chief aim in trying to accomplish sustainable development is to assure the proper, effective, and efficient use of present resources without adversely affecting future generations. To answer this question in terms of economic principles is to find appropriate cost-minimizing policies. Historically, the market has being regarded as an efficient and effective way for allocating resources. That demand shall equal the supply—or the condition of market equilibrium—is one of the most important determinants of economic activities. The notion of the market economy was simplified by classical economists such as Adam Smith (1981 reprinted) as a combination of households (consumers) and firms (providers). Operating like an 'invisible hand', the market touches every corner of his hypothetical economic society and is effective in promoting public interest.

Every individual has to work to render the annual revenue of his society as great as he can. But generally he neither intends to promote the public interest, nor knows how much he is promoting it. He intends only *his own* gain, and he is in this, as in many other cases, led [as Smith metaphorically put it] by an 'invisible hand' to promote an end which was no part of his intention. Nor is it always the worse for society that it was no part of his intention. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it. "I have never known much good done by those who affected to trade for the public good" (Smith, 1981, 459).

However, real societies are much more complex and unstable than that of the Smithian ideal. The market can sometimes fail in the allocation of resources. The market is supposed to be the most efficient instrument for using resources, by minimizing costs and achieving optimal prices. On the one hand, those providers who can make products at the lowest cost can make money. Hence they endeavour to reduce their costs by maximizing the use of resources. On the other hand, consumers, who try to minimize their purchase prices, always buy goods of the same quality at the lowest available prices. The motivation for both providers and consumers is self-interest. (The 'invisible hand' is at work.)

Nonetheless, based on the assumption that people are self-interested, they may decrease their costs in some, but not all aspects, in that they ignore externalities. When factory owners attempt to reduce their costs, the fixed and variable costs are relatively easy to determine, but these do not reflect the real costs that can be handled by the market and this may lead to market failure. Market failure is a condition in which a market does not allocate resources efficiently to achieve the best possible consumer satisfaction.

2.6.2 Market Failure

There are a number of ways to deal with or 'solve' market failures. One way has been outlined by Coase (1937, and 1960). They consider the example of two farmers engaged in a dispute about the use of land, and one farmer's animals damaging the other's crops. In the case of clearly-defined property-rights the transactions costs will be low (lower than litigation costs) and there is free bargaining. Agreement will be reached between the person causing and the person suffering damage without governmental intervention. Mutually agreed compensation will be paid. However, when transaction costs involved in reaching an agreement are high, the Coase argument implies that governmental or judicial policy may be able to alleviate the problem better than the market can (i.e. the two farmers). In sum, proactive public policy is thought to be able to improve on what the market produces and can alleviate market failures.

There are four major kinds of market failure, associated with: (1) public goods; (2) externalities; (3) imperfect information; and (4) 'commons'. In each case, market acting without governmental direction does not direct an efficient amount of resources into the production, distribution, or consumption of the 'goods'.

The famous economist Paul Samuelson (1964, 159) used the lighthouse as an illustrative example of market failure. The lighthouse prevents disasters by means of a light that guides ships during the night. However, the cost of building the lighthouse is not collected from each ship that passes by. The lighthouse is a typical public goods and can also be regarded as a kind of positive externality. But the difficulty is to know how to encourage actions that bring about positive externalities. The most significant distinction between private goods and public goods is non-excludability and non-rival consumption. A 'non-excludable' resource is one that is open to the public, and no one can be barred from making use of it. For instance, the air we breathe can be considered to be a 'pure public goods'. The term 'non-rival' refers to a situation such that if one consumes a resource, the consumption does not reduce the total benefit produced by the resource. For example, if a family likes to enjoy its leisure in a pleasant communal place, this does not imply that other families do not also have access to the opportunity to use it.

The two distinct attributes of 'non-excludability' and 'non-rival' may cause markets to fail to function according to the law of market equilibrium. Everyone can access the resource at no cost. The provider of the resource cannot make a profit, since people can take pleasure from sharing the resource without contributing money or effort. If people are indeed self-centred, as economists suppose is the case in the real world, then people will take advantage of the resource without payment and thus take it for granted. Consequently, nobody wants to be a provider of public goods for 'free-riders' in the market, or to be left 'holding the bag'. This is the case even though people enjoying the 'goods' probably realize that their behaviour will result in the deterioration of the resource in a long run (Hanley, Shogren and White, 2001, 20). For example, a park can be spoiled by overuse.

The very existence of public goods is generally perceived as an argument that they should be provided by governments. As the representative of the common interest, governments are expected to take responsibility for providing public goods. However, such goods are sometimes provided by private organizations or businesses through contractual arrangements. Such solutions are actually examples of the 'Coase Theorem' in action, in a somewhat different way. People realise they are in a prisoner's dilemma situation, and they negotiate a contractual way around it, to maximize their mutual gains.

Public goods are in general a kind of positive externality. An externality is usually discussed in terms of negative effects. An externality is a cost or benefit for a party not directly involved in a transaction. Externalities can be negative if a cost is imposed on a third party; or positive, if a benefit is obtained by a third party. The prototypical negative externality is the production of pollution, such as smoke emitted into the air or sewage poured into the water. Externality leads to underestimation of the costs, ignoring the impacts made during the production procedure upon society.

The most commonly proposed solution is the Pigou tax (1932). A Pigou tax would tax a polluter a per unit amount equal to the marginal external cost of the unit. The idea here is to internalise the external cost by charging for use of the normally un-priced factor of production. It is like having a government act like the owner of the air or water and charge firms for using it.

The main difficulty here is an information problem: how can a government determine the appropriate size of the tax? Normally, we rely on the market to tell us the cost of an activity or resource—but here the problem is precisely the fact that no market exists for the resource in question, so we cannot really know how much it is worth to society. Another proposed solution is that of pollution permits. A government would set some maximum permitted polluting activity, and then allow permits to be sold and traded on the market. This proposal has the advantage of allocating the right to pollute to those who value it most. But it assumes that all governments will behave in a responsible manner, which can hardly be assumed in the light of US attitudes towards carbon dioxide emissions and the Kyoto Protocol.

Monopoly is also an area, which governments should take into consideration. Monopolies can be classified into two kinds according to two different causes of their formation. One is 'technical monopoly', such that other companies cannot have access to a field in the market because they do not know how to produce this kind of product. The other form of monopoly is based on what are called 'substantial economies of scale', which happens when a great deal of initial capital is needed. After that, the larger the quantity of the goods in a factory, the cheaper the average costs per unit can be. Under this condition, a firm that dominates the whole market can best contribute to social welfare. In addition, because of the large amount of initial capital required, investors cannot gain returns for a quite long period of time.

There is high risk for investors to put money into 'natural monopoly' areas and they must be patient in waiting to gain from this business. Usually, governmental intervention is necessary in such fields. Theoretically, only governments can afford the huge initial capital and they are not so anxious as private investors to get money back in a short term. Therefore, those who do business in natural monopoly trading are usually state-owned enterprises, or at least firms that receive subsidies from the government. 'Natural monopoly' is a kind of failure of usual market forces, and is thus another example showing the significance of governmental intervention.

Take the supply of natural gas as an example: if it is a purely competitive market that permits the existence of many competitors, then great waste will occur when each competitor builds his or her pipeline for transferring natural gas. Hence, a government may be expected to take the responsibility for building the pipeline

2.7 The Role of Government

2.7.1 Governmental Intervention in Resource Management

Conversely, there is no certain answer to the problem of whether or not market failure can be made up by governmental intervention. Government intervention has already been criticized for inefficiency and bureaucracy, or government failure.

Government intervention is designed to make corrections for market failure and thereby achieve improvements in economic and social welfare. Likewise, a government may choose to intervene to achieve a more equitable distribution of income and wealth. For example, governments may seek to regulate the activities of firms with monopoly power or the consumption of 'de-merit' goods, subsidize the provision of merit and public goods, or introduce pollution taxes to compensate for the effects of environmental pollution. After a government intervenes in such areas that are not handled well by the market, the performance of government may still not be as satisfactory as people hoped. Proponents of public-choice theory first diagnose the failure of government and use the diagnosis as arguments to drive government intervention out of the market. They believe that, even with good intentions, governments seldom get their policy applications right. They can tax, control, and regulate, but the eventual outcome will be a deepening of the market failure; or, even worse, a new failure may arise.

2.7.2 Government Monopolies

Take the case of natural monopoly. If a government keeps subsidizing state-owned enterprises, and if there is no effective method to estimate the loss made by those enterprises, this will only encourage losses. There is no motivation for enterprises to make profits, and they do not need to worry about bankruptcy. Thus there is no motivation for them to reduce costs and innovate. As to governments, they cannot stop giving money to state-owned enterprises (because of the social damage caused by their closure), or private ones that are *essential* to a country (e.g. ferries to Tasmania, Australia). Such problems may arise because certain private enterprises have very significant political power (e.g. farmers in France). They receive government assistance even though both the government and the farmers know that such enterprises cannot make money and may waste resources. Consequently, governments often cannot help but abuse taxpayers' money. In some cases, limitations of choice may mean that consumers can only purchase products made by state-owned enterprises. This can cause loss in social welfare and hamper sustainable development.

Governments can sign contracts with private companies for supplying public goods, in which case costs and benefits can be accurately estimated. The government then changes its role from a provider to that of a buyer that watches over the quality of products and services. Externality is often seen as a difficulty that only can be overcome by governments. However, some authorities argue that there is no evidence that shows that governments must own and operate trading entities.

Officer and Quiggin (1999, 20), for example, regard property rights as a major problem, suggesting that:

> the solution to externalities is to assign property rights and then let the management of the entity be in the hands of those who are the most efficient at producing the goods or services generated by the entity. The presence of externalities is not an argument for government ownership, it is an argument for assignment of property rights.

The faith in the ability of governments to correct market failures declined in the 1970s–1980s and a new belief that governments can make situations worse gradually emerged. In the words of Charles Wolf (1993, 117):

> [g]overnment intervention to correct market failure may generate unanticipated side effects, often in areas remote from that in which the public policy was intended to operate.

Moreover, when the origins of governmental failure, or more accurately non-market failure, are discussed, the defects in governmental structure have been exaggerated, and governments became symbols of ineffective, inefficient, and uneconomical resource management.

2.7.3 'Pork Barrelling', 'Short-termism', and Lobbying

Governments are supposed to present the interests of society as a whole. However, in reality, governments are composed of different sectors, departments, and individual public servants. Accordingly, there are both departmental and personal interests. In an ideal political model, voters regulate the process of policy making. Voters, however, have difficulty in obtaining information essential to making correct decisions. Pressure or lobby groups commonly influence governmental policies. Moreover, 'rent-seeking' governmental policies may only benefit those who have enough power to persuade governments to take appropriate actions. In practice, individuals seek to influence the state in order to transfer welfare to themselves. Hence lobby groups will invest resources to influence the form, structure, and incidence of regulations, licensing laws, tariffs, and quotas. Individual efforts to maximise their personal utility results in social waste overall.

There is a tendency to look for short-term solutions to problems rather than analysing long-term considerations. The risk is that myopic decision-making will only provide short-term relief to particular problems, doing little to address structural problems. A decision, for example, to build more roads may simply add to traffic congestion in the long run. Short-term subsidies to the steel industry or coal producers to keep open loss-making steel plants and coal pits may eventually prove to be a waste of scarce resources if the industries concerned have little realistic prospect of achieving an economic rate of return in the long run. Stiglitz (1989, 45) explained this phenomenon as follows:

> The limitations of current governments to impose binding commitments on future governments (a limitation which can be traced both to restrictions on property rights transfers in the public sector and to the democratic process) may impose large economic costs.

For government officials, the desire to display the contributions of their terms of office is more powerful than their concern for social benefit as a whole. For instance, a long-term urban development plan may take a long time to show its benefits. But politicians—especially in frequently-voting democratic societies—are chiefly interested in short-term results.

2.8 Sustainable Development in China

Before the 1970s, environmental problems were not even supposed to happen in China, because of the belief that environmental degradation only occurred in capitalist countries. Furthermore, the idea of ‘human power can conquer nature’ was a mainstream thought for the country’s leaders. Chairman MAO stated when he was young that it was greatest pleasure “to wrestle with the heaven, to wrestle with the earth, and to wrestle with people”, which becomes one of his popular sayings. His words show his confidence when facing difficulties—an important characteristic for being a leader. However, when it becomes a belief, it leads to exaggeration of human power, and a collision with the natural environment. During the Great Leap Forward (*Da yue jin*), small and poorly built backyard furnaces were encouraged to stimulate steel production, resulting in great damage to forest and poor-quality steel was produced.

Change in attitudes towards the environment and human activities occurred in the 1970s. In 1972, former Premier ZHOU attended the United Nation Conference on Human Environment and hosted the first National Environment Meeting the year after. In 1978, the National Environmental Protection Office was founded.

In the 1990s, China adopted the concept of ‘sustainable development’ at the national level and was active in international conventions and agreements. In 1992, former Premier Li attended the Earth Summit and signed *Agenda 21*. The same year, the State Council issued the document, *Countermeasures for Environment and Development in China*, which examined the environmental situation in China. In March, 1994, the sixteenth meeting of Standing Committee of State Council passed *China Agenda 21*, which became the landmark for sustainable development in China. Thereafter, some administrative organs, either at the state level and local levels, were organised. At the fifth Plenary Session of the 14th Party Central Committee (1995), General Secretary of the CPC, JIANG Zemin again emphasised:

> It is a major strategy to realise sustainable development in the modernisation of construction. Population control, resources saving and environmental protection must be put at important position, so as to make population increase coordinate with social productivity development, and economic construction coordinate with resources and environment, fulfilling a perfect cycle (*People’s Daily*, 9 October, 1995).

In 2001, Leading Group of National Promoting the Strategy of Sustainable Development, which originated from the former leading group of '*Agenda 21*, China' founded in 1992, was organized, and its director LIU Jiang came from National Development and Reform Commission, and deputy-director DENG Nan (former Chinese leader DENG Xiaoping's daughter) came from Ministry of Science and Technology of P. R. China.

Major efforts have been put into legislation against actions that despoil natural resources, such as the Forest Law and the Land Management Law (modified in 1998), the Air Pollution Control Law (2000), and—most important for the purpose of the present thesis—the new Water Law and Environmental Impact Assessment Law (2002). All were necessary for China because of the grievous deficiency of its environmental laws and regulations. Meanwhile, the State Environmental Protection Office was upgraded to State Environmental Protection Administration of China, which has the same power as a ministry.

Since the later years of last century, many publications by scholars about the topic of 'sustainable development' have come out, such as, LI Wenhua's "Strategy for Sustainable Development of Natural Resources", in the *Journal of Natural Resources* (1994); CHEN Shupeng's "Environmental protection and sustainable use of resources", in *China Population, Resources and Environment* (1995); QIAN Yi and TANG Xiaoyan's *Environmental Protection and Sustainable Development* (2000), LIU Yanhua and ZHOU Hongchun's *The Situation of China's Resource Environments and Sustainable Development* (2001), ZHOU Hailin, *Principles of Sustainable Development* (2004). Chinese Academy of Sciences regularly issues a series of *Reports on China's Strategy of Sustainable Development* from 1999 to 2006. One of the books most pertinent to this thesis was written by QIAN Zhengying[4] and ZHANG Guangdou:[5] *On*

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[4] QIAN Zhengying (1923–), Minister of Ministry of Water Resource (and Hydropower) from 1974–1988. She was elected as an academician of Chinese Academy of Engineering in 1997. Also she was Deputy-president of the seventh, eighth and ninth National Committee of Chinese People's Political Consultative Conference (1988, 1993, and 1998).

[5] ZHANG Guangdou (1912–), Professor of Tsinghua University, Academician of both Chinese Academy of Sciences (1955) and of Engineering (1994), Foreign Academician of National Academy of Engineering, Mexico. He once acted as deputy-president of Tsinghua University, Director of Institute of Water Resources and Hydropower, the Ministry of Water Resources and Hydropower.

the Sustainable Development Strategy of Water Resources of China (2001). In this book the authors elucidate eight necessary strategic transformations in water resources. One of which points out that the strategy in agriculture should transform from the emphasis on the projects for new water sources and building of new irrigation districts to construct an agriculture with water saving and high efficiencies. In urban area, the strategy should be "preference of water saving, taking treatment of water pollution as essential task, and developing water sources through various channels" instead of that of laying equal stress on developing water sources and water saving. In the book, the STNWTP is taken as the seventh strategy (QIAN Zhengying and ZHANG Guangdao, 2001, 10–23), which the present author will give a full discussion.

Thus no one can deny that sustainable development has become the strategic aim of China's development. Moreover, the concept of 'sustainable development' has particular significance for developing countries such as China without a strong civil society background, inadequate environmental education and public awareness, and economic growth largely dependent on the exploitation of natural resources. On November 19, 2004, the Chinese President HU Jintao delivered an important speech to the 2004 APEC (Asia Pacific Economic Cooperation) CEO Summit held in the Chilean capital, Santiago. He pointed out that the development of mankind faces both unprecedented opportunities and grievous challenges. The *only* correct choice for us, he stated, was to promote "win–win cooperation" (cf. the prisoners' dilemma) and the common objective must be to realize sustainable development (*People's Daily*, 22 November, 2004). However, the way to achieve sustainable development is still a question, not only for China but for the whole world. With its rapid economic development, the demand for natural resources in China will affect, and indeed already has affected, the world's natural resource allocation, so that natural resources in China are not a problem for China itself alone and cannot be seen in isolation from other countries. China cannot adopt the Western development model without reservation, because of its population burden. Therefore China must find its own way to sustainable development and natural resource management, but without international cooperation and learning from the experiences of other countries, sustainable development cannot be achieved.

CHAPTER THREE
SUSTAINABLE WATER RESOURCE MANAGEMENT AND POLICY ISSUES

3.1 Setting the Scene—Water Resource Realities in Relation to Sustainable Development

Water is a fundamental natural resource for all living organisms. Perhaps humans' first consideration for selecting a settlement is the possibility of obtaining water. Today, water is required for drinking, cleaning, cooking; and for industry. Water is used in agriculture and electricity generation. Rivers, canals and the oceans have been used for communication from ancient times to the present.

Water resources affect the wellbeing of humans in regard to both quantity and quality. Lack of water affects health, agricultural production, industry, and fisheries. Too much water can cause flooding. Impure water, with contamination by micro-organisms or harmful chemicals, can have serious adverse social and economic effects.

At the beginning of the twenty-first century, the Earth, with over six billion humans, is facing a grievous water crisis in many countries. All the signs suggest that the situation is getting worse and will continue to do so. Fresh-water consumption is rising quickly, and the availability of water in some regions is likely to become one of the most pressing political issues and already is in the Middle East. About a third of the world's people live in countries that are already experiencing moderate to high water shortages. That proportion could (at current population forecasts) rise to half or more in the next thirty years (perhaps more considering possible climate changes) unless institutions change to ensure better conservation and allocation of water. "More than a billion people in low- and middle-income countries—and fifty million in high-income countries—lacked access to safe water for drinking, personal hygiene, and domestic use in 1995" (World Bank, 2002, 2).

3.1.1 The Hydrological Cycle

As is well known, water circulates in the natural environment. By the heat from the sun, water evaporates from the sea and the earth's surface. Water vapour is accumulated in the colder atmosphere and converted into clouds. Finally it returns to the ground as rain or snow. This process (see Figure 3.1) has been repeated from the beginning of the world and presumably will continue into the future indefinitely.

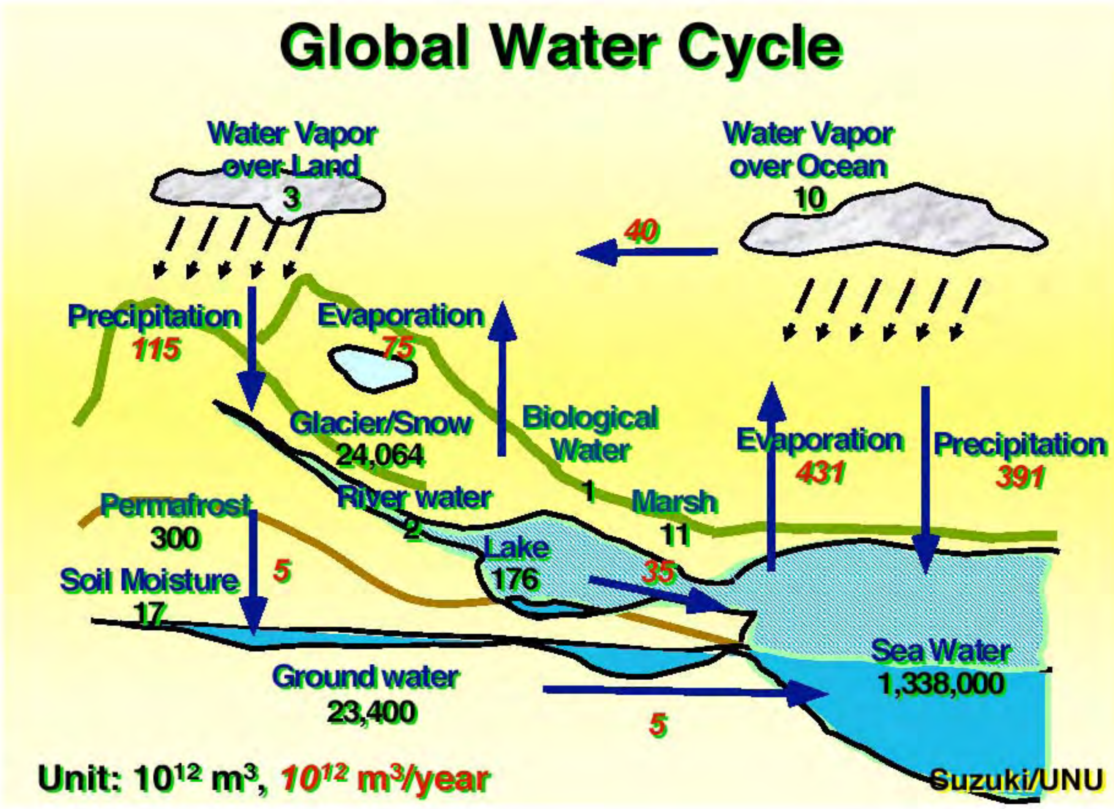

Figure 3.1 The Global Water Cycle[1]

Trees and forests are of great importance in the cycle, in that water passes through trees from the ground to the atmosphere and the evaporation causes cooling. With the

1 Source: Motoyuki Suzuki, http://www.unu.edu/hq/japanese/gs-j/gs2003j/hokkaido3/suzuki-full-e.pdf

removal of trees, water can evaporate more readily and is brought to the land surface. Salination results, tending to distort the cycle. One might say that the forest is actually ‘raining upwards’, thrusting water into the air in vast quantities (Suzuki, 2002). The cycle has also been interfered with by humans in other ways for thousands of years (though with short-term economic benefits). But with the deforestation that has occurred, especially during the last hundred years, rainwater runs directly to the sea more rapidly, and this alters whole ecosystems. Climate change also occurs as a result of the disappearance of trees, which can lead to desertification as well as salination.

3.1.2 Human Impacts on the Natural Water Cycle

Human activities may only influence the natural hydrological cycle unintentionally, but more worryingly, intentional controls and changes are made to the natural systems. During the last century there has been a fever of mega-water projects, such as super-dams and huge water-transfer projects (examples of which will be discussed in the present dissertation).

Dams designed to hold back the natural flow of rivers profoundly affect river ecosystems and people’s interactions with the river. For example, damming of the Lancang River, the part of Mekong River in China is having a severe adverse effect on fish farming in Cambodia (Pearce, 2006, 123–125). Moderate sized dams and diversions (e.g. that at Dujiangyan in China; see Figures 5.7 and 5.8) were used successfully for irrigation in ancient times in the great ‘hydraulic civilizations’ (Pearce, 1992, 9–20). But the situation is radically different today. By 1950, governments, or in some countries the private sector, were increasing the number of dams as populations increased and national economies grew. There are at least 45,000 large dams up to 2002 had been built in response to energy or water needs (International Water Association and UNDP, 2002, 23). Today, nearly half of the world's large rivers have at least one large dam. This work was carried out to a large extent without major objections from the public. “To question their own motives is to bring blind incomprehension. Mankind needs water; water is in rivers; therefore the rivers must be tamed, runs their creed” (Pearce, 1992, 131).

Large dams emerged during the twentieth century as a significant tool for managing water. Dams were built for different purposes: irrigation dams, hydropower dams, water-supply dams, flood-control dams, and multi-purpose dams. But most dams fail to meet their original targets and have had huge impacts on the environment. For example, the Cross-Check Survey found that “a quarter of the twenty-nine sampled dams with a water-supply function have delivered less than 50% of their targets. Furthermore, over time on average 70% of the samples did not reach their targets for the delivery of bulk water supply” (Clarke, 2000, 35). Based on the report issued by International Commission on Large Dams (ICOLD) (2001, 84), the sampled dams were withdrawing a total of 3,800 cubic kilometres of fresh water annually—twice as much as was the case fifty years previously. The report concluded that dams favour humans much more than the environment. It emphasized repeatedly that the crucial rule of a sound project depends on the good governance that empowers people’s voices to be heard. Therefore the World Commission on Dams (WCD) maintained that “at the heart of the dams debate are issues of equity, governance, justice and power, which underlie the many intractable problems faced by humanity” (WCD, 2000, xxviii).

The key issue is that even though people know the side-effects of large dam projects, they heedlessly continue to conceive dam schemes that will try to satisfy ever-increasing demands. The environment cannot ‘tell’ people how much it suffers from the foolish behaviour of humans until people come face to face with the consequences. Thus, in most cases, nothing happens until after the damage has been done. People, it seems, cannot or will not stop building dams and interfering with the natural water cycle. Yet, as Professor Kader Asmal (WCD, 2000, I), the chairman of the World Commission on Dams, has written:

> Consider: on this blue planet, less than 2.5% of our water is fresh, less than 33% of fresh water is fluid, less than 1.7% of fluid water runs in streams. And we have been stopping even these.

Modern societies never consider themselves, or function as, part of nature, and they rarely respect ‘Nature’s rules’. Moreover, their self-centredness leads to irresponsible behaviour, which causes severe damage to the natural environment and shortage of resources. And at the same time it deprives the rights of future generations to have access to resources. In the case of water in particular, people, unlike other creatures, do not play their roles ‘properly’ in the drama of Nature. They are only too eager to change it by building dams, with detriment to the hydrological cycle. They pollute water, and may well destroy the whole system for future societies.

As for diversions (which usually involve dams), they too can and do interfere with the natural hydrological cycle. Examples will be discussed at length in the present thesis.

Even facing the daunting challenge that less than 1% of the earth’s total water is accessible as fresh water, and we more or less recognise this fact, we still disregard it by polluting rivers, lakes, and oceans, so that we are slowly but surely harming our planet to the point where organisms are dying at an alarming rate. In addition, the drinking water used by humans has become seriously affected in many places.

In the natural world, wild animals and plants also cause pollution of water—such as dead bodies of animals and leaves fallen from trees into ponds. Under natural conditions, the environment can ‘cope’ with these. Indeed, dead animals provide food for other creatures. But if there are too many dead bodies in a body of water, the quality of that water will be adversely affected. Modern humans are the most active and dangerous causes of water pollution, because their activities produce effects beyond the ability of the nature to absorb.

Water pollution can be classified into two types according to the affecting sources: point source and non-point source pollution. Point sources of pollution occur when harmful substances are emitted directly into a body of water, for example oil emission from a sunken oil-tanker. A non-point source delivers pollutants indirectly, through environmental changes, as when fertilizers from a field are carried into a stream by rain, in the form of run-off, which in turn affects aquatic life. Non-point pollution is harder to control than point-source pollution, though it is pollution from point sources that attracts most of the headlines.

3.1.3 The Relationship between the Water Cycle and the Water Crisis

The failure to understand the natural environment, and the disregard of the 'rules of nature', and interference with the natural water cycle, breaking the natural balance between the earth, its organisms, and the atmosphere, rivers and oceans, have led to the water crisis. A shortage of water is now a problem for most countries in the world. It is a global problem. Currently, exploration for new (usually underground) water sources (non-renewable in the short term) is a major and expensive task because most areas suitable for human habitation have already been developed, while the areas with few inhabitants usually have inhospitable environments, where finding or transporting water is almost impossible.

The response to the evident water crisis at the beginning of the twenty-first century has been largely in the direction of attempted technological fixes—such as digging deeper wells into underground aquifers, constructing higher dams, attempts at water transfer, or installing desalination plants (which in the Middle East in effect involves turning oil into water!). To avoid interfering with the hydrological cycle, electricity should be produced by solar or wind power. Biofuels should be used more. Agricultural practices should be sustainable (e.g., grow rice in Indonesia, not Australia). The world population (which lies at the root of all problems) should be curbed. Rail transport should be restored and developed, as opposed to the ever increasing use of roads. Water prices should be 'realistic': water should not be treated as a free resource.

Therefore it is time for people to rethink the water issue, 'respect' the natural water cycle, and recognise that we literally plunder the earth's water.

3.2 Integration of Principles of Sustainability in Water Resource Management

The significant role of water has become more widely recognized in recent years. The 2nd World Water Forum, which took place at The Hague in 2000, made water 'everybody's business' and there was a significant increase in interest compared to the first, more low-key, Forum, held in Morocco in 1999. The 3rd World Water Forum in

Kyoto (2003) emphasized the implementation of water strategies and examples that could be applied worldwide. It enlisted governments, industries, and NGOs in water management, and encouraged them to report their practical experiences (Cosgrove and Rijsberman, 2000; Ministerial Conference on the Occasion of the 3rd World Water Forum, Final Report, Provisional Edition, 2003).

An increasing awareness of water issues has developed from a deep-rooted historical background that can be traced back even to Mayan times (1000AD). After the Mayans destroyed their forests, they suffered severely from their ill-considered short-term actions and their civilization collapsed. Such devastation has occurred elsewhere in many places, notably in the Middle East.

In modern times, by using advanced technologies, human beings are building dams and spare no efforts to change natural systems for their intended benefit. But such changes overload the capacity of the ecosystem and cause the disasters of salination, flooding, desertification, etc., as mentioned above. The recent alarm signals about failures to cope with water issues is simply due to the present scarcity of water resources, which has led to a widespread, but belated, acknowledgment of the prime importance of wise water management.

Water management is a significant component of sustainability. Sustainable development requires a positive attitude towards the relationship between humans and the ecosystem. The present use of natural resources should not compromise or adversely affect the opportunities for future generations. Water is one of the natural resources that can*not* be left out in attempts to achieve sustainable development.

3.2.1 Connections between Water Resource Management and Sustainable Development

Water resource management is a matter of great urgency. And sustainable development cannot be achieved without considering the capability of the global ecosystem, because our society is built upon it. The environment should not be treated as an ‘add-on’. Rather, it is a perspective from which other activities and decisions should be viewed.

Natural resources are essential in the areas of food and housing, raw materials and power, and aesthetic values. In fact, everything we have originally came from some natural resource. So, as realized by *Agenda 21* (1992, 31),

> [s]pecial attention should be paid to the demand for natural resources generated by unsustainable consumption and to the efficient use of those resources consistent with the goal of minimizing depletion and reducing pollution.

The management of natural resources is the frontline of the struggle for more sustainable and equitable development. All actions ultimately have consequences that impinge on the quality and quantity of natural resources on the planet. Hence the key point for a sustainable future is the utilization of natural resources at a sustainable level with a focus on minimising depletion and the reduction in the input of pollutants to these resources.

3.2.2 The Route to Sustainable Water Management

Obviously, at the beginning of human history, water management was not as complex as it is now and water was plentiful compared with the small populations of the ancient world. But water was regarded as a gift from God. In ancient times, water was considered as a sacred entity that could control lives. In Buddhist mythology, the God of water was represented as a snake with seven heads, revengeful to people who did not show respect to water and polluted it. Thus, for Buddhists, there has long been a requirement for them to build toilets far away from lakes or rivers in order to keep water clear and not alienate the Water God (Kabilsingh, 1998, 95–100). Thus what was in fact a good hygienic principle was seen in religious terms. However, modern people no longer ‘cherish’ water. As Neeru Singh, Executive Officer at the United Nations Centre for Human Settlements, has put it:

> The advent of the industrial revolution and the consequent dawn of Western materialism have led to a non-traditional commodity-based perception of nature's resource. This has resulted in a price tag being placed on water and, ironically, devaluation of the intrinsic worth of water. Western materialistic

society [has] scorned ancient values, which regarded nature as sacred (2000).[2]

People in the modern world have changed their traditional attitude towards water and Nature. They think that they, or the 'people in charge', understand everything and can control everything. They have little regard for the consequences of their actions. This may be a good thing for human beings (in the short term) because it may produce economic advantage; but such self-centeredness leads people to ignore everything but themselves—which will eventually threaten people's life on this planet. Or at least the long-term interests of a country may be harmed. Here nation states can also be detrimental, if a country upstream in a river system acts (even if inadvertently) without regard to the interests of those downstream.

Although water was often revered as something sacred, it was also viewed as a free and endless resource that people could draw on without even questioning. But following the Industrial Revolution, the situation changed dramatically. Population rose rapidly and industrialised society became more and more urbanised, which resulted in ever-increasing difficulty in finding adequate water supplies. But the water problem could not be solved in isolation from other aspects of the global ecosystem. Water problems are linked to land use difficulties. The *World Water Development Report* (2003) has pointed out that although the precise impact of climate change on water resources is uncertain, recent estimates suggest that climate change will cause a 20% increase in global water scarcity (World Water Assessment Programme, 2003, 10). Therefore, the close linkage between water and other environmental issues is a fundamental problem for water management. But the environmental consequences of water-resources development and management can be described as a relative newcomer as an area of major national concern. Before the present era of environmental awareness, society as a whole placed an overriding priority on the first-order effect of technology and economic growth.

But times are changing. Social values and norms are shifting significantly from an acceptance of economic growth for its own sake to a concern for its environmental and social impacts. Unfortunately, many politicians (until *very* recently) have not concerned

[2] http://www.twnside.org.sg/title/2139.htm

themselves with long-term planning and management but with short-term economic and political advantage. Thus the route towards sustainable development has often been impeded or delayed by short-sighted politicians. This tendency has been particularly noticeable in the US and Australia in the early twenty-first century, but also countries in Asia, South America, and Africa, where devastation has been inflicted on forests, thereby affecting the hydrological cycle adversely in these parts of the world, or even globally.

Complexity and Uncertainty in Resource Management

In terms of sustainable natural resource management, governments can play an important role in preventing or mitigating externalities or other side effects caused by inappropriate individual management behaviours. In an ideal situation, the owner of a piece of land will make good use of the land and try to maximize the benefits and reduce the costs of using it at the same time. However, the 'real costs' are often distorted and do not reflect the overall damage, which should include the long-term impact on the natural environment. Thus governments need to take actions to emend poor resource management practices and misunderstood prices.

Australians and Natural Resource Management 2002 (2002, 36) lists four challenges to governments in fulfilling their obligations in regard to natural resource management:

a. A lack of knowledge about the causes and consequences of resource use
b. A long-term view and strategy
c. Externalities
d. Differences between private and public objectives.

Such challenges that may lead to a management crisis for governments are ascribed to complexity and uncertainty of natural resource management issues. No doubt, complexity and uncertainty are unavoidable and inextricable problems that greatly impair governmental effectiveness in natural resource management, from which governments often earn a bad reputation for perverse or ill-founded policy, or pork barrelling.

However, the sticking point here is not the complexities and uncertainties *per se*, but how to cope with them. Several preconditions, including governmental interests, corporations in different departments and organizations, long-term and dynamic view, restrict the possible solutions to dealing with complexity and uncertainty. Therefore, for governments and organisations as a part of the gigantic bureaucratic system, the usual way of struggling with two conflicting difficulties is to try to reduce complexity and uncertainty in policy making and implementation, which may entail (over)simplification and seeking to standardise natural resource management issues on the basis of insufficient information.

If the available information is perceived as inadequate, the result may well be inaction. More subtly, an emphasis on technical information can skew the outcome in favour of those who control the information, and increase the standing of quantitative methodologies and cost–benefit approaches to the detriment of qualitative analysis and rights-based considerations. Therefore, the problem is how to face complexity and uncertainty with insufficient information.

Classifying Water Uses

Water resource management involves the interplay of water quantity and quality demands, water quantity and quality supplies, water pollution, and water recycling and re-use. In the past, people have been inclined to focus on the issue of quantity. A major aspect of water management has been to seek new water sources. Ignoring the importance of water quality not only causes concerns about public health, but also may wastes some high-quality water for low-quality needs. Drinking water should meet strict standards without harmful chemicals, radionuclides, and pathogens. However, the quality of industrial water use varies dramatically in terms of different processes and different plants. In some cases, water is used to cool equipment in manufacturing process or power stations. For example, in Australia cooling at some facilities is accomplished by the one-off use of fresh water that almost meets the requirement of drinking water, which is absurd.

Therefore the different purposes of water use directly influence the requirements of water quality. Moreover, the quantity of water used and the ways in which it is used, are also affected. Historically, water use has been classified only broadly: for example household use, agricultural use, and industrial use. However, the traditional approach of classification of water use is inadequate and misleading for water conservation. For instance, the urban use of water can be divided into residential, public, and commercial use. Besides the three big categories, the recreational use of water[3] seldom attracts the attention of either governments or the general public. As a result, Spulber and Sabbaghi (1994, 16 and 35) have argued that in order to put emphasis on each user-specific demand for quality, in whatever sector, different levels of water quality should be provided at different prices for different consumers, so that high-quality water will not be wasted on low-quality needs. They support the view that the best solution is to privatise the water sector, making water like other commodities with different suppliers selling at different prices. However, their idea of reclassifying water demand in the light of more specific purposes fails to take account of the fact that water is different from ordinary products. It is related to public health, social equity, and environmental significance, and requires government regulation. It would cause chaos and hardship if the water market were totally open in the way they recommend.

Market Forces

The significance of water is now recognised by most people and by governments. The real difficulty is how to handle water issues. The focus should not only be put on the results that can be achieved hypothetically. Concrete action is needed. After the notion of 'sustainable development' was put forward, it gained popularity almost immediately (although some dissent still exists). The phrase 'sustainable development' became fashionable for governments. But one must question whether the discussion of 'sustainable development' is based on the true needs and understanding of the problem or whether it is simply a fashionable or 'feel good' idea. Recognition of the importance of managing resources in a sustainable way is obviously desirable, but how is it to be implemented and how can the goal of sustainability be realised in practice? The concept is ambiguous and the problems are complex and uncertain as regards water issues.

[3] Recreational uses of water includes bathing, swimming, waterskiing, and other water sports; boating; and other forms of enjoyment, including aesthetic appreciation.

Indeed the difficulties in achieving sustainable development in practice are enormous. Thus the notion of sustainable development in natural resource management area has become something of a fashion, or an indication of politicians' good intentions, rather than a solution to the resource crisis. Talk of 'sustainable development' continues as a kind of mantra, though it is a concept rather than a reality. The water crisis remains!

In the field of water management as well as other natural resource management areas, the private sector model is viewed by many economists as the most effective method for allocation since it uses cost–benefit analysis and strongly emphasises the output. However, not everyone agrees. Some think cost–benefit analysis is useless because it is essentially static. Others feel that political processes should be the focus of the water issue, not economic incentives. Others worry that overuse of cost–benefit analysis will become an excuse for governments to establish projects to try to please public pressure-groups or other bodies. Alternatively, if the projects are economically sound, they should be paid for by the beneficiaries. Thus, instead of cost–benefit analysis, many feel that 'willingness to pay' a portion of the costs should be the criterion for public resource development.

In the past, water was provided by and charged for by public utilities almost everywhere in the industrialised world. Even now, after a 'typhoon' of privatisation, water and sanitation services are still 95% in the hands of public sector, worldwide (Alexander[4], 2002, 7). The present urgent water crisis calls for more efficient use of water and an idea change, so that water is not thought of as a limitless economic, environmental, and social resource. When most governments feel that they are powerless to stop the waste of water by legislation, they turn to economic incentives, thought to be effective in achieving efficiency, both in ideal economic models and actual practice in private sectors.

Basically, there are several steps for establishing economic incentives in water resource management. The first change, which most countries are now taking, is in the pricing of water. People expect that a high price for water will prevent consumers from abusing its use. Indeed, price signals can work well in adjusting the balance between demand and

[4] Williem-Alexander, the Prince of Orange

supply. Pricing water can do much more for people than just balancing supply and demand. Tom Jones, of the OECD Environment Directorate, points out that "water pricing is becoming more widespread, with the dual aims of expanding supply and encouraging more responsible use" (March 2003). His thoughts remind people that a fifth of humanity does not have access to potable water and three billion people throughout the world do not have access to adequate sanitation facilities. Based on such the facts, one must ask: who gets the benefit from pricing water and who suffers the results of the new change?

In most countries, the price of water for agricultural use is extremely low compared with water used for industrial and domestic purposes. Even in countries like the Netherlands and Austria, the price of agricultural water is still substantially lower than the price of household water. Therefore water pricing attends to the use of water in agriculture. But this cannot be treated simply as an economic problem. It has a huge political dimension.

Not only will agriculture face hard times if governments start to take actions in pricing water, but also the urban poor people will encounter the difficulty of getting sufficient water to meet their essential needs. In fact, the urban poor are already disadvantaged as Table 3.1 demonstrates.

Table 3.1 Intra-urban Differentials in the Price of Water[5]

City	Prices for those connected to municipal supplies (US dollars per cubic metre)	Prices for the urban poor, paying private vendors (US dollars per cubic metre)
Nairobi, Kenya	0.30	1.50–2.00
Port au Prince, Haiti	1.00	5.50–16.50
Jakarta, Indonesia	0.09–0.50	1.50–2.50
Lima, Peru	0.15	3.00
U.S. cities	0.40–0.50	—

During the process of urbanisation, more and more people cannot gain access to municipal water systems to get safe water because of the financial inability to connect the newly developed urban areas into the original water systems. Moreover, governments may easily ignore powerless people, because governments always keep their eyes on the redevelopment of a whole area and do not want to bother with 'trivial' things like water pipes. Compared with citizens in urban areas, those people who originally lived in rural areas rarely have any channel whereby they can communicate with governments. Therefore for the people who live in the urban fringes, they can only get water from private water dealers or travel to other places that have water comparatively close to their home to obtain their water. However this raises concerns about two questions. The first is that people in shanty towns round large cities usually pay more for their water than do city-dwellers, as clearly showed above in Table 3.1. Second, the quality of the water that they use is not guaranteed or inspected by any authorities.

One fact that cannot be disregarded is that the speed of urbanisation makes the shortage of water even more acute. The world's urban population is expected to rise to 5 billion by 2030 from 2.9 billion in 2000. From 2000 to 2030, nearly all the global population increase will be concentrated in urban areas. Population growth will be particularly

5 Source: Water Supply and Sanitation Collaborative Council (1999) and UNCHS (United Nations Center for Human Settlements) (2000), quoted from (Ray, K., 2001, 2)

rapid in the urban areas of less developed regions, which will be 2.4% per year averagely during that period (United Nations Population Division, 2002, 1).

Therefore pricing water is only one aspect of a whole set of necessary policy changes for the water market. Changes cannot be achieved without governments taking a leading role in this matter. They must guide and supervise the changes to prevent encroachments on the rights of weak parties. But this requires good governance.

Demand-side Management

Definition of water demand-side management can be straightforward as "any action that reduces the amount of fresh water we use, or that keeps water cleaner in the course of the use than it otherwise would be" (Brooks, 2006, 522)[6]. Although that concept set the boundary of demand-side management, as an ideal goal to achieve, it fails to give specific guidelines on how to pursue. Brooks redefined the concept and stated that demand-side management cannot be accomplished with five points[7], which still focus on goals to fulfil rather than the roads to achieve.

Water demand-side management can be achieved through water pricing, wastewater charging, and education and innovation in water use. The aim of pricing water is to calculate the demand for water and reflect the true value of water, which takes environmental and social costs into account. Water pricing that reflects the true cost of water use is a fundamental requirement in any policy designed to encourage economic efficiency and environmentally sustainable water use. The first goal of pricing water is much easier to achieve than the second one. Although different measures may be taken, no matter whether economic or technical, the real cost especially the environmental cost, is impossible to estimate and control. Therefore, even though people mention the idea of pricing water, it is always only used as a method to attempt to correct distorted prices.

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6 The definition is firstly put forward in 2002 by Brooks

7
a. Reduce the quantity or quality of water required to accomplish a specific task
b. Adjust the nature of the task or the way it is undertaken so that it can be accomplished with less water or with lower quality water or with lower quality water
c. Reduce the loss in quantity or quality of water as it flows from source through use to disposal.
d. Shift the timing of use from peak to off-peak period
e. Increase the ability of the water system to continue to serve society during times when water is in short supply (Brooks, 2006, 524)

In fact, the main purpose of pricing water is to give economic incentives to consumers in order to discourage excessive use of water. Two methods, depending on either fixed price or the volume of used, can be applied. The second one is more popular for policy making, because it is considered more effective and satisfactory in its results. However in some cases, fixed price is still crucial to meet the fundamental requirements of low-income groups.

Historically, wastewater charging was considered as a supply-side management issue rather than one of demand-side management. The change that occurred twenty years ago indicates a fundamental shift in the conception of water conservation, from thinking about usage to saving. Water that becomes polluted is also now regarded as ‘use’ of water, as it involves a loss of clean water. Therefore wastewater treatment should not be separated from water use, for if this is done the connection between the supply and the demand would be severed.

The last part of demand-side management, education and innovation, is a process that is crucial for maintaining sustainable water management in the future. Regulation and legislation, and market forces may direct individual actions to reducing water use, but raising public awareness is the main goal—when people understand the present situation and are active in addressing problems, not passively waiting. Then they are forced to make changes in their water usage. For instance, in Europe until recently, the direct reuse of treated water has been in response to water shortages rather than as a planned activity (Lallana *et al.*, 2001, 47).

It is widely accepted that demand-side management is the best means to reduce the demand for water use, especially if effective economic incentives are used. The worry about exaggerating the role of economic incentives arises from the contradiction between the economic methods and the classical economic concepts. The core of applying economic incentives is to use ‘market signals’ or privatise the water sector and encourage supply companies to reduce demand. However in classical economic theory, suppliers will increase their scales until the limit of their capital is reached or until they are pushed out of the market because of the competition. Otherwise, a company will continuously expand its scale to promote purchasing power and maximize profits.

Hence the motivation of companies to apply demand-side management is contrary to their customary business interests.

Thus the feasibility of converting water supply companies into economic-driven companies is questionable at this point. But there are some cases that successfully show the possibility of implementing demand-side management to reduce water use. The Gelsenwasser Group in Germany is in charge of supplying water and gas in the North Rhine-Westphalia city of Gelsenkirchen. The volume of water sold by the company dropped from 137.4 million m^3 in 1997 to 133.5 million m^3 in 1998. However, the pre-tax profits rose from DEM 36.8[8] million to DEM 37.2 million because of the increase in price (Lallana *et al.*, 2001, 80). The success of the policy depended on the extensive knowledge of water saving, and the broadly acceptable level of price increase, based on careful investigation before implementing the policy. Therefore the key was not to discuss whether water management should be a public matter or private matter, but how to apply an appropriate policy to specific cases, taking into account differences in political, economic, cultural, and legal system, and the natural environment as well.

Unsuccessful cases for applying water pricing are few and most have been in developing counties. Volumetric charge was an unrealistic means of encouraging significant reductions in demand in Egypt because the price required to induce a 15% fall in demand for water would have reduced farm incomes by 25%, which caused strong resistance of farmers (Perry, 1999, 48). In the Chao Phraya basin, Thailand, the result of implementing demand-side management contrasted sharply with what is usually conjured up to justify pricing as a way to induce water savings. This was owing to the technical failure to establish volumetric water deliveries while the wholesaling of water removed the possibility of influencing users' behaviour through pricing (Molle, 2002, 15). Therefore the contradiction lies in the fact that a dramatic increase of water price will not be successful because of political infeasibility, while a reasonable price increase will not make a significant difference to changing water consumers' behaviour.

The political perspective is not the only one that should be taken into account for water

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8 According to FXConverter, 1 DEM (German Mark) = 0.7978 AUD in 1997, http://www.oanda.com/convert/classic

resource management. For instance, Australians use more recreational water than New Zealanders because of its warmer climate. Consequently, policy makers have to take such factors into consideration when they make policies about water resource management.

Water shortage is not a new issue that has just appeared in recent years. Historically it has been addressed in terms of 'quantity/quantitative aspect' (i.e., supplying more water), but this finally reached its natural limit. The emergency of the idea of demand-side management that starts to focus on the quality management of water resource shows the great change in attitude towards water in recent years, in part because of the notion of sustainable development. This does not, however, apply to all situations. There is no uniform method for water resource management, because of the different situations worldwide.

3.3 Policy-making Process of Water Management

3.3.1 Policy Implications in Natural Resource Management

The idea of achieving 'sustainable development' is to use natural resources wisely instilling in people appropriate ideas about the interaction between physical environments and social processes. This is a major subject for policy science for the core of policy is dealing with people: who gets what, when, and how. In other words, policy processes should involve the equitable and rational distribution of resources. Resources include not only tangible natural resources but also intangible resources like knowledge, reputation, etc.

In his books *Foundation of Natural Resource Policy and Management* (2000) and *Policy Process:A Practical Guide for Natural Resource Professionals* (2002), Clark has provided a set of guidelines for those involved or interested in the use of policy science in professional practice. Clark is one of the chief advocates of employing policy science in practical areas like natural resource management. Thus based on the rule of problem-orientated methodology, more than one question should be asked before thinking about 'what to do and how to do it'—otherwise a problem cannot be solved optimally, or actions may make a situation worse rather than better.

The first issue to be considered is the very nature of the problem and *why* there is a problem. Problems are targets for policy makers. They must find out what and where the target is; then aim at it; and finally do their best to eliminate it. Therefore, problems must necessarily be placed in their social context in order to examine them explicitly. The fundamental elements in social process, as envisaged by Clark, are participants, perspectives, situations, base values, strategies, outcomes, and effects.

The second conceptual framework for the policy sciences, according to Clark's theory, is the decision-process itself, which is what was mentioned previously as 'what to do' and 'how to do it'. Policies are products that are supposed to bring changes to current situations that are unsatisfactory. The decision-making process is the specific process for making 'products', i.e. policies. Clark argues that there are seven functions or activities in decision-making: intelligence (i.e., information collection); promotion; prescription; innovation; application; appraisal; and termination.[9]

Clark's theory provides guidelines—or an 'instruction kit'—to analyse policies, to determine whether they have clear and reasonable objectives; whether they are implemented without misunderstandings or misuse so that their original purposes are fulfilled; and whether they are proven as good solutions to problems or whether there is room for modification and improvement.

The policy science approach put its focus on 'people'. However, the conflict between the natural environment and social environment is more starkly revealed in natural resource management, because the policy process in natural resource management directly links to the natural environment by determining ways of allocating natural resources. Compared with policy processes in other areas, natural resource management should not only consider 'people', but also 'nature'. But, with the huge increases of population and urbanisation in the modern world, there is almost inevitably a conflict of interests between the natural world and human societies. The mismatch between the

[9] These 'components' may be related to the policy cycle discussed in Section 3.3.2, though the relationships are not exact.

natural and social environments is an inevitable dilemma for policy makers in natural resource management. In particular, future world development relies on appropriate natural resource utilisation today; and this entails the question of sustainable natural resource management. This kind of imbalance should not, however, be exaggerated. If it is, it can result in total opposition between the natural and the social. Nevertheless, the imbalance should be noticed as an important factor in policy-making. Therefore the policy processes in natural resource management may be much more complicated than those in other areas.

3.3.2 Policy Implications in Relation to Water Diversion Schemes

In thinking about policy making and policy procedures, it is common to consider a circular model for the various processes involved, such as that shown in Figure 3.2. Probably no specific historical case follows this ideal model exactly, but it is convenient to refer to it here and to use it in this thesis as a kind of 'template' for discussing policy procedures in general and more specifically in the several water diversion cases that are analysed in the present study.

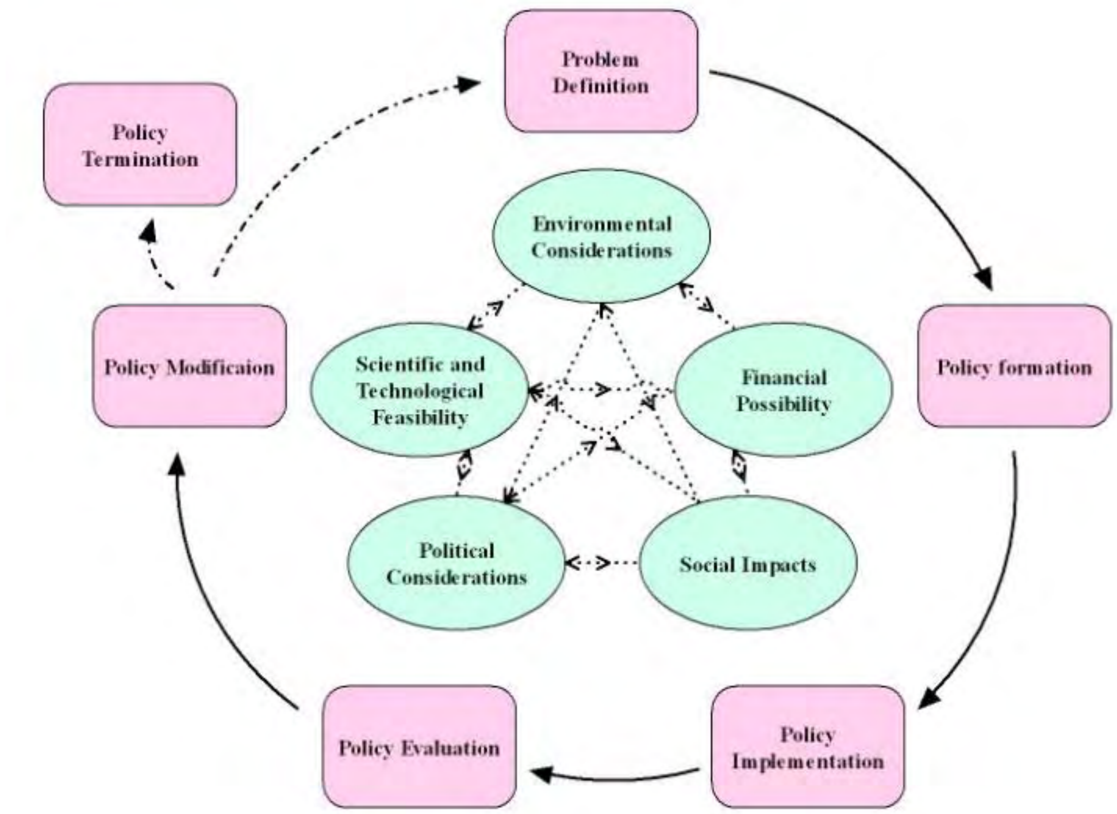

Figure 3.2 Idealised Policy Cycle

In this diagram, five main steps or stages in an idealised policy process are represented in the form of a cycle. Individuals in a society recognise the existence of a problem and endeavour to bring it to the attention of the appropriate authorities. (Or in some cases the authorities may be the first to become aware of the problem.) Policy makers, as representatives of society, recognise the existence of a problem and look for ways to deal with it. This entails determining the real nature of the problem, at least in a preliminary way. This process we call *problem definition*.

Then various possible solutions to the problem have to be canvassed. From the various possibilities, one, or perhaps more than one, policy response is selected for trial, and after some preliminary investigations a decision is reached as to which policy is to be implemented. This process is called *policy formulation*.

The chosen policy (or actions) is then put into practice. This we call *policy* *implementation*.

After an appropriate period of time the policy has to be appraised or evaluated. Or better, the process of evaluation is ongoing and is carried out as soon as the policy has begun to be implemented. This stage we call *policy evaluation*. (What is or is not an appropriate period of time may well be uncertain.)

Following evaluation, it may become clear that a policy requires various changes or modifications. This step we call *policy modification*. This may lead to abandonment or *termination* of the policy or it may become apparent that new problems have arisen, which lead to another cycle of the policy circle: i.e. a new stage of problem definition.

It should be noted that the whole process is dynamic and interactions between different stages of the cycle may commonly occur. For example, an unfavourable policy evaluation may lead one directly back to a revised policy formulation. Moreover, it is not usual for a policy to have only one component. For example, at the present time planners are considering multiple renewable energy sources in order to combat climate change problems. Also in some cases policies cannot be reversed. For example, after federation in Australia there was the problem of where to locate the capital. Canberra was chosen and the city was built after the evaluation of many competing designs. But it is impossible to build a new capital according to a different plan, or move to a new site, today. The problem of irreversibility is particularly acute in mega-projects where huge amounts of money have been spent (the Concorde Effect).

The five ellipses within the main policy cycle diagram contain issues that can or should be taken into consideration at one or more of the phases indicated in the outer circle. That is close consideration should be given to: *financial possibility*, *environmental considerations*, *social impacts*, *political considerations* (often involving questions of political power and possibility), and *scientific and technological feasibility*.

The way all these things have operated and interacted in specific cases involving water diversions is considered in the chapters that follow. It should be emphasised that any particular case is normally exceedingly complicated and the diagrammatic policy cycle as such cannot capture all the complexities satisfactorily. Nevertheless, it provides a useful framework for the analysis of even the most complex cases.

CHAPTER FOUR
CASE STUDIES PART ONE

Overuse and pollution have turned fresh water into a precious, only partly renewable, resource, a fact that has attracted worldwide attention during the twentieth century and even more so in the twenty-first century. But inequalities in water supply have often been viewed as a geographical distribution problem rather than a question of faulty management. There has been a fever of building dams, channels, and pipes to transfer water from regions assumed to have ample water supplies to areas where there are shortages. However, the world's delivery-capacity of natural fresh water is limited, and diversion measures never fulfil increasing demands in the long run, since they constantly rise. Furthermore, evaporation and pollution can reduce the quantity and the quality of usable water. In fact, the efforts to increase water supplies frequently exacerbate the imbalance between water supply and demand. For example, irrigation typically increases water demand, sometimes to a greater extent than the increase of water supply.

According to 'rational' economic models, prices adjust the balance between demand and supply, but this only occurs under ideal conditions and is not necessarily applicable to natural resources like water. One key reason is that the price commonly does not reflect the actual value of fresh water, since it does not take external costs into account. Moreover, in the 'rational' model, demand is supposedly the major factor in the interaction between demand and supply. To some extent, suppliers make the decision to increase or decrease their products in terms of market demands. But for natural resources, increasing the supply is not a permanent solution. The amount of fresh water on the earth depends on the natural water cycle, which cannot be controlled globally. Moving water from one place to another boosts water consumption and may, in fact, end up by increasing the overall water deficit.

In various cases around the world, the idea of supply-side management of water has already caused environmental disasters. Even so, water diversions still dominate water resource practices as a favoured method to cope with water shortages, and transferring water is a policy that has been followed by many countries. Even if the deleterious effects of water diversions do not manifest themselves today, they will probably do so in the future. Therefore it is important to understand the motivations behind water diversions, the outcomes of specific examples of water diversions, and the long-term economic, social, and environmental gains and losses for some illustrative diversion projects. This is done by considering some specific cases.

Based on a structure that includes the five stages and elements of policy processes given in Chapter 3, this chapter analyses four large water diversion schemes (or intended projects): the Aral Sea Case (Central Asia), the Snowy Mountain Scheme (Australia), the National Hydrological Plan (Spain), and the Central Arizona Project (America), from four different continents. The discussions are not equal in length, but the key elements of each case are examined

4.1 Aral Sea

4.1.1 Background

The dying Aral Sea (see Figure 4.1) is regularly cited as a massive failure resulting from ignoring the balance between human activities and the wellbeing of an eco-system, and one that caused environmental disaster and social crisis on a huge scale. Many publications (e.g., Micklin, 1988; Glanz *et al.*, 1993; Kobori and Glantz, 1998; Fergus, 1999; Spoor, 1993, and 1998; Ashirbekov and Zonn, 2003; Pearce, 2006) reveal how bad is the situation in the Aral Sea today, and the sad story is a warning to planners to avoid similar cases happening again. With more than enough awareness of the tragedy, it is time for a review of the major causes that sentenced the Aral Sea to death.

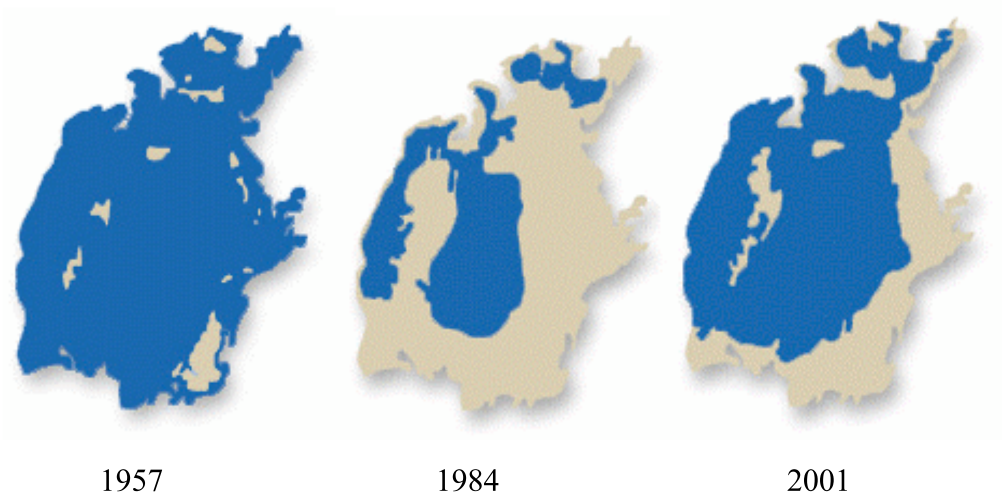

Figure 4.1 Map of the Aral Sea Region (prior to the Sea's decline)[1]

The large amount of water of high salinity, with no outlet to the oceans, in the Aral region, is often referred to as a 'sea'. This Aral Sea lies in Central Asia and is shared by the present republics of Kazakhstan and Uzbekistan. The Amu Darya and Syr Darya Rivers wind down from the western end of the Himalayan range to feed the Sea. Formerly, the fresh water from these rivers maintained the constantly evaporating Aral's water and salt levels in balance. During World War II and the Cold War, however, the USSR assigned the Aral Sea region for rice and cotton production to achieve independence from the West. But the agricultural development caused a devastating effect on the region, including water quantity decrease, salinity increase, loss of biodiversity, and health problems for the population because of the contamination of soils and water by salt and added fertilisers and pesticides.

From the 1960s, the water level of the Aral Sea was observed to be steadily falling (see Figure 4.2) and the region was in a state of 'ecological decline'.

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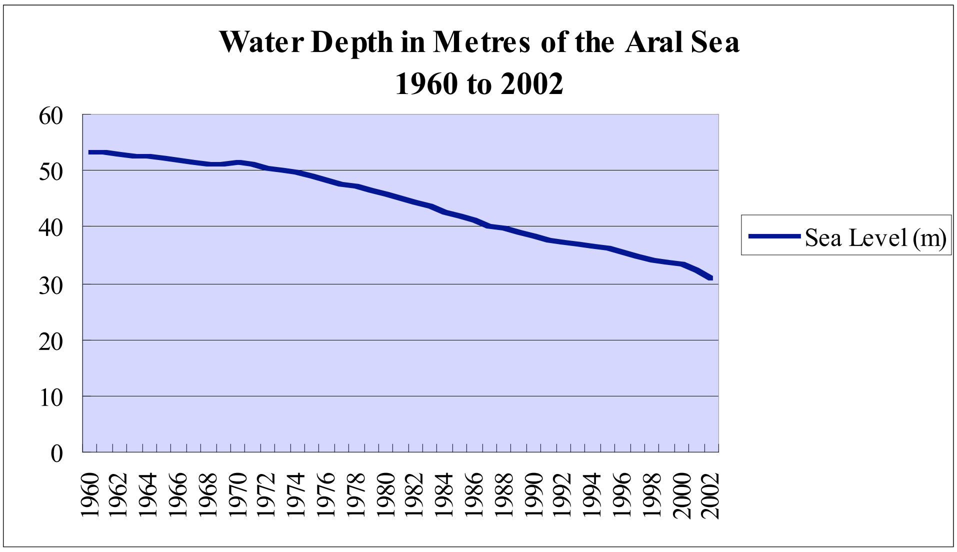
1 From Aral Sea Info http://www.aralseainfo.com/.



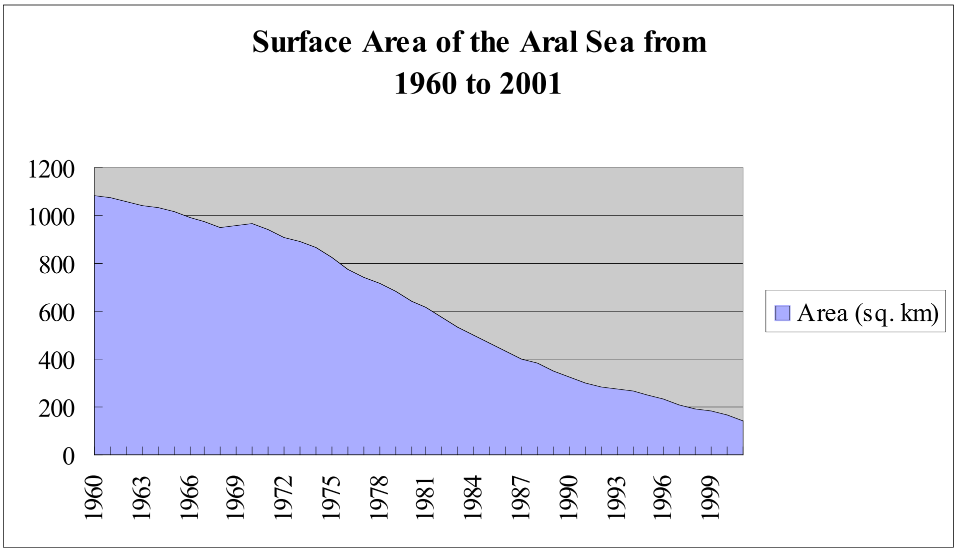


Figure 4.2 Levels and surface areas of the Aral Sea for the period 1960−2002[2]

So what was the fourth largest inland body of water in the world is now one third of its former size. As the water quantity diminished, salinity rose to levels that were toxic for fish and other wildlife. The first drastic increase occurred between 1971 and 1975, when salinity rose to 12–14%. In the late 1980s, the salinity reached 23%. Commercial

2 Data from Ashirbekov and Zonn (2003).

fishing ceased in 1982. All twenty-four native fish species in the Aral disappeared, and the fish catch, which totalled 44,000 tons in the 1950s and supported 60,000 jobs, has dropped to zero (Postel, 1992, 62). The environmental degradation in the Aral Sea area has not only affected the living standards in that region, but also has put people's lives in danger. A toxic dust carried by NE winds has created a health crisis. The soil and land are now so contaminated, that local people suffer from increased rates of cancer and lung diseases along with rising infant mortality. Mortality rates have increased fifteen times in a ten-year period. Cardio-vascular diseases, problems with gallstones, and tuberculosis have risen significantly (Owen, 2000, 17).

4.1.2 Historical Context

In early times the region of the Aral Sea was inhabited by Muslim peoples and was scarcely known to Westerners before the seventeenth century, when it was first mentioned by Russian sources. It only began to be mapped in the eighteenth century and was militarily occupied by Russia in the nineteenth century, with gunboats being assembled on the Sea in 1852. Soon the idea of using the rivers for the purpose of irrigation was proposed by the engineer N. F. Uljanov in 1869, and work was started on a diversion channel from the Syr Darya in 1872 (the 'Kaufman Channel') but was discontinued in 1881 because of the cost. However, Russians were granted irrigation rights on unoccupied land, and the first exports of cotton from Turkestan (near the Syr Darya River) to Russia were recorded in 1885. The Bukhara Channel was constructed from the Amu Darya River in 1886 to transport water into the area of Bukhara, and the so-called Tsar Dam was built across the Syr Darya River in the same year. Grand plans were also made (1893) for linking the Aral Sea to the Caspian Sea, with a waterway extending via the Volga and Marinsk River systems right up to the Baltic Coast! In 1896, the Nikolay Channel was in operation, distributing water from the Amu Darya into the former steppe lands.

Already in 1907 the American geographer Ellsworth Huntington was warning, in his well-known book, *The Pulse of Asia*, about the hopelessness of trying to develop agriculture in Central Asia by irrigation. However, the Russians were much more sanguine, and began to draw waters from the Kashkar Darya also (near Samarkand) and more from the Syr Darya through the 'Romanov Channel'.

The irrigation projects from this early twentieth century were privately owned, but new State ownership took over after the Bolshevik Revolution in 1918, when Lenin signed a decree for the expenditure of 50 million roubles for irrigation works around Turkestan and all the projects quickly came under governmental control. The new Soviet Socialist Republics of Central Asia were established in 1924, and many more projects were begun, with innumerable water channels constructed. Uzbekistan became almost one huge, state-controlled cotton farm. Work was pushed ahead in the 1940s, with the 'Lenin Channel' drawing water from the western side of the Amu Darya to irrigate the areas to the southwest of the Aral Sea, with the towns of Leninsk and Bolshevik being established there.

After the War, through the successive five-year plans, Stalin and his successors imposed quotas for the delivery of cotton to Russia from Uzbekistan and neighbouring states, and ever more dams and channels were constructed, so that in time the region around and between the two rivers became a vast network of irrigation channels. For a while, the region prospered and by the time the expansion of the irrigation system ceased, some nineteen millions hectares along both sides of the main canals were irrigated and cultivated. But the technology, when introduced, was often unsuitable, with the irrigation water washing away topsoil, along with the planted seeds. On the other hand, much of the agricultural work was done manually (Tsukatani, 1998, 55).

Through the 1950s cotton production was continually increased, so that by 1964 Uzbekistan was supplying about 4 million tons of raw cotton to the Soviet economy.

Rice, sorghum, barley, wheat, tobacco and sugar beet were also grown extensively. But by the 1960s, measurements began to show a steady (and subsequently accelerating) drop in the level of the Aral Sea, and warnings were sounded by the Institute of Geography of the USSR in 1969.

Undoubtedly the construction of the Karakum Canal (see Figure 4.3), initiated in 1956 (Ashirbekov and Zonn, 2003, 33), was the most serious factor leading to the death of the Aral Sea. This channel carried water 1,300 kilometres across the Karakum Desert to Turkmenistan, which became the Soviet Empire’s “biggest and most profligate water user” (Pearce, 2006, 230). It wasted almost 50% of its water, which flowed through a channel chiefly dug through sand (Kamalov, 2003, 226).

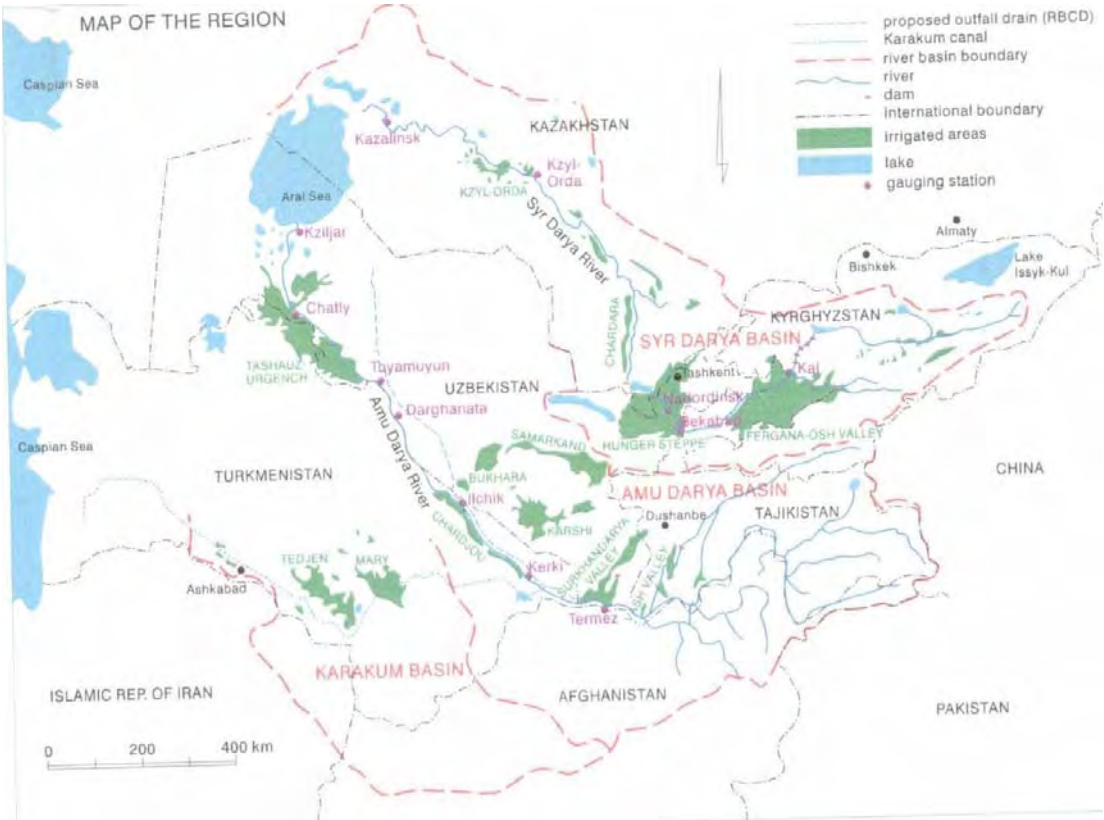


Figure 4.3 Map of the Region and Karakum Canal[3]

3 Source: http://enrin.grida.no/aral/aralsea/english/water/map1.htm.

Vast quantities of water that would normally have flowed into the Aral Sea were diverted to Turkmenistan to be used without regard to conservation. Also, much water was lost from the Canal by evaporation. The Aral Sea was starved of water and unsurprisingly it died.

In the 1970s, the Russian authorities began to consider the ecological impacts of what had been, and was being, done by the canal building and agricultural activities, but nothing effective was done, though some drainage, as well as irrigation channels were constructed in attempts to limit salination. In the 1970s, a plan was proposed for bringing water southwards from the Ob and Tobol Rivers in Siberia to supplement the supplies in the Aral Sea, but this suggestion was strongly opposed by Academician A. Yanshin and others and the scheme did not proceed.[4]

By the 1980s, the Soviet authorities were obviously seriously concerned and task forces to deal with the problem were convened, many reports written, and various books on the topic published. But nothing was able to halt the steady decline of the Sea, so that by 1987 it had become divided into two separate bodies of water and two years later the Soviet Government officially recognised that an ecological *disaster* had been created in the area. There followed extensive discussions in newspapers and among the public. The following year an expedition of scientists and journalists ('Aral-88') was made and the whole sorry mess was exposed to public view.

The Soviet Government came to an end in 1991 and the outside world began to take greater interest in what was going on, and tried to 'lend a hand', through UNESCO, the

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[4] I have been informed by Dr Zoya Bessudnova of the Vernadsky Museum, Moscow, that a television programme in Russia in 2006 told people that atomic explosions were used in the early 1970s in order to try to blast a way for water to flow south to the Aral Sea. But I have no independent confirmation of this information. Dr. Bessudnova also informed me about the role of the Academician Yanshin.

Stockholm Institute (in Boston), the World Bank, [5] and various other bodies. Conferences, books, and reports proliferated. But there has been no success in reversing the ecological disaster. Today, probably the main interest in the Aral Sea is as a region for oil prospecting.

The problem was that, because water was being drawn from the feeder-rivers, the water naturally lost from the Aral Sea by evaporation was not replenished, and salt was exposed over the area of the dried-up Sea-bed. Also, the excessive irrigation led to salination of the land watered for agriculture, which effect the authorities tried to counter by the increased application of chemical fertilisers. Many of these chemicals ended up in the dying Sea, and as its bed was exposed they were blown, with dust and salt, by northwesterly winds across inhabited areas towards the mountains, where the chemicals increased snowmelt, and a destructive self-reinforcing cycle was established. The chemicals in the dusty atmosphere caused numerous chronic illnesses (Tsukatani, 1998, 61–63), and even the climate has changed, so that with the loss of natural vegetation cover summer temperatures are now significantly increased, while winter temperature has fallen. The irrigation areas by the rivers are now virtually wastelands, scarcely fit for human habitation.

4.1.3 Policy Issues

It is easy to think simplistically that the disaster was due to the (mismanaged) water diversion project. But, like it or not, water transfer projects are still used and will be used in the future to try to alleviate water stresses world wide. To terminate all water transfer projects and leave the environment untouched is unrealistic. Hence for a case like the Aral Sea, to identify what went wrong is more meaningful than simply

[5] Dr G. McDonell, formerly of the School of Science and Technology Studies at the University of NSW, was seconded to a team of experts employed by the World Bank in 1994 to study the Aral Sea problem and related issues in the now independent states of Central Asia. He held a two-year contract, but resigned after one year, having concluded that there was no viable solution to the problems.

considering the project itself as a conceptual failure. How the institutional system went awry, and why the governments made the wrong decisions are the most valuable lessons that can be learnt from the case.

Though it is usually assumed that the idea of diverting water from Amu Darya and Syr Darya was an example of ill-advised centrally controlled Communist ambition, the proposal to use the two rivers for irrigation was put forward before 1917 during Czarist times. But it was the USSR that vastly expanded and recklessly implemented the scheme until it was too late to rectify matters.

Problem Definition—National Security: the First Priority but a Wrong Starting Point

When the water diversion projects were planned, it was not the practice in the USSR to conduct environmental assessments for major projects. The Government disregarded the potential risks of water diversion projects, because there was a much more important issue—namely preparation for a possible war. Like the Snowy Mountain Scheme in Australia, which started at about the same time (though that case was different in many ways; see Section 4.2), projects were justified in the name of national security, which made them immune to criticism. It was plausible, from the Soviet perspective, that if there were a devastating war, it was essential to be well prepared and win the war. The USSR Government was very clear about that point and they applied this philosophy in the water diversion case.

The water projects and cotton planting were paramount, and became the dominant priority. During harvest seasons, every person in the cotton planting region had to help pick cotton, giving up their own usual work or study (Pearce, 2006, 229–230).

The Aral Sea was killed as a sacrifice to the ‘cotton fetish’. One high-level official in the USSR Water Affairs Ministry even said that the Sea must die like a soldier in battle

(Kamalov, 2003, 226). And in fact the Aral Sea *is* dying, and so are fifty million people in that area (Blagov, 18th December, 2002). They were not attacked and harmed by war, but by what they were required to do in order to win a war that never happened. (Of course, this is viewing the matter from hindsight.)

The tragedy in the Aral Sea might even be called a murder. The diminution of Aral Sea was actually done deliberately. Some maps drawn by Soviet engineers show that they *planned* to dry up the Aral Sea with the intention of turning it into a cotton planting region (Pearce, 2006, 231). This act of hubris was an example of the Soviet's calculated policy of transforming Nature by technological means for the intended benefit of society. For the Soviets, the *problem* was national military security and economic independence from the West. The *solution* (or part of it) was the attempted conversion of the Aral Sea region into a rich source of cotton and food.

Policy Formulation: An 'Insane' Technological Option and the Institutional Situation

The formulation of the water diversion policies that destroyed the Aral Sea was the result of arbitrary decisions made by ambitious engineers and politicians with little consideration of possible negative consequences, the Karakum Canal construction being perhaps the most disastrous.

The human-caused environmental disaster in the Aral Sea was an immense policy failure, or to be more specific a series of policy, technical, and institutional failures. The Soviet Union had a belief in the merits of gigantic technological schemes ('gigantomania') and when this was coupled with large-scale political corruption the outcomes were inevitably shocking. There was institutional failure in the USSR and more particularly in Uzbekistan, where a so-called Uzbek mafia reigned during the period of maximum ecological deterioration and the collapse of the Aral ecosystem. In Uzbekistan, much of the blame has been placed on Sharaf Rashidov, the First Secretary of the Uzbekistan Communist Party Central Committee from 1959 until his death in 1983. He succeeded in quelling the internal strife in the Party, by filling the chairmanship of the Republic Council of Ministers and of the Presidium of the Uzbekistan Supreme Soviet with his followers. But the cost was an organised state crime group: the Uzbek mafia. Rashidov presented himself to the Kremlin as being devoted to General Secretary Leonid Brezhnev.

The cotton monoculture was to a considerable extent Rashidov's creation. He responded to the land degradation and declining yields by sending inflated production reports to Moscow, but also siphoning off money for the benefit of himself and his supporters. The embezzlement of Federal money, acquired by report padding, led to increased production targets set by Moscow, to which the Uzbeks responded by submitting yet further inflated production reports. Moscow paid for, but did not receive, increased quantities of cotton, and cotton was delivered containing excessive moisture, or even padded with stones! Bribes were paid to ensure that the corruption was not noticed in Moscow; but some high political figures in Moscow, such as Brezhnev's son-in-law Yuri Churbanov, were also involved in the scandal. It was only with the replacement of Brezhnev by Andropov that the KGB began to look into the matter, but even then they did not get to the bottom of it properly. (The Party was not up to the task of investigating itself.) The legacy for Uzbekistan has been a continued autocratic regime, and on-going political instability in the country. The combination of political corruption and technological megalomania and incompetence proved disastrous (Tsukatani, 1998, 57–60).

But perhaps the disaster was not due principally to the faults of individuals. The whole command economic system of the Soviet, with its control centralised in Moscow, was susceptible to such mismanagement. The people at the 'centre' made the plans but did not have to live with the consequences. Corruption could flourish at the periphery, without the central government knowing fully what was going on; and the people living in Moscow and other large cities in the USSR were largely unaware of the state of affairs in the Aral region as there was no free press to inform them, and people's movements were restricted.

Policy Implementation: Wrong Signals due to Economic Incentives Boosting Water Consumption

There was little encouragement for people in the Aral region to save water (and even less in Turkmenistan). On the contrary, there were incentives to promote excessive water use, because water was viewed as 'free goods' and it would only be 'wasted' in the natural evaporation of the Aral Sea. Hence the USSR did not consider water conservation. No water-resistant materials were used in the construction work of the canals, and water was distributed to farmers without charge. Flood irrigation methods were applied in most areas.

The traditional farming systems were abandoned and replaced by cotton and rice cultivation, which were both heavy water-consuming plants. However, as said, these two kinds of farming were considered important for the country so that it could be independent of imports from other countries. Moreover, the (collective) farms were (initially) profitable. Over half of the twenty million rural residents of Central Asia were involved in the cotton industry and there was almost no other type of farming left (Morris, 1990, 3). The future was not foreseen. Necessary remedial measures were not taken. An unsatisfactory political system and ill-considered economic policies, engineering plans, and hubris combined to produce a catastrophic result.

Redefining Problems: Nationalism and Collaboration

As mentioned before, a policy cycle is a dynamic process. Ideally, after a policy has been implemented and evaluated, and if necessary modifications are carried out, the policy cycle goes to the next run, with any emerging problems being identified and dealt with.

There is no chance to go back and correct all the mistakes made in the past, but at least remedial actions may be taken; but thus far without much success. The tragic story of the Aral Sea was revealed as early as 1988. A group of prominent Soviet scientists, writers, doctors, agricultural experts, hydrologists, and geographers toured the region in the 'Aral-88 Expedition' and attracted international attention. However, almost twenty years have passed and the Aral Sea was still dying and overuse of water for irrigation continues. Why could not countries in Central Asia stop the disastrous management system and adopt a more environmentally friendly model of development? The answer must be found in the institutional system arranged by the Soviet Union.

The funds for the whole project came from the central government, and the Aral Sea region governments relied on money from Moscow to build their water infrastructures. All republics were part of the USSR's centralised economic system and the central government purchased the cotton at a fixed price. After the break-up of the USSR, the twelve constituent republics gained political independence. However, to a large extent they maintained the old economic system and the water distribution system that had been inherited from the Soviet Union. On the one hand, this increased tension among the republics over the finite resources, while on the other hand the economic pressures forced them to rely on each other.

In a sense, the region is rich in water resources but more than 90% are concentrated in the mountains of Kyrgyzstan and Tajikistan. The region's two main rivers, the Syr Darya and Amu Darya, originate in these two countries, while Uzbekistan, the single biggest consumer of water, and Turkmenistan (the beneficiary of the Karakum Canal) are located downstream. As much as 40% of the region's water resources are concentrated in Kyrgyzstan (Kobori and Glanz, 1998, 19) The two main consumers, Uzbekistan and Kazakhstan, can only supply 14% and 45%, respectively, of their water needs. Cotton-growing Uzbekistan alone consumes more than half the region's water resources. So Kyrgyzstan and Tajikistan control the water needed by Uzbekistan and Kazakhstan, and unsurprisingly the upstream states view water as a commodity for trade and profit, especially since they are poorly endowed with other resources (though oil is now beginning to be found in the region). Control over water is also important for them as they need it to generate much of their power needs (Smith, 1995, 565–586).

For reasons of self-interest, each country is reluctant to embrace real changes, and each blames the other for making the situation worse. For example, Uzbekistan the second largest cotton supplier in the world market after independence started a market economy and privatisation in some areas. However, the cotton industry is, overall, still in the hands of the Government (or the former high-ranking officials of the Soviet system), which buys almost all the cotton from the farmers**.** After harvesting, the Government sends the cotton to factories for cleaning and packing, and it is then ready for export. The whole process from production to sale is still controlled by the Government today (Pearce, 2006, 231).

Accounting for 41% of total exports in 2001, the cotton industry plays a fundamental role in the national economy and is monopolised by the authoritarian Government, so that the necessary reforms are not occurring. Recent (2005) violence has reflected the unstable political situation in the country, and also the bleak hope of institutional reform. The workers on the land are paid pittance wages and are, even now, effectively serfs since they have no alternative sources of employment. Of the considerable amount of money that is still generated by the cotton industry, only a tiny fraction actually reaches the farmers (about US$2.00 per month). The rest is skimmed off by the corrupt Government or local officials, who were the only ones to gain as a result of the 'privatisation' after independence from the USSR (Murray, 9th November, 2004). [6]

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[6] *Trouble with Uzbekistan*, Speech given by Craig Murray, former British Ambassador (2002–2004) to Republic of Uzbekistan on 9 November, 2004

Without a radical change of Uzbekistan's political and economic system, there seems to be no real prospect of future improvement of the Aral Sea and the surrounding region. Although Uzbekistan claims that it has built a market economy after its independence, in practice it has followed a centrally-controlled economic pattern. Willingness to change is important, but it appears to be lacking. Furthermore, in this case system-change can only occur with the cooperation of other countries, including Russia. If each country only considers its own gains or losses and blames others, no agreement can be made and no effective actions taken. And the situation in Uzbekistan, where the Government (called a kleptocracy by Murray [2004]) apparently has no interest in the wellbeing of its peoples, cannot be expected to improve, at least in the short run.

4.1.4 Lessons from the Aral Sea

Environmental Impact Assessments are crucial for water diversion projects, and should be considered at the early stages of any project; and environmental considerations should be kept in mind throughout the water diversion policy process. Only if the natural environment can be protected and preserved, can a country have *sustainable* natural resources, for use in the long term. Regrettably, the Soviet experiment in Central Asia proceeded with almost criminal disregard for the monitoring of the environment, and it relied on falsified information as to agricultural outputs being presented to Moscow by the officials at the 'periphery'. But, as already mentioned, it was almost part of the plan that the Aral Sea should 'die'. But the healthy, economic, social, and environmental consequences for the region were unforeseen, overlooked, or ignored. The case shows what may be the results of centralised and imposed or 'dictatorial' planning. This raised another question of transparency of policy-making and public participation. For large-scale water diversion projects, it is virtually certain that they will affect the natural environment. Environmental Impact Assessments can at least indicate the potential dangers of diversion projects and provide opportunities to disclose the negative side of projects, which may attract people's attention so as to minimise risk—or even give up the idea of a huge water diversion project in the first place.

Unlike the time when the water diversion project was greatly expanded after World War II (or the Great Patriotic War as the Russians call it), the countries involved now compete with each other, mainly for economic rather than military strength; and the economic competition depends on natural resource consumption. Therefore, applying sustainable resource management strategies is a major task, which should have been undertaken right at the beginning. Under peacetime conditions (but ones of economic competition), the importance of sustainable water management increases.

The problems mentioned above are not new. But more importantly, the Aral Sea case should prompt policy makers to consider several questions: if environmental assessment is important for making policies on natural resource management, how can one embody this idea into policy-making practice? Secondly, as mentioned before, after the problem of the Aral Sea was exposed to the world, why was it so hard to make changes? The policy makers paid lip-service to the idea, but in practice, the absence of effective ways to change and supervise the operations resulted in inertia; and disaster followed. However, it must be acknowledged that the whole problem in the Aral Sea region was exacerbated by the political changes that accompanied the collapse of the Soviet Union, which made it exceedingly difficult to take effective remedial measures.

The most fundamental lesson from the Aral Sea story is that large-scale water diversion projects can cause devastating environmental, social, and even political consequences. Moreover, those consequences may be *irreversible*. Hence, in managing natural resources such as water, it is essential to consider the environment, rather than trying to change and control it without regard to these possible consequences. But it appears that that is what the Soviets did. Bad governance is likely to produce negative results, for the environment, and thus for human societies too.

But it should be emphasised that democratic forms of government can also produce dire environmental results. Many politicians in democratic societies have very short-sighted views and actions. They plan for the next election, not the long-time benefit of the environment.

Ascher has written that “the real challenge is to create conditions in which government leaders can gladly embrace sound natural resource policies” (Ascher, 1999, 3). How this is to be achieved in either totalitarian, theocratic, or democratic states will depend on good environmental policy and management. Understanding past mistakes can help, for future changes for the better can only be made in the light of what has happened in the past.

4.2 Australian Case: The Snowy Mountain Scheme (SMS)

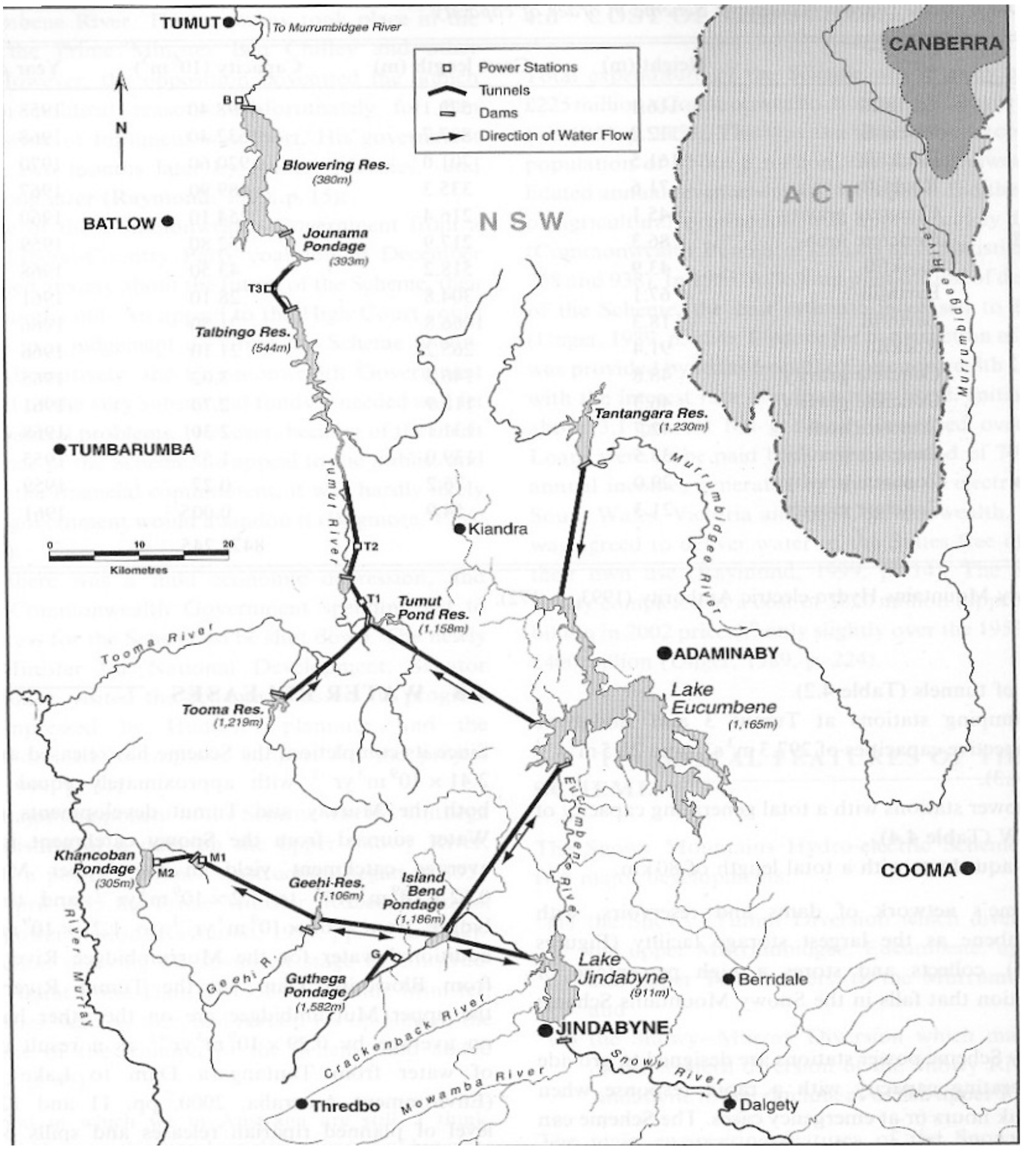

Figure 4.4 Map of the Snowy Mountain Scheme[7]

4.2.1 Background

The Snowy Mountain Scheme (see Figure 4.4) has played an important part in Australian history. It was a great engineering achievement, carried out in the years

[7] Source: Shaw, J., 1984, Collins Australian Encyclopedia, William Collins, 697.

following World War II, which involved the settlement of returned soldiers as well as 'refugees' from war-torn Europe. It also helped the establishment of multiculturalism in Australia and fundamentally altered the 'Australian way of life' as a result, as many people from many countries in Europe laboured together on the arduous project.

There were two stages in the planning of the Snowy Mountain diversion. In the first stage, the only concern was the provision of additional water for farmers. But from the 1890s, the idea of building a dual-purpose project (redistributing water and generating electricity) was considered and then came to be widely accepted. A series of droughts from 1881 to 1884, and a belief that water running to the sea was a 'waste', formed the background to the Snowy River Scheme.

The final scheme, as eventually carried through, was a compromising between the conflicting interests of New South Wales and Victoria. Hence, the project was not actually the best option either from an economic perspective or from an engineering point of view, from among the competing proposals. The Scheme was completed in 1974 after twenty-five years of construction work. It includes sixteen major dams, seven power stations, one pumping station, and 135 kilometres of tunnels, pipelines, and aqueducts (Ghassemi and White, 2007, 97–97). But the Snowy Mountain Scheme has caused serious environmental problems such as the shrinking of the Snowy River and severe salination in the irrigation areas that received water that earlier ran into the sea. This case indicates that ignorance and neglect of the environment in a large-scale scheme, and considering natural resources as 'free', can lead to grievous consequences. And when the problems become apparent it is not easy to turn back.

4.2.2 Policy Considerations

Problem Definition—Hunger for Water and Electricity

The idea of diverting the Snowy Water emerged in the late nineteenth century.

Proposals to divert water from the Snowy River dated back to the 1880s as a result of repeated droughts in eastern Australia. The N.S.W. Royal Commission established in 1884 (the Lyne Royal Commission 1884–1887) showed that the cost of sheep losses arising from the 1880s droughts was nearly AUD 24,000,000 (Wigmore, 1968, 56). In response, the Commission sought a better way to manage water and increase its supply. Simultaneously, proposals for diversion of the Snowy, where a great volume of water runs from the Australian Alps runs into the Tasman Sea, were put forward by Philip Adams, the New South Wales Surveyor-General in 1884. He noticed that from October to the end of January the thawing of alpine snow would allow an ample supply of water for one or two inland rivers and he claimed that a permanent system of irrigation could be adopted by transferring snow-melt water from east to west.

Meanwhile Alfred Deakin, Chairman of the corresponding Victorian Royal Commission, also paid close attention to water supply problems. He made personal investigations of irrigation schemes and practices in India, Egypt, Italy, and America and, based on the results of his visits, an Irrigation Act was issued for Victoria, which empowered the Government to construct large works, and give financial assistance to trusts elected to carry out work in Snowy Mountains and other water projects (Wigmore, 1968, 53).

With the invention of the use of hydropower in 1882, public attention was soon drawn to a clean and low-cost way of generating electrical energy. Australia quickly grasped the possibilities of hydropower, and by the 1890s it was ready to utilise the new technology. Departing from the early plans for water diversion, which only considered water diversion for irrigation purposes, the generation of electricity became one of the main targets of what became the Snowy scheme. (In fact, in the later discussions of the scheme, generating electricity was put in the first place.)

From the 1890s, many plans for diversion of the Snowy River were submitted to Royal

Commissions in New South Wales and Victoria (1884). The key difficulty was the conflicting interests of the two States. New South Wales wanted to divert the upper reaches of the Snowy River into the Murrumbidgee, mainly for irrigation. Victoria wished to concentrate the water in the Murray River, initially to allow reliable river transport and irrigation, and later (because river transport was replaced by rail and roads) for generating hydro-electricity. However, because the Murray River forms the border between New South Wales and Victoria, it was hard to exclude either State from the use of the water. Thus the division of the water quota for each State inevitably became a bone of contention. South Australia as the State that is the final recipient of the water also had an important stake in the Scheme.

By 1885, both New South Wales and Victoria had established the previously mentioned Royal Commissions to inquire into the future of water supplies in general and irrigation in particular, and it was agreed that the whole of the water of the Lower Murray should be deemed to be the common property of New South Wales and Victoria and each should be entitled to divert one half of the available water. In 1885, South Australia established its own Royal Commission in order to deal with water issues with the upstream colonies.

In 1890, the three Royal Commissions stated in a joint meeting that a three-State

> agreement should be sought . . . [t]o establish and define the mutual rights of the riparian colonies to the River Murray and its tributaries. Such agreements should establish the minimum amounts of compensation water [that] South Australia must receive, and establish the proportional shares of New South Wales and Victoria for irrigation (Standford, 1971, 27).

Rivers for transport, trade, and irrigation were of primary concern to the three colonies in the 1890s. Control of the Murray River was vigorously debated at the 1897–1898

Federation Convention, with South Australia being well aware of its vulnerable position, to which issue the leading newspaper in South Australia, the *Adelaide Advertiser*, gave considerable attention.

However, all efforts spent up to then did not produce much action because none of the States involved in this matter could convince the other States. And the plan would be a large one that could not be accomplished by any single State.

Policy Formulation—Reaching a Compromise Decision

In a series of Federal Conventions in 1898, water arrangements were a major consideration. It showed the disappointment that South Australia had in the Conventions. Various proposals about the rivers were put forward, which finally resulted in the involvement of the Commonwealth Government, which came into being on 1 January 1901, and hence became the fourth party in the discussions about the River Murray arrangements. The serious drought of 1914–1915 pushed the four parties to seek a framework for agreements on intergovernmental water issues. The debate was not, however, concluded before and until the Commonwealth Government brought national defence into consideration of the Scheme. The Constitution of 1900 failed to deal with the regulation of water—a major failing (which remains to this day) in that rivers cross inter-State boundaries, so that there was a real need to settle the legal arrangements for the distribution of water on a national basis. But if the issue was regarded as a matter of *national security*, then the Commonwealth could legislate on matters that affected the interests of the individual States (overriding the 'parochial' interests). But with World War I, the Great Depression, and the following World II, little was done.

However, in 1944, the Government of New South Wales submitted a report to the Commonwealth recommending the diversion of the Snowy into the Murrumbidgee

(Commonwealth and State Officers, 1948, 2). Also at a conference between Commonwealth Ministers and the Premiers of New South Wales and Victoria in Canberra in 1946, it was decided that the Commonwealth should carry out preliminary research on the diversion of the Snowy to the Murray and complete a report within six months. Since the Commonwealth was starting to play an active role in the proposed Snowy diversion project, a joint Commonwealth–States Technical Committee was established in 1947, which was responsible for the overall investigations. The Commonwealth Hydro-electric Power Act (1947) was passed and in the same year the Snowy Mountains Hydro-electric Authority was set up to administer the Snowy Mountains Scheme. During the construction of the project the main interest and concern was the production of electricity for New South Wales, Victoria, and the Commonwealth's new capital, Canberra.

In November 1948, the Committee completed an official proposal, the first to be produced by the joint efforts from the Commonwealth, New South Wales, and Victoria. The fear of a coastal attack was invoked as a major consideration of the Snowy Mountain Scheme, encouraging energy generation far from the coast and possibly built underground (Commonwealth and State Officers, 1948, 10). The reduction of coal consumption and decentralisation were the second and the third points emphasised for the Scheme. Irrigation was listed in a separate section as another major consideration. However, even this section stated that: "[c]hanges in economic structure and the effects of the war have placed greater emphasis on the need of power" (*ibid.*). So in the event, the highest priority was given to power development in the final planning of the Scheme.

Because of technical difficulties, the power development plan and irrigation were considered incompatible before the late 1940s and this incompatibility caused debate between NSW and Victoria about the Scheme. However, the proposal, as published in 1948, revealed that consensus had been reached that a *dual* energy/irrigation scheme was technically feasible—a project that focused on electricity generation, but would also serve to divert water for irrigation. In the view of the investigative committee, changes of economic structure and the possible influence of war could boost future demands for power, the shortage of which could, in the long-term, be a major impediment to economic development and national defence. Thus, the Snowy Scheme was expected to become a valuable counter to future energy demands.

As said, the Committee emphasised the importance of hydro-electrical energy rather than irrigation. In fact, there was to be no charge for water and it was stated that there would be no special costs involved in diverting water to the Murrumbidgee and Murray rivers for irrigation, additional to the estimated budget for the hydro-electric power scheme. Thus even before the decision was reached about which proposal was to be chosen, the Committee had indicated that if the proposal of hydro-electric power proceeded, the Scheme could be built for electricity generation and irrigation could come along as a 'bonus'. Compared with the earlier direct Snowy–Murray diversion, which was attractive but not sufficient to the Committee's remit, the power development plan cost was based more on cost/benefit analysis, but was considered crucial to meet the future demands for energy and reduce the pressure on coal consumption.

Two preliminary investigations, the Snowy–Murrumbidgee proposal and the Snowy–Murray proposal, were put forward prior to the 1948 Proposal, but the Committee recommended that neither of them should be adopted because of the perceived advantages of a dual scheme in respect of both power and irrigation development (though the chief emphasis was placed on power generation). In retrospect, it appears that the Committee gave a wrong signal at the very beginning of the scheme, paying too little attention to the diversion of water for irrigation purposes, and to possible adverse environmental effects. As a result, *little research was done on the ecological outcome of the water transfer*, which eventually led to grievous environmental deterioration in the irrigation area, and to social disputes about water use. What would now be called precautionary principles was ignored. The Snowy Mountain Scheme, as eventually implemented, did not assume responsibility for its environmental impact on the inland regions, where vast irrigation projects were subsequently developed. The Scheme focused all attention on the technicalities of the tunnelling, dam construction, and electricity generation.

Strong emphasis in the official governmental report, *Proposals to Divert the Snowy River* (Commonwealth and State Officers, 1948) was placed on the importance of the Scheme in terms of national security, which allowed the Commonwealth to have a strong influence on the development and implementation of the Scheme. Using its defence powers (permitted by the Constitution), the Commonwealth passed the Snowy Mountain Hydro-electric Power Act, 1947, which entitled the Commonwealth to control the water arrangement and play a leading role in the development of the Scheme, through the subsequently established Snowy Mountain Hydro-Electric Authority.

The 1948 report considered five possible proposals: the Snowy–Murrumbidgee Scheme; the Snowy–Murray Scheme; the Tumut Scheme; the Snowy–Murrumbidgee and Tumut Scheme; and the Snowy–Murray and Tumut Scheme. For the Snowy–Murrumbidgee Scheme (as modified), the proposal consisted of three parts: the main structures (dams, etc.) at Jindabyne and Billingera; the drawing of water from the upper Snowy River, and the further development in the Murray Valley. The Snowy–Murray Proposal would also divert water westwards from Jindabyne. Since there is a drop about 500 feet between Jindabyne and the Murray area, the Snowy–Murray Scheme would provide a large quantity of water (910,000 'acre-feet' per year) and could generate 1,100,000 kilowatts at the second of its two stages of production. From the very beginning, the third (Tumut) proposal was not considered as an independent scheme, but as supplementary to the main scheme. It envisaged transferring water from one of the largest tributaries of the Snowy, the Eucumbene River, to the Upper Tumut. The main reason for putting forward the Tumut proposal was to divert water from Ad(a)minaby, on the Eucumbene River and Tantangra on the Murrumbidgee River to the Tumut Valley, enhancing power generation. Connecting the three rivers would provide a great benefit in regulating flow and allowing interchange between the different catchment areas. The fourth proposal, the Snowy–Murray–Tumut simply integrated the Tumut proposal into the Snowy–Murray proposal.

The last scheme combined the three main proposals, and involved the Tumut, the Snowy–Murray, and the Snowy–Murrumbidgee schemes together, with some reduction to the quantity of water delivered to each river. As the result of taking water from the Tooma (a tributary of the Murray River), the fifth scheme could 'balance' the water quantity by diverting water from Jindabyne to the Murray River even before reaching the Murrumbidgee River.

The final proposal for diverting the Snowy River completed in 1950 included more detail than the one considered in 1948, which was, however, the foundation of the later one. The recommendations made in the 1948 Report were approved by Commonwealth, New South Wales, and Victorian Ministers in February 1949. The Committee made follow-up investigations and submitted a second report in June 1949, which was approved by the Ministers in July that year, by which time the mission of the Commonwealth and State Snowy River Committee was accomplished. An Advisory Committee of representatives of the Commonwealth, New South Wales, and Victoria replaced the previous one to advise and coordinate the development of the Scheme, both at the National and the State levels (Commonwealth and States Snowy River Committee, 1950, 7). The Report in 1950 was the result of nearly three years of investigation done by the Committee, including a general description of the Snowy area, and the power and irrigation situations in New South Wales and Victoria. It recommended the implementation of the Scheme and provided much detailed information. Compared with the report of 1948, which can be described as a policy explanation, the 1950 report was a technical and economic document, intended to demonstrate that the recommended development of the Scheme in 1948 was correct.

The final decision of The Snowy Mountain Scheme was mostly based on the combined proposal. The Snowy Mountain Scheme includes two parts: The Snowy–Murray Diversion and The Snowy–Tumut Diversion. For the Snowy–Murray Diversion, Snowy water is diverted westward through a tunnel to the Geehi Reservoir and passes through two power station to the Murray River. The Snowy–Tumut Diversion collects the headwaters of the Murrumbidgee and Eucumbene Rivers and than also through a tunnel to the Tumut Pond Reservoir. From there, they join the waters of the Tooma and Tumut Rivers, which rise on the west of the range and are passed through a succession of power stations located in the Tumut Gorge. Once the waters have passed through the power stations, they are released via the Blowering Dam into the Tumut River and pass on from there to join the Murrumbidgee River west of Yass (Snowy Mountain Hydro-electric Authority, 1999, 23).

The decision as to which proposal was to be accepted was the outcome of a compromise between the political interests of Victoria and New South Wales as much as economic and technical considerations. As the result of comparison among the five proposals that were submitted, the Snowy–Murray would have been the best from the point of costs and benefits. However, it would not have satisfied New South Wales, in that water demand in the Murrumbidgee irrigation area would not be met sufficiently. Therefore The Snowy Mountain Scheme finally was designed in two parts, the Snowy–Murray and the Snowy–Murrumbidgee (Seddon, 1994, 46).

The Commonwealth was accused of using defence as an ‘excuse’ to intervene in State affairs, which was unconstitutional. At this stage, the Commonwealth, New South Wales and Victoria had not sorted out the distribution of water and electricity for the recommended Scheme. In order to solve the problem, the Commonwealth Government first put forward an interim arrangement in 1950, which was later accepted by both New

South Wales and Victoria. So the 'defence ruse' was used successfully to circumvent the deficiencies in the Commonwealth Constitution, which (as said) had failed to make adequate provision for the legal problems associated with water distribution. In the following seven years, New South Wales and Victoria Governments worked with the Commonwealth Government to complete the final arrangement, The Snowy Mountain Hydro-Electric Agreement was finished and ratified by each State Parliament in 1958. According to the Agreement, the Commonwealth, New South Wales, and Victoria would undertake the construction, operational, and maintenance cost, in proportion to their electricity entitlements: Commonwealth 13%, New South Wales 58% and Victoria 29% (Vanderzee and Turner, 2002, 5).

Policy Implementation—A Marvellous Plan?

The investment in the Scheme was $820 million. In the long-term outcome of the project was to increase the agricultural productivity in the Murray–Darling Basin as well as being a reliable source of power. By diverting water to the Murray and Murrumbidgee Rivers, the Snowy makes an important contribution to the $8.5 billion of agricultural production in the Murray–Darling Basin annually. The Snowy–Murray Diversion provides around 5% of the flow to the River Murray under average conditions (Murray–Darling Basin Commission, 1997, 114). The Murrumbidgee irrigation supplies water to 3,168 shareholders. The rice industry accounts for 52% of the total water consumption, pasture 9%, cereals 18%, and vegetables 2% (Murrumbidgee Irrigation Limited, 2002, 6).

The Snowy Scheme has a generation capacity of 3,756 megawatts, which means that it is able to produce up to 16% of the total power requirements of mainland south-eastern Australia at any one time. Over a twelve-month period, the Snowy Produces approximately 5,000 gigawatt-hours of energy, which is around 5% of the total electricity demand of the south-eastern Australian grid.

It took twenty-five years to finish the enormous project and more than 100,000 people from thirty different countries were involved in the project, which is commonly viewed as the cradle of Australian multiculturalism (since people from many parts of Europe came to the country after the War, to make new lives for themselves). The Snowy Mountains Scheme extends over 2,000 square miles along the border of Victoria and New South Wales. It provides hydroelectric power to areas from Melbourne to Sydney and is used to irrigate western NSW and SA through the Murrumbidgee and Murray Rivers. The Scheme provides a minimum of 2088 gigalitres of water a year to the Murray–Darling Basin, providing additional water for an irrigated agriculture industry worth about $4.5 billion per annum, representing more than 40% of the gross value of the nation's agricultural production (Murray–Darling Basin Ministerial Council, 2002, 8). *But*, all this has contributed to many devastating effects on the Murray, Murrumbidgee, and Snowy Rivers and the surrounding environment.

Policy Evaluation—Aftermaths

Throughout the planning and construction of the Snowy Scheme, erosion was seen as the most important problem for the environment in terms of conservation. In fact, erosion was the only environmental concern that was raised independently throughout the planning process, along with other concerns such as water allocations between States. Erosion due to human intervention was already a major problem in the Snowy Mountains. During the second half of the nineteenth century, the alpine highlands were being used more and more as grazing lands and as stock routes. By 1851 the Cooma district held 97,764 heads of cattle, and 32,783 sheep (Wigmore, 1968, 31). These figures must, however, be regarded with caution, as prior to 1889 the Snowy Mountains were open to all, with summer grazing particularly popular with those in surrounding areas during times of drought, when the upland country often remained green and fertile. As such, over-grazing in the high country was common. To compound the problems, the practice of burning off dry grass to encourage green shoots to appear was also widely undertaken. The problems with grazing were not mitigated with the introduction of pastoral leases, as Sir William McKell (Premier of NSW from 1941 to 1947 and later Governor-General of Australia) discovered during a visit to the area in 1941.

> We camped over the area and I was appalled. You see the whole area—about one million and a quarter acres—was subject to leases, grazing leases. The large graziers had very big areas down there and they could put as much stock as they liked on them. The whole area was being completely eroded. I saw all that sphagnum moss and the snowgrass and it was all getting eaten out. Well, that was the lifeblood of the Snowy because that moss and grass holds the water and lets it seep out slowly (Unger, 1989, 179–180).

But it was not simply for altruistic or aesthetic reasons that the Snowy Authority set out to correct years of neglect and erosion. To be sure, large-scale plantings of native grasses, regeneration of native plants and providing compensation to those with grazing leases to keep their stock below 4,500 feet as well as buying out grazing leases all occurred. But if erosion were to continue unchecked at the rate it had been, in very little time silting of the rivers, creeks, and waterways which fed the Scheme would occur, as well as in the storage areas, and would greatly reduce its efficiency, and possibly effect its entire viability. For this reason, erosion control was seen as of major importance to the Scheme's operation, with erosion protection works constantly being carried out, including bank stabilisation and river improvement projects (Snowy Mountain Hydro-electric Authority, 1997, 39–40).

Perhaps the most serious side-effect of the Snowy Mountain scheme has been the destruction of much of the environment in the irrigation areas due to salination, caused by excessive irrigation. Under normal circumstances in a vegetated area, water passes from the ground to the atmosphere via plants (particularly trees), rather than evaporating directly from the surface. But with excessive irrigation in a dry climate, water evaporates directly from the surface, and subterranean water is drawn to the surface. There the dissolved salts that it contains crystallise and eventually this makes the growing of crops impossible. (This happened in the Aral Sea case too, as has previously been described.) Salt water also enters the waterways, and whole river systems may become saline, particularly if (through drought or the diversion of water for irrigation) a good flow of water is not maintained. For this reason, it has been predicted that the water supply for Adelaide will become undrinkable in fifty years or less, unless drastic measures are taken to deal with the 'salt problem' and curb salinity.

Because of the low-cost water from the Snowy Scheme, there was a profligate use of irrigation water, with the result that vast areas of land in the Murray-Darling Basin and the Riverina Irrigation Area have become saline, and in some cases are no longer usable for agriculture. It was not the increased flow of water into the western rivers that itself caused the trouble, but the fact that water, as a cheap source, was spread onto land that had had its trees felled so that cash crops could be grown. The removal of the tree cover, and the disruption of the natural hydrological cycle, caused the water table to rise, and salination to occur.

The economic attraction of planting water intensive cash crops led to a huge increase of land clearance. Under these circumstances, the quality of soil has been gradually declining since large-scale irrigation began. More water flows into the subsoil and the water table gradually rises. Consequently, the salination problems are increasing across the areas. The Murray–Darling Basin Ministerial Council (1999, 22) estimated that the economic impact caused by salinity in the region was $46.2 million per year, and this figure could be expected to increase if the environmental degradation continues. About 5.7 million hectares of agricultural land and pastoral area is under the threat of salination and this area could be tripled by 2050 (National Land and Water Resources Audit, 2001).

Salination can occur naturally in dry-land regions, but in the Murray–Darling Basin the environmental degradation has been driven by short-sighted decisions, taken for short-term benefits. This problem was largely ignored until the 1970s, which meant that opportunities were missed to cope with it in time. Even, at present, the battle against salinity in irrigation areas is still intensive. It relates to research in land care, irrigation patterns, crop types (changing to more salt-tolerant crops is one of the solutions), and social and economic affects impacts on farmers and the local towns that serve them. All this again illustrate the fact that massive water projects can have huge negative consequences, which can be both irreversible and costly.

It is, however, the Snowy Scheme's impact on river flows that has raised the most environmental concerns. The Snowy River has recently received particular public attention. However, the Eucumbene, Murrumbidgee, Tooma, Tumut, Swampy Plain, Geehi and Murray Rivers are also affected by the Scheme. These are currently (from 2002) the subject of an intergovernmental inquiry, the Snowy Water Inquiry, by the New South Wales and Victorian Governments. However, it is commonly accepted that it is the Snowy River that has suffered most heavily, with dramatic changes having occurred since the inception of the Scheme. The parts of the Scheme that have had the greatest impact on the Snowy River are the Eucumbene and Jindabyne Dams, and the Guthega and Island Bend Pondages. The releases from these dams were agreed upon in 1960 by the then NSW Water Conservation and Irrigation Commission and were followed for many years. Only riparian users were considered, with no account taken of the water flow required to maintain ecosystems.

In the early years of the twenty-first century, however, Australia suffered a series of serious droughts and this caused much public disquiet. One of the concerns was the degraded condition of the Snowy River and it was (after considerable discussion) agreed to restore a portion of the Snowy's original flow and a variety of targets has been set (with 28% of the flow to be restored), the first of which was implemented in 2002 (Ghassemi and White, 2007, 104–105).

With the drought situation getting ever worse, the need to develop new policies to remedy the negative consequences of the Snowy Mountain Scheme has thus become an urgent task. One of the major results after the corporatisation of the Snowy Mountain Hydro-electric Authority (SMHA), the governments of the Australian Commonwealth, New South Wales, and Victoria agreed on restoring the annual river flow of the Snowy to 21% of its natural state by 2012 (New South Wales, Victoria and Commonwealth Government, 2000, 2). Theoretically, such a decision was a straightforward solution to restore the dying river. However, once an ecosystem has been changed, the environment in which decision-makers have to act changes accordingly. The problem is much more complicated than simply releasing water into the river if governments expect their policies to be implemented merely through market forces. Economic considerations have been invoked.

For example, Jeff Bennett, an economist at the Australian National University, has proposed that governments should seek to place an economic value on environmental flows and thereby make policy decisions that take account of the economic significance of riverine environments. Working in this way, an environmental flow target for the Snowy might be made from an economic perspective. Bennett suggests that there can be two techniques to evaluate non-market values: ‘revealed preference techniques’ and ‘stated preference techniques’; but neither reflects the full value of environmental flows.

Revealed preference techniques are based on people’s preferences for non-market resources; stated preference techniques involve investigating “a sample of people who are potentially affected by a policy change regarding their reference for the alternative outcomes” (Bennett, 2003, 240–241). Bennett has developed a project using questionnaires and surveys of people’s preferences (e.g. the recreational value of a national park) to find the point at which the threshold of the environmental marginal costs meets the environmental marginal benefits. His method to identify the value of non-market resources thus helps policy makers to build a bridge between policy making and the market. However, these methods can only cover part of the externality costs, i.e. those that will directly affect people, and respondents to questionnaires cannot gauge the long-term and/or remote effects of environmental damage. Thus the difficulties in setting the 'right' price for environmental resources cannot be solved. Obviously, this case indicates the difficulty in formulating successful practical policies based on economic considerations for ever-changing environments. This problem will be discussed further in Section 6.6.

Policy Modification—A Necessary Action But How?

a. War Against Whom?

Under public pressure, research on the environmental impacts of water flows was examined in the Snowy Water Inquiry (1998). The Commissioner, the Honourable Robert Webster (1998, 5) argued that:

> When Australians are told that the Snowy River is presently flowing at only 1% of its original flow below Lake Jindabyne, and that an increased flow is required to restore the river's environmental, economic, social, and heritage values, they understandably react positively to the suggestion of increasing flows. However, when they realise that increasing flows into the Snowy may impact on the viability of the Snowy Mountain Hydro-Electric Scheme and the irrigation areas to the west, as well as the social and economic values of the broader communities, which rely on them, they begin to realise how challenging it is to find a solution for the Snowy River.

His statement illustrated the general problems of environmental protection: easy to form a view of what is wrong, but hard to take action to put things right.

The negative impacts of the Snowy Mountain Scheme have been widely recognised. To save the ‘dying’ Snowy and the ‘groaning’ Murray River, and achieve an overall sustainable environment, governments, communities, farms, scientists, and other stakeholders all reckon that it is time to take actions to stop the further deterioration of the situation. In fact, the outcry first appeared over forty years ago, after a serious flood. However, many years passed and the problems are still unsolved, and are in fact now more severe, especially with the grievous drought that Australia is still experiencing in some areas (2007). It is a long-term battle for water, but the core of the problem of who will be against whom in the war is unclear. The relationships among different interest groups are tangled. When policies have been changed, it is inevitable that some groups gain whilst others lose.

In the case of the Snowy diversion, the Federal Government’s aim has been to mediate the conflict between environment protection and irrigation demand. But the story behind the scene goes far beyond balancing environmental safeguards and irrigation needs: it encompasses decentralisation, energy and industry policy, urban or development strategy, and agricultural policy; and Australian politics more generally.

Thus it was that when Victoria and New South Wales promised to restore some of the water flow to the Snowy River, South Australia objected, since it was naturally worried that diverting the water that now flows into the Murray would have a disastrous effect downstream. Some dissenters have argued that even after the release of water flows to the Snowy, the environmental situation will not be dramatically improved, due to the inertia of environmental capacity. The thirty-year ‘domestication’ of the Snowy River, has already changed the environment owing to the reduction of flows. Therefore the problem is not simply a ‘take and return’ process, which possibly can cause further serious problems, with suddenly increased flows. It will take a long time to reach any conclusions as to what can happen after the flows return to nature. At present, no one can be certain that the return of environmental flows will be a cure for the dying river. The other possible option for the healthy rivers in the future is employing engineering methods to renovate the Scheme to give improved ecological outcomes, and planting more Red River Gum trees in the Murray/Darling basin to help counteract salinity problems. However, no matter which option is chosen, a single change cannot be the answer for rivers in danger. The trouble was caused not simply by the Scheme itself, and thus cannot be solved solely by the changes to that project alone.

Dating back to the initiatives of The Snowy Mountain Scheme, population decentralisation was the second priority for the investigation committee. Accordingly, the governments intended to encourage township development in the areas that were to benefit from water diverted from the Snowy River. According to an ABC '7.30 Report' programme on the Murray Valley in 2000, "40% of Australia's agriculture, with rice alone worth $700 million a year, and 8,000 jobs, relies on water from the Snowy diversion scheme (McKew, 2000)". In other words, the economy of the Murray–Darling basin depends on a non-natural supply of water. If the supply is reduced, the economy must inevitably shrink. "A reduction in the water supply means a reduction in the number of farms and employment opportunities, and towns like Griffith, and Coleambally that had very low unemployment rates in 2000 will start seeing higher unemployment rates and other problems that are facing rural Australia" (McKew, 2000, 8). The series of droughts that have occurred early in the twenty-first century have indeed seen the economic decline of the irrigation areas of the Murrumbidgee–Murray–Darling Basin.

This fact obviously indicates that social, economic, and environmental elements are closely interrelated. Thus the solution of the problem should not be a 'one-way only' route, trying to solve one problem in isolation, but ignoring others related problems. For the Murray Darling basin and the Snowy River, the dilemma is that sacrificing the rice industry is not a desirable (or politically attractive) option to resolve the problem. Without the rice industry, the River Murray communities cannot afford $360 million for the vital Land and Water Management Plan, and the rice industry cannot exist in an unhealthy environment. Water management in this case involves the attempted reconciliation of different competing interests. It cannot be a win–win situation. But in discussions of 2006–2007, when the gravity of the drought finally came to be realised by nearly everyone in Australia, the environment itself has increasingly come to be seen as an 'interested party'.

The Snowy Mountain Scheme has, as noted, led to two fundamental environmental problems: a dying river and soil degradation in the irrigation areas. To return environmental flows back to the rivers is the most widely accepted plan for the future of healthy rivers. However, how much water should (or can) be restored is still uncertain. But more than a decade ago Seddon (1994, 36) claimed that the main problem for the irrigation area was that the water was too cheap. (In fact it was and is supplied *gratis* by the Snowy Scheme to the irrigation areas.) Changes in water pricing and irrigation rights throughout Australia are the key to making the necessary changes. However, the difficulty is that changes must come along with the impacts on people's lives, which is a most complicated problem to sort out. And in a democracy, with several political entities involved, policy changes cannot simply be imposed, even if they may be desirable from the large-scale or national perspective.

b. Disjointed Management and attempts to Privatise

Shifting emphasis from its first stage of planning, after discovering the potential of hydroelectric generating capacity, the Scheme was designed mainly for energy; and at the same time it met irrigation water demand by diverting 'free' water. Because the major function of the Scheme came to be the provision of water power to generate electricity, close attention was given to how to make better use of hydroelectric resource. When 'disharmony' occurred between the two purposes of electricity and water, governments showed a preference for energy considerations rather then irrigation.

The SMHA was the organisation for the construction, operation, and maintenance of the Snowy Scheme and was under the control of the Commonwealth Government before 2002. Although environmental management was a priority for the Scheme and environmental safeguards were written into the *Snowy Mountain Hydro-electric Act 1949*, the SMHA only aimed at minimising the impact and protecting the catchments *in which the Scheme was to operate* (Snowy Mountain Hydro-electric Authority, 1999, 16). The SMHA took charge of the Scheme itself but environmental problems *in the irrigation areas* were not its responsibility. As mentioned, water was (and still is) provided free from the Scheme to the States and the State governments and local councils are in charge of the distribution and sale of water in the water-receiving areas. The resultant disjointed management 'leaves a blank' in answering the question of who should take responsibility for the environmental cost of the whole Scheme and take action to make changes when necessary. In the development of the Snowy Scheme, the tensions between the different interests of the different States confused and interfered with the decision-making processes and have become an excuse for inaction.

The main advantage of the Snowy hydropower as compared with electricity generated by burning coal is that it can generate capacity within 90 seconds after it starts, which is what is needed for peak-hour demand (Ghassemi and White, 2007, 97). From the 1980s, the Commonwealth Government began to consider corporatising the SMHA as an integral part of the Commonwealth's desire to drive national electricity reform. However, by June 1993, the Council of Australian Governments (COAG) agreed to establish a competitive national electricity market by 1 July 1995 (Vanderzee and Turner, 2002, 5). Owing to corporatisation requirements, two important reports, 'The Snowy Water Inquiry' (1998) and 'Environmental Impact Statement' (2000) have been undertaken. The former inspected the water-flow problems resulting from the Scheme and also provided possible solutions to handle the environmental issues. The latter Report was intended to ensure that the public and the Commonwealth Government were made aware of the possible outcomes after corporatisation of the SMHA.

The South Australian Government questioned the environmental impact statement (EIS) in the submission that all costs associated with the Scheme would in fact be borne by the electricity side of the Scheme; but it pointed out that there are significant *external* costs, such as environmental impacts, which are not borne by the Scheme. The response in the second part of the EIS to the question raised by the South Australia Government was unconvincing in clarifying the cost in the Draft EIS referring to operational costs (Department of Industry, Science and Resources, 2000, 1 and 16). As stated at the beginning of the EIS, it was written with the intention of taking into account the possible environmental consequences after corporatisation, but it came out as a proposal for corporatisation, which only accounted for the operation costs.

Although the two documents were investigations of water issues, the motivation of them was for the establishment of a competitive electricity market, and the fact that the generation of power was still a key consideration for governmental policy-making. Indeed, throughout the construction and operation of the Scheme, the generation of power has always been given greater consideration than the health of the rivers.

Some aspects of the environment seemed to have managed quite well, however. Not surprisingly, these are the areas, which, if left unattended, could adversely affect the viability of the Scheme. As mentioned, erosion was always an important issue, and silting was seen as a possible problem, right form the outset. The results reflect this: there have been few environmental concerns about silting and erosion through the life of the Scheme. By contrast, those areas that have suffered—namely water flows in the Snowy River, loss in biodiversity, and salination—did not directly feed back onto the

Scheme itself, and as such were of little concern to the planners during the establishment of the Scheme. With hindsight, this was evidently a serious shortcoming of the Scheme.

4.2.3 Lessons from the SMS

a. Big is not always good

In 1958, Sir Robert Menzies, who was Prime Minister at that time stated in a speech:

> In a period in which we in Australia are still, I think, handicapped by parochialism, by a slight distrust of big ideas and of big people or of big enterprises . . . this scheme is teaching us and everybody in Australia to think in a big way, to be thankful for big things, to be proud of big enterprises and . . . to be thankful for big men (Wigmore, 1968, 194).

But the 'big difficulty' that emerges because of the 'bigness' is how to manage such a 'big project' as the Snowy Scheme. People do not always 'think big'. Once dissent arose, such as interest-conflicts between New South Wales and Victoria during the development of the Scheme, ensuring that environmental welfare would not be sacrificed for other purposes should have been a major consideration. In fact, one might say that Menzies did not think big enough! His thoughts did not travel as far as the possible salination of the Murray–Darling Basin. In most cases of water diversion schemes, governments are inclined to use big project to demonstrate the power of the country and assume that one large-scale project can ultimately solve a multitude of problems.[8] However, these ideas of 'big is the best' can end up with disastrous consequences, because of neglect of the natural environment, and the ways that 'Nature'

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[8] Good examples, not specifically considered in the present thesis, are provided by the Aswan Dam Project in Egypt, or the transport of water from underground reservoirs below the Sahara Desert to the coastal areas of Libya (called by some 'Colonel Gadaffi's pipe dream').

is likely to respond to human interventions.

b. Politics and the Threat of Climate Change

In January 2007, the then Prime Minister John Howard hurriedly proposed a ten billion dollar national water plan to secure the future of Australian water supplies (Howard, 2007). The Project especially targeted the Murray–Darling Basin irrigation problem. The policy, which was in favour of the farming community, had the support of the NFF (National Farmers' Federation). However, the Victorian Government, perhaps with the forthcoming election in mind, took a guarded or even unco-operative attitude towards the Federal Government's plan and no immediate legislative action was taken. One of the controversial issues had to do with the control and management of the water in the Murray–Darling areas, which cover four states. According to the National Water Plan, Federal Government would take over the management role. The suspension of the water plan demonstrated that in practice, for trans-boundary projects, interest groups and political bargaining powers, not direct economic drive, can be the main drivers for policy making. But economic considerations can strongly influence political factors and this probably happened in the case of the Victorian Government's action.

These manoeuvrings all occurred in the context of a possible permanent climate change in Australia already evident in rising temperatures, drought, and the beginnings of the collapse of the Murray–Darling irrigation system and threats to the water supply of Adelaide. But action remained delayed because of political rivalries. In all this, the SMHA plays an incongruous role in the management system. After corporatisation, it has focused on pursuing the electricity market. Because of the water shortage, the SMHA has had to turn to traditional energy sources such as gas and coal, which aggravates the resource crisis and exacerbates the environmental pollution problems. Considering the climate change issue, the SMHA's new policies are clearly inappropriate. The traditional energy resources are not sustainable in the long-run and intensified climate change has already affected the snow cover in the Snowy region. At Spencers Creek, "there w[ere] 2283 metre-days of snow in 1960s, 20% reduction in 1970s, and 30% in 1980s and 1990s" (Hughes, 2003, 425). And in the future the snow cover has been predicted to contract to 66% by 2030, and 96% by 2070 (Hughes, 2003, 427). Or in less than seventy years the snow in the mountainous areas will virtually disappear. This is a daunting challenge for the SMS and SMHA.

4.3 National Hydrological Plan (NHP) in Spain

4.3.1 Background

The NHP case in Spain is quite a good example to indicate political debate in the policy process and the five elements involved in the policy cycle. However, the NHP only went through to the first two stages of the policy cycle (problem definition and policy formulation). Then, because of the financial difficulty, environmental campaigns and political pressures, the Plan was abandoned by the newly elected socialist government in June 2004.

The north of Spain (in the Ebro Valley) has a relatively mild Mediterranean climate and, compared with the south, is rich in water flowing from the Pyrenees Mountains that form the border region with France. The aim of the NHP was to reverse the imbalanced water distribution and provide water supply for irrigation and the extensive tourism industry in the south. The Plan was estimated to cost around 4.2 billion Euros and would involve a 1,000 km waterway (later reduced to about 900 km) and some 100 new dams (Ibáñez and Prat, 2003, 488; Biswas and Tortajada, 2003, 377). It was designed to divert three-quarters of the Ebro River's water to Murcia and Almeria in the growing tourist area of southeast Spain by the Mediterranean for irrigation and 'watering golf courses' at new or enlarged tourist resorts (Pearce, 2006, 264). The Plan was to construct a canal following an irregular course roughly parallel to, but inland from, the coast. The water was to be drawn off from the Ebro River about fifty kilometres from its delta region. There was also the intention of transferring water northwest from the same point on the Ebro towards Barcelona, the capital of Catalonia with its large population. (See Figure 4.5)

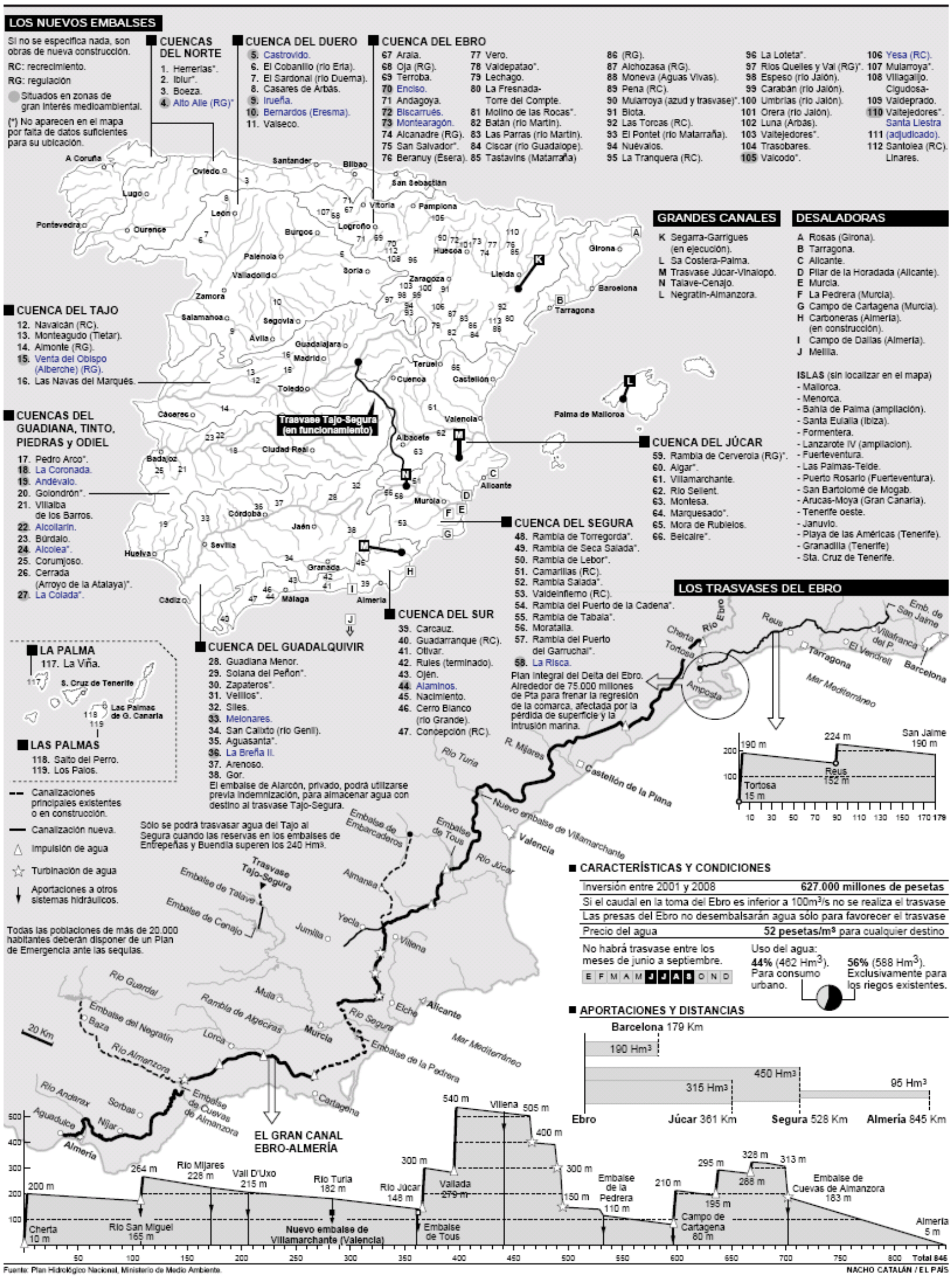

Figure 4.5 Map Showing the Proposed Route for the NHP (see only the lower map in the figure)[9]

The debate about the feasibility of the NHP lasted almost four years. The proposal for the NHP was prepared in 2000 and was approved by the Conservative Spanish

[9] Source: http://www.rivernet.org/Iberian/imgs/phngraphic.pdf.

Government on 17 February 2001. The Plan raised environmental concerns from the beginning and marked the prelude to a four-year battle between environmental advocates (involving WWF and Friend of the Earth) and Spanish governments. The major concerns of the NHP were its negative environmental and economic impacts; and more importantly the very need for the Plan was questioned. The NGO 'Friends of the Earth Spain' criticised the NHP for the possible impact of seawater intrusion into the mouth of the Ebro River and catastrophic consequences for the environment of the Ebro Delta with its important wetlands. Also the construction of the many new dams would entirely disrupt the natural flows of the Ebro river basin. The opponents submitted an amendment against the NHP to the Commission on Environment of the European Parliament and this was passed on 15 November 2001. Due to wide-ranging criticism of the NHP, Spain provided further details of its intentions and insisted that the Plan was purely a matter for Spain. Subsequently, the controversy was carried to European Union (EU) level. In order to convince the EU Parliament, in January 2002 the Spanish Government issued an environmental assessment of the NHP, which indicated that the NHP would be an 'environmental friendly' project and would comply with the EU environmental regulations. Moreover, when the final water transfer plan was submitted in March the same year, the Spanish Government hoped to get financial support from EU, which would account for 30% of the total cost of the Plan. However, the EU did not respond to the NHP until March 2004, when it declined to fund the Plan and described it as overestimating the benefits and underestimating the costs. Without hope of money from the EU and also as a result of the political power shift to the Socialists after a general election, the NHP was dropped in June 2004.[10]

[10] The details of the debate about the NHP from Rivernet. See http://www.rivernet.org/Iberian/planhydro.htm.

4.3.2 Policy Implications of the NHP

Problem Definition—A Question of Necessity

The central issue about transferring water from the Ebro was simply whether it was *necessary*. The transferred water was intended to be used mainly for irrigation purposes and also for tourism in newly developed areas along the southern coast of Spain. However, the policy should not encourage farmers to plant water-demanding crops and bring unsuitable land into cultivation by water subsidies and the provision of cheap water. Instead, there should be limitation of water use, so as to promote the growth of water-saving crops, more suitable for agriculture in water-deficient regions. Because the rainy season and warm weather do not coincide, there is limited vegetation cover. The cultivation of maize, alfalfa, potatoes, and beans in such a climate is ill-advised because these crops depend upon a lot of water. (Ireland is the country for potatoes!) (Olives and dates would make much more sense, but the global demand for these crops is limited.) However, with the subsidies from the Government, there is no motivation for farmers to adopt environmentally prudent policies.

Climate change is making matters worse. With drought and temperatures increasing, farmers urgently need reliable water sources. The new plan (2004) of the social democrat government has been to focus on a variety of small-scale projects, including building desalination plants close to where the water was needed. It would not change the farmers' situation much, but there could also be an increase in the efficiency of water use by recycling water and other local strategies. A series of other policies for solving the problem, such as taxing water, increase the water price and the institution of a water market, are measures under consideration.

The second major problem is the water use in land newly-developed for housing, commerce and recreation. Developers buy tracts of land, turn them into golf courses (etc.), and subdivide the land into holiday homes for other Europeans. In such areas, most new houses have their own swimming pools. Governments (both the previous one and the new one) considered such development as a major source of revenue. Even in the new plan, water for golf courses and tourism use is still given a high priority. So although the debate about the NHP has stopped (at least for the time being), the demand for water has not stopped. The economic situation has left a potential water crisis for the future and for this reason the Ebro water transfer plan may be revived at some time, particularly if there is a change back to a conservative government. Such development strategies as those presently underway are not sufficient in the long run because water demand will increase as a result of tourist development.

The debate about the NHP raised a fundamental question for water diversion projects, especially for large scale, inter-basin transfer plans, which is that technological fixes will not solve a water problem permanently if there is a concomitant increase in the demand for water. Therefore, policies should change to water demand management that focuses on respect for the limits of water resources and the control of water demand, rather than simply increase water supply.

Policy Formation—Termination for the NHP?

The EU played an important role in the debate over the NHP. On the one hand, environmental advocates such as WWF suggested that EU taxpayers' money should not be used for an unsound project like the NHP. Also the people in Aragon[11] who felt they were going to be robbed without appropriate compensation measurements, also conveyed their discontent to the EU and argued that the Plan would break EU Laws as passed by the EU Commission (Boné, 2003, 432). On the other hand, the Spanish Government needed financial support from the EU. Thus it spared no efforts to convince representitives to approve the plan. In the Spanish case, funding was a fundamental issue if the Plan was to succeed. Without EU money the Spanish

[11] Aragon: the autonomous community in the northeastern part of Spain.

Government could not implement the Plan.

Not only did the Plan start without a sound financial, environmental, and social foundation, but also there was a failed previous example that seriously affected the decision making in the EU. The NHP plans were not the first that the Spanish Government had devised for diverting water to where additional water was needed. The Tagus–Segura Transfer (TST) scheme has been operating since 1979. (See Figure 4.6, upper map.) The NHP was supposed to use the same transfer model as the TST, even though a report from the World Wildlife Fund (WWF) and the European Environmental Bureau (EEB) revealed the disastrous effects of the TST. The Report showed that the TST increased water deficit, caused habitat destruction, generated unsustainable agriculture, and led to a black market and illegal water usage. It resulted in deterioration of the rivers' ecosystem and also social imbalance (WWF, 6 May 2003).

Apparently, such results did not mean much to the previous Spanish Government. But the EEB was not impressed, as can be seen from the comments of one of its officers:

> The Tagus–Segura water transfer has created a huge burden for the present and future generations. It has increased the 'thirst' for more and more water, while water resources are limited and continue to decline. Instead, the EU water policy requires that water demands be managed and water transfers like the Tagus–Segura *not be repeated* (International Institute for Sustainable Development, March 2003, 9, emphasis added).

So when the Spanish Government applied to the EU for financial assistance for the NHP (which was to use the same construction strategy as the TST), remembering the experience of the Tagus–Segura case, the EU was not inclined to assist.

Also the key issue in wining the battle against the NHP was that in June 2004, the new social democratic government abandoned the plan and turned to a cheaper, more environmental friendly alternative, such as water saving plants. Two reasons pushed the new government to give up the three-year old plan, which had been strongly supported by the previous Conservative Cabinet. The Spanish Socialist Workers' Party (*Partido Socialista Obrero Español* or PSOE) promised to revise the plan before the election. Consequently, after it defeated the People's Party (*Partido Popular*) in 2004, it was time for them to fulfil their promise.

There were more than enough reasons to terminate the NHP, environmental unfriendly, economically unsound, politically unfavourable, and socially negative. However, the water transfer plan may return to government's agenda. On 19 December 2005, the Spanish Government passed an emergency law that allowed the inter-river basin water sales to try to tackle the drought on the Mediterranean coast (*Environment Daily*, 19 December, 2005).[12] The future of the Ebro's water is still uncertain. But obviously, no matter whether it is right-wing or a left-wing government, the solution of a water crisis still follows the 'traditional' method—that is simply try to increase supply.

4.3.3 Lessons from the NHP

From the Spanish case(s), it is clear that several factors should be weighed before starting a water diversion project: the *purpose* of diversion; *for whom*; *influencing whom*; and *possible alternatives*.

The purpose cannot be simply described as 'solving a water shortage'. More important is the identification of the *kind* of shortage. If it has resulted from unsound economic practices or policies, changing the policies is the appropriate solution, rather than encouraging the retention of the bad system and the use of more resources.

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[12] Information from http://www.rivernet.org/prs05_08.htm#191205.

Second, *all* parties involved in the matter should be considered: who get benefits and who may suffer losses. Applying water for tourist use in an important place in Spain meant that water would flow to the rich, driven by the goal of increasing revenues for various levels of government. This has happened not only in Spain, but in other countries as well. Urban use, particularly for recreation, often takes priority because of the demands of the people who hold power (either economic or political) to express their opinions and implement policies that serve their interests. And the potential environmental effects of any proposed diversion scheme must also be gauged (if possible). Indeed the environment can reasonably be regarded as one of the parties involved.

Third the solution to water problems should be considered from the perspective of the demand as well as supply. Reduction of demand—e.g. by recycling, changing water-pricing policies, or changing the crops that are grown—may be preferable to increase of supply.

But there can also be positive effects from water diversion projects. In Australia, as we have seen, the Snowy Scheme delivered essential power; it gave prosperity to a huge region for a substantial, but not indefinite, time; and it promoted the development of a multicultural society in the country.

4.4 The Central Arizona Project (CAP)

4.4.1 Background

Arizona has good experiences in water management. It has five designated Active Management Areas for groundwater management (Megdal and Moxley, 2003, 9), which designate irrigation non-expansion areas that have restricted the unlimited increase of irrigation water use. However, as in other places in the world, population growth and economic development have still caused water shortage problems.

The aim of the Central Arizona Project (CAP) was to reduce dependence on groundwater in Arizona, but initially a more important task or the ultimate mission for CAP was to deliver its full entitlement (Figure 4.6) of Colorado River water to central Arizona, and particular the major population centres of Tucson and Phoenix. The controversy about water allocation among the seven States of the Colorado River Basin (Arizona, California, Nevada, New Mexico, Wyoming, Colorado, and Utah) dated back to the early 1920s, when they negotiated for shares of the Colorado River's water. In 1922, the commissioners authorised by the seven 'Colorado States', under the leadership of Herbert Hoover as representative of the Federal Government, concluded an agreement for the water apportionment of the Colorado River and its tributaries.

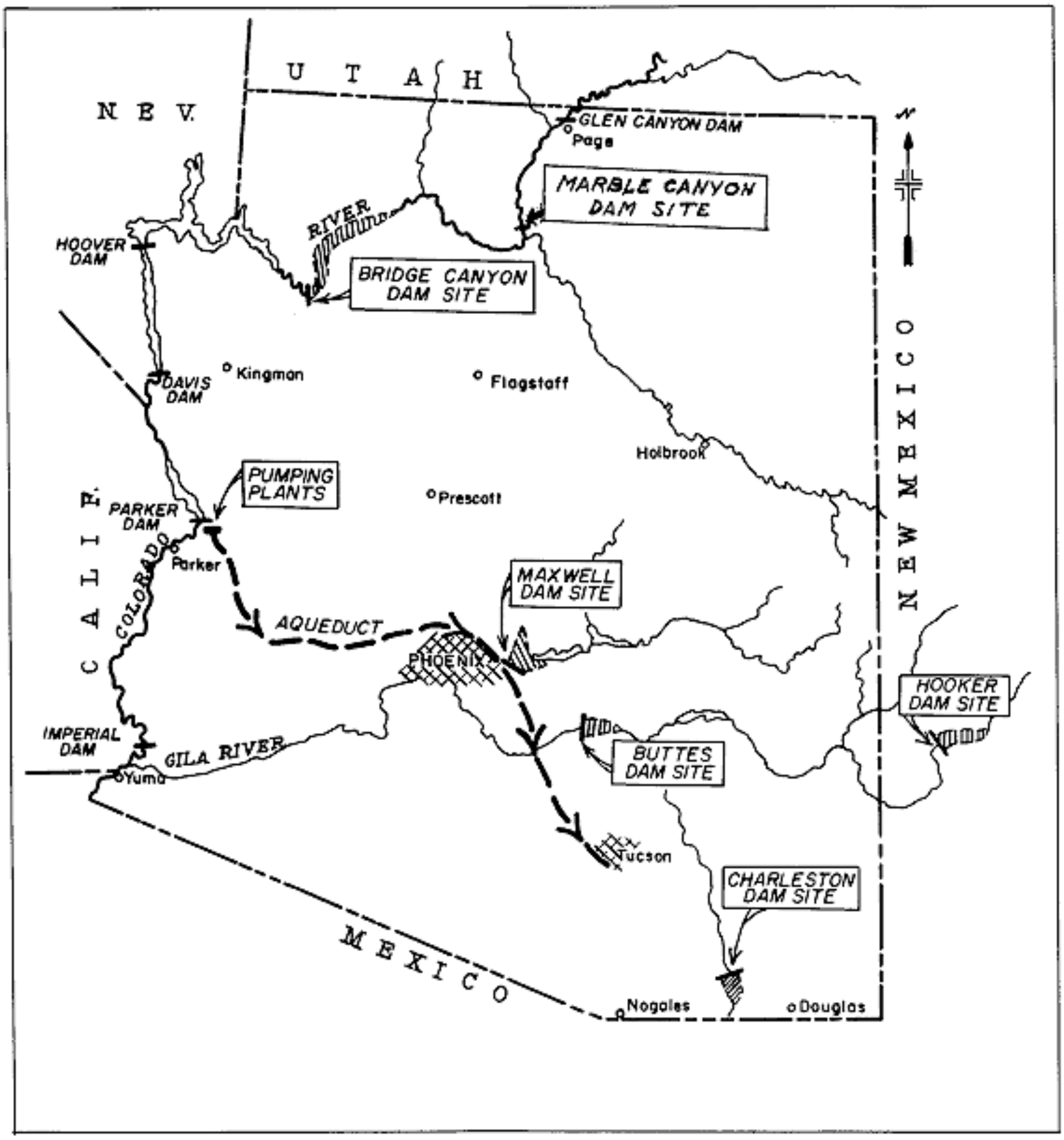

Figure 4.6 Map of the Central Arizona Project[13]

A feasibility study was conducted before the CAP started. However, the Project turned out to be different from that which was forecast, which led to financial trouble for the whole project.

13 Source: www.library.arizona.edu/.../88th/630521.html

4.4.2 Policy Implications of CAP

Problem Definition and Policy Formulation—Water Allocation

The fundamental motivation for the Project was the provision of more water for Arizona so that it could utilise its allocated quota. Similarly to the Snowy Mountain Scheme, dispute between different states that share the same river was unavoidable. But the difference is that the Project was planned and completed inside one state and served only Arizona.

The Colorado River Basin is divided by Lee's Ferry (about a mile below the mouth of the Paria River in northern Arizona to the southwest of the Glen Canyon Dam) into two parts: called the Upper Basin and the Lower Basin in the agreement (Arizona Department of Water Resources, 2004, 2). The Compact allocated 7.5 million acre-feet[14] of water annually to the Lower Basin including California, Arizona, and Nevada. The quota of each State in the Lower Basin was defined six years later in the Boulder Canyon Project, which granted 4.4 million acre-feet annually to California, 2.8 million acre-feet to Arizona, and 0.3 million acre-feet to Nevada (Trelease, 1963, 166). However, although President Hoover announced agreement on the Boulder Canyon Project and Colorado River Compact in 1929, Arizona was not satisfied with the Compact and did not approve it until 1944, when the competition between Arizona and California over water allocation of water from the Colorado River really started.

The Bureau of Reclamation completed a feasibility report for the CAP in 1947. In the same year, the CAP Association (CAPA) was established, which encouraged Arizona to implement the CAP. However, the authorisation of the CAP encountered opposition from California in Congress. Arizona sued California at the US Supreme Court in 1963 and finally won its case and obtained permission from Congress to begin building the CAP in 1968 (Arizona Department of Water Resources, 2004, 4).

14 One acre-foot equals 1233.5 cubic metres.

The CAP was intended to serve two purposes. One was based on the issue of the water quota: since Arizona did not fully utilise its water entitlement with the unused portion flowing through to California. Also, Arizona expected that the CAP could change the water shortage situation in Arizona by delivering water to the metropolitan areas of the State such as Phoenix and Tucson, and some irrigation areas.

The judgment from the Supreme Court did not however, end the CAP controversy. In fact, the Project was almost abandoned in 1977 when President Jimmy Carter listed it as one of nineteen Federal water projects to be cancelled. But in the end, the CAP survived, though at the cost of enacting the 1980 Groundwater Management Act, which restricted groundwater use and committed the State to eliminating the groundwater overdraft by 2025 (Hanemann, 2002, 1).

The length of the canal for the transfer is 336 miles, from Lake Havasu City (at the California–Arizona border on the Colorado River south of Las Vegas) southeastwards to Tucson, Arizona. The average size of the channel at its beginning is 80 feet across the top and 24 feet across the bottom and the water is 16.5 feet deep. A larger section of the canal, which acts as an internal reservoir system, is 160 feet across the top and 80 feet across the bottom. CAP cost US$3.6 billion to construct. According to the contract with the Federal Government, US$1.65 billion has to be repaid by the CAP to Washington. The canal is intended to deliver an average of 1.5 million acre-feet of Colorado River water annually. If the canal were operated at maximum capacity, year round, the capacity would be approximately 2.2 million acre-feet. Due to the design, constant delivery system and efficient operation methods, the average annual loss is estimated to be around 7%, evaporation loss being estimated at about 3–4%.

There are three classifications of users: municipal (e.g., cities such as Phoenix, Mesa, and Scottsdale—all essentially one large city); agricultural (delivery of water to agricultural irrigation districts such as the Maricopa–Stanfield Irrigation District, south of Phoenix); and Amerindian communities (twelve tribes have allocations—there are several Amerindian reserves in the region) (Central Arizona Water Conservation District, 2001, 7). The CAP has played a crucial role in sustaining the local economy and also has become a good example for countries that are planning to build (or expand) major water diversion projects.[15]

The CAWCD (Central Arizona Water Conservation District) has more complex tasks than Snowy Hydro-electric Limited. It was formed to repay the cost of the CAP to the US Federal Government. It has a General Manager and a senior management team, which is in charge of day-to-day system maintenance and operations. Besides that, one of the most significant tasks for the CAWCD, different from the SMHA, is to create water management programmes for Arizona. Therefore, the CAWCD is a water management group rather than a water technical advisory group. The other main difference is that the CAWCD is one of a number of actors in the water market. Whereas Snowy Limited plays an important role in the electricity market it has nothing to do with water allocation. But the maintenance and operation costs of the CAP depend wholly on the revenues received from selling water to customers. Therefore for the CAWCD, there are more incentives to consider long-term benefits. This requires sustainable water management strategies; and this is reflected in the management of the CAWCD.

Policy Evaluation—Bargaining Powers

When construction of the CAP's aqueduct approached the first irrigation service area in 1984, the battle over financial management started. Although some researches had

[15] Sid Wilson, General Manager of the CAP, gave advice to the Government of the Republic of Uzbekistan that in coping with the water disaster of the Aral Sea, Uzbekistan should create water-user organisations, as did the CAP. He concluded that poorly defined water rights are the major obstruction for Uzbekistan to 'unravel' the water crisis (U.S. Water Online, 1997). But the politics of Uzbekistan has hindered such approaches.

shown that the CAP was likely to encounter financial trouble because the eventual cost would be higher than estimated previously and the revised price of CAP water would not have been acceptable to farmers in the 1970s (Young and Martin, 1967, 15; Barr and Pingry, 1977, 1–25). But the Arizona Government did not pay attention to the warnings of future financial reefs. Contrary to the predictions that farmers would not be interested in the CAP, since the CAP water would cost more than groundwater, farmers were at first supportive of the CAP. And in 1984, the long-term contracts with the CAWCD signed by potential irrigation users accounted for 71% of the total water entitlement for agricultural use (Martin, 1988, 114).

Not only the farmers, but also the urban water agencies showed great interest in the CAP, thinking of the problems of a booming population and restrictions on groundwater uses (1980 Groundwater Management). As a result, the CAP allocated 640,000 acre-feet of water for urban use, which accounted for more than half of the State's unused entitlement (Hanemann, 2002, 2).

However, both farmers and urban water agencies anticipated that they might be able to bargain with the CAWCD. In other words, farmers and urban water agencies did not expect to have to pay the initially agreed price. The reason why they agreed with the price at the beginning was to support the Project and make it financially feasible to start with. Ingram and Lacy (1982) did a survey of farmers in the CAP service area. They found that farmers signed up for CAP water in order to make sure that the project got built. Once it was built, past experience with Federal water projects had shown that the Bureau of Reclamation would be willing to modify contracts to accommodate the farmers, rather than holding rigidly to the original contracts and ending up with water that could not be sold (Ingram, Martin, and Laney, 1982, 133–139).

The urban water users were supposed to pay more for water than agricultural users, but since the agricultural entitlement was not fully subscribed, the urban users successfully lobbied the CAWCD to offer them water at the same price as that charged to agricultural users in the early years of the Project. However, Tucson hesitated to join the Project because groundwater was *cheaper* than the water provided by the CAP. With the promise from the CAP that the price for urban users would only be reduced if Tucson were involved in the project, Tucson finally signed the long-term contracts in 1985.

But the prosperity of the CAP did not last long, as a result of the downturn in the agricultural economy, and Tucson stopped using CAP water because of the claimed unsatisfactory water quality. Lack of demand led to temporary price-cutting and the CAWCD began to face a critical financial situation. In 1992, the first irrigation district to accept CAP water was unable to make suitable arrangements and sold its rights back to the Federal Government. The first agricultural contractor filed for bankruptcy in 1994, and in the same year the second largest agricultural contractor also went bankrupt. The following year, the largest agricultural contractor announced a bankruptcy plan. Since then, in order to solve the problem, Arizona has decided to 'bank' unused water under the ground for future use. (In 2001, it stored 295,000 acre-feet of CAP water underground for future use (Hanemann, 2002, 4).

4.4.3 Lessons from CAP

The parties involved in the CAP case were the Federal Government that provided financial support for the construction of CAP; the Bureau of Reclamation, which did the feasibility study of the Project; the CAWCD, a quasi-governmental entity that aimed at marketing CAP water and repaying the Federal Government, based on the contract between the State and the Federal governments; the irrigation district; the agricultural contractors (who sold water on to farmers); and the urban water agencies. But the governments made the faulty assessments of future water prices, by overestimating future groundwater prices and misinterpreting the (admittedly hidden) signals given by farmers when they consented to the Project.

The main mistake in the feasibility study made by the Bureau of Reclamation was overestimating the demand for water. In order to manage the CAP successfully, the key point had to be the provision of CAP water at a lower price than that of ground water. The feasibility study done by the Bureau estimated that CAP water could compete with groundwater when the CAP water cost US$58 per acre-foot, while ground water would be US$109 per acre-foot. So the CAP should have been financially viable (Martin, 1988, 118). The price for the CAP water was accurate, but they overestimated the cost of ground water because they did not consider the technological improvements that made pumps more efficient, lower than expected energy costs (which had been expected to rise rather than fall), the decrease of farmland due to difficulties in obtaining crop financing, the 1980 Groundwater Management plan, and changes in the kinds of crops planted (Hanemann, 2002, 8).

Hanemann, quoted from Wilson (1981), stated that the feasibility studies failed to take uncertainties into account, and did not use 'sensitivity analysis', which could have responded to the uncertainties. He considers that the major problem for the feasibility study of the CAP was that it only concerned the question of 'ability to pay analysis', which was hard for the Bureau to predict. It could not represent the farmers' interests and ignored the situation that would arise if the farmers were to refuse to pay what had been agreed to. Ingram and Laney (1982, 136) considered the contract for CAP water as a 'willingness to play', not a 'willingness to pay'!

Why were farmers willing to participate in the Project but not 'willing to pay'? In a free market, a buyer will not buy commodities from a supplier if that supplier asks a higher price than other suppliers for the same quality commodities. So a supplier could well make a wrong judgment about a market and go bankrupt. In the CAP case, from an economic perspective, the farmers have been unwilling to buy CAP water because of its high price compared to that of ground water. In a free market, if a supplier cannot compete with other suppliers, the supplier will be driven out of the market. But the CAWCD cannot just leave the market, since it is not a private enterprise. As a quasi-governmental entity, how it should act in the market where there are other suppliers is not merely a question of making profits (or not), but also a question of how to optimise the utilisation of available water resources.

There are several questions that need to be examined in the CAP case. First, Ingram and Laney's research has indicated that the motivations for farmers to show support to the CAP were only to 'get the Project started', but not necessarily to accept the future price of CAP water. Why were farmers so sure that they could bargain with a government agency and would have advantages in the argument about the prices? It was because, based on past experiences the farmers had had with governments and agencies on water issues and knowledge of the management system of water issues and related policies, they were encouraged to play 'tricks' with the agencies. It was not only a problem of the CAP being a financial failure. There was also a need for major change(s) in the rigid pattern of irrigation contracts.

Second, the Bureau needed a feasibility study to predict the prospects for the CAP plan accurately and it was fundamental for the study to show that the CAP could be financially sound—which was one of the preconditions for beginning the Project. And for the farmers, if they had not agreed on initial prices, then the Project would not go ahead.

And third, if the high price of CAP water was the major reason to affect its performance in the water market, why was it not possible for the CAWCD to reduce the water price to compete with ground water? From 1986, the CAWCD did in fact start to cut its price (Megdal, 2003, 12). However, this did not work, presumably because the price of CAP water was still not low enough to compete with the price of ground water.

This raises the further question of whether or not there are other issues besides the price battle. Hanemann (2002) has stated that the failure of the CAP resulted from the neglect of the economic viability; and in the event the political power of the farmers prevailed in the area of water management over the interests of the State Government, by application of a rule that keeps as much water as possible within the State. If considering the project from the point of view of *that* goal, the CAP has utilised its share and recharged groundwater for future use, so it has been successful to some extent, although from a short-term financial perspective, it has failed.

CHAPTER FIVE
CASE STUDIES PART TWO
THE SOUTH-TO-NORTH WATER TRANSFER PROJECT (STNWTP)

We now turn our attention to the water transfer scheme that is the main object of inquiry in the present dissertation.

Because of China's special economic, political, and social situation, water management in that country follows the top-down system, according to which key decisions, such as the establishment of the STNWTP, are in the hands of the Central Governments. This background must be borne in mind when examining the STNWTP. My analysis focuses on policy aspects of the case, and is divided into four parts: problem definition, policy formulation, policy implementation, and policy evaluation.

Although water quality was concerned in the discussions and planning, the main focus was put on the quantity of water and its redistribution—given that the North of China has a shortage of water while the South has a 'superabundance'.

5.1 Problem Definition: The Necessity and Possibility of the STNWTP

In this section, the question of why the STNWTP was considered by the Chinese Government is discussed. The decision to begin the project was not only based on engineering and economic feasibility, but also on the unique historical background in China and the political perceptions of its present water problems.

The 'problem definition' section examines the motivations, possibilities, and difficulties of the Project. Jones (1977, 15, 27–32, 230–231) describes ‘problem definition’ as a phase when problems come to the attention of governments. Whether governments’ consideration will form an agenda for policy making depends on their evaluation of whether they have enough resources to planning and implement the policy. Therefore, the arguments about the feasibility of the Project and its potential risks are also discussed in the ‘problem definition’ section.

5.1.1 Historical Context

The Chinese Governments’ Obligations in the Matter of Water Control and Management

Historically, China has been a country with agriculture as its mainstay, and rulers often undertook water resource projects in ancient times.[1] Early in Emperor YU’ s time (2070 BC), people tried to dredge river channels. The earliest channel for irrigation according to written records is the one described in *Poem Scripture*:[2] in the so-called Spring and Autumn Period (722–481 BC): “the water from Biao Lake was flowing northwards to irrigate rice field there” (*Biao Chi Bei Liu, Jin Bi Dao Tian*).[3]

Water projects also played a significant role in Chinese history for nourishing Chinese culture and civilisation. At Hangou (486 BC), water was diverted from the Yangtze River into the Huai River (the forerunner of the Grand Canal). The second one was Honggou (361 BC), which diverted the Yellow River water into the Huai River. Another was Zhengguoqu (246 BC), which diverted Jinghe water into Luoshui (Shaanxi). In South China, there was the Linqu project (219 BC), which connected the Xiang and Zhu Rivers (ZHENG Liandi, 2003, 5–8).

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1 Water Conservancy (*Shui Li*) was coined two thousands year ago in *Shiji*, a historical record book, dated 104–93 BC.

2 *The Book of Odes* (722– 481 BC), the oldest classical Chinese theological text.

3 Biao Pond/Lake was the source of River Biao (one of tributaries of the Wei River in Shaanxi Province), and the water irrigated the rice field near Xian.

Perhaps the best known of the early achievements is the Dujiangyan Irrigation System (256 BC), located in the vicinity of the modern city of Chengdu in Sichuan Province. It provided water for irrigation and also reduced the threat of flooding in Sichuan. The prosperity of the Sichuan basin, which later was referred to as “the land of abundance” relied on this project and it still functions well, even now. As early as the Shu Civilization (2100–1100 BC), water from the upper reaches of the Minjiang River was run into channels for the purpose of irrigation, but this did not prevent severe and frequent flooding on the plains of Chengdu at the time of the spring thaws. However, through a scheme devised by the local Governor, LI Bing, and implemented in the years 272–256 BC, the flooding was brought under control and irrigation was extended on the plains, giving prosperity to the Chengdu region ever since.

LI’s remarkable scheme involved dividing the river into two streams, near to the place where the waters left their mountain valley and flowed onto the plain. For this purpose his workmen had to construct a new waterway, to carry water to the north of the river’s normal course and thus drain off floodwater. This entailed cutting through the corner of a mountain and constructing a strong dividing structure in the main river, which came to be known as the ‘fish’s mouth’. This structure divided the river into two streams. The normal river flow could be blocked off during the summer months by a temporary dam, constructed of ‘pyramids’ of connected logs, the gaps being filled by reed sacks filled with stones. During the summer and winter months, sediments in the river’s normal course could be dug out and removed. The dam was broken with ceremony at the time of the spring floods each year, so that the water then had two exits from the mountains and could be distributed in channels over a wide area, thus making possible a considerable increase in the area of agricultural production. And the danger of floods was greatly decreased. The excavation of the rock on the mountainside was achieved by breaking it up by lighting large fires on the rock surface and then rapidly quenching them with water, which process caused the rock to fracture.

The scheme as originally developed is shown in an old map, a copy of which is now displayed at the temple museum near the point of the river's artificial bifurcation (see Figure 5.1). The scheme as it currently operates is shown in Figure 5.2. In fact, the engineering details have been modified several times since LI Bing's scheme was completed. In particular, the temporary dam is now replaced by a set of adjustable sluice gates. But the essence of the scheme remains to this day. This represents a successful example of water diversion in ancient China. It is not known to have had adverse 'side-effects'; and, as said, it brought great prosperity to the region.

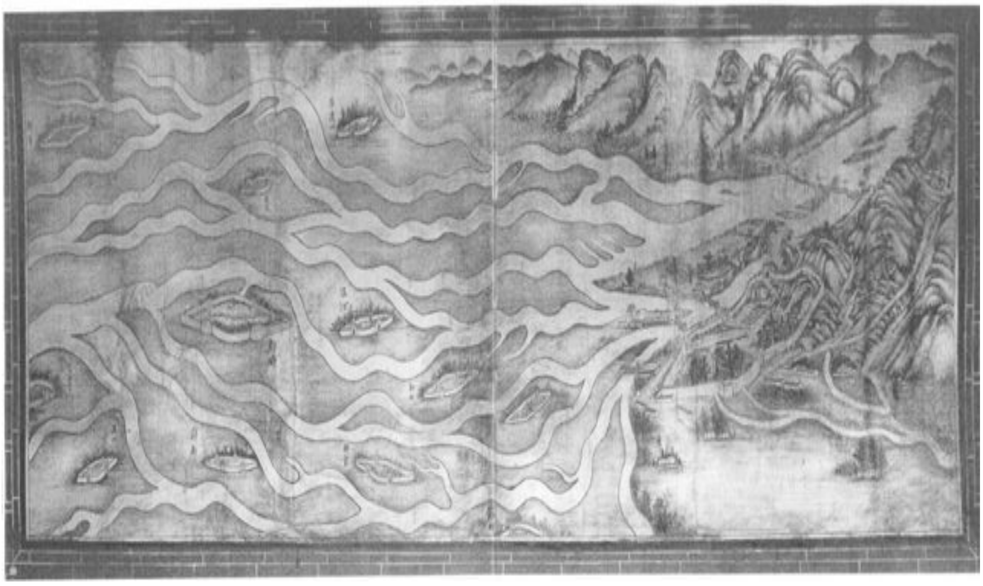

Figure 5.1 Map of the LI Bing Water Diversion Scheme[4]

Left (north): LI Bing's new waterway; right: the normal river course in the dry season; centre-left: the 'fish's mouth'; top/right: corresponds to the area of the mountain that was removed by Li Bing's excavation technique; lower/centre: the modern sluice system

4 The World Cultural Heritage, 2005, *Dujiangyan Irrigation System*, China Travel and Tourism Press, Beijing, 48–49.

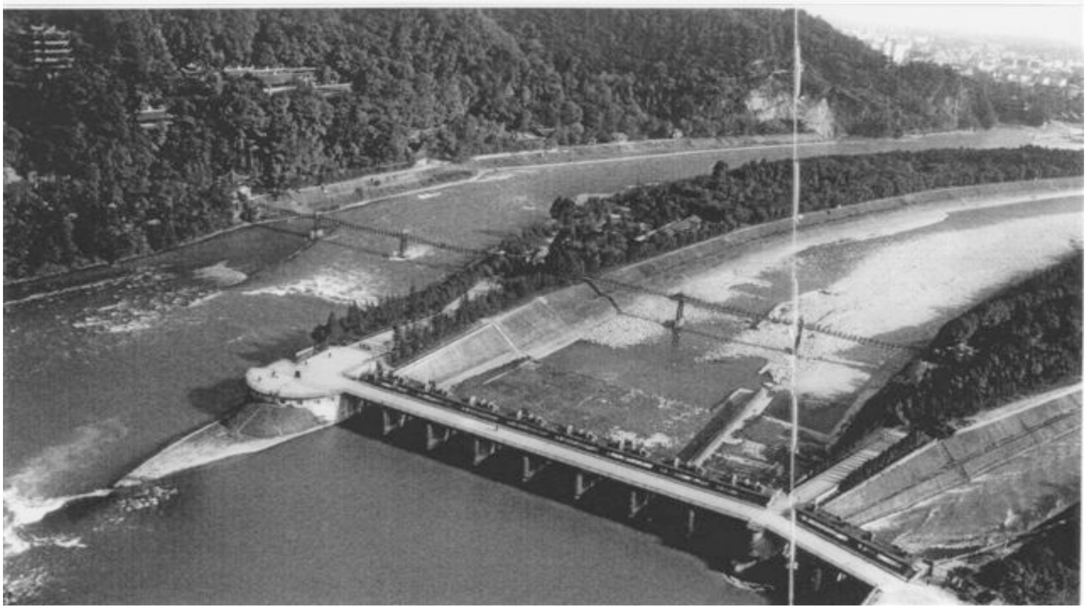

Figure 5.2 Aerial View of Part of the Modern Dujiangyan Diversion Scheme[5]
Note the spillways to allow excess water to pass from the new to the old river system

The other very famous ancient water project was the Jing-Hang Grand Canal (the main part of which was completed during the period 600–700 AD). So far as the water source for what later became the Central Route of the STNWTP is concerned, some papers have pointed out that there were plans as early as 978 and 988 AD to build a diversion project, which was to connect the Baihe (one of the tributaries of the Han River) and a river near Kaifeng (Henan Province), in order to ship grains and goods from Hubei and Hunan to Kaifeng, the capital city of the Song Dynasty (SHENG Fuyao and CHEN Daiguang, 1982, 80–88; YANG Wenlei, 1995, 34–35; TANG Qun, 1997, 5; CHEN Huaiquan, 2003, 175–178). However, both of the plans came to nothing.

Historically, the Chinese rulers paid great attention to water resource projects because they had a doctrine "If a ruler is good at governance, he must place importance on water

[5] The World Cultural Heritage, 2005, *Dujiangyan Irrigation System*, China Travel and Tourism Press, Beijing, 6–7.

resource projects" (GU Hao, 1997, 1; JIN Maochun, 1999, 41).[6] In SUN Yat-Sen' s book *Policies for the Nation*, SUN put forward "The Plan for Industrial Development", in which he suggested how to improve the conditions of the Yellow, Huai, Yangtze, and Han Rivers (Commission of Party History, National Party of China, 1973, 534–556). He also proposed the idea of a Three-Gorges Reservoir (JIN Changjiang, 2003, 5; FANG Sanwen, 2003, 51).

Thus there is nothing *fundamentally* new about the STNWTP concept. It is an extension of a long-standing tradition. But its scale is without precedent, exceeding even that of the famous Three Gorges Dam Project on the Yangtze River.

The 'Dream' that the North Should be Water-Rich Like the South

There seems to have been a belief in China that water shortage prevented North China from being a land of beautiful scenery and a wealthy place with plentiful rice and fish (JIANG Zhibing and WU Tao, 12 July, 2001).[7] If there were sufficient water, it was believed, the desert could be turned into fertile land, and the North would be just like the South. Thus the whole country would be wealthy and beautiful, not only the area to the South of the Yangtze River. Such thoughts were significantly influenced by the belief that "Man can conquer Nature".

However, the arid and semi-arid conditions of North China were formed over a long period of time. We should realise that Nature is not without limits and cannot be remolded entirely. We must learn how to adapt ourselves to Nature and live with it harmoniously. Only on the base of sustainable development, can one carry out

[6] The thought originated with GUAN Zhong (725−654 BC).

[7] Just as YU Chengsheng, a professor from the Yangtze River Water Resources Commission says "Water is important resource, you see, there are green mountains and hills, and green water in the South. However, in the North, there are bald mountains and hills, and Gobi desert. The reason why there is such difference is that there is plenty of water in the south, and water shortage in the North", see *Han River Daily*, July, 11, 2001.

successful construction projects (PAN Jiazheng, 14 February, 2003).

5.1.2 The Perception of Water Issues and Countermeasures: The Governmental Perspective

According to the former Minister of Water Resources, WANG Shucheng, in an interview on World Water Day, 2003, water problems in China are 'too much water' (referring to flooding problems), 'not enough water' (water shortage), and 'dirty water' (water pollution). These three factors constitute the fundamental problems on the basis of which the Chinese Government has approved the STNWTP. We shall therefore, in what follows, explore this trichotomy as the basis of our discussion.

Perceptions of Present Water Problems

Flooding has been a major problem that affected peoples' lives even before the Xia Dynasty (2033–1562 BC). Although some historians do not believe that story about how YU the Great taught people to control floods by diversion was true, the legend did reflect how serious the flooding problem was in ancient China. Since then, flood control has become one of the most important functions for governments. A good Emperor in ancient times was always regarded as the one who could make a great effort to control floods, and have some success. Today, flooding is still a major consideration for governments. The most recent major flood occurred in 1998. It caused 4150 deaths and direct economic losses of over 30 billion US dollars (ZHANG Chunyun, 1999, 3). It was a warning sign for the Government to take real action against the flood problem and indirectly prompted the urgent commencement of the STNWTP.

The total amount of water resource in China has been estimated at 2,800 billion m^3 *per annum*. However, divided by the huge population, the annual amount of water resource *per capita* in China is only about 2,300 m^3, which is only one fourth of the world average (ZHANG Chunyuan, 1999, 1). In the North China Plain, the average annual water resource *per capita* is 462 m^3, and only 348 m^3 in the Hai River Basin, which is one fifth of the national average and less than the level in Israel (449 m^3) (WU Jisong, 2005, 28–29) It is predicted that the Chinese population will peak in 2030. By then, the average amount water *per capita* will drop to 1760 m^3 (QIAN Zhengying and ZHANG Guangdou, 2001, 2; State Development Planning Commission and Ministry of Water Resources, 2002, 1).

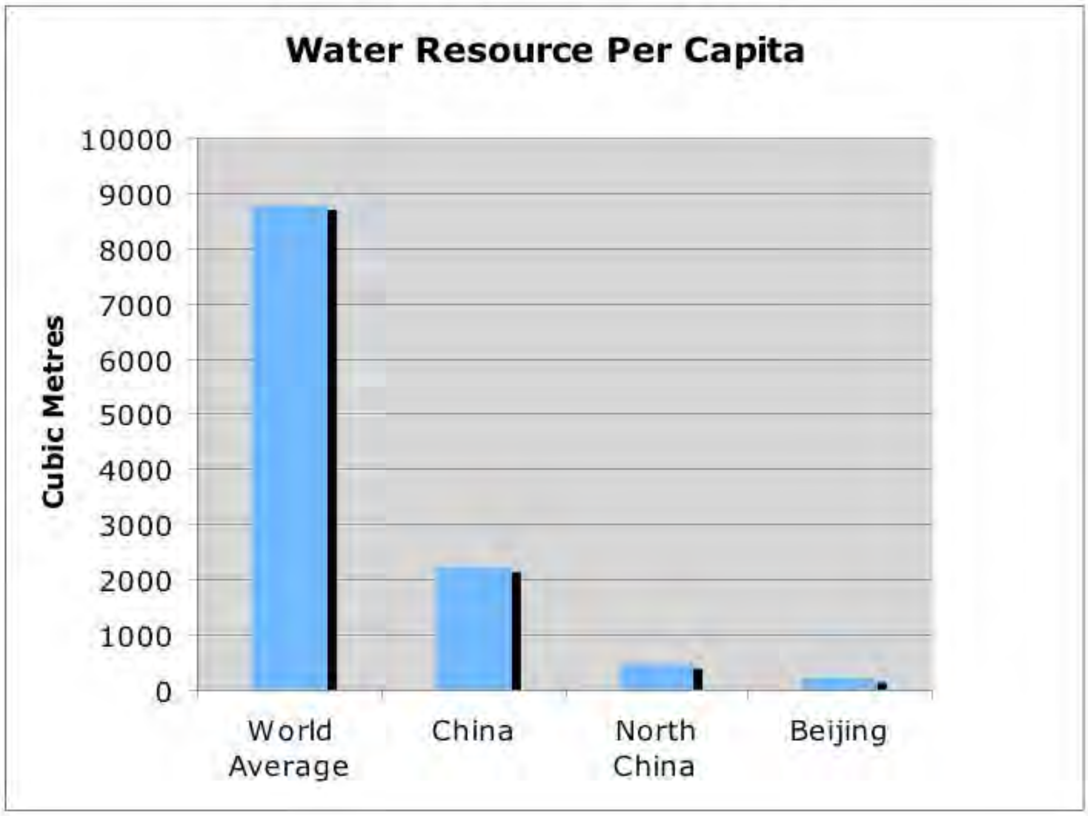

Figure 5.3 Water Resources *Per Capita*[8]

With the high rate of urbanization in China, the gap between water demand for household use and water supply will be much greater in the future. Estimates show that by 2030, the household use in cities will be 100 billion m^3 per year. At present, the total number of Chinese cities is 666. Among them, more than 400 cities have a water shortage to some degree, and 108 cities have a serious shortage of water (Chinese

8 Water *per capit*a in Beijing is less than 300 cubic metres (YAN Changyuan, 2000, 26).

Ministry of Water Resources, 2003, 13).

Water pollution is a serious problem in China as a result of rapid economic growth. At present, the total discharge of the industrial and urban waste-water all over the country is 58.4 billion tons, and of this amount only 23% is currently treated to reach the stipulated discharge standard. The re-use rate of treated waste-water is much lower. For 70% of the country's total monitored rivers, water quality does not meet drinking water standards. More than 90% of water bodies in cities all over the country are polluted to different extents (ZHANG Chunyuan, 1999, 5).

Countermeasures

Chinese governments, both at the central and at local levels, have issued policies and regulations in order to try to counter the three major water problems.

The fundamental environmental laws addressing the issue of water pollution in China consist of the Water Law and the Law on Prevention and Control of Water Pollution. In order to enforce these laws, a number of water standards have been set up at the national, provincial, and local levels, including the Environmental Quality Standards for Surface Water (ambient standards), the Integrated Wastewater Discharge Standard (discharge standards), and other discharge standards of water pollutants from special industrial sectors, as well as facility standards and material standards. Also, a number of national programs have been gradually integrated into the practices of water pollution prevention and control over time. The Discharge Permits System, Pollution Control within Deadlines, Pollution Charge System, and the recent Total Amount Control of Pollutant Discharge are the main programs regulating existing industrial pollution sources.

China is a country with a severe soil erosion problem, as is acknowledged by the Government. In order to prevent soil erosion and desertification, the Chinese

Government implemented a set of policies in the mid-1990s, including the Project to Return Farmland to Forest, the National Natural Forest Protection Belt, and the Sand Control around Beijing scheme. Among them, with respect to the scope, the number of people involved in, and the financial budgets, the Project Return Farmland to Forest is the biggest and the most influential project in the country. It first started from a pilot programme in Shaanxi, Gansu and Sichuan Provinces in 1999, and quickly spread to thirteen provinces and municipalities in 2000. By the end of 2003, the area being turned into forest from farmland was 227 million *mu* (1 *mu* = 667 square metres). According to the compensation policy of the Central Government, the Government paid less than $0.3 per kilogram of agricultural product for the farmers' losses caused by changing the farmland to forest. China was manifestly inequitable because different crops have different values per kilo. On average, the Central Government spent near $8.3 billion on this project in five years. This project has improved the environmental condition in some areas, not only reducing soil erosion to a certain degree, but also protecting the river systems, especially in arid regions. However, this project has been stagnant since 2003 because of the shortage of grain.

After the floods in 1998, the Government realised that the flood problem was partly due to the diminishing lakes in the middle and upper Yangtze River. Thus, as part of the Return the Farmland Back to Forest, and the Return the Farmland Back to Lakes schemes, projects have been implemented since 1999 to increase the flood mitigation capabilities. By the end of 2003, nearly 2,075 m^3 of farmland had been turned into flood storage areas (necessitating migration). The restored area can store an additional 7.4 billion m^3 of flood water. Besides that, the Three Gorges Project is designed to serve the goal of flood control. Furthermore, 20,000 hydrological stations and over 8,000 reporting stations are located all over the country, and 333 anti-flood measures involving 60,000 people have been organised at different levels (Chinese Ministry of Water Resources, 2003, 47–49).

The increasing tension between water demand and water supply has been pushing the Government towards seeking a solution that can mitigate water shortages for an extended period of time: and the proposed solution is the STNWTP. From the Government's point of view, the Project would kill two birds with one stone. On one hand, it would provide a large amount of water for the north; on the other hand, it would help the middle and lower reaches of the Yangtze River to control flooding. However, questions remain unsolved—such as whether the north suffers from a real water shortage problem; whether the project would solve the problem or somehow make the situation worse; whether the South could in fact supply the required water at the appropriate level of purity (in fact, there have been some hints of problems, such as pollution and climate change). Large cities like Guangzhou and Shanghai are all struggling with their own water shortages caused by pollution and the sharp increase of demand for water. But it seems that the Government is presently trying to ignore such questions. For them, it is more important to get the STNWTP done.

Although the three major water problems have been widely recognised by governments and academics, for example, by WANG Shucheng, the Minister of Water Resource, ZHANG Chunyuan, the former Vice Minister, MA Jun, the author of *Water Crisis in China*, and XIA Jun, the Vice President of the IWRA (International Water Resource Association). However, the several problems seem to be viewed as unrelated matters. For example, pollution is often considered as a separate issue from water supply so that the pollution policies ignore the connection with water use and lack incentives to encourage water recycling programs. Recently, water-saving projects have been encouraged by the Government in industrial, agricultural, and household uses. However, ideas and institutional changes take time to implement.

Under such circumstances, the STNWTP was considered to be a direct and immediate 'fix' for the water problems. The Project should be considered against the background of the above-mentioned three key water issues. Water shortage is given as the principal reason for proposing the Project. Flood control is listed as the secondary aim; but it becomes the main argument when it comes to obtaining consent from the South.

5.1.3 Water-Deficient North and Water-Surplus South

The Daunting Reality

From the Government's point of view, too much water in the south and too little in the North was the most convincing reason to put the Project on the agenda.

In broad terms, North China means the area north of the Qinling Mountain and the Huai River, which includes the municipalities of Beijing and Tianjin, Hebei Province, Henan Province, Shaanxi Province, Shandong Province, Jilin Province, Liaoning Province, Helongjiang Province, and the Autonomous Region of Inner Mongolia. However, in a general sense, North China refers to the North China Plain also called the Central Plain, which covers the area south of the Yanshang Mountains, north to the Dabie Mountains and the Yangtze River, east to the Taihang Mountians, west to the Yellow Sea and the Gulf of Bohai. For the STNWTP itself, the main purpose is to alleviate the severe water shortage in North China that mainly involves Beijing, Tianjin, the Shandong Peninsula, and Hebei Province (see Figure 5.4). Also, the Project will not only benefit the above areas, but also the cities along the Beijing to Guangzhou rail route in Henan Province will also take advantage of the Project.

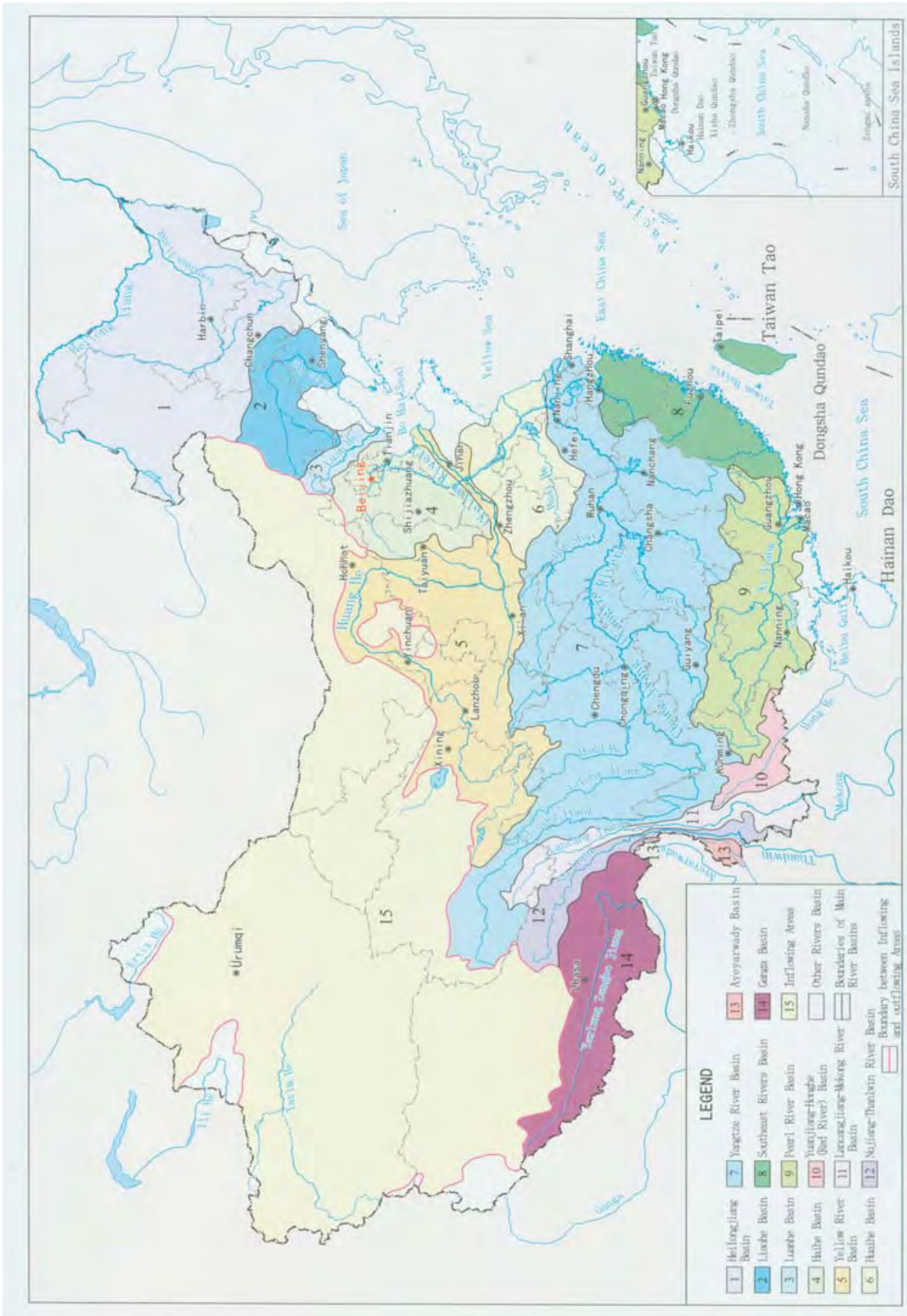

Figure 5.4 Major River Systems in China[9]

9 Source: (WANG Shucheng, 2006, see Map: Major River System in China)

The monsoonal climate of China is characterised by variable rainfall and by damaging droughts and floods. The precipitation in North China occurs mainly from June to August, which accounts for 70% to 80% of the total annual rainfall (PAN Jiazheng and ZHANG Zezhen, 2001, 4). Geographical distribution forms the natural environment in North China Plain, which has less water resources than does South China. Moreover, the dramatic population growth, high-speed urbanisation, and rapid economic development are intensifying the water crisis in northern China.

Table 5.1 Differences between North and South

Region	Percentage of Population	Percentage of Water Resources	Percentage of Land
North China[10]	45.6%	7%	47%
South China	54.4%	81%	34%

Source: *China Human Development Report 2002*, 24.

Meanwhile, water resources in the area of the Yellow–Huai–Hai basin, which is the main water receiving area for the STNWTP, are estimated to be $2{,}023 \times 10^8$ m^3, occupying 7.2% of the total water resources of the country. But with this amount of water, 34.6% population (about 4.4 hundred million) of the whole country live in this district; its grain yield provides 36.8% of that of the whole country, and its GDP occupies 35% of that of the whole country (With their high population density, the urbanised areas with many mega-cities and some super-mega-cities play a significant role in the national economic system.) (Office of Construction Commission of the South-to-North Water Transfer Project, 2004, 8).

10 Here North China refers to the area north of the Yangtze River, including Heilongjiang, Jilin and Liaoning Provinces. South China refers to the area that is south of the Yangtze River.

Specifically, for the area of the Yellow River basin, the average amount of water resource *per capita* was 633 m^3 in 2000. In the same year for the Huai River basin, the average amount was 478 m^3; and for the Hai River basin the average amount was 292 m^3—less than one-seventh of the average amount of water resource of the whole country. The problem of water shortage is thus very serious (State Development Planning Commission and Ministry of Water Resources, 2002, 2–3).

The average water resources *per capita* in the North China (not including inland river basins) is 747 m^3 (QIAN Zhengying and ZHANG Guangdou, 2001, 30). An analysis of water resources in the Yellow–Huai–Hai area should be the key to solving the water shortage problem in North China. By the year 2030, the average water resource *per capita* in the Yellow–Huai–Hai area will be reduced to 400 m^3 (QIAN Zhengying and ZHANG, Guangdou, 2001, 59).

We should also take the balance between water demands and water supply into consideration (see Table 5.2, next page).

Table 5.2 Balance between Demands and Supplies of Water Resources in the Yellow–Huai–Hai Area (10^8 m^3) (probability: 75%)

Districts / Items		Hai River District			Huai River District			Yellow River District		
		2000	2010	2030	2000	2010	2030	2000	2010	2030
Water Supply	Surface Water	100	100	100	382.7	407.5	442.2	295.3	317.8	329.4
	Ground water	210	210	210	185	190	200	110	110	110
	From the Yellow River	55.0	46.1	46.1	32.5	48.5	48.5	—	—	—
	From the Yangtze River	—	—	—	81	90	104	—	—	—
	Recycled	2.5	17.0	35.0	3.6	8.5	14.0	2.5	7.0	14.0
	Other	3.8	10.0	14.4	1.0	2.0	4.0	0	5.0	10.0
	Sum	371	383	406	686	746	813	408	440	463
Water Demand	Industry	67.1	85.3	100.2	96.5	139.8	168.0	59.1	83.7	110.2
	Agriculture	333.8	330.9	329.0	522.3	533.3	536.5	340.4	346.0	351.5
	Household	46.8	62.4	83.9	60.5	88.0	124.2	29.1	45.9	63.9
	Ecology	2.0	12.3	25.8	7.0	9.2	14.0	0	12.0	25.0
	Sum	450	491	539	686	770	843	429	488	551
Amount of water shortage		79	108	133	—	24	30	21	48	88
Rate of water shortage (%)		17.0	22.0	24.7	—	3.1	3.6	4.9	9.8	16.0

Source: PAN Jiazheng and ZHANG Zezhen (ed.) (2001), 22, Table 19.

Table 5.3 Demands and Supplies of Water Resources in the Yellow–Huai–Hai Area

Year	Demand of Water (10^8 m^3)	Water Supply (10^8 m^3)	Water Saving (10^8 m^3)	Water Shortage (10^8 m^3)
Present	1483−1633	1352–1453	—	131−178[i]
2010	1905−2052	—	149	193−259[ii]
2030	2213−2335	—	134	347−407[iii]

Notes:

i. The amount of water shortage in cities is 53×10^8 m^3.

ii. The amount of water shortage in cities is 87×10^8 m^3.

iii. The amount of water shortage in cities is 150×10^8 m^3

Source: Based on a speech given by ZHANG Jiyao, Deputy Minister, Ministry of Water Resource on 26 October, 2002.[11]

The total water quantity in the Yellow River basin, the Huai River basin and the Hai River basin only makes up 7.2% of the water of the whole country. Since the 1980s, drought has affected the Yellow–Huai–Hai basin area. Water shortages have been more serious than previously. In the year 2000, the area whose water shortage rate exceeded 10%, increased to 0.627 million m^2, i.e., 43% of the whole area. The area of water shortage in the Hai River basin reached 70% of the whole basin. The water shortage problem in cities and towns was becoming ever greater (State Development Planning Commission and Ministry of Water Resources, 2002, 3).

Consequences of Water Shortage

First, the exploitation and utilization rate of water resources in the Yellow–Huai–Hai area has reached to more than 67%, 59%, and 90%, respectively—considerably exceeding the recommended 40% limitation of river exploitation, which is the

11 www.nsbd.mwr.gov.cn

consensus of opinion shared among the international community as a whole.

Second, because of the surface water shortage, people have to exploit a great ideal of groundwater. The water-supply to cities in the whole of northern China comes largely from the exploitation of groundwater. According to 1997 statistics, the percentage of groundwater in the total water supply was 28% in the Huai River basin, 33% in the Yellow River basin and 61% in the Hai River basin. In contrast, the utilisation ratio in the Yangtze Basin was 18.6% (lower than the national average of 20%) and the proportion of groundwater in the total water supply was 4.2% in 1997 (SHAO Xunjun, WANG Hong, and WANG Zhaoyin, 2003, 6). Thus, owing to over-exploitation of groundwater, the level has dropped considerably in northern China. In ten to fifteen years, people will be trying to pump water from bedrock (WANG Shucheng, 10 January, 2002).

When, by the 1970s, water demand could not be met from surface flows, the North China Plain's development relied on extracting groundwater, which has caused overuse of groundwater, land subsidence, and seawater intrusion (the Bohai Gulf and Tianjin). In Beijing, the groundwater level was about fifteen metres deep by the end of 2000 and had dropped by about twelve metres since 1960 (WU Jisong, 2005, 19). In some areas, groundwater has already dried up.

Third, there have been the consequences caused by over-exploitation of groundwater. Overuse of underground water in North China causes funnels or the collapse of underground structures (see Table 5.4). The exhaustion of groundwater resources has led to land subsidence. Cangzhou City in Hebei Province has had the most significant water collapse structure. It covered 10,000 m^2 and is 109 metres below the surface. Moreover, the groundwater level in Cangzhou is falling at a rate of 1.4 metres annually (ZHENG Deming, 2002, 23).

Table 5.4 Subsidence of Some of the Main Cities in China

Cities	Land Surface Subsidence		Period
	The Total Amount in mm	The Rate of Subsidence mm/year	
Shanghai	2,638	Max. 200	1921–1965
Tianjin	2,960	Max. 200	1959–1994
Xian	2,000	Max. 300	1970–1994
Fuyang[12]	8,35	Max. 73	1970–1990
Cangzhou[13]	1,000	Max. 100	1980–1990
Suzhou	1,050	67.3	1980s

Source: JI Chuanmao, and WANG Zhaoxin (1999, 65).

The water for Beijing comes from groundwater, which occupies two-thirds of the whole water supply. Because of land surface subsidence, some infrastructures such as buildings and roads were damaged (JI Chuanmao, and WANG Zhaoxin, 1999, 64–65). Land subsidence also occurred in Taian (Shandong), and ground cracks appeared in Xian (Shaanxi Province), Datong (Shanxi Province), Handan (Hebei Province), and Yanzhou (Shandong Province) (JI Chuanmao, and WANG Zhaoxin, 1999, 65).

The fourth important point is that water shortage is becoming a bottleneck in the economic development in North China. The total amount of water shortage is 300×10^8 m^3 to 400×10^8 m^3. The economic loss by water shortage is more than that caused by flooding or waterlogging (QIAN Zhengying and ZHANG Guangdou, 2001, 4). In 2003, economic loss caused by floods and droughts was 200 billion *yuan*, which equals to more than AUS$ 33 billion (ZHANG Zhitong, 11 February, 2004)[14].

12 In Anhui Province.

13 In Hebei Province.

14 At the meeting of National Hazard Prediction,

More than 400 cities and towns are suffering from water shortages and associated damages, and the annual amount of water shortage is more than 60×10^8 m^3 (WU Jisong, 2005, 11).

Fifthly, owing to the water environment destroyed, water pollution has become serious. According to the *Water Resource Bulletin 1997*, among the 100,000 km of river length that were under assessment, the contaminated length of rivers (water quality is above Level IV[15]) amounted to 47%. In the Liao, Yellow, Hai and Huai River basins, the proportions of contaminated water in the total amount of surface runoff were ranged from 1:14 to 1:6. Among the 118 cities whose shallow aquifers were under investigation, 97.5% of them were contaminated, and 40% of them were heavily contaminated (QIAN Zhengying and ZHANG Guangdou, 2001, 4).

A serious problem was that, in some places, people who had had to drink water drawn from deep aquifers, with high fluoride content, are suffering from fluoride-induced bone disease and thyroid disease (WANG Liuquan, ZHU Haiyan and DONG Xiaoyan, 2000, 50–51). So water shortage can affect people's health indirectly as well as directly.

The foregoing problems related to water shortages in North China are real. However, whether there are adequate to justify the implementation of the STNWTP is still a question. Those problems only reveal the gravity of the water crisis in North China, but are not in themselves sufficient reasons to justify the STNWTP. Therefore, in the following section water shortages in North China will be analysed further and consideration will be given as to whether the south has the capacity to provide enormous amount of water for the north.

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http://www.nbstats.gov.cn/ShowArticle.aspx?ID=16657.

15 Water Quality is divided into five degrees in China. Grade I and Grade II are drinkable water. Grade V is the poorest level that is seriously polluted.

5.1.4 How Much Water Does the North Really Need and How Much Water Can the South Provide?

Water shortages in North China became a policy problem for the Government without much public participation and campaign. It was taken for granted that there was such a problem according to technical reports and bureaucratic decisions. However, there have been and are debates around whether and how governments should take measures to alleviate water stress in the thirsty North.

The STNWTP has been endorsed as a national policy to solve water shortages in the North, by the highest authority in the nation. However, from the beginning, there were, and are, different opinions about the Project. Therefore the diverse opinions about how serious the water shortage in North China actually is, and whether there is enough water to be diverted from the south, will be examined in what follows.

The Magnitude of the Water Shortage in North China

> On the problem of water shortage in North China, there seems to be agreement. However, on the problem of how serious water shortage in North China is, there have been, and are, different voices. Early in the 1970s, DAI Guangxiu and MAO Tongxia from the General Seismological Bureau of China held that in addition to the fresh water exploited in the Yellow–Huai–Hai area, which was about $300 \times 10^8 m^3$, there were $200 \times 10^8 m^3$ of fresh groundwater and $900 \times 10^8 m^3$ of saline groundwater which could be used for irrigation. So, there was still some latent capacity to be exploited (*Guangming Daily*, 1 August, 1979).

Some people complained that the figures for the amount of groundwater storage and its amount exploited were imprecise, owing to insufficient basic data and inadequate calculations. Different conclusions could be drawn from different calculations of the amount of water usage in agriculture, industries and daily life in cities and towns. Even those who held that the water diversion project should be built had diverse ideas as to how much water should be diverted. In a word, if a water account was not clear, planning such a project would lack a sound base (The Institute of Agricultural Economy, Academy of Social Science, 1 August 1979).

Following an 'Academic Symposium on Planning the Eastern-Route of the Water Transfer Project' held in Tianjin from 29 March to 11April in 1979, ZHOU Kaige et al., from the Science Society of China, wrote a paper questioning the figure for the water shortage, and what the figure for the water diverted from the Yangtze River would be in the final analysis. At the Symposium, Professor Huang Wanli from Tsing Hua University thought there would be 120×10^8 m^3 groundwater in Hebei Province, and another speaker said there would be 100×10^8 m^3, or even less: 30×10^8 m^3. According to the different calculations, the evaluations of the Project's investment, economic benefit and water resource utilization would obviously be different (ZHOU Kaige and CHEN Zhong, 13 August 1979).

How serious is the water shortage in North China? Some people said several hundred million m^3 of water *per annum*; others have said several thousand million m^3. Some people have thought that North China was not lacking water at all, so long as appropriate measures were taken, such as reducing the number of water-consuming industries, establishing water-saving agriculture, and not planting water-consuming crops such as wet rice. Because the amount of water resources was not precise, it was difficult to make a decision.

The famous scientist Zhu Kezhen[16] (ZHU Kezhen, 1959, 145) pointed out that:

> The figure of cultivated lands in the Yangtze River basin and the district to the south of it occupies 33% of that of the whole country, but the figure of their runoffs is 70% of that of the whole country. The cultivated lands in North China and Northwest China occupy 51% of that of the whole country. However, their runoffs are merely 7%.

So he thought water diversion was both necessary and inevitable.

Both the amount of water resources *per capita* and the amount of water per *mu* in the north are only one-tenth of that in the south, according to Evaluation of Water Resources in China (1987). Because these data were provided by powerful authorities, and no one could question them at the time, it appeared that there was a great difference between the south and north in water conditions, and that it was essential to carry out a water diversion project.

The Urgency of the Water Shortage in North China?

Facing drought and scarcity of water resources, some people maintain that the construction of the STNWTP must necessarily be on the agenda. For instance, ZHANG Youshi from the Commission of Comprehensive Survey, China Academy of Sciences, reviewed historical documents from 1470 to 1949, with the purpose of providing proofs as to whether the water transfer project was necessary or not. He argued that the historical documents showed that there occurred a drought every five years in the past 480 years, and every drought strongly affected economic development in North China. He estimated that there would be more than 500×10^8 m^3 of water to be replenished to meet the demands of industrial production, agricultural irrigation, and urban water

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16 ZHU Kezhen (1890–1974), Vice-President, later President, of the China Academy of Sciences.

consumption. ZHANG thought there was no other way than the STNWTP to solve the problem (*Guangming Daily*, 1 August, 1979).

A study by LIU Zongyao, from the Institution of Survey and Design, Headquarters of the Harness of the Hai River Project for water resources in Hebei Province concluded that most basins were under-controlled by reservoirs in mountainous regions, except for some parts of the River Luan. It was difficult to retain all the floods on the plain regions. Hence, for groundwater, the water level dropped year by year, and by 1975, the average level of the deep aquifer reached to 7.8 metres deep, and a large area of underground funnel was formed, centred in Cangxian, where it reached to more than 50 metres. There was no potential for water storage, and thus it was essential to divert water from other places, where would be necessary to built such projects in the South (LIU Zongyao, 9 May 1979).

For the idea of transferring water from south to north, discussions from various perspectives have been made by authorities who are key decision makers. National Institutions of Water Resources pointed out that in order to maintain the social and economic development during long period of droughts, both surface water and groundwater are over-exploited, agricultural water use and ecological water use are not balanced, polluted and waste water flushes into rivers without treatment. Consequently, the Yellow River dried up at some places twenty-two times between 1972 and 1999. The Huai River was contaminated seriously. For the Hai River, "wherever there is a river, there is no water in it; wherever there is water, it is polluted" (ZHANG Jiyao, 21 December, 2000).

ZHANG Jiyao[17] emphasised that it is difficult for the Yellow–Huai–Hai area to solve its economic development problem by itself. Besides, the water resource utilization in

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[17] ZHANG Jiyao, vice-minister of Ministry of Water Resources, China, and the Head of the office of the South-to North Water Transfer Project, State Council.

the middle and lower reaches of the Yellow−Hai−Hai area is at a higher level, the average utility rate (the so-called *you xiao li yong lv*) in agricultural irrigation has already exceeded 0.5, and the utilization ratio of recycled water in industries has reached 50−60%. On the basis of unified management (*tong yi guan li*) in water resources, a policy of quotas in water supply, or water supply being fixed quantitatively would need to be implemented, while at the same time, some measures in law, administration, and economy would be required to save water on a large scale (ZHANG Jiyao, 16 October, 2000).

In brief, ZHANG thought there is only option is to implement the STNWTP to solve the problem of water shortage in North China.

Is Beijing Really Short of Water?

As mentioned in most official documents, the STNWTP is intended to secure water use in the Capital. Thus water demand in Beijing was one of the principal considerations underlying the Project.

From the historical point of view, Beijing is not a city that is short of water in total quantity, though it suffers great temporal rainfall disparities through the year. Rainfall is concentrated in the summer from June to August. The Beijing area was called Youzhou for most of time from 206 BC to 907 AD. Going back to the earliest written records, Beijing has endured both droughts and floods. The earliest big flood happened in 294 AD, as a result of an earthquake (YIN Junke, YU Deyuan and WU Wentao, 1997, 1 and 7). Since 936 AD, when the political centre of China moved northward, Beijing played a more and more important role at the national level as a strategic place. It was chosen to be capital in the Yuan Dynasty (1267 AD), mainly based on military considerations and since then Beijing functioned as the centre of the country through the Ming and Qing Dynasties. In the Yuan Dynasty, floods happened about once every two years, mainly caused by intensive summer rain, while droughts happened once every three years. Following the Ming Dynasty, the frequency of floods and droughts reversed (droughts once less than every two years, and flood every three years). It is worth mentioning that one of most serious droughts happened from 1465 to 1487, which lasted sixteen years. In the Qing Dynasty, the average frequencies of floods and droughts were both around once every two years. In 1802, water even flooded the Forbidden City, which never happened before (YIN Junke, YU Deyuan and WU Wentao, 1997, 43, 89, 120, 138, 189, 277, 298). The droughts and floods were closely related. Often, droughts and floods occurred in the same year. Floods were most likely to happen in July and August, when rainfall accounts 70% or even up to 90% of total annual rainfall. Droughts usually occurred in winter and spring. As a living environment for humans, Beijing is not a place to live comfortably.

In order to rectify the situation, since 1949, reservoirs and dams have been built to regulate water resources and secure Beijing from disasters, with constructions such as the Miyun Reservoir (1958), the Guanting Reservoir (1951), and the Shisanlin Reservoir (1958). After their completion, ‘floods’ were successfully moved away from Beijingers’ daily life. However, recent droughts that have lasted for up to seven years, has led to water supply becoming an ever more serious for Beijing. Different from purely natural disasters such as drought or earthquakes, this problem is publicly known as the ‘water shortage’.

With Beijing’s population and economic development boom, shortage of water has become a major issue for the city. According to Dr Eva Sternfeld,[18] Beijing’s water crisis is caused by conflicting interests, especially the provincial-conflict between Beijing Municipality and Hebei Province. All this started from a controversy about the Miyun Reservoir (Peisert and Sternfeld, 2005, 33–46). Beijing is expanding and

18 Director of the China Environment and Sustainable Development Research and Reference Centre, Beijing.

becoming a mega-city. When its expansion affects the interests of Hebei Province, which surrounds Beijing, inevitably conflicts between two areas has emerged. However, because of Beijing's special political status, the conflict was not evident to the world at large for a quite long time.

Two main rivers, the Chaobai and the Yongding, flow through Beijing from Hebei Province, pass Tianjin, and reach the sea at Bohai Gulf. The Miyun and Guanting Reservoirs, the main drinking water sources for Beijing, are located at the border between Beijing and Hebei, and are supplied by the Chaobai and Yongding Rivers. That is what should happen in normal year. During a drought, additional water is transferred to Beijing from Hebei Province. However, because of pollution problems, Guanting Reservoir has not supplied drinking water since 1997, although after countermeasures, such as a total ban on fishing, were taken, it may be usable again by 2010 as a drinking water source for Beijing (*China Youth*, 3 September, 2006). To meet the anticipated water demand for the Olympic Games in 2008, 4 to 5 hundred million m^3 of water will be delivered to Beijing that year (*Xinjin News*, 15 July 2004).

The sacrifice of Hebei for the 'heart' of the country, Beijing, is a political act, which does not include economic compensation to the Province. In return, however, Beijing has collaborated with Hebei in some water projects. Even so, such collaborations are not direct compensations for water resources ceded by Hebei and there are no long-time agreements between the two governments. Beijing receives water from Hebei without paying actual money.

Hebei 'voluntarily' donates a huge amount of water to Beijing.[19] But to protect the water source in the Miyun Reservoir since the Guanting Reservoir has already set a bad example, Hebei (located upstream from Beijing) has to slow down its economic

[19] The amount of how much water is transferred from Hebei to Beijing is still a confidential issue, according to Sternfeld and Peisert, 2005, 37.

development in the catchment area. A particular polluter—a brewery in Fengning County, Hebei—is a clear example of the impact of small enterprises upstream on water quality in the Miyun Reservoir (Peisert and Sternfeld, 2005, 37). Beijing demands that Hebei put more effort into dealing with pollution. But wiith only one third of the *per capita* GDP compared with Beijing (UNDP and SEI[20], 2002, 116), Hebei has demanded economic compensation for the water resources taken by Beijing and essential help in the management of water, and not only for the catchment areas. A report by the Hebei Government reveals that 482 funnels have been found in the plain of Hebei, which have resulted from overuse of underground water, adversely affecting seventy counties and cities. Although Beijing has agreed to pay 20 million *yuan* to Hebei annually as compensation[21], that amount of money will only be sufficient to clear up the catchment area of Miyun, and will not be sufficient to deal with the larger environmental collapse in Hebei. If Beijing continues its political intransigence, the conflict will continue.

In fact, Beijing's role in China is beginning to expand from being a political and cultural centre to an economic, political, environmental, cultural and recreational complex, which affects its urban development. To satisfy the rising middle-class, recreational facilities such as artificial ski fields and spas—large water-consuming 'industries'—are increasing in number. In 2005, a public debate about whether Beijing should develop artificial ski-fields was initiated by an article 'Ski Fields are 'Drinking' the Water of 42 Thousand People Annually' in *Focus* (Jiao Dian Fang Tan) (31 July 2005). According to this report, thirteen ski sites in Beijing consume 3.8 million m^3 of underground water each year, which could supply the needs of 42,000 people. This report brought debate, even panic, about the unsustainable use of water in a large water-deficit city, Beijing. The Head of the Marketing Department of a Governmental organisation, 'Beijing Sports', which is subordinate to the General Administration of Sports, FANG Zheng, argued that people with common sense would know that the area

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20 SEI: Stockholm Environmental Institute.

21 Interview with Beijing Local Government Officials

of a ski resort is totally different from the area of the ski-lanes. Thus the report had exaggerated the water use of the ski-fields. In fact, he maintained, the thirteen ski spots only consume 500 to 600 thousand m^3 of water annually, according to an investigation done by China Ski Committee (*China Sport News*, 9 August, 2005).

In the event, there have been some positive results from the public debate. The Beijing Water Bureau issued new stringent regulations that required companies to comply with strict controls. The ‘ski debate’ highlighted the conflicts between urban expansion and natural resource capacity.

The water shortage in Beijing should not be viewed from the physical perspective alone. Problems such as provincial conflicts, industrial development strategies, and population policies should be also taken into consideration. Beijing should have a more explicit and limited status in the country, as a city with political, cultural, and economic significance, and not try to do everything (e.g. being the country’s financial centre). Expansion without limit, taking resources from other places, is not a long-term development strategy. Besides that, over-emphasizing its privilege over other places will only intensify conflicts with other provinces, which can be an unstable factor for society as a whole. The dispute between Beijing and Hebei is an epitome of the conflicting interests at the provincial level. The STNWTP is likely to generate analogous problems, with Beijing being seen as a plunderer of resources.

Moreover, since the promise from the Government about the STNWTP first appeared in the 1950s, the hope of getting extra water has only encouraged the water demand in Beijing, and it will continuously boost water use rather than encouraging water saving and recycling.

Is There Enough Water in the South for the North?

The water of the Yangtze River places it fourth among the world's largest rivers, with its average annual flow of more than 9,000 $\times$ 10^8 m^3. Even in the drought years its flow can be more than 6,000 $\times$ 10^8 m^3. The water volume of the Yangtze River is twenty times greater than that of the Yellow River, and forty times more than that of the Hai River. There is a belief that if only one-tenth of the water (1000 $\times$ 10^8 m^3) of the Yangtze River were diverted to the north, the water shortage in the North could be relieved. Theoretically, therefore, such a transfer is feasible, and the water diversion would not exert any substantive impact on the Yangtze River (CHANG Jianjiao, 1981, 90).

PAN Jiazheng and ZHANG Zezhen have also maintained that even if the earlier plan of Western, Central and Eastern Routes were adopted, the greatest water amount to be diverted would merely be 800–900 $\times$ 10^8 m^3, which would only be about 10% of the Yangtze River flow. The flow rate could be regulated by the Three Gorges Reservoir in drought seasons, and would not have any impact on navigation and the ecological environment (PAN Jiazheng and ZHANG Zezhen, 2001, 40).

But even in the early 1970s, some people from the Office of the Yangtze River Basin Programming and the Department of Geography, Shanghai Normal University, pointed out that there was not enough water to be diverted from the Yangtze given that the average annual quantity of water had dropped dramatically in the previous twenty years. The decline of the water supply was attributed to the fact that more water was being pumped from the Yangtze River to irrigate the cultivated land in the Yangtze and Han River basins, the lakeshore of Dongting Lake and the lower reaches of the Yangtze River.

Even the Tai Lake basin, which frequently used to suffer from water-logging, also required a water supplement from the Yangtze River. But the Eastern Route of STNWTP alone would divert 150 × 10^8 m^3 of water, which was called “the poor wanted to borrow money from the poor”. The main point was that there is no great excess of water in the Yangtze River.

Because of the STNWTP and the Three Gorges Reservoir, great changes of flow will take place at the Yangtze River estuary. Owing to the Three Gorges Reservoir project, the flow at the Yangtze River estuary decrease by 8000 m^3 per second in November and December (the dry months); and because of the STNWTP the flow will decrease by 1900 m^3 per second. Thus in total, over 10,000 m^3 of water, nearly 24.8% of the outflow at the Yangtze River estuary, will be reduced because of the two giant projects (CHEN Kun, 2004, 6).

The Han River’s Resources: The Source for the Central Route of the Project

The Han River is the major tributary of the Yangtze. It originates from the south side of the Qinling Mountains, Shaanxi, and enters the Yangtze River at Wuhan. The area of the Han River basin is 1.59 million km^2. The general amount of water resource is 606 × 10^8 m^3 *per annum* (TONG Shenzhong and LIN Zhao, 2001, 249). In the Han River catchment area, rainfall is relatively abundant, the average being 700−1300 mm *per annum* Most of the rainfall is concentrated in the period from May to October, accounting for 70%−80% of the annual total. The annual variation of runoff is relatively great, the average flow-rate being about 3,300 m^3/s in flood years and about 570 m^3/s in drought years (XU Xinwei et al., 2002, 1934).

In addition, both the amount of water resource *per capita* and per *mu* are lower than the average amount of the country, so, relatively speaking, its water resource is really not very abundant. Limited by the amount of water available at the water source district, the Central Route for STNWTP is not, by itself, able to solve the water shortage of North

China plain satisfactorily. According to the STNWTP plan, the average amount of water diverted would be 145×10^8 m^3 for the first phase. During extremely dry years, however, the amount of water diverted would be only 60×10^8 m^3 from the Han River; and even worse, the amount of water diverted from the Taocha, the channel head of the Project from the Han River, would only be $40-50 \times 10^8$ m^3 (TONG Shenzhong and LIN Zhao, 2001, 249). The question of whether there will be enough water to transfer via the Central Route remains uncertain.

5.1.5 Warnings of the Potential Negative Impacts of the STNWTP

Water Pollution

There are some problems potentially associated with the STNWTP that are not directly linked to water crisis (shortage). The reason why the cities in the North are suffering water shortage is that the water management is not operating satisfactorily.

The quality of water diverted, especially from the Eastern Route of the STNWTP is a matter of serious concern. The protecting and monitoring of the water environment is the key to the whole project. It will be ridiculous if the Project transfers polluted water to the thirsty north. So far as inter-basin water diversion on a huge scale is concerned, the ecological impact of the project either upon water resource districts or the water-accepting districts is complicated. It is difficult to draw scientific conclusions without systematic scientific monitoring and long-term research.

Therefore, the most serious problem in the Project is that people are concerned with water quality problems, especially for the Eastern Route. HUO Youguang, from Xi'an Jiao Tong University, has pointed out that the outlets of the Eastern Route are located between Nanjing and Nantong, one of the most seriously polluted areas of the Yangtze River. This concerns people, because along that part of the Yangtze River there are various factories and plants, such as chemicals factory, a textile factory, and a paper-making factory. HUO listed the serious local pollution along the Yangtze River and concluded that the water along the Eastern Route would be seriously polluted, and in some places the water quality only comes up to Levels IV–V on the Chinese standard for water quality (HUO Youguang, 1999, 37–39).

In 2000, in testing the forty-seven sections of the Eastern Route, there was only one measurement where the water quality was found to reach Grade II, one reached Grade III, and five sections met Grade IV standard, five sections were assessed as Grade V, while thirty-four sections were worse than Grade V. One had no monitoring datum, according to the statistics of the relevant authority (Institution of Environmental Plan of China, Management and Planning Bureau of the STNWTP, MWR, 2001, 52–53).

The Eastern Route was considered as the most practical route to start. However, serious pollution hampered its implementation. Compared with the Central Route now, it is difficult to carry out. According to the plan of the Project, the Eastern Route would pass through the Huai River Basin, thus pollution control in the Huai River Basin became a priority for starting the Eastern Route. Since 1994, 60 billion *yuan*, was invested to control pollution in the Huai River. However, not many progresses have been made (OU Zhengtao, *et al.*, 20 September, 2004).

Ecological Problems

Minister WANG Shucheng has urged that Chinese water conservancy projects should be ecologically sensitive, but has claimed that the diversion of water from south to north will improve the overall ecological environment, and will maintain the balance of the ecological system. The water diversion must also be accompanied by water saving (WANG Shucheng, 2006).

There are two aims for the STNWTP: one is to meet the demands of water for the economic development of North China; the other is to improve the overall eco-system. By reallocation of water resources, the ecological system that has previously been destroyed in the North will be able to be restored by pumping water underground and into the subsoil. These two aims are equally important. Therefore, for Minister WANG, the Project is desirable in order to ensure the sustainable development through the sustainable utilisation of water resources.

Water shortage is not only a limiting factor in social and economic development, but it also leads to environmental deterioration, such as the over-exploitation of groundwater, land subsidence, land desiccation, water pollution and desiccation. Water for agriculture has to be used for the water supply of cities, so that the ecological systems in agriculture are deteriorating as a consequence (Institute of the Yangtze River Water Resources Protection, 2004, 1).

However, can ecological problems caused by water diversion be solved? Are there negative influences of water diversion as well as positive ones? Some matters for consideration are the following.

Geographically the western part of China is higher in topography, and the eastern part is lower so that most of the rivers flow from the west to the east. However, the main trunk of Central Route goes from south to north, spanning 1,246 km, and crosses the natural boundaries of four major rivers (the Yangtze, Huai, Yellow, and Hai), which will alter the exchange between the material and energy in the four rivers basins, seriously affecting the ecological environment.

From an ecological perspective, the main trunk of the STNWTP's Central Route is a closed river. In consequence, the exchange between the surface water and soil water, and the exchange of microorganisms, together with the exchange between surface water and soil water will be stopped.

Regarding water-receiving areas, the total volume of water diverted to the North is to be 130×10^8 m^3, considerably in excess of the annual natural flow (merely 276×10^8 m^3) there. Can water-receiving districts (Beijing, Tianjin, Hebei, Henan) absorb such a large amount of diverted water? After so much water has been diverted there, the previous balance of natural water system will be radically changed. This area is semi-arid, and the amount of evaporation of surface water is great, so *soil salination can be anticipated*. As the consequence, more water will be needed to wash the salted material from the soil. Therefore, in effect, water diverted cannot meet water demands of the north, but will result in a more serious water shortage. (Cf. the Aral Sea and Australian cases.)

Public Health Problems

Schistosomiasis japonica is one of the serious epidemic diseases of South China, in provinces such as Hubei, Hunan, Jiangxi, Anhui, Jiangsu, Sichuan, and Yunnan and at the time of writing the number of patients is about 0.81 million. So far as the water diversion is concerned, is there the possibility of Schistosomiasis japonica spreading to the north through the water diversion channels? Some people think that, at present, the water in the southern part of Grand Canal flows from north to south, so that the area of Schistosomiasis japonica is restricted to the south of Baoying, in Jiangsu Province (33^o N). In the near future, once still water condition is formed as the result of water being pumped and held back grade by grade in the Eastern Route, with the water flow going from south to north, it is important to considerthe problem of Schistosomiasis spreading to North China (CHANG Jianqiao, 1981, 94; MIAO Feng and FU Zhaoyi, 2005, 235; MIAO Feng, YANG Guohua and ZHAO Bo, 2004, 18; CHEN Yiqiu, 25 March 1979).

Salination

In the 1950s and 1960s, large-scale irrigation in Hebei, Shandong, and Henan Provinces, along with water storage projects in those provinces, destroyed the drainage systems, leading to serious soil salination. The area of saline soil soon increased from about 28 to 61 million *mu*, with disastrous results. The great intercepting bank on the Yellow River had to be bombed out, a building that was obstructing the drainage was demolished, the irrigating ditches were levelled, and the irrigation was stopped. Now it is estimated that the area, including salinated soil (40 million *mu*), that with soils liable to be salinated and those with barren salinated soil, occupies 26% of the total area of the Yellow–Huai–Hai plain (ZUO Dakang, LIU Changming and XU Yueguang, 1982, 31−39). ZHU Shouquan *et al*., from the Institute of Soil Science of the Chinese Academy of Sciences, have given an analysis of why the Plain is prone salination. They suggest that owing to the influence of the monsoon, this region has always suffered from drought in spring, and flood in summer. In addition, the area is low and flat, the drainage system is not in good condition. Moreover, there are some salt ingredients in the subsoil and groundwater. Thus, during drought season, water in the soil evaporates and the salt in the soil is accumulates near the surface continually. They predict that a condition contributing to secondary soil salination will occur, and secondary salination will be more likely after the Eastern Route is completed (ZHU Shouquan *et al*., 1984, 111).

At the 'Academic Symposium on the South-to-North Water Transfer Planning' (1979), the distinguished agronomist XIONG Yi explained in details in 1979 that the Eastern Route would be very likely to give rise to grievous salination. There were three reasons:

a. Conveying water by the Eastern Route would follow the Beijing−Hangzhou Grand Canal and would inevitably intercept the existing drainage systems and the natural trend of drainage from the west to the east.

b. Building dams on the rivers' beds, and pumping water through fifteen pumping stations, would increase the seepage of water along the banks.

c. Conveying water through channels and water storage on the Plain would inevitably increase the likelihood of salination. He wondered why, given that irrigation by diverting water from the Yellow River had caused salination, people were sure this would not occur further due to water diversion from the Yangtze River by electric pumping.

XIONG argued that drought, water-logging, and soil salination co-exist in North China. The water diversion, and comprehensive regulation and controlling of those disasters in the Yellow–Huai–Hai basin should be considered together. He thought that if the problems were not given full consideration, even if the water were diverted to the north, it could not bring benefit to people there. Rather, it would cause a water disaster (XIONG Yi, 1 August, 1979).

Algal Blooms

The Han River meets the Yangtze River in the area of Wuhan. Usually, the flood period of the Yangtze River begins earlier than that of the Han River, and the Yangtze flood period ends later than that of the Han River. Therefore, during the medium flow period of the Han River, the high water level of the Yangtze River will hold it back, slowing the flow rate of the Han River. After the Central Route project of water diversion is completed, the flow of the Han River during the medium flow period would increase somewhat, as compared with that during the low flow period. The water level would be lower, and the holding back effect due to the Yangtze River would become more obvious. Consequently, the flow rate of the Han River will be effectively slowed down. At the end of spring and the beginning of summer, or late autumn and early winter, corresponding to the periods of medium flow, the weather is fine, and sunshine is plentiful, daily average temperature being about 20^{o} C. This is the optimum temperature for algae to reproduce, and the slow flow-rate of the Han River will be accompanied by algal blooms (SHA Hongxun, 1998, 23–24).

Seawater Intrusion

One of major environmental consideration is seawater intrusion. At Yangtze River estuary, sometimes, the seawater invades more than 200km inland. In dry season, intrusion of seawater is more serious. In 1978, the middle and low reaches of Yangtze River was attacked by drought, the amount of water entering the sea decreased, and a huge volume of seawater invaded, and water turned salty in Shanghai for quite a long time (CHANG Jianjiao, 1981, 98). This was situation before the STNWTP is put into operation. A large volume of water (total amount is 448×10^8 m^3) being transferred to the north will decrease the natural flow of the Yangtze into the sea and encroachment of the sea in the river's delta area will result. In fact, this is already happening. Residents in Shanghai sometimes can find tap water tasted a little bit salty. (*Jiefang Daily*, 3 January, 2002).

5.1.6 Are Other Options Available?

The Possibility of Water Savings

Table 5.3 ('Demands and Supplies of Water Resources in the Yellow–Huai–Hai Area') provides some information about water shortage. The amount of water shortage at present is about 130 to 180 $\times$ 10^8 m^3, of which 53 $\times$ 10^8 m^3 applies to cities. It has been estimated that by the year 2010, it will be about 190 to 260 $\times$ 10^8 m^3, of which the shortage in cities will be 87 $\times$ 10^8 m^3. By 2030, it will be 347 to 407 $\times$ 10^8 m^3, of which the city shortage will be 150 $\times$ 10^8 m^3. (ZHANG Jiyao, 26 October, 2002).

These figures suggest major problems for the future.

But there are two ways to solve water shortage problems: one is to explore for and exploit water sources; the other is water conservation.

Water saving in North China has already been achieved by a series of measures, such as adjusting the industrial structure, increasing the repetitive utilisation of water in industries (recycling), enlarging the areas of irrigation that use water-saving methods, and raising the efficiency of the utilisation of the channels. In the Yellow–Huai–Hai area, it can be predicted that by the year 2010, 149×10^8 m^3 of water may be saved, and by the year 2030, 134×10^8 m^3 of water could be saved (ZHANG Jiyao, 26 October, 2002).

Nevertheless, the water shortage in North China, especially in the Yellow–Huai–Hai area, is incompatible with social economic development and protection of the ecological environment. This problem is so serious that it is difficult to solve by water-saving alone and tapping the full potential of local water resources. In order to release increasingly sharp conflict between water supply and water demand, besides water-saving and so on, the STNWTP should be constructed to realise rational allocation of water resources (ZHANG Jiyao, 26 October, 2002).

The amount of water for irrigation accounts for approximately 70% of the total amount of water in agriculture. But with flood irrigation, half the water is lost by seepage and evaporation, and about 30−35% of the water is wasted in using flood irrigation. The water for irrigation exceeds by 0.5 to 1.5 times the reasonable amount of water (CHEN Kun, 2004, 8)

In North China, the annual amount of water supply for agriculture is 99.9 billion m^3, and the amount of water demand is 118.0 billion m^3. The utility ratio of water in agriculture in the North China is relatively higher than in the South, but is still only about 50%. That is to say, about 49.9 billion m^3 of water is wasted. If the utility ratio of water in agricultural irrigation could be raised to 70%, that would increase the water supply by 19.9 billion m^3, which could be enough to solve the problem of water shortage in agriculture in North China (CHEN Kun, 2004, 8).

At present, the area where people use spray and drip irrigation only is 1.5% of the whole irrigation area (compare USA, 40%; former Soviet Union, 47%). According to a rough estimate, if the utilisation rate of water in agricultural irrigation could be raised from 0.5 to 0.7, there would be $1000-1200 \times 10^8$ m^3 of water saved (CHEN Kun, 2004, 8).

As for water used in industries, the amount of water used per ton of product is several times as much as that in developed countries, i.e. for China, the amount of water per ton of steel is 70 to 100 ton, but for Japan, the amount is only two tons to produce one ton of steel. The Chinese rate of water recycling in industry is only 20%, compared with over 70% in developed countries.

Water wastage is also serious in Chinese households. CHEN Ming, Head of the Office of National Water Saving, has pointed out that the amount of water used by flush toilets is one-third of the water used in daily life. In addition, the seepage rate of the pipeline-web of the water supply system in China has, in fact, reached about 35% (LI Hujun and ZHU Liyuan, 17 August, 2001).

In 2000, the amount of live sewage discharge was about 220×10^8 m^3, which was 90% of the total amount of water used. Only 10% of sewage was treated. If the recycling rate were 30%, then there could be 66×10^8 m^3 of additional fresh water. (CHEN Kun, 2004, 10)

Only when the public realises the importance of water saving, can it efficiently promote water saving in practical management. In 2004, the Social Survey and Investigation of China carried out an investigation into the public awareness of water saving: in Beijing, Shanghai, Canton, Wuhan, Changsha, Shenyang, Changchun, Xian, Chongqing, and Zhengzhou. About 1,500 people responded to this questionnaire (see Table 5.5).

Table 5.5 Questionnaire on the Public Awareness of Water Saving

Items	Responses	Percent
Do you know anything about water-saving?	Yes	27%
	Uncertain	54%
	No	29%
Do you think about applying water saving strategies?	No, and do not intend to do so	31.2%
	Sometimes	56.2%
	At any moment	12.6%
Do you have the same attitude to water saving when at home and at other places?	Pay attention both at home and at other places.	52.1%
	Same at home and other places	47.9%
	Pay attention in other places, not at home.	0.0%
Do you think there is any relationship between you and water saving?	Yes	28%
	Never considered the matter before	48.2%
	No	23.8%
Do you worry about water shortage?	Yes	14.3%
	No idea	35.7%
	No	50%
What is your attitude towards increasing the price of water?	Support	26%
	No idea	31%
	Against	43%
Other suggestions about water saving?	Education	76.4%
	Restricting amount of water use	54.3%
	Stopping water supply sometimes	49%
	Punishment	41.4%

Source: DONG Min, WANG Xing (Social Survey and Investigation of China), Questionnaire on the Public Awareness of Water Saving[22]

From the table, it can be seen that in response to the question 'Do you know anything about water saving?', only about 27% of participants' answered 'yes'. And to the question 'Do you think there is any relationship between you and water saving?', about 48.2% of respondents had apparently never considered this question before. This reflects that on the one hand, public perception of water shortage is not a 'big deal', at least at present; and the idea of water saving is not on people's minds; on the other hand, there is great potential for promoting water saving, if policies can encourage its popularity.

The Deputy-President of the Chinese Academy of Engineer, PAN Jiazheng, pointed out that "If some provincial and municipal authorities were not serious in water saving, sewage purified, and increasing repetitive utilization rate, even if water from the Project comes to your place, we would not permit you to use. [We would not let] great water transferring project become great waste, great pollution, even great corruption" (PAN Jiazheng, 2000, 27). However, in practice, not many people are willing to take actions, because it is difficult to show their achievements in short period.

5.1.7 Other Approaches to Solving the Problems of Water Shortage

a. Relocation or Replacement of Industries?

Most of the large cities in the north of China and along the coast are in need of water. But their construction projects start one by one, and in an unco-ordinated way, regardless of water resources already being near crisis point. Taking Tianjin as an example, since the 1970s, there have been seven water crises, and various water diversion projects have been built, with water diverted from Luan River, and from the

22 www.chinasurvey.com.cn.

Yellow River. Now water is wanted from the Yangtze River! The inadequacy of the earlier projects shows that water shortage problems cannot be solved only by water diversion. From an ecological and economic perspective, removing factories may be more economical, more rational, and technologically safer. Large plants should not be allowed to be built in the North, and water-demanding industries should be distributed near the large southern rivers (such as the Yangtze), whose water resource occupies 80% of the whole (LIU Shiqing, 2001, 40).

b. Desalination of Seawater

Desalination of seawater is a programme that has been claimed to have lower costs and greater benefits than the STNWTP. The average cost of desalinated water is 6.5 *yuan*/m^3 (CHEN Kun, 2004, 7). The difference between desalination and fresh water is about 0.95 *yuan*/m^3, so the cost of desalinated water is lower than that of diverted water diverted. However, energy costs for desalination may increase greatly in the future and the production process for the generation of electricity for the desalination process adds significantly to carbon dioxide pollution in the atmosphere.

c. Conservation of Water and Soil at the Middle Reaches of the Yellow River: An Alternative Approach to Water Shortage in the North

There are great quantities of sands in the Yellow River, and a large amount of water has to be used to wash the sands. If more investment were put into the conservation of water and soil, say, about 500×10^8 *yuan* (equal to the estimated investment in the Central Route of the STNWTP), it would definitely solve the problems of water shortage and soil erosion in the Yellow River basin, and amount of sands could be reduced by 90%. Thus, a large amount of water, which was previously used to wash sands in the Yellow River, could be saved—about 220×10^8 m^3 of water. The efficiency of water resources by this approach would be superior to any achievable by implementing any of the three routes for the STNWDP (JIA Shaofeng, 1994, 33; FANG, Zongdai1991, 196–198).

Reforestation should also be considered. The STNWTP's opponents think that the target should be increasing water resources, instead of water diversion. Planting trees is a way of making water. A tree is a small reservoir; a large forest is a great reservoir, and the forest can either store or discharge water, and local precipitation can be formed.[23]

d. Relocating the Capital

There are proponents of relocating the capital who think that dust storms will eventually bury Beijing, just as they did the ancient city of Loulan in Xinjiang. As the Capital's population and social economy are developing apparently without limit, water resources have become a critical problem (WU Jisong, 2005, 5). The only way is to remove the Capital to some other place. Some people have suggested that Wuhan could be a suitable candidate, while Guangzhou has also been proposed. However, choosing an alternative city as the Capital will not, in practice, reduce water demand in North China. But it will have a negative political impact on the country and realistically the proposal will almost certainly never be implemented.

e. Underground Reservoirs

Professor HUANG Wangli, who had criticised and strongly opposed suggestions from Soviet Union experts about building a dam at the Sanmenxia, considered that, based on the natural rainfall in North China, water deficiency is not a problem. However, the present water shortage is mainly caused by evaporation. In 1979, HUANG suggested

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[23] There is a debate on whether a tree is a small reservoir, or a pump. Forest resources are preconditioned by water resources. There will be no life, no tree, no forest, if no water. Only in those districts where the precipitation is much enough, can a forest be formed. Generally speaking, the precipitation is above 400–500mm.

the construction of an underground reservoir to store some of the water from precipitation. He took Nangong, Hebei Province, as a Chinese example and North Africa and Israel as overseas examples (FANG Zongdai, 1991, 197).

Against HUANG and others, YAO Bangyi[24], the former Head of the Administration Bureau for Planning and Design of the STNWTP, argued that building such a reservoir underneath the land surface was under investigation, which used ancient river channels. However, some of the proposed techniques needed further study. It is one-side of the coin, and there is no warranty in practice to solve the drought of the Hai River Basin by reducing the evaporation of shallow groundwater, and depositing $200-300 \times 10^8$ m^3 of water more in soil from the precipitation. How could this approach be followed? (YAO Bangyi, 21 November, 1979).

5.1.8 Some Responses to the Different Opinions

Authorities have responded, in various ways, to these different opinions. YAO Bangyi argued that in practice not all irrigation causes salination; therefore, not all water diversion projects will lead to soil salination. As for the water pollution problem, he admitted that water had indeed been seriously polluted, but he did not think that the STNWTP would cause water pollution problem (YAO Bangyi, 21 November 1979).

In a book, *Comprehensive Report on Optimal Allocation of Water Resources in North China and Some Problems about the STNWTP* in 2001, PAN Jiazheng stated that for more than twenty years, people from the Ministry of Water Resources, and the Academia, have undertaken numerous researches in laboratories and have made many analyses and given much consideration to the problem. Now they have more precise knowledge about the adverse influences upon environments, and countermeasures to such influences. The problems are:

24 YAO won the Special Award for the Design and Planning of the South-to-North Water Transfer Project from the Ministry of Water Resource in 2004.

a. Diverting water will cause salt water to invade inland waterways around the Yangtze's estuary district; and deposits will clog up the Yangtze's channel.
b. Salination in the water receiving area;
c. The possibility of a schistosomiasis epidemic shifting to the north;
d. The influence upon the marine life in the adjacent seas and the lakes along the water-diversion routes.

PAN stated that research showed that the adverse influences of diverting water in these aspects are very limited, or even without influence at all. Moreover, some countermeasures can be adopted to prevent such developments. However, he emphasized the need to strengthen the observation and examination of the environment and to master and understand the regular (natural) patterns of environmental change (PAN Jiazheng and ZHANG Zezhen, 2001, 41).

In the Programme of Ecological Environment Protection of the STNWTP, it has been acknowledged that the Eastern Route will lead to seawater invasion of the Yangtze estuary. A proposed countermeasure would be to stop the water diversion when the flow rate reaches 9,500 m^3/s at the Datong Hydrologic Observatory (the Observatory at the lowest reach of the Yangtze River) (Project Management and Planning Bureau of the STNWTP, MWR, 2001, 160).

The amount of water diverted in Phase I of the Central Route will be reduced from 14.5 billion m^3 to 9.5 billion m^3, for the sake of the ecology and environment of the middle and lower reaches of the Han River—not because of investment problems.

HAN Yifang stated that the probability of 'algal blooms' would increase from 10% to 20%, under conditions, like in those proposed, when the amount of water diverted was

14.5 billion m^3; but when the amount of water diverted was 9.5 billion m^3, the probability of 'algal bloom' occurrence would not increase, on the basis of simulation analysis.

The Institution of Environmental Planning of China, Management Bureau of Planning and design of the STNWTP, MWR has also expounded the 'algal bloom' problem. After the Central Route project is completed, the water flow rate will not decrease significantly in that part. On the contrary, the variation of water flow rate in the middle and lower reaches of the Han River will be stable, and compared with the present variation, the range of variation in the density of water quality will be in equilibrium, compared with the present situation. Water diversion will not cause any radical variation in water quality. The Bureau draws the conclusion that considering hydrological factors, diverting 95×10^8 m^3 of water will not result in increased algal blooms, as deduced from the simulation experiments, making comparison with the conditions that obtained when algal blooms occurred during the period from 1956 to 1998. Therefore, water diversion will not cause an increase in the annual frequency of blooms (Project Management and Planning Bureau of the STNWTP, MWR, 2001, 128−131).

As regards the algal bloom problem, one approach mentioned above is to decrease the amount of water diverted from Danjiangkou Reservoir. Another approach could be to transfer water from the Yangtze River to the Han River. After the Project is completed, the water flow rate will increase at some parts, so that places where algal blooms used to occur will no longer be conducive to algal growth. On the other hand, owing to the strengthening of abilities in diluting pollutants in water and self-cleaning, bloom occurrence in the middle and lower reaches of the Han River will decrease considerably, and algal blooms can be well under control (Institute of the Yangtze River Water Resource Protection, 2004, 92).

When the STNWTP started on 27 December 2002, ZHANG Jiyao, the Deputy Minister of Water Resources, again emphasised that there would be countermeasures put in place to cope with the unfavourable influences aspects of the diversion. ZHANG at first acknowledged that the Project would have some negative influence on the environment, but, he maintained, the problems could be solved. When making the plan for ecological protection, the water quality in the Eastern Route and the influence of the Project's Central Route upon the ecology of the middle and lower reaches of the Han River, and the influence of the Eastern Route on seawater invasion of the Yangtze estuary, were given special attention. ZHANG claimed that the Diversion would not only provide a 'clear water corridor', but also 'a green corridor (ZHANG Jiyao, 3 February, 2003). However, methods will be adapted to deal with negative impacts are still sealed.

5.1.9 Defining the True Problem: A Summary

The motivation of the STNWTP has a long historical and cultural background. Even in ancient times, Chinese society was 'water projects-prone'. Economic disparities were viewed from a 'water makes a difference' perspective. Since 1949, following the previous Soviet Union model, China has been even more keen on engineering projects that can display human power over the nature. Most arguments over the STNWTP are still centred on engineering and technological perspectives, and ignore social factors. To be sure, there have been some environmental arguments. However, once the decision to proceed was made, arguments about the negative environmental impacts were easily ignored. Alternatives to the Project are regarded as starry-eyed notions. There is no doubt that the preliminary research for the STNWTP left many questions unresolved, such as whether there is enough water to divert, how to maintain water quality in the Central and Eastern Routes, and how much water the north really needs. Such questions cannot be solved satisfactorily unless abandonment of the Project becomes one of options!

5.2 Policy Formulation

5.2.1 Introduction

In the policy formulation, after a preliminary decision is made, discussion will focus on selecting the optimal policy arrangement. The choice of one proposal rather than another is a result of interaction between different interest groups. Each party that is likely to be affected by the policy weighs its potential gains and losses and tries to influence the policy-making process accordingly. In the case of the STNWTP, this process has been and still is reflected in the negotiations between the Central Government and local governments, and among the local governments the water receiving and diverting areas each have their own interests.

The proposals about the routes for the water transfer have inevitably led to heated debates. Discussion here will be focused on the proposals about those routes that were given official consideration, even if they were not eventually selected or implemented. In these proposals, some basic factors, such as water sources, the scale of the diversions, the routes for the water transfer, and the ways in which water is to be conveyed, have varied in some degree. Many factors are involved in policy-making in relation to water resources projects. As ZHU Chengzhong, the former Director of the STNWTP Planning Office, pointed out, hydraulics is different from other scientific/technological subjects, because essentially half of hydraulics falls in the category of science while half of it is social science. In planning process of water projects, in addition to the scientific and technological rules, some other factors have to be taken into consideration, such as 'geopolitics', harmonising the interests of the inhabitants of the upper and lower reaches, between right and left banks, between various provinces and districts, etc (LI Meng, 23 May, 2005). Only in this way, can a reasonable plan be arrived at. A plan for water projects is, in most cases, not optimal from the point of view of science and technology, but is the best available consensus that can be achieved by people with various interests.[25]

So far as the STNWTP is concerned, it is an undertaking of enormous scale, and both its positive and negative influences are great and far-reaching. It is not easy to make a decision. But here I shall discuss how the key decision-making was undertaken, so far as it can be understood from what is on the public record.

In September 2002, the then State Development Planning Commission (SDPC[26]) and the Ministry of Water Resources (MWR) jointly completed *The Outline of the STNWTP*, including twelve appendixes and forty-five special reports of researches on special aspects of the scheme. The *Outline* described the layout of 'four latitude and three longitudinal water courses', the former means the Yangtze, Huai, Yellow, and Hai Rivers, the later meaning the Eastern, Central, and Western Routes of the STNWTP (see Figure 5.5). The total volume of water transferred is planned to be $448\times10^8 m^3$. It is planned to complete STNWTP in 40–50 years.

25 The Snowy Mountain Scheme is a good case in point.

26 This body has changed over time and has been renamed twice. From 1952 to 1998, it was called 'State Planning Commission' (SPC). From 1998 to 2003, it was named the 'State Development Planning Commission' (SDPC). From 2005 up to now, it is named the 'National Development and Reform Commission' (NDRC).

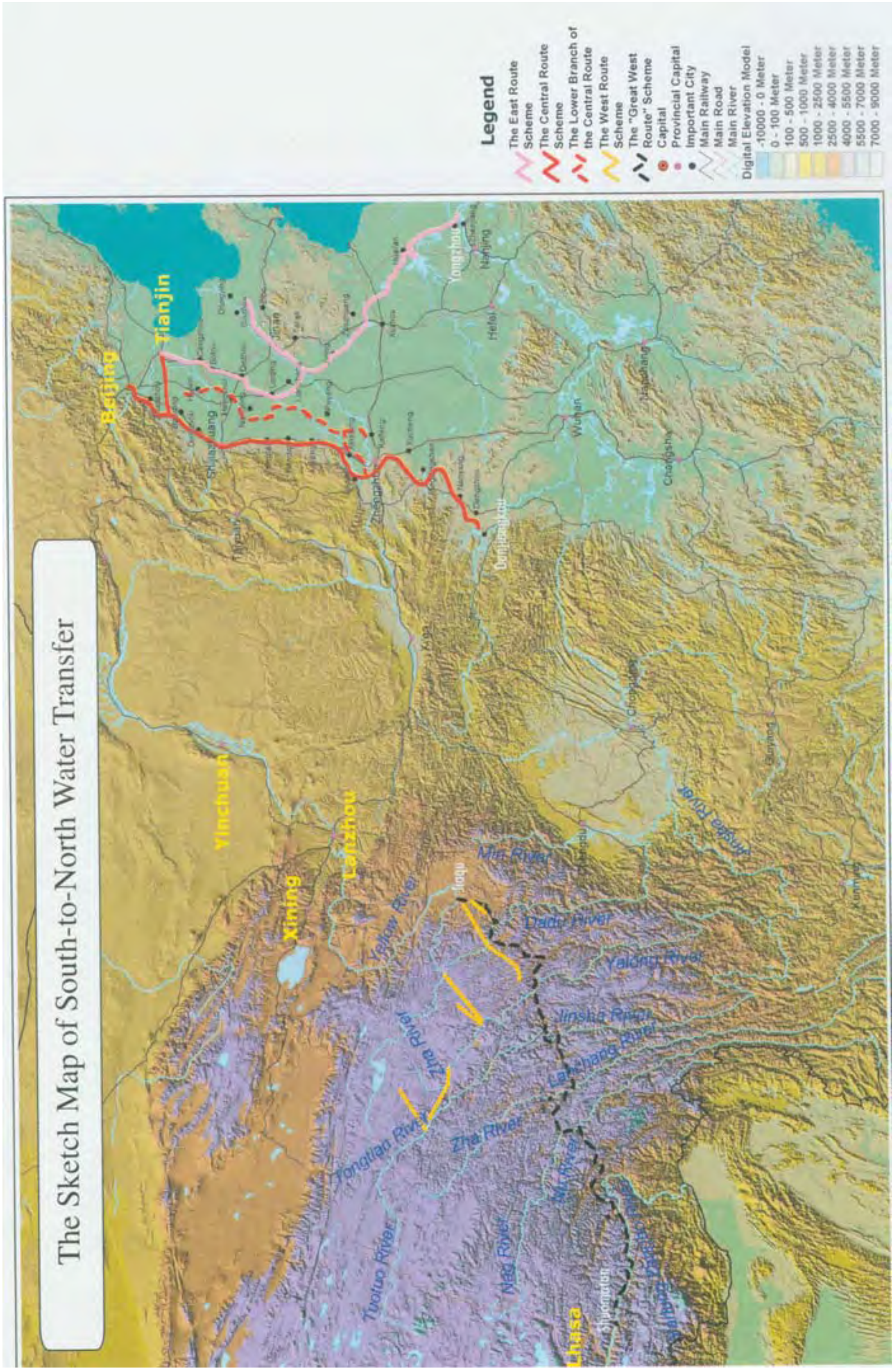

Figure 5.5 The Sketch Map of South-to-North Water Transfer[27]

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27 Source: (WANG Shucheng, 2006, 95)

As mentioned previously, and as shown in Figure 5.5, the STNWTP includes three routes, the Eastern Route, the Central Route, and Western Route:

a. The Eastern Route

The water source is Jiangdu (near Yangzhou, Jiangsu province). Water is moved by step-wise pumping and transferred from the Yangtze River to the north, along the Jing−Hang Grand Canal and its parallel rivers. When water reaches Dongping Lake, the route will be divided into two parts: one will flow northwards, joining the Yellow River and flowing to the Datun Reservior near the city of Dezhou. The scheme in Phase 1 is expected to be completed in 2007. The total amount of water diverted will reach 89 $\times 10^8$ m^3. The route will extend to Hebei Province and Tianjin Municipality in Phases 2 and 3. The total length of the Eastern Route will be 1,156 km, and the annual amount of water diverted will be 148 $\times 10^8$ m^3.

b. The Central Route

The Central Route starts at the intake of the Taocha Canal of the Danjiangkou Reservoir, with water flowing by gravity. The Central Route will pass along the west of the Tangbai River Basin, cross the watershed divide of the Yangtze River and the Huai River, and then go north along the west of the Yellow−Huai−Hai plain. The Central Route will run 'across' (under) the Yellow River near Zhengzhou, and then go north by gravity to Beijing and Tianjin, flowing in a channel constructed along the west of the Beijing–Guangzhou railway. The total length of transfer canal is 1,427 km (the Tianjin part is 154 km). The annual average amount of water diversion will be 95 $\times 10^8$ m^3. The scheme in Phase 1 is intended to be completed in 2010. Water diversion in Phase 2 will increase to 135 $\times 10^8$ m^3, when taken together with the amount of water diverted in Phase 1.

c. The Western Route

Reservoirs or dams will be built in the Dadu, Yalongjiang and Tongtian Rivers in the upper reaches of the Yangtze River. Then tunnels for water diversion will be drilled in the Bayan Har Mountain: the watershed divide of the Yangtze River with the Yellow River. Thus water from the Yangtze River will be diverted to the upper reaches of the Yellow River. The project will be divided into three stages. The amount of water diverted in Phase 1 will be 40 $\times 10^8$ m^3. Construction is planned to start in 2010[28] (ZHANG Guoliang, XU Xinyi, and LI Yuanyuan, 2003, 334−338).

5.2.2 Decision-making Stages of the STNWTP

It took half a century from the idea of the STNWTP being put forward in 1952 to 2002, when it was actually started. The decision-making process can be divided into three stages.

Stage 1: Preparation Period (1952−1961)

When people were preparing the Yellow River basin plan and the Yangtze River plan, the problem of inter-basin water diversion came to the fore. From 1958 to 1961, the Yellow River Water Resources Commission organised about 400 people to make successive survey and design schemes. They investigated the possible routes for water diverted from the Jinsha River to the Yellow River, and the possible amount of water that might be diverted. They suggested that the possible maximum quantity of water to be diverted was 5,000 $\times 10^8$ m^3, and four possible routes for water transfer were

[28] In 2006, a book edited by LIN Ling and LIU Baojun, *Memorandum of the Western Route of the South-to-North Water Transfer Project* raised public attention to potential negative impacts caused by the Western Route. As a result of that, MWR announced at the end of 2006, the proposal for the Western Route would be delayed and there was no confirmation of new timetable for the Western Route. Therefore the Western Route is in a stage of suspension.

considered. (It is worth mentioning that this was the time of 'Great Leap Forward'.) The planning of the Central Route was in the hand of the Office of the Yangtze River Basin Planning (the forerunner of the Yangtze River Resources Commission). In 1957, this Office submitted to the MWR a report, *Main Points in the Planning of the Han River Basin*, in which the necessity, proposals, and time-span of the proposed water diversion from the Han River to the Yellow River and Huai Rivers, the allocation of water, investment and other matters, were analysed.

It should be highlighted that in *A Report on the Main Points in the Planning of Water Resource Comprehensive Utilisation in the Yangtze River Basin* (1958), by the Office of the Yangtze River Basin Planning, the authors proposed to divert water from the upper, middle, and lower reaches of the Yangtze River: in the upper reach, water diversion would be from the Jinsha River to the Yellow River; in the middle reach, it would be diverted from the Danjiangkou Reservoir to the Yellow and Huai Rivers; in the lower reach, it would be diverted along the Grand Canal from the Yangtze River to the Yellow River and Huai Rivers. Prior to the planning for the Yellow River, Huai River and Hai River basins, the plan for the STNWTP had already been accepted as a strategic measure for the future development of water resources in China.

It is well known that in 1952, Chairman MAO suggested the notion of the STNWTP. Thereafter, many Chinese leaders mentioned the plan at various major conferences. At the meeting of the Central Politburo of the CPC in 1958, held with additional persons in attendance at the Beidaihe resort, Hebei Province, the idea of water diversion from the south to the north was suggested (i.e., connecting the Yangtze, Huai, Yellow, Han, and Hai Rivers), thereby forming a unified water resource system for China.

The Danjiangkou Reservoir scheme can be taken as a kind of 'epitome' of the Project, as it was in its early stages. In the 1950s, the Planning Office of the Yangtze River Basin[29]

[29] The name has been changed since 1998 and now it is called Yangtze River Water Resources

and some other institutes began to make a plan to build a reservoir at Danjiangkou (adjacent to Wudan Mountain, about 500 km northwest of Wuhan), and the plan was approved by the Central Political Bureau of the CPC in 1958 (LAO Xi, 1997, 42−43). At that time, the top of the Danjiangkou Dam was planned to be 175 m above sea level, and the level of the stored water would be 170 m. The purposes of the project were flood protection, the generation of electric power, irrigation, and shipping. In the future, the reservoir would also have a function in diverting water to the Yellow and Huai Rivers.

The project started on 1st September, 1958. However, during the construction, China experienced three years of economic depression. In addition, the Soviet Union's experts were recalled because of the deteriorating political relationship between the two countries. It was therefore beyond China's capacity to continue such a huge project at that time. The former Ministry of Water Resources and Hydropower submitted a report, recommending the reduction of the scale of the project, which was approved by the State Council in 1964. Thus the elevation of Danjiangkou Dam would be 162 m, and the water level would be 157 m. This project was completed on 24 February 1974.

From 1950−1960s, water resources and hydropower development in China were constrained not only by technology, but also by investment problems, as was the case in the history of the Danjiangkou Dam and Reservoir. In addition, the water resources and hydropower development were influenced by international politics.

Therefore, in the preparing stage, two factors, technology and economy, were essential to the development of water resources and hydropower; and political, even international political, factors played an important role.

Commission

Stage 2: Designing the STNWTP (1972−1994)

a. Planning the STNWTP: Focus on the Eastern Route

In 1972, a severe drought led to the start of the water crisis in North China. To meet the water demand at that time, the Ministry of Water Resources and Hydropower considered the possibility of diverting water from the Yellow River. However, it was estimated that only 15−20 $\times 10^8$ m^3 of water could be diverted from the Yellow River in winter and spring, which could not meet the demands. In addition, it was difficult to dispose of the sands in the Yellow River. Therefore the suggestion of a diversion from the Yangtze River was taken into consideration as a long-term measure was examined. In 1973, a 'Planning Group of the South-to-North Water Transfer Project' was formed and began to study plans for water diversion from the Yangtze River to North Chain Plain. The Group thought that the Central Route project would be difficult to complete, but the route along the Grand Canal was feasible, though its cost would be high, because it needed pumping water level by level.

In 1977, the Ministry of Water Resources and Hydropower, the Ministry of Communication, the Ministry of Agriculture and Forests, and the Ministry of the Industry submitted *A Report on the Near Future of the STNWTP* to State Council. In that Report, a water diversion project was suggested, involving the diversion of the Yangtze River to Tianjin and the Hai River Basin following the route of the Grand Canal. In 1978, more than a hundred people from various Ministries and Committees, universities, and the Chinese Academy of Sciences, along with people from the interested provinces and municipalities, began a survey along what was to become the Eastern Route, and following their preliminary examination of the problem, it was agreed that this Route could be taken as the initial part of the STNWTP.

b. Planning of the Eastern, Central, and Western Routes

For this stage, an important meeting should be mentioned. CHEN Yun, then Vice-Chairman of the Central Committee of the CPC, wrote a letter to QIAN Zhengying, then the Minister of the Ministry of Water Resources and Hydropower, suggesting that several meetings be held, letting people state their different opinions, taking some lessons from the San Men Xia Project.[30] This meeting was held from 29 March to 11 April, 1978, in Tianjin. About hundred people attended the 'Academic Symposium on the South-to-North Water Transfer Project Programming', discussing the exploitation of water resources in the north, the magnitude of the water shortage, and alternative water diversion routes. Obviously, there were diverse opinions at the meeting, some of which I have discussed in previous sections.

In October 1978, the Planning Office of the STNWTP was set up, which was in charge of organising and giving instructions to the Project. On the 12 December 1979, the Ministry of Water Resources (the part of Hydropower that had been incorporated within the Ministry of Electrical Power) issued 'A Notice about the Strengthening the Planning of the South-to-North Water Transfer Project', in which proposals of the Western, Central, and, Eastern Route should proceed separately. The three Routes would be examined by the Yellow River Water Resources Commission, the Planning Office of the Yangtze River Basin, and the Huai River Water Resources Commission, respectively.

In 1980, officials and experts from the United Nations and the United Nations' University (in Tokyo), along with Chinese officials, made a survey along the Project's Central and Eastern Routes. They thought that in terms of technological feasibility, both Routes had no insuperable problems. So further research should be undertaken on the

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30 San Men Xia is a dam on the Yellow River constructed in the 1960s for the purposes of electricity generation and flood control, which has resulted in a major sediment problem.

financial and environmental aspects.[31]

In January, 1988, after more than a year of work, the China International Engineering Consulting Corporation (CIECC) finished its *proposals for the First Phase of the Eastern Route*, and submitted its evaluation results to the State Council. The China International Project Consultant Company pointed out that the project plan had no outline, and it had not yet been determined how much water would be diverted to North China. In consequence, in December, 1992, a *Revised Feasibility Study of the First Phase of Eastern Route* was issued.

From 15 April to 16 May, 1980, about sixty experts were organised by the MWR to make a survey from the Dangjiangkou Reservoir (the proposed water source district), to Beijing. They thought the water in the source district was of high quality and that the terrain along the trunk of the proposed water conveyance channel was sufficiently level. This was therefore thought to be a relatively better route for an inter-basin diversion than the Eastern Route.

In 1987, the Planning Office of the Yangtze River Basin completed *Proposals of the Central Rout*. In 1991, this Office finished another report: *A Report on the Preliminary Feasibility Study for the Central Route*. This *Report* was approved by the MWR in 1994, and submitted to the State Council.

On the basis of numerous other surveys and preliminary studies, the Yellow River Water Resources Commission wrote further reports, the last one being its 'Comprehensive Report on Studies in the Western Route', which marked the Western Route entering its planning stage.

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[31] As mentioned by Ghassemi and White (2007, 312–313), environmental impact assessment had been done by Biswas *et al.* (1983) and WWF twenty years ago. However, these studies did not fit with the Chinese decision-making process at that time, since the final decision had already been made though not formally legislated.

Stage 3: Overall Planning of the STNNWTP (1995−2002)

In 1995, a 'Discussion Group' for the STNWTP was established. In March, 1996, a 'Assessment Commission' for the Project was also established, being headed by ZOU Jiahua, former Vice-Premier of the State Council. ZOU and his colleagues examined *A Report on the South-to-North Water Transfer Project* by the 'Discussion Group', and *A Report on the Examination of the South-to-North Water Transfer Project* was completed and submitted to the State Council. An instruction from the Council was issued and read as follows:

The Project should be implemented in the [following] order: the Central Route, the Eastern Route, and the Western Route. The dam of the Danjiangkou Reservoir should be raised. The polluted water treatment in the Eastern Route should be further improved; Comprehensive investigation and research should continue for the Western Route.

Owing to severe drought that occurred in North China from 1999 to 2001, people from all quarters reached a consensus as to the magnitude of the water-shortage situation, and urged that the water diversion should start as soon as possible. On 27 September, a meeting on the Project was held in the State Council, collating various September 2000, opinions about *The Implementation of the South-to-North Water Transfer Project* by the MWR. At this meeting, Premier ZHU put forward the (admirable) principle of 'Water conservation before water diversion; water pollution treatment before water transfer; and environmental protection before water usage', which later became the fundamental principles for the Project. However, it is easy to say, but hard to achieve in practice, since no clear-cut policies can be designed to meet these ends.

5.2.3 Critical Decisions for the STNWTP

During the fifty years of investigation and preparation for the Project, what happened in 2002 must be highlighted. In about six months, the Project passed (with short cuts) the necessary legal processes and some of important documents were published (internally). A fundamental change happened and the Project was formed at last as a definite practical policy, rather than an idea in the Government's mind.

August

The Outline of the South-to-North Water Transfer Project was finished and submitted to the State Council by the State Development Planning Commission and the Commission of Water Resources. Then on 23 August, 2002, the former Premier ZHU Rongji held the 137st Premier's Working Meeting, reviewing *The Outline of the South-to-North Water Transfer Project* and approved the *Outline* in principle.

10 October

The former Secretary-General of the CPC, JIANG Zemin, held a meeting with the Standing Committee of the Politburo, and examined and accepted *The Outline of the South-to-North Water Transfer Project*.

24 and 25 October

The Members of the Standing Committee of National People's Congress (NPC) and the Members of the National Committee of the National Political Consultative Conference (NCNPCC) all received the introductory reports on the STNWTP.

8 November

At the 16th Session of the National Conference of the CPC, JIANG Zeming announced that it was intended to embark on the Project in order to solve the water scarcity problem in some areas as soon as possible.

23 December

The Outline of the South-to-North Water Transfer Project was approved by the State Council.

27 December

Former Premier ZHU Rongji announced in the Great Hall of the People that the STNWTP was to be started. On the same occasion, the former Deputy-Premier WEN Jiabao (the present Premier), who succeed ZHU three months later, made a speech in favour of the Project. The same month, the Secretary-General of the CPC, JIANG Zemin, sent a congratulatory letter to the opening ceremony, indicating his pleasure that the Project was about to get started.

Half of century (1952–2002) has passed between the initial idea of the STNWTP and the beginning of its construction. In those fifty years, diverse voices arose from time to time: from society, the media, and various experts, scientists and scholars. Three particular problems were:

a. Only *The Outline of the South-to-North Water Transfer Project* was available for scrutiny. Not all the reports on the feasibility and evaluation of the project had been completed when the higher authority approved this project. Why was the project of water diversion implemented in such a hurry?

b. About 500 billion *yuan* (RMB)[32] will be spent on the project to solve water scarcity in North China. Is it worth spending so much money? Are there any alternatives and better approaches, such as water-saving and water recycling or water pollution control that can be applicable for solving the water shortage problem in north China?

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32 Approximately AUS$ 83 billion.

c. Why was such a great project as the STNWTP not listed as an independent act in the agenda of the NPC, in accordance with legal procedure? This is a question from political/legal perspective.

5.2.4 Institutional Arrangement

Political Power and Technical Experts

From the time-table given above, it took only half a year from the submission of *The Outline of the South-to-North Water Transfer Project* to the beginning of construction. In terms of policy process, the time was too short to examine the details of the project with due care and caution. On the other hand, around a hundred symposia, and consultative or review meetings have been held since 1999. Thousands of specialists participated in those meetings, among which thirty have been academicians from the Chinese Academy of Sciences or the Chinese Academy of Engineering. It is presumed that there were ample discussions and investigations before the final decision was made. But in the light of the legality of policy plan and political feasibility, the actual procedure followed is open to question.

In the decision-making process for the STNWTP, there have been several groups of actors, such as politicians and bureaucrats at different levels of government, the NPC, the National Committee of the National Political Consultative Conference, scholars in Academic institutions, the general public, and the media. Among these actors, the Standing Committee of the Politburo of the CPC and the Premier's Working Meeting are two key players and have the ultimate control over decision-making. The members of the NPC and the National Committee of the NPCC received preliminary reports on the STNWTP, but were not directly involved in the decision-making process.[33] Some

[33] There have been some reports that the members of the NPC or the NPCC were making local investigations themselves. There was a report in the *Hebei Daily*, entitled "Ensuring that the

people questioned why the STNWTP was to start without the prior approval of the NPC, which, according to the Constitution, is the highest authority in China. They pointed out that the project would take several decades to complete, during which time there could be several changes of government ministers and perhaps of policy. In order to keep policy continuity, the Project should be approved by the NPC: then the project would be legally legitimate (*Yangcheng Evening Post*, 22 June 2003).

A possible explanation is that the STNWTP was mentioned several times in the *Report on the Work of Government* to the representatives of the NPC, and that the Reports were approved by the representatives, which meant that the Project was in effect also approved by the representatives. However, the STNWTP is a much larger and more significant project than that of the well-known Three Gorges Scheme. Indeed it is the greatest project of its kind in the world, and as such it should be listed as an independent act in the agenda of the NPC. This great project should be approved in the name of NPC, as the supreme organ of state power.

Institutional Arrangements for the STNWTP

As mentioned previously, owing to the manner of planning of China's economic system, most research programmes in scientific and technological institutions were and are guided by national plans or local government plans. Major projects such as the STNWTP are guided by the State, which is appropriate for a national project of such magnitude. The Central Committee of the CPC, the NPC, the State Council and the NCNPCC are the highest organs of power. Usually, major decision-making is initiated at the National Conference of the Central Committee of the CPC, and is then ratified by

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Decision-making of the South-to-north Water Transfer Project is based on Science", which stated that a few people from the Commission of Population, Resources and Environment of the National Political Consultative Conference came to Hebei to survey, investigate and collect opinions and suggestions along the lines of the project of STNWTP (*Hebei Daily*, 15 December, 2000).

State Council, as in the case of the project of STNWTP.

Right from the beginning Chairman Mao fancied the Project after WANG Huayun had reported to him the possibility of water being diverted from the Yangtze to the Yellow River. This is a project that is driven from the top. Thereafter, the relevant water resources departments are under the leadership and authority of the Minister of Water Resource (MWR). Other institutions, or universities, might be involved by engaging in researches, but according to the plans and policies of the higher authorities. On the other hand, these institutions appear to be made up of professionally trained people, well versed in hydraulic engineering and technology.

In terms of the STNWTP, there are (were) some special institutions that are (were) in charge of the Project: the STNWTP Planning Office under the MWR, guide and coordinate various departments work with each other.[34] In 1994, NIU Maoshen (Minister of the MWR at that time) was appointed Head of the body in control of the STNWTP construction. In 1995, NIU Maosheng was appointed Head of STNWTP Commission, MWR. By the end of March 1996, this Commission submitted *A Report for the STNWTP,* suggesting that the order of the implementation of Project should be: the (1) Central Route, (2) the Eastern Route, and (3) the Western Route. In 1996, an Assessment Commission for the STNWTP Planning was set up at the State Council level, headed by Deputy-Premier ZOU Jiahua. The total number of members in the Commission was eighty-six, and about forty experts were co-opted for the examination of the Project.

Then in 2003, a Construction Commission for the STNWTP was also established by the State Council, headed by ZHANG Jiyao, Deputy Minister of the MWR.

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[34] It was established at the end of 1978. In 1997, the Administration Bureau of Planning and Design for the STNWTP was substituted for this Office.

In 2004, a Sub-commission of experts, under the STNWTP Construction Commission, was organised. Two academicians, QIAN Zhengying and ZHANG Guangdou, acted as consultants to this body, and Academician PAN Jiazheng was appointed as its Head. There are, at the time of writing, about forty scientists and engineers in this body, twenty of them being Academicians.

The China International Engineering Corporation: One of the Assessment Organs of the STNWTP

The China International Engineering Consulting Corporation (CIECC) was established in August 1982. Though the company was owned by the State, it is supposed to be a market-oriented organisation, as a result of the reform of the investment management system in China in the 1980s. Major clients of the Corporation are various governmental bodies, especially the Central Government. The purpose of establishing the Company was to improve transparency for the decision-making processes of the main engineering projects in China.

In the past, under the centralised economic system, executive leaders at various levels made decision directly as to what kind of the key infrastructure work should be carried out, what facilities should be in imported from abroad, etc. But at present, decisions must be assessed by the CIECC. After evaluation, the items of construction and introduction will be put into the agenda and wait for the approval of the Committee of State Economic Plan. However, this Corporation is not an independent body. It acts as one of the institutions of the State Council and in practice, has a close relation with the State Council. For example, the General Manager (or Vice-General Manager) of the Corporation, BAO Xuding[35] has attended State Council meetings relevant to the Project

[35] BAO Xuding was formerly Minister of the Ministry of Machinery Industry and Vice-President of the Commission of National Development and Planning, following which he was General Manager of the CIECC. He frequently attended routine meetings of the Prime Minister with the other ministers. For example, in 2005, he attended meetings as a non-voting delegate on 26

as a non-voting delegate quite frequently.

Major national projects, such as gas transfer from the west to the east, electricity transfer from the west to the east, the Tibetan railway, the high-speed railway between Beijing and Shanghai, the Beijing Olympic Games buildings, the National Opera, etc., have all been evaluated by the CIECC. So far as the STNWTP has been concerned, the Corporation has evaluated *Suggestions for the Eastern Route of the South-to-North Water Transfer Project*, and has made assessments of the emergency measures to be taken and if water has to be supplied from Shijiazhuang to Beijing, if the Project cannot be completed before the 2008 Olympic Games, the project of raising the Danjiangkou Dam, the project of getting water across the Yellow River, etc. (LI Zhichao, 2005, 25). This Corporation represents the 'wise heads behind national projects'. But it is not truly independent of the main Government authority.

5.2.5 Interactions among Various Groups

The Non-institutional, 'Bottom-up' Approach to the STNWTP

In the decision-making process, some voices from the bottom endeavour to reach the highest authorities through a variety of approaches, though it is difficult for individuals to have an influence on the higher levels of the system. An example is given here. One of the plans for the Western Route is GUO Kai's 'Grand Western Route of the Water Transfer Project'.

With the former Premier ZHU Rongji's support, the State Council also organised two days of academic meetings, attended by more than forty of the leading experts in water resources, electric power and geology, who made a close study of GUO's proposal. In June, 1999, the MWR organised experts from various fields, including six national

January, 2005; 1 February, 2005; 2 March, 2005; 16 March, 2005; 23 March, 2005; 20 April, 2005; 29 June, 2005; 26 July, 2005; 24 August, 2005; 31 August, 2005; 7 September, 2005.

departments and committee, and relevant areas such as Sichuan, Yunnan, Tibet, for a research trip in Sichuan and Tibet, and conducted field surveys (YANG, Shuqing, 2004, 123).

With JIANG's support (which may have had some reservations), there was a favourable response to GUO's proposal and he received numerous interviews. He also invited influential statesmen to compose 'epigraphs' (*ti ci* or slogans) for his Grand Western Route (*Current Ideological Trends*, 1998, 12), which were intended to proclaim the virtues of the Grand Western Route to the public.

Because GUO used to serve in the army, he was supported strongly by senior army officials, and generals, some of whom were members of the National Committee of the National Political Consultative (NCNPCC), and they submitted proposals about GUO's plan to the NCNPCC, though in the event these proposals failed to be listed in the agenda.

So far as I am aware, there are conflicting opinions about the worth of GUO's proposal. Supporters of his idea have claimed that the Grand Western Route Project will not only provide a large amount of good quality water, but also will reduce the quantity of sand in the Yellow River, which would have a beneficial environmental effect on the Yellow River and the Loess Plateau. More importantly, the Route is feasible, can be completed in a relatively short time, and is less expensive than the Central and Eastern Routes (DENG, Yingtao. et al., 1999, 254).

However, severe criticism came from some experts in the water resource community. For example, HAN Yifang argued that the total flow of the six rivers, from which water is planned to be diverted along the Western Route, would be about 1,550–660 $\times 10^8$ m^3, The greatest amount of water diverted is estimated to be no more than 1,000 $\times 10^8$ m^3, Therefore, GUO's proposal is not feasible.

They regarded GUO's proposal as a 'scientific fairy tale'. The question of whether GUO's plan is or is not feasible is beyond my scope to judge here—but what I am interested in is how some people in China are able to gain access to political patronage.

The case exemplifies a non-institutional approach, in which scientists or engineers may sometimes influence statutory bodies and politicians in China. In doing so, there has at least been a public debate, to some extent, which might not have taken place without the discussion of ideas such as GUO's. This is a positive aspect of the matter. However, one should be aware that the politicians may have had ulterior motives. The widespread discussion of what may have been a 'fairy tale' scheme could (perhaps) have been a diversion, so that with its rejection the 'official' scheme could avoid closer scrutiny!

Public Participation

The most convenient way to argue something in China today is on a website. According to China Internet Network Information Centre (17 January, 2006), there are 110 million internet users in China (and the number is increasing very rapidly). Through this lens, the observer can know what the public really thinks.[36] Here are some public comments on the STNWTP from supporters and opponents. (The authors mostly write under pseudonyms, which is the prudent way to express personal opinions.)

West Wind and Snow Flying:

I hope the Yangtze River will not become a second Yellow River. I am from the

[36] CWS (China Water Science) online public forum, which is operated by China Institute of Water Resource and Hydropower Research, http://www.chinawater.net.cn.
BaiDu, a popular search engine in China, and also famous for public forum, http://post.baidu.com.
China Water Net, http://www.h2o-china.com/.

south, perhaps there is something selfish. I think, the North should look for its own water potentialities, such as taking measures in water saving, and controlling polluted water and sewage. After all, that kind of water shortage, related to water quality, can be solved (at 12:09:10, 12 June, 2004).

Coexistence of Human Beings:

I think it is necessary to build the STNWTP. The rainfall in the south has been increasing in recent years, and the flooding is getting more and more serious, whereas rainfall in the north is low. Though a huge amount of investment will be spent on the STNWTP, people will have a permanent benefit (at 11:20:36, 27 June, 2004).

Xia Zong:

I think that the water diversion can only be a temporary measure. The problem of water scarcity can be solved substantially by improving the ecological environment. The amount of water usage in the cities is mainly decided by the water-consuming factories. If the North lacks water, we might well relocate those factories, which consume a great deal of water, to the south. Thus, the population in the [northern] cities will be decreased, and the problems in water supply, energy resources and communication could be solved too (at 11:31:04, 1 July 2004).

Obviously, the responses from the general public on the internet cannot all be listed. However, based on the words they used, most of the writers considered that the Project had to be started though they were concerned about environmental risks (although most of them were not sure what they might be), economic disadvantages (such as increases of water price and low compensation rates), and corruption.

Although officially the Government did not carry out any questionnaires, some research projects or media surveys were made with the support of the Government about the public opinions of the STNWTP.

Table 5.6 Public Attitudes to the Water Situation, and Possible Approaches to Water Shortage Problems (percentages in favour)[37]

	Water saving (%)	Pollution treatment and increasing the use of recycled water (%)	Water diversions in general (%)	The STNWTP (%)
Urban population	42.1	39.5	8.3	82.0
Farmers	27.3	8.3	40.3	79.2
Working units (*Dan Wei*)[38]	30.7	43.6	12.9	80.2

From Table 5.6, it can be seen that a low percentage (8.3%) of the urban population agrees with the idea of diverting water from other places. But paradoxically, a high percentage of them agree with the STNWTP. This is, I suggest, due to the fact that the general population has a favourable view of the STNWTP because they think it will be

37 From "Investigation and Analysis of the Social Psychology and Public Attitudes towards the South-to-North Water Transfer Project", *China Water Resources*, August, 2001, 62. This research programme was conducted by SHI Guoqing, and supported by the MWR.

38 Working Unit is *Dan Wei* in Chinese. It is "a basic unit in urban life under socialism"(Bray, 2005, 1), [which] not simply offers economic reward for their work; in addition, through the provision of housing, free medial care, child care centers, kindergartens, dining halls, bathing houses, service companies, and collective enterprises to employ the children of staff, the danwei provides its members with a complete social guarantee and welfare services".

beneficial to them (more water in the north and alleviation of floods in the south). Moreover, they have been exposed to a great deal of information favourable to the Project in the media in accordance with the Government's policy agenda. On the other hand it may well be that thinking about water diversions in general they realise that there may be considerable problems associated with such projects.

There have also been the joint investigations of *China National Geography* with Sina.com (the column 'Science and Technology') on the STNWTP (based on the statistics of May, 2006), yielding the following results:[39]

Table 5.7 How much do you know about the STNWTP?

	Have a general understanding of the nature of the Project	Know something about the Project	Know little or nothing about the Project
Percentage	17.69%	71.57%	10.74%
Number	219	886	133

Table 5.8 Are you in favour of the South to North Water Diversion Project?

	For	Against	No comment/don't know
Percentage	46.69%	50.28%	3.02%
Number	741	798	48

The percentage of people who are against the STNWTP is slightly greater than that in its favour. But the samples are obviously very small, considering China's population, and at best can only be 'indicative'. It is not impossible that people have no clear ideas

[39] http://www.cng.com.cn

on the matter and the results are analogous to those that would be obtained by tossing a coin.

WANG Shucheng, the Minister responsible for water resources, has provided some information about how actively people are concerned about the STNWTP. He said:

> Today, Shandong is going to start excavation, but a report has been put on my desk by an influential figure, stating that the route is unsuitable. The disagreement in techniques does always exist, and is welcome. I told the people in the Bureau of Planning and designing of the STNWTP, MWR, that we will set up a Museum for the Project, and put a collection of all the disagreements in it.

From what WANG said, we can infer that not a few people contacted the authorities to make suggestions or give their opinions; but little is known about the authorities' responses to the opposition.

Opinions from the public may reach the higher authorities through direct or indirect routes. Here is what was said in an interview held in China Central TV, with the title 'Six Questions Concerning the STNWTP' in the programme 'Decision-Makers' Talk' in 2005. The interview with ZHANG Jirao the Deputy-Minister of MWR can be regarded a feedback to the questions about which the public was concerned at that time.

The six questions were:

a. Do you think it likely that the STNWTP will divert polluted water to the North?
b. The STNWTP involves many provinces and districts. How can the various interests be balanced?

c. Is there any corruption in the STNWTP?

d. Is there a possibility that the STNWTP will become like 'bean curd scum' [i.e., have serious deleterious consequences]?

e. Can the STNWTP provide a permanent solution to the problems it seeks to solve?

f. Will seawater invade the estuary of the Yangtze River after the STNWTP has been completed?

The *questions*, on a major Government-owned television station with a large audience, presumably reflect what people are concerned about. Two (a. and f.) relate to environmental protection; two (d. and e.) are concerned with the project's 'quality'; and two (b. and c.) are concerned about political and management problems. The six questions can be taken as a reflection of areas of concern and the public's silent 'superintendence' of the Project. But viewers' *actual* views cannot be gauged simply on the basis of the television programme.

Negotiation among Interest Groups in the Decision-making Process

The most fundamentally interested parties are: the water-source district, the water conveyance district, and the water-receiving district. In terms of governmental structure, the interested parties are the Central Government, the governments of Jiangsu, Shandong, Hebei, Henan, and Hubei Provinces, and Beijing and Tianjin municipalities (not considering some political entities that are not directly related to the Western Route), and the different departments of these governments. In terms of society and government, the interest groups are: governments at different levels (and their departments concerned), commercial and industrial interests, the agricultural communities, the general public, and NGOs. Each party or stakeholder constitutes 'an interest community/entity', and all can carry on various negotiations to try to uphold their specific interests.

a. Negotiation between the Central and Local Governments

The water source district for the Central Route is in Hubei Province in South China. The interests of this Province and the negotiations that it has conducted are important in discussion.

The management body of the STNWTP consists of the Water Source Company and the Water Diversion Company. The latter is required to pay fees to the former, based on the volume of water diverted. That is, the fee for the water transferred via the Central Route will be paid to the Water Source Company in Hubei. Who or what is the Water Source Company? In effect, it is the Yangtze River Water Resources Commission under MWR. Thus, the water fee is collected by the MWR, and does not pass directly to Hubei Province.[40] But it is intended that the Central Government will recompense Hubei by means of various practical projects such as raising the Danjiangkou Reservoir's dam, resettling people, establishing four compensation projects for the middle and lower reaches of the Han River where water flows will be reduced as a result of the Project.[41]

Some Hubei experts argue that, as it is the water source district for the Central Route, Hubei cannot avoid taking some of the responsibilities and some of the risks, given that:

About $100 \times 10^8 m^3$ of water is to be diverted every year from the water source district in Hubei;

The water source district contributes soil resources, water resources, and manpower resources for the construction and management of the Central Route;

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40 But the fee for water taken from the Eastern Route would be paid to the Jiangsu Provincial Government, because it was Jiangsu that invested in the preliminary investigations relating to the Project, and the Government of Jiangsu is an agent of the Central Government.

41 By following this procedure, rather than making direct money transfer to the Provincial Governments associated with the STNWTP, the Central Government might hope to minimise 'seepage' of money at the local level!

The water source district will necessarily suffer some negative environmental and ecological consequences, as a result of the water diversion;

The water source district will be subject to various risks, in its economy, society and ecology because of the diversion;

The water source district will have the problem of relocation of people necessitated by the diversion.

Hubei Province, as a water-source district, should have a share of the water fee, given that it must protect the water resource, perform some essential duties in connection with the Project, and take certain risks or expenses after the diversion.

Thus it might appear that Hubei is being 'hard done by'. However, the officials in local governments play two roles: either as agents of the Central Government, or as heads of the local governments. In the conflict between the various interests, they will not necessarily consider their own Provinces' interests. (There are some exceptions, but Provincial officials commonly do not come from the Provinces that they represent.) And the Central Government could argue that Hubei would do well out of the project. WANG Shucheng has said that, in the past five years, the MWR invested 1,786 x 10^8 *yuan*, and Hubei received 148 x 10^8 *yuan*, the largest sum among all the provinces. Hubei can place the Han River under the control of the STNWTP, after the Yangtze River's Construction (Three Gorges Dam). Hubei will be able to build four water resource projects on the Han River. Moreover, Hubei can solve the migrant[42] problems handed down from history by the Danjiangkou scheme. Hubei is receiving considerable benefits from the project. "If the STNWTP were not to go ahead, when could the Han River scheme proceed?" WANG asked.

42 'Migrant' here is a direct translation from Chinese, which means people who are asked to leave their home and moved to other places, because governments will take the areas where they used to live for certain projects. For instance, building highway or water infrastructure. People will receive compensation from governments differently according to what type the project is.

Furthermore, he continued, “Opportunity is very important. If you miss this opportunity, I do not know when the project of harnessing the Han River can be put on the agenda again as an independent item” (YANG Shuqing, 2004, 129).

Even so, local writers from Hubei on the Internet and in some newspaper articles, have suggested that there is in fact substantial opposition to the STNWTP in the Hubei area. Yet it appears to be having no effect upon the course of events. The Hubei officials are doing little to defend their Province's interests in the matter of the STNWTP.

b. Negotiation between Governments and the Public, Especially Pricing Problems

One of most difficult problems for the STNWTP is concerned with migrants. There must be a negotiation between government and the people who are required to move. However, this problem will be dealt with in more details in next Section 5.4. The negotiations between the Government and the public as regards the water-price problem are discussed in the present section.

The investment is more than 500 billion *yuan* (RMB, according to year 2000 prices), of which 65 billion *yuan* are for the Eastern Route, 170 billion *yuan* for the Central Route, and 304 billion *yuan* for the Western Route (HAN, Yifang, 2003b, 34–35).[43]

The water price that the residents and industries along the routes of the Project can manage to pay depends on their income, or the production value of their industry. With reference to a World Bank document and documents issued by the Ministry of Construction, PRC, and other institutions' reports, the preferable proportion of the payment of water to income in large cities is 3%, and for the main cities it is 2.5%. For industries, the proportion is 1.5%. Based on preliminary analysis, the water price for the residents in the water-receiving districts will be 3–6 *yuan*/m^3, while the water price for

[43] But cost estimates seem to rise continuously!

industries will be 2.6−6.6 *yuan*/m^3 (HAN Yifang, 2003b, 34–35).

On 3rd June, 2004, an inquiry meeting was organised by the Commission of Development and Reform, Beijing Municipality. This was the seventh such meeting and thirty people attended. On this occasion, the authority would inquire as to the opinion about the water price rising from 2.90 *yuan*/m^3 to 3.70 *yuan*/m^3, of which 0.56 *yuan* would be collected for the STNWTP (HAN Xiangyun, 2004, 14).

At the meeting, some people enquired whether it was appropriate for the present generation to pay the water fees for future generations. JIANG Wenlai, from the Institute of Agricultural Resources and Agricultural Regional Programming, Chinese Academy of Agricultural Sciences, raised the problem of 'guarantee of consumers' rights'. To his knowledge, the management of the STNWTP would operate like a company. To collect money by price rises was analogous to the consumers of water taking part in the project construction as a kind of 'investors'. Under the conditions of a market economy, what kind of rights would the consumers have? Would they have a share of stock, and would they get a share bonus from future profits? This was no small detail. It concerned tens of thousands of households (CUI Hong, 2004, 16).

Now, water price might seem to have three clearly distinguishable components: the resource price, the project price (including interest charges that may be involved), and the environmental price. The project price (construction, administration, and interest) is a relatively transparent figure. The resource price is less obvious and is to an extent interconnected with the environmental price. The environmental price is undoubtedly opaque and there is considerable difference of opinion as to the way this part of the price should be calculated or estimated**.** In particular, there are huge uncertainties as to future costs arising from such problems as salination. How much money should be set aside to deal with such problems, or others as yet unforeseen?

Nevertheless, regardless of these uncertainties, at a public hearing, people in Beijing said they could understand why water prices would probably rise. There was a view that charging 'market prices' would cope with the problem. However, water pricing is not a complete solution for all problems. Be this as it may, the water price has already gone up, and today people have to pay 3.70 *yuan*/m^3 in Beijing. It will be remarkable if it does not increase further. However, after the Project is completed, people in Beijing may have to pay more than two times the present price or even higher price for water.

c. Negotiations between Government Interests and the Subordinate Departments' Interests

One of the debates in the decision-making with respect to the STNWTP has had to do with the Eastern and Central Routes. PAN Jiazheng, one of best-known Chinese authorities, has acknowledged that in the past some individual leader(s) put the Eastern and Central Routes in opposition to one another, so that the debate became endless. What people were worried about was that once a particular plan was approved and adopted, the other plan would be suspended, involving the loss of the considerable personal investments of many people associated with the rejected plan (PAN Jiazheng, 18 December, 2002).

It should be pointed out that there are also interest relationships between governments and their subordinate departments. These are worth looking at. Behind the debates about the different routes, there are matters of interest and concern, over and above the scientific and technological, and financial problems.

d. Interest Conflicts between Provinces

The Central Route has been supported by the Yangtze River Water Resources Commission, the Department of Water Resources for Agriculture, and the Committee of State Economic Planning. The debate on water diversion routes has evolved and has involved various Provinces' interests. There have also been academic disagreements between some of the experts and institutions concerned. The weakest point for the Eastern Route is water quality. Hence most of the provinces and cities along the railway from Beijing to Guangzhou support the Central Route. This is one of the reasons why the Central Route was able to gain comparatively extensive support and construction begins relatively quickly.

In 21−24 September, 1993, at the meeting on the Eastern Route held by the MWR, the representatives from Beijing were in favour of the Central Route, and asked Beijing not to be listed in places that would receive water from the Eastern Route. The representatives from Tianjin expressed their concern about water quality, if the water-protection measures could not be implemented well in practice and the water quality fell short of Grade II. The representatives from Hebei complained that the amount of water diverted was too little, and diversion would only occur when the South did not need water.

In 2001, the Tianjin Municipality submitted a report to the MWR, stating its opinion that the water quality of the Eastern Route would not meet Tianjin’s requirements. In addition, if they received water both from both the Central Route and the Eastern Route, they must share the cost for both routes, and they could not bear such heavy financial burden. Therefore, they applied for water supply only from the Central Route, and hope to have more water shares (Administration Bureau for Planning and Design of the South-to-North Water Transfer Project, MWR, 28 September, 2001).

However, the representatives from Shandong and Anhui strongly favoured beginning the Eastern Route first. But there had previously been differences of opinion between Shandong and Jiangsu and further research was evidently required. The publication of the *Working Proposals for the Design of the First Phase of the Eastern Route* had to be postponed from June 1983 to November 1984.

5.2.6 Debates on the Proposals for the STNWTP

Debate as to Whether the Eastern or the Central Route is More Feasible

From the discussion above, the project is evidently on an enormous scale, and both its positive and negative influences are tremendous. So it is not easy to make a decision. I will take the debate between the proponents of the Eastern Route and those of the Central Route as an example.

The first question is whether it is necessary to build the Eastern Route. In the 1970s, a severe drought occurred in North China, and a plan to divert water from the Yangtze River along the Grand Canal was mooted, which was the first time the term South-to-North Water Transfer Project was used. The Eastern Route was approved in 1983 by the State Council. In the plan, the first phase of the project was to end at Dongping Lake[44], and not cross the Yellow River. In 1988, the plan was revised so that the Eastern Route could end at Tianjin.

But already in 1987, the birth of a proposal for the Central Route had been put forward by the Yangtze River Water Resources Commission delayed the process, and the voice for the Central Route was getting stronger, so that a dispute broke out between the proponents of the Eastern Central Routes. There was also disagreement about the water supply areas for the two Routes, which and both encountered some specific problems, such as the scales of the two routes, and the question of whether the Eastern Route would go 'across' the Yellow River.

However, there were and are some problems associated with the Eastern Route, such as water quality, soil salination, and the spread of disease (discussed in Section 5.1). So

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44 Dongping Lake, the second large fresh water lake in Shandong Province, located at the southwest of the Province.

early in the 1970s, there was a proposal that the Central Route could take the place of the Eastern one (CHANG Jianjiao, 1981, 95). The proponents of the Central Route argued that it was not necessary to build the Eastern Route, because the Central Route was situated at a relative higher altitude, and the water could thus flow by gravity to the eastern parts of China; and the whole of North China could benefit from it. Against this, it was argued that the amount of water diverted from the Danjiangkou Reservoir was limited. But the advocates of the Central Route argued that there would be abundant water if the Danjiangkou Dam were raised to 175 m above sea level as previously planned, in which case the reservoir capacity would be 340 x 10^8 m^3.

In a paper, 'My Opinion about the *Outline Plan for the Control and Development of the Yellow River*' HUANG Wanli (1998, 53; 1999, 108) discussed some further problems and was an opponent of the Eastern Route. To obtain water from the Eastern Route, a large amount of electric power would be required to pump water, which was uneconomical. On the way, water could be taken by local people, and would not be transferred to the destination and supplied cities such as Beijing according to the original plan. It would be difficult to carry out such a project with confidence.

For the Central Route, HUANG (1998, 53) thought it reasonable to divert some water from Danjiangkou, but in his view the Danjiangkou Dam should not be raised, as more land would be submerged. In addition, the water disaster in Ankang shows that pebbles in the Han River have caused great damage.[45] People do not know how to deal with the pebbles already deposited in the Han River, and the problem should not be made worse. He suggested that about 100 $\times 10^8$ m^3 of water could be diverted from the Jialing

45 Ankang Water Disaster: after the completion of the Danjiangkou Dam, pebbles began to accumulate at the areas above the Dam. Ankang is located at the upstream in Shaanxi Province. In 27th to 31st July, 1983, there was dramatic increase of water level because of continuous rain. Since the riverbed was raised, flood covered the whole city. About a thousand deaths are caused by disaster happened in Ankang.

River).[46]

Floods, water-logging and soil salination have occurred often in various parts of China. The fundamental cause was that the water-courses of rivers[47] to the east and entering the sea could become blocked, or the watercourse of the Yellow River could alter. Thus some rivers to the north of the Yellow River had to be collected near Tianjin and allowed to flow into the sea from there; the rivers to the south of the Yellow River had to be collected in the Huai River trunk, forming Lake Hongze. The Beijing−Hangzhou Great Canal (the old south Great Canal, now 1−1.5 m higher than the land surfaces on both its banks) formed another obstacle to south-to-north transfer, to impede the escape of floodwaters into the sea. In addition, some engineering projects had been built since 1949, which blocked up the rivers in their flow eastwards—such as the great channel from the south to north for diverting the Yellow River for irrigation, constructed in the 1950s and 1960s (XIAO Bingjun, *Guangming Daily*, 25 February, 1979).

If the Eastern Route were to use the Great Canal as the main channel for conveying water from south to north, there would be problems for flood control, and with water-logging.

Questioning of the Central Route

ZHU Chengzhong, the former Director of the Planning Office of the STNWTP and an advocate of the Eastern Route, made an analysis of the advantage and disadvantages of the Eastern and Central Routes. For the Central Route, he listed the following problems:

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46 It should be noted that HUANG thought that the Western Route was the best. For a Western diversion, he suggested that some water could be diverted from the Jialing River. And in the future, water could also be diverted from the Yalong, Jinsha, Lancang, and Nu Rivers, and even from the Yaluzangbu River in Tibet. If this were done, the water shortage in North and Northwest China could be solved, and the Yellow River would never run dry (HUANG, 1998, 53).

47 Those which originate from Mt Yan and Mt Taihang, to the north of the Yellow River, and those that originate from Mt Funiu and Mt Tongbo to the south of the Yellow River.

a. By comparison with the Eastern Route, the amount of water that could be diverted is limited (for the near future it would 90 $\times 10^8$ m^3 *per annum*, and in the future it could be 130 $\times 10^8$ m^3).

b. The investment was greater: he thought it would be no less than 60 billion *yuan*,[48] and perhaps more.

c. The impact would be great upon the environment of the middle and lower reaches of the Han River after 40% these rivers' water had been diverted.

d. It was an enormous task helping about 300,000 local residents to resettle. Therefore ZHU thought it was too early for submitting the report on feasibility of the Central Route and he stated this viewpoint to the higher authority.

Also, in 1997, Professor ZHANG Guangdou[49] argued that insufficient work had been done on: the problem of regulating water storage; various necessary 'sub-projects'; the problem of 'crossing' the Yellow River; and compensation projects for the adverse effects on the middle and lower reaches of the Han River. Therefore, the Central Route was not ready to be approved (CUI Jin, and WANG Liuquan, 2000, 75−80).

The most fatal problem for the Central Route project is that there are no regulating and storage facilities along the more than 1,000 km length of the water conveyance channel. Another difficulty is the resettlement problem, the cost of which has been estimated at about 60 billion *yuan* (or about 11% of the general State investment), but which is obviously low.

Furthermore, the Central Route will go through seven coalmine areas, including the

48 The estimated cost is 920 x 10^8 *yuan* from the Office of Construction Commission of the STNWTP, State Council.

49 ZHANG Guangdou (1912−), professor of Qinghua University, an Academician of the Chinese Academy of Sciences, and the Chinese Academy of Engineering. He was formerly in charge of or participated in the Gezhou Dam and various reservoir projects, such as the Miyun, Sanmenxia and Three Gorges Reservoirs.

famous Jiaozuo Coal Mining. A total length of 51 km of the transfer channel would be affected, because of there being some underground cavities. So some people suggest that the Central Route should not be listed as the first batch of projects to be implemented (YU Fuliang and LUO Ling, 2001, 313).

Opinions about the Central and Eastern Routes still differ at the time of writing (2007). The water source condition in the reach of the Han River above the Danjiangkou Reservoir is not markedly superior to that in the water-acceptance area, given that the rainfall is 800−900 mm in the water-source district with 95 thousand km^2 of water-collection area, whereas the amount of rainfall is 500−700 mm in the water-acceptance district with 155 thousand km^3 of water-collected area.

The trunk channel will involve 219 rivers. These rivers originate from Mt Funiu and Mt Taihang. At the upper reaches of the rivers of the catchment areas, storms occur quite frequently. If it is not high enough for the flood control standard of dike at the west side of the trunk channel, the dike may break in a time of flood and disaster will occur.

As for the Eastern Route, problems remain, notably ones related to water quality. Though the State Council has issued *Provisional Regulations for Controlling and Preventing Water Pollution in the Huai River Basin* (1995) and various other Regulations, achieving even Grade III water quality calls for more stringent controls than those currently envisaged. Nevertheless, some people adhere to the view that the Eastern Route is a practical plan and recommend its implementation.

5.2.7 Final Decisions

For a long time in the decision-making process, the problem was not whether water diversion should or should not be carried out. Rather, it was whether the Eastern or the Central Route should be preferred. So the debate about water diversion concentrated on the Central and Eastern options. In order to try to solve the problem and reach the agreement, many experts made repeated investigations, but often reached contrary conclusions. Academicians from the Chinese Academy of Science and the Chinese Academy of Engineering were organised and they carried out their own investigations. By the year 2000, ZHANG Jiyao, the Deputy-Minister of the MWR, was able to say that a consensus had been reached that there was a definite water shortage in the Yellow–Huai–Hai area, and that both the Eastern and Central Routes were needed; and he hoped not to have to talk about the pros and cons of the two routes any longer. Moreover, the Eastern Route would not undermine the Central Route, or vice versa. It is not proper, he stated, to consider the Eastern and Central Routes as alternatives. Those who were working on the Eastern Route disagreed with the idea of the Central Route, and those who are working on the Central Route thought the Eastern Route was unsatisfactory. In fact, each of the routes had its own advantages and disadvantages, and it would be sensible to pursue both options. This view was also taken by the Premier WEN Jiabao (6th September, 2000).

By the beginning of the 21st Century debate about the Eastern and Central Routes had officially ended. But the whole nation is now paying close attention to the STNWTP, and a good many people continue to make suggestions and proposals. These should be welcome, and considered seriously, and useful ideas will probably be absorbed into the Project's design. However, not all suggestions are based on reliable data, careful research, and well-informed design.[50]

Although the plan and timetable have been decided and work has been started on both the Central and Eastern Routes (but only in a preliminary way for the Eastern Route) only time can tell whether or not the STNWTP will ultimately be successful. But even now, Professor LIN Ling and some experts in Sichuan Province are urging the

[50] Some of the suggestions have been hare-brained! For example, it has even been proposed that atomic explosions should be let off in the Himalayas to induce climate change and thus melt more snowy and ice to release fresh water.

Government to reconsider the Project, especially the Western Route. They published a *Western Route Memorandum*, in which they warned the environmental loss caused by the Project. Considering the rapid retreat of glacier in Qinghai-Tibent Plateau, the Western Route is not feasible. They raised public debate on the Western Route, which resulted in the suspension of the Western Route.

5.2.8 Key Points in the Policy Formulation Stage

According to WANG (former Minister of the MWR), there have been four periods of water resources and hydropower development in China: (1) a period in which the development was conditioned by technology; (2) the period in which the development was conditioned by investment; (3) the period when development was conditioned by markets; and (4) the period in which development has been conditioned by environment (WANG, 2004, 12). However, there have been other factors that have affected investigation and decision-making on the Project. For example, from the 1950s to 1960, water resources and hydropower development in China was not conditioned by technology alone, but also by investment considerations. Owing to the financial difficulties, the Danjiangkou Dam was not built according to the original design.[51] Moreover, the international political situation has been relevant in decision-making; and even the fact that Chinese senior politicians mostly have engineering/technical backgrounds, which may make them sympathetic towards grand engineering projects and 'technological fixes' has probably affected the course of events. Some of them trained in Russia, and therefore may have embraced the Russian/Soviet technological ethos.

Therefore, in the preparation stage, two factors, technology and investment, were essential to the development of water resources and hydropower, and political, even international political factor played important roles. As for ecological factors, they

[51] Interview with anonymous officials in Hubei on 14 November 2004.

appeared in some official documents, but have never been regarded as the key consideration. However, an official report of possible salination occurring in North China as a result of water diversion from the Yangtze River led to some suspicion of the STNWTP (Administration Bureau of Planning and Design of the South-to-North Water Transfer Project and the TIDI, 2002, 5).

It is, however, worth considering WANG's the 'fourth period', in which the development of water resources and hydropower is (supposedly) conditioned by ecology. Many ecological and environmental problems are certainly relevant to the debate as to whether the STNWTP is a feasible or desirable plan and which diversion route is preferable. The authorities and proponents of the scheme have expounded the reasons why the STNWTP should be implemented. They have highlighted the environmental problems (such as the severe deterioration of the environment in North China, owing to water shortage), which can supposedly be fixed by the Project; while the dissenters emphasised the latent deterioration incurred by water diversion in the water source district and in the pathway of the water conveyance. Both sides placed emphasis on the ecological environment, but from different perspectives. Especially, for the decision-makers, they must proceed very cautiously in planning stage for a water project.

5.3 Policy Implementation: Compromising and Bargaining

This section will be focused on conflicts raised in implementation stage of the STNWTP. Some of the problems have been mentioned in the previous chapter. However, the issues will be examined from a different angle according to their relevance to policy implementation. The Eastern and Central Routes are taken as examples to analyse the main characteristics of policy implementation of the STNWTP. Thus the discussion will involve six provinces (Shangdong, Jiangsu and Anhui in the

Eastern Route; Henan, Hebei, and Hubei in the Central Route) and two municipalities (Beijing and Tianjin).

In both horizontal arrangement and vertical hierarchy, there are competition, cooperation, and interaction between the Central and Local Governments, and also between Local Governments. All the interest relationships will become evident and make themselves felt in the policy domain. Because of the existence of the various administrative districts, each place or region has its own economic, political, and social interests and (as might be expected) seeks to maximise its own benefit. Limited policy resources are insufficient to 'make everyone happy' and thus conflicts of interests are inevitable in the process of policy implementation.

Moreover, the differences in policy and institutional arrangements inevitably encounter 'territorial boundaries' between the several districts, and there has been inconsistency and lack of coordination in policy implementation. Revision of any policy is inevitable. For such a mega-project like the STNWTP the initial planning was formulated and implemented from the highest level of government, and must therefore be examined from a top-down perspective. However, though the local or 'street' levels have no power to change the ultimate goal of this policy, they may affect the details of the policy so as to protect local interests, especially given the fact that the STNWTP is too large to be planned in every detail from above (or by the Central Government). There is plenty of space left for bargaining, which continuously influences and reshapes the Project.

5.3.1 China's Strong Governmental Authority Guarantees Policy Implementation

Successful policy implementation cannot be achieved without powerful and strong authorities at the top level. The STNWTP is an enormous, complicated, and significant project that calls for coherent management and unified control. Thus, a strong authority is fundamental for the Project's implementation to be effective and an appropriate institutional structure is required. To achieve that goal, the Central Government set up a powerful top-down organisation specifically for the Project.

The Strong Leadership Group Consists of the Top Political Elite

The highest organ of the STNWTP is the Commission of the South-to-North Water Transfer Project under the State Council. Its task is to set guidelines, policies, measures, and so on, for the construction of the STNWTP.

The Commission is headed at the time of writing by Premier WEN Jiabao and Deputy Premier ZENG Peiyan. Members of the Commission are MA Kai (Chairman of National Development and Reform Commission), WANG Shucheng (Minister of the MWR), XU Guanhua (Minister of Ministry of Science and Technology), JIN Renqing (Minister of Finance), SUN Wensheng (Minister of Land and Resources), WANG Guangtao (Minister for Construction), ZHANG Cunxian (Minister of Communications), DU Qinglin (Minister of Agriculture), ZHOU Xiaochuan (Governor of the People's Bank of China), SHAO Ning (Deputy-President of the State-owned Assets Supervision and Administration Commission of State Council), ZHANG Jiyao (Head of the Commission of the STNWTP Construction, State Council), and some leaders from other Ministries and Provinces and municipalities.

The institutional structure for the STNWTP at the provincial level follows the model at the Central Government, in that highest administrative officials of the Provinces are directly in charge of the Project. However, their formal positions are somewhat misleading in that the provincial heads are not required to give all their attention to the Project. Rather, they have a general supervisory role.

Taking Hubei as an example, the 'Leading Body' of the STNWTP Construction of

Hubei Province consists of: the Chairman, LUO Qingquan (the Provincial Governor); the Deputy Chairman, ZHOU Jianwei (Deputy Provincial Governor), LIU Youfan (Deputy Provincial Governor), LI Yuanjiang (Deputy Secretary-General), and DUAN Anhua (Director of the Department of Water Resources, Hubei Province).

The Office's duties are to implement the policies issued by the Commission of the STNWTP Construction and the State Council, to coordinate the various departments and communications, with both the local public and the Central Government.

The Multi-level Structure of Power in the Implementation Process

In the implementation process of the STNWTP, the power structure of the political elite consists of the following levels, from the top to the bottom:

Level 1 (highest): The Standing Committee of the Politburo of the Communist Party of China's Central Committee (SCPCPCCC). (Besides the Secretary-General of the CPC, there are the Chairman of the National People's Congress [NPC], the Premier of the State Council, and the Chairman of National Political Consultative Conference [NCNPCC], all of whom are members of Standing Committee of Politburo of CPCCC.)

Level 2: The Standing Committee of the State Council or the Premier's Working Meeting, State Council.

Level 3: Major functional departments of the Central Government, such as the National Development and Reform Commission, and the MWR.

Level 4: Various Provincial Governments and Municipalities directly under the Central Government. Their positions are ostensibly as high as the MWR, but the information they have about the STNWTP is not the same (with the Central Government being better informed). (Therefore the powers of the Provinces are to some extent weaker than those of the Central Government.)

Level 5: Institutions subordinate to the functional departments—such as the Yangtze River Conservancy Commission, the Yellow River Conservancy Commission, the Huai River Conservancy Commission, and the Hai River Conservancy Commission under the MWR. Because these bodies have specialised local knowledge and expertise, their suggestions often have considerable influence on the decision-making of the political elite at the upper levels.

Level 6: Cities and counties under the jurisdiction of Provincial Governments, and Municipalities directly under the Central Government. The function of cities and counties is to implement the policies issued by higher authorities. They have direct links with the general public, and to the Project to some degree, so they can have an important influence on the implementation of the Project.

Level 7: Scholars and experts from different fields and social classes. They will have their own opinions about the STNWTP, based on their specialties and interests. They are the professional elites and have some power to influence the political elites. Owing to their varied social status, their influences will also vary considerably.

Level 8: Public representatives, including some NGOs. They think of themselves as representatives of the public, and in the negotiations between governments and the public, they can exercise some influence, though mostly they are quite weak.

Level 9: The general public.

However, the communication channels under the nine-level structure are not unhindered. Down to Level 7 there are established regular and smooth communication procedures.

But communication from the higher orders to Levels 8 and 9 is incomplete, not formalised and not always accurate.[52] Also upward flow of information or opinions has no formal channel.

Coordination of Political Relation is Put at the First Place in Implementation

As mentioned above, the strong 'leading body' is not only the organizational warrant, but also the political warrant for the implementation of the STNWTP. Conflicting interests will inevitably occur in such a large-scale trans-basin project. If the relations of interest are to be coordinated well, the 'contradictions' between leaders must first be untangled. One of the most efficient ways to solve them is by political methods under the present institutional arrangements. Every governmental official pays more attention to his responsibilities to the higher-level officials, rather than communications with persons at the lower levels (which is natural and understandable because of the direct connections to his or her promotion).

ZHANG Jiyao, the Head of the Office of the Commission of the STNWTP Construction, State Council, was asked whether, for a project as grand as the STNWTP, conflicts between himself and local leaders (ZHANG's rank is at same level as that of the provincial governors) would be unavoidable. When a problem becomes hard to solve, will the Central Government (or the CPCCC) interfere or intervene in the matter. Have such situations occurred thus far in the implementation of the Project? ZHANG (2005) answered:

> No such troubles have bothered me because of the 'socialistic' institutional advantage. For example, a Provincial Governor told me, when we had a talk,

[52] From my interview with local residents in the Danjiangkou catchment region, the details of policies were not explained to them sufficiently (See Section 5.4).

that he had to speak in 'Hebei dialect',[53] because what he said was on behalf of the many people's interests in Hebei Province. But, once the Central Government [or CPCCC] had decided on a major policy and guiding principle, we [the people of Hebei] would follow them. This was an essential principle. So, the different Provinces and Municipalities would implement the decisions made by the Commission of the STNWTP Construction without reservation, conditions, or hesitation.

Thus the basis for implementation by the local authorities without any preconditions was political power.

The Political Leader(s)' Directions and Principles Provide the Basic Norms for Policy Implementation

From the present Premier WEN Jiabao through to the leaders at various levels (including ministers and provincial governors) of the STNWTP, whenever they have talked about the Project, they normally mention the slogan put forward by former Premier ZHU Rongji at the meeting about the STNWTP on 27 September, 2000:

> Water conservation comes before water diversion, water pollution treatment before water transfer, and environmental protection before water usage.

ZHU's prescription became the fundamental guideline for the Project and was summed up as three general principles for the STNWTP.[54]

The idea of 'three general principles' (stated in the quotation above) did not necessarily

53 The Provincial Governor was not referring to any kind of linguistic difference, but saying (metaphorically) that he had to speak on behalf of his Hebei constituency.

54 This became known in China as the 'three before three' maxim.

originate from ZHU, but at least ZHU and other leaders at the highest level agree with it (in public), and insist on the principles. Such a value preference forms the most significant foundation for the policy implementation of the STNWTP, especially for the governmental officials who consider the Project as merely a technological or economic enterprise,[55] and neglect the importance of water pollution treatment and environmental protection.

In fact, the principles become essentially a 'political idea' that has strong political influence on the present Chinese political system. If the principles were put forward either by the MWR, or the SEPA, they would have much less influence on the governmental officials' actions at the lower levels. The relation between the leaders at the highest level and the local leaders is primarily a kind of 'political relationship', in which 'local interests must be subordinate to the overall national interest; and individual interests must be subordinate to the relevant organization's interest.

5.3.2 Power Speaks in Resource Management

In the administrative structure of Chinese governments, the ministries of the Central Government are ostensibly at the same level in the hierarchy as provinces and municipalities, directly under the Central Government. All of them are at the level of the Chief Ministries (*Zheng Bu* Level). However, when specific projects are under their leadership, ministries directly under the Central Government have greater rights and responsibilities in the disposition of resources. This situation gives them considerably greater controlling power when they are dealing with the relations between themselves and institutions at the local level. This is evident from the previously-mentioned speech of the former Minister of the MWR. WANG negotiated with Hubei Province, and also with Jiangsu Province. He told the provincial leader of Jiangsu:

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[55] E.g., the Project is simply a channel to promote the local economy and thus increase the revenue to local governments.

> Take the opportunity, to modernise water management resources in northern Jiangsu.[56] Based on the present system of management, the whole river network should function in a unified and self-regulating manner. The State will invest in the project, and Jiangsu will not suffer any economic loss.

He also talked to the leaders of Beijing Municipality, telling them that if the STNWTP did not go ahead, the Capital would have to be moved elsewhere (*Memorandum of Opening Ceremony of the STNWTP*, 2003, 9). It is obvious that the MWR makes use of its controlling power on finance and technology to impose its views on the various interest groups.

Because of water pollution problems in the Eastern Route, none of the water receiving areas was or is willing to take the risk of paying money for polluted water. However, despite such a vital problem, the Eastern Route is still part of the Project and the question appears to be the place or places that would compromise to accept the water from the Eastern Route—otherwise the Eastern Route would become a project existing only on paper. When the MWR promised Tianjin that it would get water from the Central Route in Phase 1, and in Phase 2 the amount of water that would be diverted from the Eastern Route to Tianjin would be increased. Thus Tianjin weighed its benefits and costs, and made a compromise with the MWR to accept water from the Eastern Route.

The other province that would receive water from the Eastern Route is Shandong. Because of its geological location, it is difficult for Shandong Province to benefit from the Central Route. Shandong is not like Beijing, Tianjin, and Hebei, which have alternative options. Up to now, Beijing and Hebei have won the battle for better-quality water, but on the other hand, as a compromise they sacrificed some of the water that

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56 Compared with southern Jiangsu, the northern part is poorer and less well developed and does not have the financial resources to fix its water pollution problems.

they might receive in the future (record of interview with an anonymous official in Hebei, 6 January 2005).

There are conflicting interests among local governments, both in policy making and policy implementation. Furthermore, because implementation can (to an extent) both rectify and reify the policy, all parties want to increase their benefits from the Project and safeguard their interests, so the tension among the conflicting interests has sometimes become considerable.

Administrative boundaries often are taken as an excuse for the bad implementation of polices. Local authorities in China engage in endless haggling and shifting of responsibility: the inhabitants of the lower reaches of a river will complain that sewage is discharged from the upper reaches; but the upper reaches will contend that the lower reaches create their own sewage. Thus there is the odd phenomenon that the cost of obeying the law is higher than the cost of breaking the law! This problem exists, for example, in relation to pollution treatment in the Huai River, which is fundamental for the Eastern Route and also the STNWTP as a whole (ZHU Ruichang, 14 January, 2006).

The different policies have direct or indirect links to each other. The pollution control project in the Huai River Basin can be considered as preliminary work for the Eastern Route. The unsuccessful implementation of the pollution control policy in the Huai River could therefore be a deathblow to the Eastern Route, resulting in its suspension or serious delay. Therefore, problems relating to the implementation of the pollution control in the Huai River are part of the whole policy process for the Project and also influence and reshape the Eastern Route policy and the overall water diversion plan. Moreover, the conflicts and difficulties revealed in the policy implementation of pollution control in the Huai River reflect the possible handicaps in implementing the STNWTP. Thus in order to demonstrate the integrated nature of the whole project and improve the understanding of institutional difficulties in implementation of the Project, the political bargaining process on the pollution control project of the Huai River will be discussed in the following section.

The density of population in the Huai River basin is four times that of the national level. In some places, the surface water resources use-rate has reached 90%. In order to meet the demands of household, industrial, and agricultural water use, more than 8,300 reservoirs, and 5,000 dams have been built alone the trunk of the Huai River and its main tributaries. The chief purpose of all those dams and reservoirs was to store water. Subsequently, the Director of EPB in Anhui Province, ZHANG Fengxuan stated that the Huai River was degraded and had lost its natural 'self-cleansing' ability. Owing to urbanisation, the distance between cities and towns was decreasing, so that there was not enough time for the sewage and wastewater to complete its self-clean process in the short distances, after discharge into the river system. Water with a huge amount of pollutants runs down from upstream to the intakes at the lower reaches of the river (*Economic Information Daily*, 1 June, 2004).

Because of the STNWTP, the requirement of water quality must be strengthened. There are not great problems for some of the cities in Anhui Province, such as Huainan and Bangbu. But the 'pollutant cluster' from the upper reaches of the Huai River in Henan Province runs down to Anhui and especially during the dry season, when there is no fresh rainfall to dilute the 'pollutant cluster', the problem in Anhui could become critical. As for Jiangsu, there is a vicious cycle for the region in that the people who live there have to face a fact that more than 90% of the cities have to use polluted water from upstream, whilst producing and transferring polluted water to the lower reaches of the river system. PENG has written that, because of the administrative costs of changing the present situation, it would be difficult for the Central Government to mediate the conflicting interests between the upstream and downstream cities. For polluted water is almost inevitably passed from upstream to downstream areas and pollution problems in the Huai River would therefore be intensified. In rural areas, many thousands of people rely on the Huai River directly for their drinking water, so that water quality in the river is crucial for them (*Sanlian Life Weekly*, 17 March, 2005).

The pipe network is a problem for the whole of China. Its construction lags behind requirements, especially as the separation of storm water and sewage in some cities has not completed. Under such circumstances, it is difficult for water pollution treatment to be effective. After the facilities for water pollution treatment have been built, only 50% of them can normally operate satisfactorily. The number of water-treatment plants operating at full capacity is much less. One of the causes is that the pipelines are themselves technically inadequate. However, the real cause is not simply a technical design problem, but an administrative problem. PENG has pointed out that pipelines are usually considered as underground work, and do not attract much public attention once they are constructed. But the treatment plants are above ground and can be seen as an indication of the efforts that governments are putting into solving water pollution problems. Consequently, water treatment plants, as 'image projects', are much easier to be on governmental agendas, whereas pipeline projects are regarded as a waste of time and money that do not bring much political benefit to governmental officials! This state of affairs, and the resultant imprudent allocation of funds, is, I suggest, a sad indictment of the lack of maturity of the Chinese public and media in matters of environmental policy. (ZHU, Wenxuan, 17 March, 2005)

The policy implementation, so far as the STNWTP is concerned, is an organisation action at both the Central Government and local government levels. In the next section, the institutional structure of the STNWTP will be discussed from the approach of organisation theory.

5.3.3 Key Problems for the Implementation of the STNWTP

There are several key issues for the policy implementation of the STNWTP, such as the migration, environment, and security problems. Technically, there are no insuperable difficulties in the way of the completion of the Project. The changes happen in implementation stage is a result from interaction among the nine-levels mentioned before.

Migration in Relation to the Central Route

There are now about 300,000 migrants in the district of the Danjiangkou Reservoir. Some of them were re-located as far back as the 1950s and now have to move again. The migration problem is perhaps the most difficult one to be solved for the Central Route.

The resettlement of migrants has been an important consideration in the decision-making process for the Central Route. The Danjiangkou Dam and Reservoir were initially built in the 1950s when a city, a county, and about twenty-seven towns were submerged. 59,500 households and 287,000 people had to be relocated. About 297,000 *mu* of cultivated land were submerged, equal to 1.03 *mu per capita* (LAO Xi, 1997, 42).

Danjiangkou Dam (see Figure 5.6) is presently 156 metres high. It was built in 1958 with capacity of 17 billion cubic metres. (The original plan was to build a 176.6 metres dam.) The dam was initially designed and constructed with help from Soviet experts. But with the increasing tension between U.S.S.R. and China in the 1960s, all Soviet experts departed. Because of technical and financial difficulties, the plan had to be implemented in two phases. Therefore the STNWTP is involving a second phase of dam construction. The height will be increased as originally planned to 176.6 metres.

Figure 5.6 Aerial View of the Danjiangkou Dam[57]

[57] Source: blog.yam.com/dili/archives/1316435.html 25 March, 2006.

Figure 5.7 Picture of Part of the Superstructure of the Original Danjiangkou Dam (Photograph by author, 2004). (The lettering on the vertical metal girder marks the intended future upper level of the Dam.)

Income *per capita* in the Reservoir district is only 560–1200 *yuan*/year. There are 1.24 million people whose cultivated lands are under 0.5 *mu per capita*. At present, there are some 70,000 people who have already been displaced once. In terms of contradiction between resources and population in the Reservoir district, there would be 165,000 persons displaced, even if the dam of Danjiangkou Reservoir were not raised, and water in the Reservoir not diverted. Several alterations in the water levels since the beginning of the Reservoir's construction led to unstable and poor living conditions for people in the Reservoir district for several decades. It has been claimed that through the opportunity of the Central Route's construction, people's lives in the Reservoir district can be improved (Administration Bureau of Planning and Design of the STNWTP, MWR and Tianjin Institution of Hydropower Survey and Design, 2002, 48). However, there is no doubt that the forced relocation will be a tough task, especially when the work of relocation as a result of Three Gorges Dam district has not yet been completed.

On a research field trip undertaken in 2004, I saw for myself that the local residents near the Danjiangkou Reservoir, who would be displaced if its dam wall were raised, lived in an unsatisfactory environment. They were not able to build new houses for themselves, and could not invest in plans to improve their lives, because there were regulations from the Government forbidding any development in the area, pending the further construction work on the Danjiangkou Dam (See Figure 5.7).

Figure 5.8 Picture of a village close to Yuzhen Temple that will be submerged (photograph by author 2004)

The places where they were living would be submerged, and any new houses would be submerged as well. Local governmental officials were unable to deal with the matter, and the local people could only wait for the decision from 'the top' and move from where they lived to where they were told to live, hoping for some form of adequate compensation. The Hubei Provincial Government seemed to agree with the plan of raising the dam of Danjiangkou Reservoir, because the living standard of people in Reservoir district would supposedly be improved, after implementing the project.

The submergence will affect forty-eight small towns in five counties and cities, as well as 489 villages and 2,591 villagers' groups. The number of migrants would be 249,500 in total. The area to be under water will include 234,300 *mu* of cultivated fields and plantations, five cities and towns, and 106 industrial enterprises. Some highways, electricity conveyance lines, and communication lines, and some small hydropower stations will also be submerged. The migration compensation investment for the areas to be submerged is 12.4 billion *yuan*, and the compensation cost for project-occupying land is 26 million *yuan*. The total compensation investment required is estimated to be 12.7 billion *yuan* (Administration Bureau of Planning and Design of the STNWTP, MWR and Tianjin Institution of Hydropower Survey and Design, 2002, 45).

Problems Related to Population Movements

MA Jun, author of *Water Crisis in China* (1999), has claimed that as a result of large-scale hydropower construction, there were about sixteen million migrants up to 1999, among them ten million people are still leading a hard lives after being relocated. The principle set by the World Bank is that after displacement, the lives of migrants should not be worse than before. However, for the sake of their better performance in administration, the local bureaucrats paid only very low subsidies to the migrants (*China Youth*, 29 July, 2004). The problem of reasonable subsidies must therefore be a scandal for the Central Route. Public on-line forums (*Baidu*) reveal that the local public has not received formal information on the compensation issue. Therefore, most people are confused about the rules and principles of the compensation. The chaos has been caused mainly because the Central Government delegated dealing with the matter to local governments, and thus no unified principles have been stated and made accessible to the public. Also, although the local governments have the right (or responsibility) to negotiate with the public, they are not the decision makers for final rate of compensation. The Administrative Bureau of the Central Route is in charge of paying compensation, and *it* would be the decision maker. But it has no direct interaction with general public. Therefore, there is institutional discretion for the management of compensation and one can anticipate that there will be opportunities for corruption.

In addition to the 300,000 migrants in the Reservoir district, there will also be some migrants along the main trunk canal of the Central Route. The resettlement process not only needs a large sum of investment, but also it will bring about environmental deterioration. For example, the regulation issued in 2002 of returning farmland to forests (grass) will be affected; because of the enlarged scale of waste land reclamation in order to meet the demand for grain as a result of the population increase due to people arriving from the migration districts.

Furthermore, migration would possibly destroy some forest and vegetation around the Reservoir. According to the plan for relocating people, more than half of the migrants are to be settled at places near the Reservoir. It is planned preliminarily that about 3,300 *ha* of barren hill and grass slopes will be exploited. 520 thousand m^3 of timber will be needed to build new houses, and 7,400 *ha* of lands for firewood will need to be planted for the migrants (at 1998 level). The forest and vegetation in the Reservoir area were severely damaged during the previous relocation process when the Reservoir was originally constructed. Most of the forest was left only with sparse woods and young woods. Because of migration in the later phase of the STNWTP, the exploitation of timber and firewood will again exert a heavy impact on the forest and vegetation in the

Reservoir district (JIN Yixing et al., 1995, 158).

Because of the resettlement requiring cities and towns to be removed to other places, and the Reservoir reconstruction, the demands for timber and firewood will lead to decrease of forest resources, especially in those areas that already have a high population density and limited resources. So it is suggested that most of those displaced should be remove to places distant from the Reservoir, so a comprehensive assessment of the land, resources, and social economy, etc., will be needed (Institution of Environmental Plan of China, 2001, 73).

The Volume of Water to be Diverted from Danjiangkou

I shall take the evolving process of the amount of water to be diverted from the Central Route as an example.

One view holds that because there has been 'zero increase' of water consumption in industry and agriculture in recent years, any increase in demand for water will be in households, because of the dramatic increase in urbanisation. The other opinion is that the Yellow–Huai–Hai River Basin, as one of the most important grain production areas in China, has already suffered serious environmental problems because of water shortages. Hence urban water use should not be the only consideration for the Project. The advocates of this view have suggested that the Central Route, with $145 \times 10^8\ m^3$ of water being diverted annually, should be completed in Phase 1 of the Project, for the purpose of improving natural environment in the Yellow–Huai–Hai River Basin (HAN Yifang, 2003, 4).

Water diversion projects should obviously consider the environmental and social impacts on their source areas (though this was hardly done in the notorious Aral Sea case, though the main problem was in the receiving area). The scale of the STNWTP and the amount of water diverted should be estimated according to a fundamental rule, which is to minimise the negative influences in both water delivering and receiving areas. It has been predicted that the intake flow to the Danjiangkou Reservoir would be 36.2 billion m^3 in 2010, and 35.6 billion m^3 in 2030. If 14.5 billion m^3 of water were diverted from that reservoir, this amount of water would account for 40% of the water through Danjiangkou Dam section, and 25% of the amount of run-off of the Han River Basin. Thus a water diversion with such a volume of water could cause hydrological changes along the middle and lower reaches of the River. The days of medium water-flow (800–1,000 m^3/s) would decrease by twenty per year, and the days of peak flow (1,000–3,000m^3/s) would decrease by about a hundred days—which would affect the river's ability to flush away the silt in its bed (The Office of the South-to-North Water Transfer Project in Hubei Province, 2004, 129).

Moreover, the average annual water level would drop some 0.3–0.5 m. Consequently, some pumping stations and outlets for irrigation would need to be reconstructed. The change would also affect shipping at the middle and lower reaches of the river. Third, as mentioned in Section 5.1, according to some simulation analyses of the results of the changed water conditions, the probability of algal blooms will increase. But when the amount of water diverted is 9.5 billion m^3, the probability of algal bloom would not increase. Also, even with the volume of water intended to be diverted by the Central Route being reduced from 14.5 to 9.5 billion m^3 of water, compensation projects for the lower reaches of the Han River will still be needed.

It is almost certain that additional policy changes will also be required when the Project is further advanced, but the present practice seems to place emphasis on fragmented evaluation and predication, not a full-scale examination of the effects of the Project as a whole. The evaluation should not only review the environmental situation in each river basin, but also the connections and interactions among the different river basins.

Environmental deterioration is a slow and often inconspicuous process.[58] Thus the implementation of policy should take this into consideration, and make changes continuously and flexibly.

The policy for the amount of water to be diverted by the Central Route has changed repeatedly, from 96, then 146, then 147, and eventually to 95 × 10^8 m^3. (See Table 5.9.) The objectives of the Project have also changed over time: initially for agriculture and shipping; then for agriculture only; and then primarily for urban use (but consideration also given to agriculture and 'ecological' purposes). One point that must be mentioned here is that although policy implementation is an evolving process for such a grand project as the STNWTP if there are frequent and major changes the scheme may become incoherent and contradictory policy processes may be developed—even as to the preliminary question of who should use the diverted water. Environmental compensation as an ultimate goal and giving consideration to environmental improvements are different concepts. The only constant factor that can be found is that no matter what, water for people in the North is the first priority, though in the long and unpredictable future there will be the possibility of 'ecological' use (e.g., replenishing underground aquifers, and surface lakes). However, the problem is that the environmental will most likely have suffered negative impacts already when the Project starts to pay attention to environmental problems and some of the environmental changes will be undesirable.

Thus a policy change cannot be made to a system without considering the repercussions. The volume of water to be diverted greatly influences the decision-making as to whether the height of dam should or should not be increased; and if it is necessary to make changes, then to what level should the dam be increased?

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58 See Glantz (1998) for a discussion of 'creeping environmental problems'.

Table 5.9 The Amounts of Water to be Diverted according to Various Proposals[59]

Date	Documents	Volume of Water to be Diverted Annually (billion m^3)	Construction of Project	Water Use
1985	*Report on the Programming of the Central Route of the STNWTP* (Preliminary Draft)	___	___	Agricultur e, Shipping/ Transport
1987	*Planning the Central Route of the South-to-North Water Transfer for the Han River*	9.6 billion m^3	No need to increase the height of the Danjiangkou Dam, but building some projects along the middle and lower catchments of the Han River	___
1990	State Planning Commission, the Ministry of Water Resources and the authorities of some of the Provinces concerned	___	Consensus reached for the raising the Danjiangkou Dam, but no decision as to height	___
1991	*Report on Planning the Central Route of the South-to-North Water Transfer Project* (revised September, 1991)	14.5 billion m^3 (revised 15 billion m^3)	Increase of height of the Danjiangkou Dam. (Water will be transferred by gravity.)	Shipping not taken into considerat io-n.
1992	Yangtze River Conservancy Commission, *Report on the Feasibility study of the Central Route of the South-to-North Water Transfer Project*	14.7 billion m^3	___	___
1994	(July) The Yangtze River Conservancy Commission concluded that it was unnecessary to increase the			

59 Adapted from Planning and Design Bureau of the South-to-North Water Transfer Project, MWR, 2001, *Summary of the South-to-North Water Transfer Project, Appendix 10.*

	height of the dam. However, the MWR thought that, from flood control and water diversion perspectives, they would support the Report of 1994, which recommended increasing the height of the dam and diverting water from the Danjiangkou Reservoir. Since then, there have been researches on the effects of raising the dam and the design of main canal for the Central Route			
2001	Yangtze River Conservancy Committee, *Planning of the Central Route* (2001, revised version)	9.5 billion m^3	Raising the Danjiangkou Dam, and building four Projects to compensate the middle and lower reaches of the Han River	Main focus is the urban use in cities and towns along the Cental Route, but also give consideration to agricultural and environmental water use
2001	*Outline for the Central Route of the South-to-North Water Transfer Project*	First phase (9.5 billion m^3) will be completed before 2010	——	——

5.4 Policy Evaluation in Relation to the STNWTP and another Water Transfer Project (the Luan River Scheme)

The policies for the STNWTP have involved, and will involve, a great number of aspects, a great number of participants, and in all probability a great number of changes will have to be made over time. Moreover, various policy resources may mingle or overlap, or are interconnected, creating considerable difficulties for public policy evaluation.

Another obvious difficulty in the evaluation of the STNWTP is caused by the *long-term* nature of the Project's planning and construction. At present, we only have a general idea of what the eventual outcome may be, and even that is uncertain. It will take fifty years for the whole Project to be completed and evaluated. For this reason, I shall discuss here the evaluation of a different Chinese project: the Water Transfer from Luan River (in the north of Hebei Province) to Tianjin. This scheme has already been completed, and therefore may throw some light on the STNWTP. At the time it was initiated it had high hopes and everyone assumed at that time that it would provide a permanent solution to Tianjin's water problems.

5.4.1 Factors in the Evaluation of Water Transfer Projects

How is the impact of huge water transfer projects, such as the STNWTP, upon society and economy to be evaluated? It is difficult to have well-considered and formulated norms, and often the results of evaluation may diverge greatly because there are differences in people’s knowledge, specialties, personal careers, and political circumstances. Therefore, it is important to decide the concepts and criteria of evaluation for any specific domain. But even when the concepts and criteria have been settled, there will almost certainly be problems to be considered in the policy evaluation process, though some of them may have been considered during previous stages in policy cycle.

Changes to the Natural Water System caused by the STNWTP

The STNWTP is a project that will result in considerable changes to the natural environmental, by altering the natural boundaries of the water systems between the Yangtze, Yellow, Huai and Hai Rivers, which will no longer be independent of one another. Artificial channels and natural water systems will intersect and interact and a new ecological system will be formed. There will be changes in the roles of the storage and regulation of water of reservoirs and lakes. It should be recalled that most of the rivers in China flow from west to east, whereas the STNWTP's Eastern Route will lead water from south to north, and interconnect several major river basins. It is difficult or impossible to make a full scientific evaluation of the impacts of such a project at present. Moreover, it is likely that there will be some factors that are as yet unsuspected or unknown at present, such as climate change. (Further discussion of this issue will be given in Chapter 6.)

Potential Changes in Water Demand

The ultimate purpose of the STNWTP is to provide water for North China. The volume of water demand will depend on the level of the local social and economic development. The amount of water demand in China (including North China) is expected to peak in 2035, after which demand will presumably decline. Taking the present trend of population increase, and the relationship between water demand and economic development into account, the most difficult time in water supply will be from now until about 2035. Therefore one should ask whether it is actually necessary to continue with the second phase of the Central Route, and also the third phase of the Western Route. If, in the future, people do not use the water diverted from the Yangtze River but have sufficient supplies from local surface water sources, the later stages of the Project will become redundant and uneconomic.

Interaction between Economic Development and the Objectives of the STNWTP

One of the objectives of the STNWTP that is not given prominence in most Central Government documents is the fact that it is intended to *promote* overall domestic economic demand. But local officials will make great efforts to promote local economic development, taking advantage of funds provided for the STNWTP. It can be expected that major projects will be approved, and the value of output will increase; but people may use water thoughtlessly and without limit in order to accelerate economic development. If this happens, the water transfer will result in water wastage as well as the water pollution problems. Thus, the overall consequence will be a negative impact on sustainable water usage and water allocation in China. As a developing country, China should give a serious consideration to the cost of externalities and intergenerational costs. Short-sighted thinking will be dangerous for a nation with a possible future population reaching 1.6 billion.

Imbalance and Uncertainties in Cost-benefit Estimates

Under the conditions of a planned economy in a highly centralised system, the allocation and usage of resources are usually the outcome of the Central Government's unified plans, which may overestimate the benefits and underestimate the costs involved in various major projects. But in order to get projects approved by higher authorities, local officials are likely to overestimate their benefits and underestimate the costs. Once funds are found to be insufficient, the officials will be likely to apply for additional funds, which are usually hard to reject since projects have already been started.[60] A similar situation can also occur in market economies though it may be somewhat less

[60] This is an example of the so-called Concorde Effect.

likely. But in any case a market economy has not yet been fully established in China, especially in areas related to natural resource management, which perpetuates the planned economy model.

However, there are some differences from the old highly-centralised planned economy, in that the Central Government will provide the major part of the finance for large-scale projects, and local governments will be in charge of the auxiliary projects. In the *Outline of the South-to-North Water Transfer Project* (2002), it was assumed that the auxiliary projects would be completed both before and after the principal parts of the STNWTP were completed. However, in practice, the auxiliary projects are likely to be completed behind schedule so that the accuracy of cost–benefit estimates is uncertain. Moreover, the costs involved in migration, compensation for occupied land, and the losses owing to the environmental impact of the Project have not been (and cannot be) estimated accurately on a long-term basis (e.g. over several generations).

Scientific Argumentation and Predictions with Regard to Water Transfer Projects

These are not necessarily secure for a huge undertaking like the STNWTP. Scientists and technologists are chiefly concerned about the technical feasibility of the Project and rarely take political factors into consideration. The STNWTP is an exceptionally large-scale project, of far-reaching significance and complex social and economic effects. Even assuming that the influence of the Project on society and the economy will be positive overall (since the STNWTP has been discussed by experts many times and a decision to proceed has been taken), there are still doubts about the Project. From past experience, we know that there have been projects that had been supported by experts, but have nonetheless failed.[61] Once scientific and technological experts are influenced by political considerations—either directly or indirectly—their objectivity may well be

[61] The most telling example is San Men Xia Reservoir on Yellow River; or more notably the Aral Sea diversion and irrigation scheme.

compromised (JIA Shaofeng, 2003, 37).

5.4.2 Evaluation of the Luan River Water Transfer Project to Tianjin

In this part we now have to examine a water transfer project that has already been completed and is thus able to be evaluated, whereas this is not yet possible for the STNWTP. I therefore give attention to the water transfer project from the Luan River to Tianjin (completed 1984) as an attempt to solve the water problems of that city. Thus we can examine an example of an evaluation process, as conducted in China.

Brief Introduction to the Luan River Scheme

The Luan River originates in the north of Hebei Province, runs through Inner Mongolia, Liaoning Province, and Hebei Province, and enters the Bohai Gulf at Leting County, Hebei Province. It has a total length of 888 km (see Figure 5.9). The climate in the Luan River basin is that of a continental/temperate zone, being humid in the south and becoming more arid northwards. There is abundant water in the Luan River, and the average annual precipitation can reach 700 mm. The River has more than three hundred tributaries. Such a river is rare in the Hai River Basin.

Figure 5.9 Luan River Basin (part of the Hai River System) (from Wikipedia)

Before 1950, there was only a small amount of rice cultivation alongside the lower reaches of the Luan River. However, with the increasing demands on food, water demand also increased. In the 1970s, in order to solve the water shortage problem in the Beijing–Tianjin–Tangshan region (but mainly for Tianjin), the Central Government invested in and started to build a project for transferring water from the Luan River to Tianjin. The project was completed in 1983 the reservoir at the water source being the Panjiakou Reservoir (in Hebei Province).[62] In 1984, the final stage of the project was completed with water being transferred from the Luan River to Tangshan. In the 1990s, a reservoir was built on the course of one of the tributaries of the Luan River. The amount of water it could store was some 7×10^8 m^3. Up to 2002, the project had diverted 280×10^8 m^3 of water from the Luan River, of which 110×10^8 m^3 went to Tianjin and 170×10^8 m^3 to Tangshan (LI Hongyou and CONG Liming, 2003, 24).

[62] It is intended that this reservoir will be one of those used to meet the needs of the 2008 Olympic Games.

Evaluation of the Luan River Scheme

a. The Improvement of Drinking Water Quality in Tianjin

Clean drinking water is one of the most important factors for human health. Before the Luan River to Tianjin water transfer project was completed, the people in Tianjin obtained their water from the Hai River. Although water was treated before distribution to end-users, the chloride in the water still was about 400−800 mg/L, greatly exceeding the standard of 250 mg/L. After water was diverted to Tianjin, the chloride level dropped to 28 mg/L. Moreover, the areas supplied with water of satisfactory quality increased from 284 km^3 to 550 km^3, with the number of people receiving a satisfactory supply rising from 3.49 million in 1984 to 5.12 million in 2002 (XING Yan, 2004, 48).

b. The Economic Impact of the Luan River Scheme

It has been estimated that the economic benefit of the water diverted from the Luan River is 2 *yuan* per cubic metre of water and, up to 2002, the economic benefit from the water transfer to the urban areas was 28.9 billion *yuan* (LI Fusheng, 2003, 47–49), while the overall economic benefit of water transferred to rural areas was 1.4 billion *yuan* for the same date. In the agriculture sector, the capacity of water storage reached 800 million m^3, and the effective irrigated area reached 3.54 million m^2. The gross value of agricultural production increased from 1 billion *yuan* before the Project to 18.1 billion *yuan* (XING Yan, 2004, 47). XING commented that since transfer of water from the Luan River to Tianjin, the economy of Tianjin has developed rapidly, with the gross value of domestic production increasing by 5.38 times in a period of twenty years. In both 2001 and 2002, the economic growth rate was the highest in the whole country (XING Yan, 2004, 47).

There are, however, two problems in evaluating a water transfer project in that way (i.e. according to economic considerations alone). One is that many factors other than water resources contributed to Tianjin's economic development. The City's Mayor, LI Shenglin, pointed out, the economic growth of Tianjin could also be attributed to the City's leaders making a great effort towards structural adjustments in industry, technologic innovation, and providing an open door to foreign investment (LI Shengling, 23 April，2002).

On the other hand, the economic development of Tianjin benefited not only from the Luan River, but also from the Yellow River.[63] Drought in the Luan River Basin has been ongoing since 1997, and the water level of the Panjiakou Reservoir (the aforementioned water source of the Luan River Water Diversion Project), dropped rapidly and had almost no additional water entering the reservoir. Tianjin had to draw on water from the Yellow River repeatedly in 2000, 2002, 2003, and 2004. XING's research does not make it clear whether the benefit to the economic growth of Tianjin was actually due to the Water Transfer Project alone. In fact, it should definitely have mention the role played by the water drawn from the Yellow River. Thus XING's evaluation involves overlap of two resources and fails to differentiate the effects of the two, making it hard (or impossible) to judge whether certain policy outcomes belong to a particular policy; and this makes it difficult to estimate the utility of the Luan River Project investment.

In practice, there is usually some overlap among similar policies or policy objectives, which are formulated and implemented by different departments. Different policy effects become 'knotted together', which makes it difficult to evaluate the real effect of any particular policy (ZHANG Jinma, 1992, 253). For the STNWTP, the difficulty caused by policy overlap is likely to be enormous, because of the Project's scale and

[63] Historically, there have been many times when water was diverted from the Yellow River to Tianjin, such as 1972, 1973, 1975, 1981, 1982, 2000, 2002, 2003, and 2004.

complexity. In fact, during the four periods of diversion of water from the Yellow River, water diverted from Luan River only supplied Tanggu and Dagang, the harbour districts of Tianjin (0.387 million m^3 per day) and water diverted from the Yellow River supplied the other parts of Tianjin (1.13 million m^3 per day) (AN Xiao *et al*., 2006, 39). Therefore, the Project of Water Transfer from the Luan River contributed little to the to Tianjin and to the city's economic development after 2000.[64]

A Preliminary Analysis of Some Negative Impacts of the Luan River Water Transfer Project

a. Negative Impacts on the Environment

The original environmental balance was disrupted by the Luan River Project, and various negative effects on the environment were felt. Some of these are listed in the following paragraphs.

The average annual flows was 2.87 billion m^3 before the Project but decreased to 1.1 billion m^3 so that by 2003 the annual flows had been reduced by 63.2 % (YANG Dechun, 2003, 24).

Because of decreased run-off, the level of groundwater has dropped. Based on observations during the low water seasons from 1987−1995, the level of groundwater in some parts of Luan County dropped by 4.67 metres (YANG Dechun, 2003, 24).

Because of the decreased flows in the Luan River basin, silt deposition has increased in the main trunk of the Luan River, and generally, the deposits in the bed of the Luan

64 The case can be a good example in overlap of policy resources, and we should refer to it when we evaluate the STNWTP, since in such a great area as North China economic increases will be influenced by many factors. Moreover, there are other water sources, which should be taken into account.

River have increased to 0.6−1.9 metres (YANG Dechun, 2003, 24).

Owing to the deposition of silt in the Panjiakou Reservoir, the annual loss in the reservoir's capacity has reached 8.93 million m^3. Up to the end of the year 2002, the total loss of reservoir capacity was expected to be 1.78×10^8 m^3, or 5.8% of its total capacity. As the rate of sedimentation increases, and the reservoir capacity decreases, flood threats and water shortages will be intensified (LI Fusheng, 2003, 48).

Because of the decreased run-off, the Luan River's ability to dilute sewage has decreased, leading to serious pollution problems in the river.

At the same time, the number of pollution sources has increased. Most of the open channels are excavated in bare earth and are not lined, so that when the water level in the channels is lower than that of the groundwater, this groundwater, with a high chloride content, seeps into the channels and affects the quality of water in these channels.

Moreover, during the construction period, the newly built open channel could (and did) become connected to the local irrigation, sewage and discharge systems, where it passed by. Thus the cross-linking of natural and artificial channels greatly affected the water quality (SUN Xiuying, and SU Changyong, 2001, 59).

Water pollution is now so serious in Luan River and the Panjiakou Reservoir that sometimes the water quality is only of Grade V, even at the upper reaches of the River (LI Fusheng, 2003, 49).

b. Deleterious Social Influences

After the Luan River to Tianjin Water Transfer Project was completed, the amount of flows in the lower reaches of the Luan River decreased, and the level of groundwater dropped sharply. Consequently, some industries, and agriculture, suffered severe economic losses. It was estimated that in Qianan County alone,[65] water shortage amounted to 30 million m^3 *per annum*, while the value of industrial production decreased by 2 billion *yuan*, from 1981 to 1995. In rural districts alongside the Luan River, water pumps and wells for irrigation had to be abandoned because the water level in the wells dropped, and water-lifting machines had to be changed. About 58.8 thousand of wells in rural area needed to be changed, at a cost of 1000−2000-*yuan* for the reconstruction of each well, which placed a heavy economic burden on the local farmers (YANG Dechun, 2003, 24).

Reasons for the Negative Impacts of the Luan River Scheme

Drought in the Luan River Basin was undoubtedly the major cause for the inefficiency of the Luan River Project, and, as previously mentioned, Tianjin had to transfer water from the Yellow River. However, drought was not the sole cause of the unsatisfactory result. There were several other causes.

The “Regulations for Protection of Water Resources in Luan River Basin” were in force back in 1984 (after the completion of the Water Transfer Project from the Luan River to Tianjin), but were not made available to the public until 2000, having been an internal document before then because of the difficulty in co-ordination information among provinces and cities (ZHAO Anjin, and ZHANG Zengge, 2000, 15−16). Thus the management and protection of water resources of the Luan River were not and could not be implemented properly for want of public knowledge and regulatory support.

But prior to the 1980s, no impact assessment of the Luan River Water Transfer Project was prepared. There were a limited number of treatment plants for pollution along the

65 A town at the lower reaches of the Luan River, to the northeast of Tianjin.

route of water transfer only after the Luan River Water Transfer Project was completed and water was transferred to Tianjin. In the treatment of pollution, there were some problems about which it was difficult to reach agreement—such as infrastructure funding, relocation of commercial enterprises, and migration. As a result, the sources of pollution were not controlled efficiently, and the water quality was adversely affected as a result.

This case shows that there was a trend in water transfer projects in China whereby the focus was too much on the importance of *how much* water can be transferred, and which underestimated the importance of water quality. Though this was a case in the 1980s, it should still serve as an example to warn people not to neglect water quality and the environmental impacts of human activities.

There were also problems in the prediction of water demand in the water receiving areas and water supply in water source areas. In the case of the Luan River Transfer Project, the water demand of Tianjin in 2000 was predicted to be 2.5 million m^3 per day. But in 1999, the actual water used was only 1.4 million m^3 per day and at most it was 1.8 million m^3 per day (SUN Jianfeng, 2002, 21).

There was a gap between the predicted and actual volume of water demand. One of the main reasons[66] was that predictions were formerly based on the estimated growth rate of the national economy. Hence, the volume predicted was often greater than the actual water demand.

On the other hand, the water supply in the water-source areas imposed restrictions on the actual volume of water supply that was available. With a probability of 75%, Panjiakou Reservoir, the water source of the Luan River Transfer Project, could be expected to provide 19.5×10^8 m^3 of water, of which 10×10^8 m^3 of water supplied

[66] There are some other causes, such as auxiliary projects that could not be completed as planned.

Tianjin. Later, as water consumption increased along the upper reaches of the Luan River, the volume of water coming down decreased, more and more silt was deposited, and the Panjiakou Reservoir could provide Tianjin with only 8.2×10^8 m^3, (again with a probability of 75%) (SUN Jianfeng, 2002, 21).

Therefore, when predictions were inaccurate, either in the amount of water demand or in the amount of water supply, the amount of water supply could not satisfy the scales of water transfer that had been envisaged and the water transfer project could not meet its original goal as designed.

5.4.3 Some Points for Evaluation of the STNWTP

I conclude this chapter by emphasising the following points in the evaluation of the STNWTP:

a. The STNWTP is a comprehensive project, involving vast areas of land and many river basins. It necessarily has a long construction period and a great variety of scientific, technological, and social aspects or implications. Therefore when evaluating the STNWTP, one should not focus on only one or a few factors, as indicators of the accomplishment of the project, as is the case in XING Yan's evaluation of the water transfer project for transferring water from the Luan River to Tianjin.

b. Following the criteria of sustainable development, evaluation of the STNWTP must combine consideration of the short-term benefits and future long-term effects as well as benefit. From the case of the Luan River Water Transfer Project to Tianjin, it is clear that human activities have changed natural system considerably. It is easy to evaluate short-term benefits and fixed costs, while ignoring long-term effects and externality costs. Thus we must be more critical towards the negative impacts of the STNWTP upon ecological environment, while not underestimating the potential benefits of the scheme.

c. The STNWTP should not be evaluated in isolation. When an evaluation of a project is made, it has to be done from the perspective of some value system (e.g. economic considerations, technological ideology, equity, utility, preservation of the environment, or some combination of such considerations). In China, many, officials tend to adopt engineering measures and considerations to solve water-shortage problems, which is why there are already many water transfer projects. Since 1949, there have been twenty-three major water transfer projects in China, only two of which are directed towards environmental purposes alone.[67]

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67 These are the 'Water Transfer for the Zailong Wetlands' (2001−2002) and a project to supply fresh water to reduce the salinity of the estuary of Pearl River (2005).

CHAPTER SIX
MAN PROPOSES, HEAVEN DISPOSES: INTEGRATING CLIMATE CHANGE INTO WATER DIVERSION PROJECTS

6.1 An Incognisable World?

> "There are known knowns. There are things we know that we know. There are known unknowns. That is to say there are things that we now know we don't know. [B]ut there are also unknown unknowns. [That is,] there are things we do not know we don't know; and each year we discover a few more of those unknown unknowns."
>
> Donald Rumsfeld, 12 February, 2002, US Department of Defense news briefing

As human knowledge increases, has the world becomes more predictable? To some extent, the answer is 'yes'. However, at the same time, the more we know, in some respects the less we understand about the world. Regarding environmental issues, it can be interpreted at two levels. First, the world is not a static environment. Thus new problems emerge whenever there is a change. Although the new trend can be captured by scientific forecasting, unforeseen factors can often produce unanticipated outcomes. A dynamic, ever-changing world can never be fully understood. Second, with advanced science and technology, human activities have constantly increasing impacts on the natural environment, producing unpredictable complications. Climate change (which is probably human-induced) becomes more and more influential in the future course of the world; but we do not know exactly how it will act. But uncertainty and complexity make the predication of future trends increasingly difficult.

Uncertainty[1] is a major problem not only for scientific research but also for natural resource management and policy-making in relation to water resource management. In recent years (from the 1990s), work in natural resource management has not simply concerned itself with the direct results of scientific studies alone, but has found it necessary to consider the interactions between science/engineering results and practical policies.

However, the relationship between science and policy is not simply a linear process that transfers information from science to the policy domain such that policy makers can develop policies directly from scientific results. In fact, information given by scientists affects policy makers' values and their judgments, though policy makers may not always realise that they are being influenced by the preconceptions and/or preferences of scientists (or more likely engineers). On the other hand, policy makers have their own interests, values, and political objectives. Hence, they can selectively lean towards scientific researches that are on their side (Hellström and Jacob, 2001, 23−25). The connection between science and policy is becoming more pronounced over time, despite the existence of separate areas of expertise in the social and science/engineering areas.

Therefore, interdependence is inevitable and may result in negative impacts in policy-making process. Costanza and Cornwell (1992, 14) have argued that: "problems arise when regulators ask scientists for answers to unanswerable questions". Costanza and Cornwell also consider the different attitudes between science and policy studies in the light of uncertainty, which they rightly say is an inescapable part of scientific research—though scientists are trained to try to cope with it. By contrast, policy experts are admirers of certainty, even though their field of expertise is one that is susceptible to all sorts of uncertainties. As for the lay public, it fails to recognise scientific

1 "Any situation in which the object of study is only partially described or not described at all" (Krayer von Krauss and van Asselt *et al.*, 2005, 1).

uncertainties. And present policy processes do not embrace uncertainties—which may sometimes lead to catastrophic results.

6.2 Incorporating Climate Change into Policy

A good example of the debate on uncertainty and complexity is climate change and its role in the policy arena. The former UN Secretary-General Kofi Annan (15 November, 2006[2]) claimed, at the United Nations Climate Change Conference, that "Global climate change must take its place alongside the threats of conflict, poverty and the proliferation of deadly weapons that have traditionally monopolized first-order political attention."

The climate change controversy concentrates on four major issues: first, whether there have been substantial (or statistically significant) climate changes in recent years; second, whether climate-change is induced mainly by human activities or is part of natural processes (such as those associated with changes in the Earth's orbit over time). This links to the third question: if human-induced changes have become more relevant than before, then actions must be taken to correct mistakes. But what should be done and how? Last but not least, the future of climate change is uncertain, which weakens the possibility of rigorous calculation of the effects of greenhouse emissions.

Climate change and its impacts on our planet became a heated debate at least since 1997 when the so-called Kyoto Protocol was designed. However, climate change and human dependence on it was not a new topic. Climate is always changing, but it has received enormous attention in recent years because of frequency of droughts, wildfires and abnormal weather patterns. Also, the US (Bush) Administration's refusal to sign the Kyoto Protocol made this topic more dramatic and a major political issue. On one hand, many scientists were seriously concerned and spared no efforts to find evidence to support the need to control and reduce greenhouse emission; on the other hand, many

2 United National Press Release

politicians queried scientific results and argued that the scope of human-induced climate change was still uncertain. McKibbin and Wilcoxen (2002, 3) criticized the Kyoto Protocol as being too radical and ignored the high social costs of making changes and the difficulty of achieving world-wide agreement and that became the main reason why United Stated would not sign the treaty. They offered an option that was in between the above two extremes, which was less radical than the Kyoto Protocol, and would involve less social changes and economic impacts on society. In short, the US (and Australia) wanted a regulatory plan with minimum costs, which was the fundamental difference from the Kyoto Protocol. However, even though they clearly pointed out the obstacles to implementing global strategies that target climate change, their thinking focused on maintaining the existing system rather than breaking the institutional barriers and creating new decision-making processes. Climate change, and the associated disputes, have enhanced the role of uncertainty and complex system theory and challenges the present institutional arrangements and policy processes.

The hydrological cycle is one of the systems that are most sensitive to climate change. Evidence indicates that climate change accelerates the hydrological cycle and leads to a decrease of rainfall in some regions and increase in others. Overall, however, the planet would become warmer and wetter. Precipitation patterns changes will influence natural water supplies. Thus the changes will not only affect the natural environment, but also will have a major effect on people's lives (IPCC [Intergovernmental Panel on Climate Change], 2001, 77–87). This factor *must* therefore be taken into consideration when planning water diversion projects.

The influences upon water resources caused by global climate change have two main aspects:

a. it will speed up the cycling of water so that the intensity, time-length of rainfall, and runoff will be altered, and flooding will be aggravated (in some areas of the world);

b. it will speed up water evaporation, so that the water content and permeation ratio of the soil will be altered, thus altering the ecological system, so that agriculture, forests, grasslands, wetlands, and deserts will be affected. Climate change does not influence water resources alone, but also society, the economy, natural resources, and the environment. However, because of the uncertainty of climate change, it is exceedingly difficult to predict the future climate situation and the influence of climate change upon water resources.

The impact of climate change on water resource management must, nevertheless, be seriously considered as part of water resource management process. Wood, Lettenmaier and Palmer (1997, 203–228) proposed a series of mathematical models to analyse the relationship between climate change and water resource planning. They argued that water resources planning and planning methods should be modified in line with climate change, and through their research tools they investigated whether or not climate change should be taken into account in water planning, according to individual cases. They discovered that the impact of climate change was not significant enough for consideration in three particular cases they studied, but, using the same methodology, they emphasized that there might be other cases that would prove to be susceptible to the effects of climate change. However, their efforts still concentrated on how science/technology could provide a better understanding of a situation, which would be severing the important links between technological understanding and policy concerns and practices/procedures

6.3 Climate Change in China and its Influence on the Water System

Owing to the greenhouse effect and other factors (such as sunspot cycles, the movement of the earth and other celestial bodies, movements of the earth's crust, changes of global circulation, deforestation), the average temperature in China has risen by 0.68^{o} C since the 1950s, and the lowest air temperature in North China has risen by 0.24^{o} C. The precipitation of the whole country has decreased by 23.2 mm per year, and rainfall has decreased more in the North than in the South (LI Haitao, YU Guirui, and YUAN Jiazu, 2003, 1−4).

A moderate assumption of future climate change in China from YING Aiwen (2000, 187), a departmental head in the Ministry of Water Resources (MWR), was that:

> up to the year 2030, the average temperature in China would increase between 0.9 and 1.2 ºC, with increments in the south being less than in the north. The annual average precipitation is expected to rise slightly, but the increment could be 4% in northeastern China. The increment of annual mean runoff could *rise* over 6% in the northeastern area, and *decrease* in other regions by between 1.4 and 10.5%. The water shortage due to climate change could reach 160 to 5,090 million m^3 in some areas of China [which YING did not specify]. Even so, the financial losses due to the lack of water in the northeast could [it is said] reach 1,300 million *yuan*, and up to 4,400 million *yuan* in serious drought years in the Beijing−Tianjin−Tangshan area.

There appear to be considerable uncertainties!

There is, however, also a more radical prediction about future climate change trends that includes China, though the authors repeatedly emphasized that their intention was to outline an extreme climatic situation that was unlikely to happen on a large scale. In a report entitled *An Abruption[3] Climate Scenario and its Implication for United States National Security*, Schwartz and Randall (2003) depicted a scenario in which future climate change would result in conflicts over food, water, and energy. For human societies, food and water are closely related issues. Water plays a fundamental role in food production. Thus changes in water supplies will inevitably affect agriculture.

3 Abruption = abrupt change.

Conflict over water will trigger regional disputes and even outright warfare in Asia. One of Schwartz and Randall's predictions was that there could be a mega-drought in *southern* China because of dramatic temperature *drop* from 2010 to 2020 due to disruption of global water circulation patterns. If this predication is right, the change of precipitation pattern will definitely be a major blow to the STNWTP. Again, the question of uncertainty arises.

Schwartz and Randall's report has attracted much attention in China. LU Yong, a researcher in National Climate Centre (NCC) admitted in an interview with *China Youth* (7 July, 2004) that few Chinese scientists ever considered the 'abruption climate model' and its consequences. But the report called more attention in China to climate predication research. Although based on historical record, LU considered that there was little likelihood of the scenario described in the report happening, though he acknowledged that there was the possibility of a drier south and wetter north in China. Professor QIAN Weihong and ZHU Yafen (2001, 419–444) of Peking University reached the same conclusion: that in the future precipitation in the Yangtze River region would decrease while precipitation in the north of China would rise. However, QIAN claimed that a shift of precipitation in southern and northern China happened every seventy years. Thus, the extreme dry climate in the north would last for another ten years, before the next shift to a wetter period occurred. WU Wentong (*China Youth*, 7 July, 2004), also a researcher in the NCC, argued that the possible shift of precipitation could alleviate the water stress in north China. But none of above scholars is certain about outcomes of the changes and all of them admitted that there were great uncertainties about the future climate. Therefore the impact of climate change on precipitation, and hence on the STNWTP, is at present an open question, both for scientists and policy-makers. However, there is one clear point that reflects the shortcomings of the STNWTP decision-making process, namely that the NCC is not a formal member of the decision making board for the STNWTP.

Here we should note that the Cold and Arid Region Environmental and Engineering Research Institute of the Chinese Academy of Sciences, in conjunction with Greenpeace, has issued a report (Greenpeace and the Cold and Arid Region Environmental and Engineering Research Institute of the Chinese Academy of Sciences, 2005; hereinafter Greenpeace (2005)) on climate change in the Yellow River Water source region, which reveals the severity of environmental degradation and social loss caused by climate change in the region in the past fifty years. The report discusses major changes in the region from five perspectives: glaciers and permafrost; lakes and stream discharge; grasslands; soil deterioration; and biodiversity. It is the first time that there has been such a thorough and systematic investigation of climate change and its impact on the Yellow River[4] source region.

Before Greenpeace's report, a research done by the Department of Engineering Science, Oxford University, the Institute of Environmental Engineering, Peking University, and the Yellow River Water Resources Commission, China concluded the lower reaches of the Yellow River was not sustainable anymore.

[4] Regarded in China as the country's "mother river" and "the cradle of Chinese civilization".

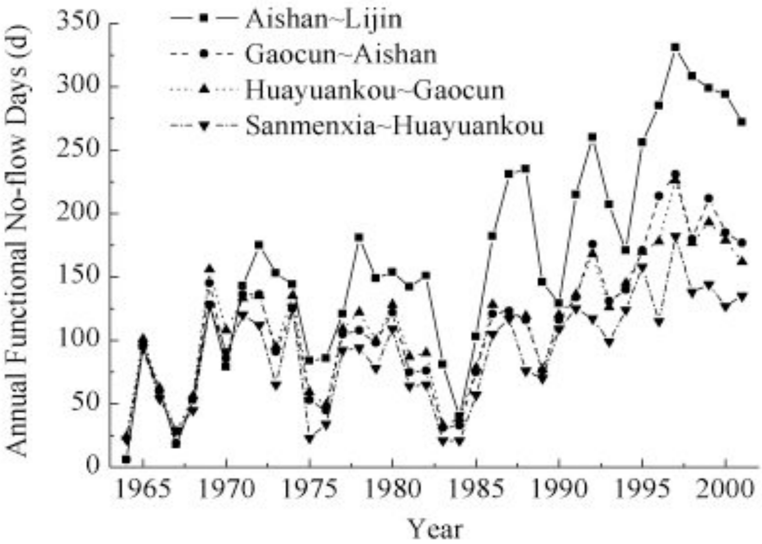

Figure 6.1 Annual functional no-flow days: 1964-2001

Note: Aishan, Lijin, Gaocun, Aishan, Huayuankou, Gaocun, Sanmenxia, and Huayuankou are names of monitoring sites along tributaries at the lower reaches of the Yellow River[5]

The increased duration of no-flow in the Yellow River is a remarkable warning sign from the second largest river in China and has drawn public and political attention to the River's environmental problems. Most research focused on the protection and utilization of water resources at the middle and lower reaches of the River, until the issue of the Report in 2005. The report showed that, with global warming, the glaciers and permafrost in the Yellow River source region have undergone significant changes. The glacier area decreased by 17% in 2000, as compared with that in 1966. And in the last thirty years, the shrinkage of the glacier is ten times faster than was the case during the previous three hundred years. Also, the edge of the sporadically distributed permafrost has moved upwards by 50−70 metres see Figures 6.2 (a, b)

5 Source: Borthwick, A., 2005, "Is the Lower Reach of the Yellow River Sustainable", SOUE (Society of Oxford University Engineers) News, Issue 4, http://www.soue.org.uk/souenews/issue4/yellowriver.html

a

b

Figure 6.2 Evidence of Retreat of the Halong Glacier, Tibet (upper picture 1981; lower picture 2005) Greenpeace (2005, 21)

Other evidence of the dramatic environmental degradation in the headwaters of the Yellow River is provided by the decline of the lakes of that region. The water area, including rivers, lakes and reservoirs, measured 2,474.5 km^2 in 2000. From 1986 to 2000, the lake area had decreased by 5.3%, of which lake shrinkage accounted for 71% of the total. Wetland basin shrinkage accounted for 13.4%. More shockingly, Madoi County, the first and highest one in the water source region used to have 4,077 lakes, but of these more than 3,000 have now disappeared (albeit mostly small ones). Moreover, many of the remaining lakes are dying (Greenpeace, 2005, 17, 27, and 28).

The crucial reality in the Yellow River's water source area is an alert not only to the management of the Yellow River, but more importantly to the Yangtze River, whose water source area is also located in the same region: the Sanjiangyuan Plain. Sanjiangyuan means the 'head of three rivers', namely the Yellow River, Yangtze River, and Lancang River (the Chinese part of the Mekong River is called the Lancang River in China). The Sanjiangyuan Plain—the main body of the Tibetan Plateau, with a vulnerable ecosystem that is highly sensitive to climate change—is known as the "national water tower". It is the main water source for North China, delivering 60 billion cubic metres water annually to downstream areas. From 1970 to 1990, the main feeder glacier retreated 500 metres, but from 1991 to 2004 the retreat was about 750 metres, which indicates that the melting speed of glacier is dramatically increasing. From 1991 to 2004, the temperature goes up to 2.8 ºC from –4.0ºC. Even people living in Qumalai, the first county at the head of Yangtze River has to buy water transported by road from thousands of kilometres away. Eighteen rivers of the Yangtze River Catchment are totally dried out. Fifty thousand local residents (mostly nomads from a minority culture) become environmental refugees. The Central Government will invest some 630 million *yuan* to relocate them, but how and where they can ultimately be settled is still a matter of concern for the Government (*Xinhua News*, 31 Augustand 13 September, 2005).

Climate change appears to be having huge impacts on the water source region, at the same time that the Government is implementing policies to extract more water from dying rivers. The Government started to concern itself about the environmental disaster in the Sanjiangyuan Plain in 2004, although scientific research revealed the potential danger of the situation long before then. Not many changes can be made in the short term to improve the ecosystem.[6] The slow response to this environmental issue is in itself enough to cause concern, but the issue remained separate from the STNWTP in official documents even though there was and is a high possibility that the Project may fail due to climate change. This shows that information that is fundamental (but subject to uncertainty) may be left outside the policy loop.

6.4 Complexity and Uncertainties of the STNWTP

As we have seen, the STNWTP is an exceedingly complicated project, involving multi-basins, multi-water sources, multi-departments of government, multi-objectives, and a multitude of areas and consumers. The project is not only an engineering one, but also involves many domains, such as politics, economics, ecology, environment, law, sociology, and culture.

The construction of the huge project, with its three routes, will involve numerous rivers and canals. The geological conditions may cause difficulties in some places and there will be safety problems in the construction of the tunnel under the Yellow River for the Central Route. Some places in the Western Route will pass through earthquake belts and regions of complicated geology. Climate is also a factor that will affect the construction and operation of the Project, in that water transfer will become a problem during the frozen period in winter, in some parts of all three routes (HAN Yifang, 2001, 36–37).

6 Mischiefs come by the pound and go away by the ounce!

The STNWTP cannot avoid conflicts with the natural environment. But the impact assessments that have been undertaken to date are limited and inadequate. A discouraging fact is that some potential impacts are difficult to monitor and predict and in the view of HAN Yifang "[t]here is no accurate method to calculate the influence of water diversion upon the ecological environment in the water source area. Sometimes an ecological system loses its balance slowly. However, once the balance is lost, it is difficult to recover" (HAN Yifang, 2001, 36). Even worse (as Mr Donald Rumsfeld would presumably agree) the *unknown* factors may well be crucial factors that can trigger a chain reaction and ruin the whole project.

The STNWTP will not affect the natural environment alone. It will also produce social changes and uncertainties. As mentioned in Chapter 5, such a major project will inevitably affect the interests of different interest-groups, and the mediation of conflicts of interest will also be complicated to solve. One of the main principles of the STNWTP is, 'whoever invests in the Project should benefit from it; and whoever suffers damage must be compensated'. However, is 'water from the south' a kind of investment? How is the loss to the eco-environment in the water source area to be calculated and appropriate compensation paid? Moreover, there are not only externality problems arising from environmental losses but also social externality problems, which cannot simply be solved by market-oriented methods.

The STNWTP can be regarded as a grand system, or whole, which consists of many complicated sub-systems. If any sub-system fails, it may bring irreparable loss to the whole project. For example, if the treatment of water pollution is not satisfactory in the Eastern Route, then the whole STNWTP may well be adversely affected. However, researches on uncertainties and complexities are not on the agenda of the STNWTP authorities. Most preliminary work has focused on what can be done, rather than what may possibly happen because of the Project. Moreover, there is no institutional or legal support for managing uncertainties and complexities. Considering the scale and time-span of the STNWTP, issues of uncertainty and complexity must be raised and examined carefully.

6.5 Uncertainties beyond Climate Change Regarding the STNWTP

We have 'uncertainty' when we are unsure whether some events will happen, when and where events will happen, how serious the events will be, and what will be the results of the events. It is these uncertainties which bring about a series of risks. Some uncertainties that have already been considered in the process of policy making are discussed in previous chapters (4 and 5). But as the main objective of this chapter is to address the uncertainties associated with global climate change that are likely to affect the policy making processes for the STNWTP, the problems are divided into two categories: risks involved, and uncertainty.

6.5.1 Uncertainties in Water Supply and Water Demand

Research on the whole project has not yet been finished for the STNWTP, not to mention any possible countermeasures that might be taken if and when any unwanted changes occur. The problem is that scientific researches have tended to become a means of 'proving the correctness' of the Project rather than identifying potential threats to, or generated by, the Project and actions that might be taken against undesirable results. Academician XU Qianqing has pointed out: "Up to now [1999], the macro-research basis has been relatively weak. There has been little research on the relation between the rational allocation of water resources, and the exploitation of water sources and water saving; and economic factors have not been given full consideration. All these are major and fundamental problems" (XU Qianqing, 1999, 29).

Currently, the water source for the STNWTP's Central Route is the Dangjiangkou Reservoir on the Han River. The water source of that part of the Han River is not unlimited, and there will be problems of water supply in drought years for that area. The Central Route spans more than 1,200 km. Under the conditions of water-loss on the way, the climatic influences (especially in drought years) will be a critical problem for ensuring that water reaches North China. These problems have already been discussed in Chapter 3. A more serious problem that I'd like to add here is the influence of the diversion from the Han River to the Wei River (Han to Wei Water Diversion Project: HTWWDP)[7] on the Central Route.

In 2005 it was stated in the *General Report of Feasibility of the Central Route of the STNWTP* (Phase 1) that:

> When the Central Route of the STNWTP plan was under revision, the HTWWDP had not yet submitted as a complete plan, not to mention examination of it by the relevant national departments. Therefore, the amount of water to be allocated to the HTWWDP had not been taken into account when calculating the amount of water that needed to be diverted via the Central Route (Institute of Reconnaissance, Planning, and Designing, Yangtze River Water Resources Commission, 2005, 10).[8]

The Wei River basin is the most rapidly developing area of Shaanxi Province. But with rapid economic and social development, the basin has become one of the Province's most severe water shortage areas. The HTWWDP is listed on the already approved 'agenda' of the Shaanxi Provincial Government work, and the amount of water that they want to have diverted annually will be $15 \times 10^8\,m^3$. Thus, the water flow from the upper reaches of the Han River to Danjiangkou Reservoir will be reduced by 2.8−5.5%, equal to $1.4–3.1 \times 10^8\,m^3$ of water. The *General Report* asserted that the project of the

7 The Wei River is the major tributary river, running through eighteen cities and counties in Shaanxi Province. The Wei River Basin is the Province's principal area for industries and the production of grains and cotton.

8 Political factors are tangled with this question. Upstream on the Han River, Shaanxi is a rather poor province, demanding water for the purposes of its economic development. Its interests were at odds with those of the Central Government in this matter.

HTWWDP would influence the water diversion of the Central Route during drought years, but would have little influence upon the annual amount of water diverted by the Central Route (*General Report*, 2005, 43). If the project of HTWWDP goes ahead, the amount of water diverted from the Han River to the Wei River for the benefit of Shaanxi, will reduce the amount of water going into the Danjiangkou Reservoir, and must be taken into account. Thus, there will be a new factor of uncertainty in the volume of water available to the Danjiangkou Reservoir. Even if, in the short-run, HTWWDP does not have severe impacts on the Central Route of the STNWTP, in the long-run the water demand increase in the upstream part of the Han River will become a significant threat to the STNWTP.

The amount of water shortage in North China is debatable. I have discussed some problems in prediction of water volume diverted to North China in Chapters 5. Many people think that the predicted amount of water required to be diverted will be higher than the real demand. There was a historical factor, which led to such a result. For a long time, the prediction of water demand amount was based on the prediction of the population growth and social development. However, "the analysis of the future economic development rate and population growth is made according to the development index determined under the planned economy system", and "in the past, the STNWTP has also adopted this kind of method to predict the water demand" (HAN Yifang, 2001, 35−36). The amount of water demand in the Yellow−Huai−Hai area is the fundamental factor for decision-making for the STNWTP. However, the data used in the planning are those provided during the period of a planned economy model, the predication of water volume that will be needed may not be accurate, since there is some doubt as to the accuracy of the information provided by the Provinces to the Central Government.

The scientific prediction of the water volume to be diverted has been based on population growth and economic development on the one hand. On the other hand, scientific assessments of water resource conditions are necessary and have been made since the 1980s. Here I discuss another kind of method, which deduces climate trends, either drought or waterlogging, or precipitation, from the most reliable historical references provided by PAN Jiazheng and ZHANG Zezhen, and JIA Shaofeng.[9]

A significant piece of research has been done by HUANG Jiayou, Professor of Atmospheric Science, Peking University. He pointed out in “An Analysis of Droughts in Beijing” that there were three periods in which great drought dominated: 1860−1870, 1930−1948, and 1960−2000, the drought lasted 11, 18, and 41 years, respectively. The latest drought is very likely to end around 2007 (HUANG, Jiayou, 2003, 441). The significance of this study is that its results are not applicable to Beijing alone, but are also applicable in North China as a whole, because of the change in summer rainfall of North China, which includes Beijing, Tianjin, Hebei, Inner Mongolia, Shandong, and Ninxia (HUANG Jiayou and LIU Ge, 2003, 435).

In another recent paper “A Study of the Periodic and Abrupt Droughts in North China”, HUANG Jiayou and LIU Ge (2003) reached the conclusion that North China has experienced five climatic periods from 1841 to the present: drought – waterlogging – drought – waterlogging – drought, it took about 3–5 years for the transitions, which were around 1866, 1894, 1921, and 1959. In terms of similarity in drought period, the first period was similar to the fifth, and in the future transition from drought to waterlogging the waterlogging period is likely to be similar to the second period of waterlogging in this area. At present, it is in the transition period (HUANG Jiayou, and LIU Ge, 2003, 348).

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9 PAN Jiazheng and ZHANG Zezhen (eds), November 2001, *Comprehensive Report on Reasonable Allocation of Water Resources in North China and Some Problems about the South-to-North Water Diversion*, China Water Conservancy and Hydropower Press, Beijing. JIA Shaofeng, 2003, “How to assess the influence of SNWDP upon social economy?”, *Impact of Science upon Society,* vol. 3, 32–37.

Table 6.1 Beginning and Ending of Periods of Drought and Waterlogging in North China (1841−2000) (HUANG Jiayou, and LIU Ge, 2003, 347)

Condition	Beginning	Ending	Length of th	Transition
Drought	1841 (?)	1865	25	5
Waterlogging	1871	1893	23	2
Drought	1896	1920	25	3
Waterlogging	1924	1946	23	3
Drought	1950	2000 (?)	51	

The authors' conclusion is that North China is in a drought period, but the situation will be like to chang. If this turns out to be the case, the possibility of having a wetter north in the future w directly affect the STNWTP. The water-receiving areas may not need so much water, or even, an extreme situation, not need the water from the STNWTP at all.

6.5.2 Political Implications

Though a huge project, the STNWTP was not formally approved by the National People's Congress, and this may cause future political uncertainty. Some people such as Wang Weiluo (*Huaxia Digest*, 10 December, 1999) questioned why the STNWTP was not submitted to the National People's Congress to approve, as was the case for Three Gorges Reservoir Project. Especially after the scandal about the MWR using the fund for the STNWTP to invest in the futures market came out. One may believe that corruption and dishonesty may hamper the implementation of the Project. It will take about fifty years to complete the STNWTP, and during this period there will be several governments. Since the Project has not been legally approved, there is certainly potential uncertainty.

6.6 Adaptation to the Uncertainty

No doubt, according to the policy cycle model, the policy making process passively responds to any problem that is happening or has happened. The main argument in this thesis is not directly about the policy itself but lies in the realm of natural resource management, and how policy processes can integrate (or deal with) uncertainty and complexity. A policy cycle in an environment *A*, which is not specifically defined as a natural environment since problems or issues may emerge due to changes in the social as well as the natural environment. It is hard or impossible to separate the two environments absolutely. Therefore, a system environment *A* should be seen as being elastic, like a rubber ball (Figure 6.3). No matter how a natural system and its social environment interact on one another, whenever there is a difficulty, a certain 'force' will pass to the policy process. The policy itself is also an 'elastic' one, which, within certain extents, will generate resistance to change (Situation *A*). On the other hand, either a good policy or a bad policy can also cause changes in the environment *A* (Situation *B*).

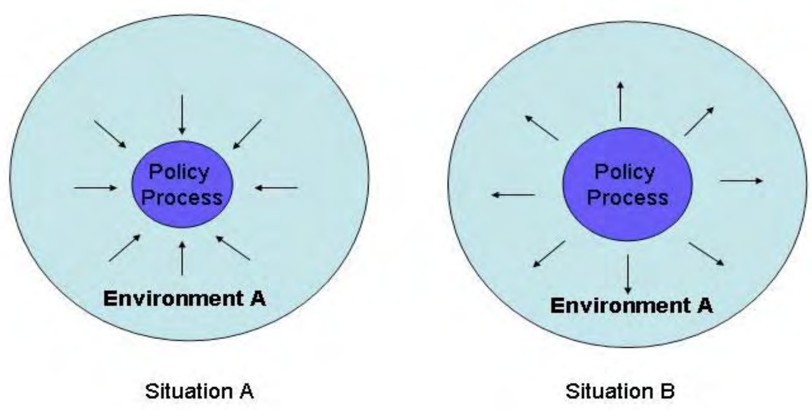

Figure 6.3 'Dynamic Ball' Illustrating the Interactions between Policy Process and Environment

As shown in Figure 6.3, no matter whether in Situation *A* or Situation *B*, when forces are extreme and exceed the limits of the system (Environment: *A*) or the sub-system (the Policy Process), then systems will collapse. Thinking in terms of a dynamic model, the policy process 'moves and bumps' in Environment *A* in a 'flexible' way. However, when a policy process moves to a certain 'position' (in the figure) and is seeking to deal with particular problems, it *takes time* for it to run the five-stage 'policy cycle'. By contrast, the environment changes gradually, but often un-noticed, most of the time. But in the face of environmental change, the 'small ball' of policy process could have moved to a new position, facing different forces. Thus, obviously, there is a time-lag for policy process to response to the changes.

Furthermore, if one separates the social impact from the natural impact, there can be occasions when the natural environmental impact is driving the policy process to 'the left', but social restraints such as political bargaining may drag the policy decision to 'the right'. Many discussions focus on how to battle with the devils of selfishness and political or economic power. However, the time-lag for policy making can produce unexpected uncertainties and complexities that are just as in the interactions among pressure groups.[10]

Fitzsimmons (2006, 131) has commented that:

> [R]ecognition of uncertainty poses a dilemma for strategists: in predicting to be wrong; but in resisting prediction, they risk clouding the rational bases for making strategic choices. Over-confidence in prediction may lead to good preparation for the wrong future, but wholesale dismissal of prediction may lead a strategist to spread his resources too thinly. In pursuit of flexibility, he ends up well prepared

[10] It should be noted further that there may be substantial time lags in the cause/effect relationships in the environment. For example, a large increase in the carbon dioxide content of the atmosphere apparently produces a climatic change some thirty or forty years later. It may also have a major, but delayed, effect on marine life. (The acidity caused by the carbon dioxide adversely affects the growth of the shells of marine organisms.)

> for nothing. A natural compromise is to build strategies that are robust across multiple alternative future events but are still tailored to meet the challenges of the most likely future events.

One can readily agree with this statement. But the question for the STNWTP is how to find the 'natural compromise'. Moreover, Fitzsimmons (2006, 136) pointed out that the fear of uncertainty may block people's ability to make sound judgments and optimal policy and "subvert exactly the value that it professes to serve: flexibility".

To solve the problem of water shortages in North China, people must insist on the principle of paying attention both to the exploitation of water resources and to water saving. "To increase water supply by exploitation of water source cannot counterbalance the results caused by water wastage and water pollution" (XU Qianqing, 1999, 28). "For water saving, it is difficult to measure the actual effect of water saving of every enterprise and institution at present" (HAN Yifang, 2001, 36). On the other hand, for the officials at various levels, it is not so easy to see achievements in terms of governance in water-saving as compared with engineering projects of water resources; for the grass-root people, neglect of water saving results from the low price of water in China's period of a planned economy. But, in the final analysis, neither officials nor people have much knowledge in the area of natural resources. *Appropriate* measures for different situations should be taken, in order to solve problems in water-saving efficiently. But what is appropriate?!

No doubt, the treatment of polluted water involves many problems, such as funding and possible negative influence on economic growth in the short term. It is a difficult and complicated matter, exemplified by the history of the treatment of water pollution in the Huai River. During 'the ninth five-year plan' and 'the tenth five-year plan', a sum of several billion *yuan* was invested in the treatment of water pollution in the Huai River, but the work produced very little effect. I have mentioned it in previous chapter. But if the water condition is not to be improved, then “great water diversion only means great water pollution and greater water wastage” (PAN Jiazheng, 2000, 27).

6.7 Uncertainties Associated with Climate Change: General Issues

There seems to be general agreement that global climate change will be in the direction of increase in global temperature changes. This will lead to melting of snow and ice in the head waters in the Himalayas and in consequence increased flows in the Yellow River, Yangtze River and Yaluzangpu (the longest river in Tibet). But with further temperature rises, the supply of snow and ice may be expected to decrease and therefore there will be decreased flows in these rivers. Unfortunately however, the time scale for such changes is uncertain. Therefore, the planners are working in a state of considerable uncertainty and it is not obvious that a single plan can be rapidly adapted to quite different situations.

A further source of uncertainty lies in the fact that melting of Arctic and Antarctic ice will alter the salinity of the world’s oceans and this may disrupt the global patterns of oceanic currents. In particular, scientists have fears that the flow of the Gulf Stream in the Atlantic Ocean will be stopped (or seriously diminished). If this happens it is possible that northwest Europe will move into a situation similar to that which obtained during the Ice Ages. We do not know what effect this might have on the situation in eastern Asia. Moreover, we do not know how long the situation might remain in Europe in a situation in which the earth is undergoing a global rise in temperature. The time frame for the completion of the STNWTP may be about fifty years and there is great uncertainty as to what will happen to global climates before 2050. Therefore, the STNWTP planners face a situation of grievous uncertainties and inappropriate actions may be taken all too easily.

Of course a global temperature rise will raise sea levels but nobody knows by how much at this stage. But if there is a large sea rise level much of lowland China will be likely to be inundated (especially the Shanghai district) and this may be a more serious problem than water shortages in the north requiring huge expenditures to put up sea walls around the coast line. Thus money spent on the STNWTP may be required for other purposes.

Furthermore, as discussed already, there is uncertainty as to the actual rainfall patterns that may be expected in China in the next fifty years as a result of global warming. Therefore, a grand inflexible plan is inappropriate, and the STNWTP plan as it stands at present is not able to be quickly modified to meet unexpected contingencies.

The question, then, is whether the Chinese planners have taken all these factors into account and tried to model the future accordingly. So far as I am aware they have not, which obviously is a matter of great concern. Indeed climate change may prove to be the Achilles heel of the project.

This raises the further question of why such an important matter has been largely ignored. Perhaps the main reason is that the Project was initiated many years ago, long before there was a serious worldwide concern about climate change. And once the decision had been taken to proceed with the Project all attention was focused on the technical engineering problems and the political and economic aspects of implementing the plan. A specific contingent issue was also the bid made by China to host Olympic Games in Beijing for which it was thought essential that the capital city should have a more than adequate water supply and the decision to proceed with the Project was made with considerable haste. Added to this there were the manifest water shortage in north China in the 1990s and floods in the south as well as the huge population growth in the north where lack of water was impeding industrial and economic development.

Furthermore, it should be remembered that many of the high-ranking politicians and bureaucrats in China have engineering and technical backgrounds and thus have seen the whole problem in terms of engineering, as was formerly the case in the Soviet Union. Moreover, as with the Soviet engineers, the hubristic Chinese leaders love major engineering projects, even if they border on megalomania. Thus they have been inclined to regard climate as an irrelevant externality. Perhaps it was fifty years ago but this is certainly not the case today.

One may add that in China political stability is thought to be of the highest importance so that the Government did not wish to be seen as one that was constantly changing its plan. But if the climate change were taken into account then the likelihood would be that the plans would have to be continually under review and changes made throughout the lifetime of the Project. Finally, considering the long history of China, during which major water engineering projects have long been undertaken and have supposedly been the mark of strong and successful government, it is hardly surprising that once having embarked on the STNWTP there has been strong resistance to making substantial changes to the Project.

CHAPTER SEVEN
CONCLUSION

7.1 The Controversy of Water Diversions—Review of Water Diversion Cases

Because one cannot see exactly what the long-term outcome of a plan may be it is important to look at the success or failure of other schemes, which is what I have endeavored to do in the present thesis. Do the successes or failures of previous schemes throw any light on what may be the eventual outcome of the STNWTP? Pearce (2006) has shown how so many large-scale schemes have had shocking unintended or unforeseen negative consequences. Is the STNWTP likely to join the list of failures?

The Aral Sea, the Snowy Mountain Scheme, Spain's National Hydrological Plan, and the Central Arizona Project are examples to indicate that in traditional ways of thinking about water management *supply* has been, and in some areas still is, a dominant method to cope with water shortages or provide water for development and economic growth. But simply diverting water to where it is needed cannot solve a water problem in the long run because population growth, economic development, social equality, and urbanisation are all related to water shortages or crises. Thus integrating sustainable development into water management calls for a change of management thinking. However, present thinking is rigid and has an inertia that hinders better water management practices.

7.1.1 Reasons for Inertia

From the cases examined, it is evident that governments have considered—or on the surface have considered—other factors (notably military spending and national defence) as more important than conservation of water resources. The starting points for unsuccessful cases have been national security, decentralization, or regional development, as well as demonstrable water shortage. However, behind apparently reasonable explanations, what really brought on those projects were false assumptions. Why have governments given so much weight to perceived national interests, or people's interests that have been too uncertain or nebulous to provide substantial reasons for constructing water diversion projects? The confusion of objectives for water diversion projects can be ascribed to the decisions and priorities of politicians and government officials (Ascher, 1999, 255). Ascher has emphasized that high-level government and state officials have their *own* objectives and agendas, including economic and political goals:

> a. Economic goals: promoting particular development projects; redistributing economic benefits, either to broad population groups or to specific individuals, families, or interest groups/classes; enhancing the overall level of [a] central treasury's financial resources
>
> b. Political goals: gaining greater control over financial resources; reducing the political cost of pursuing any of the objectives listed above; gaining the cooperation of other private or public actors in pursing any of the economic or political objectives; gaining the approbation (perhaps by generating employment) of the populace, which may or may not be fully aware of the long-term effects of a scheme (Ascher, 1999, 18–19).

The Aral Sea case, for example, shows that the USSR Government made the decision to acquire more money for the central treasury (to a considerable extent for the purposes of military spending), by increasing the income from cotton and rice production. It also considered the economic and political relationships between Soviet Union and its satellite republics, rather than genuine 'national security'. The USSR wished to be—as far as possible—independent economically from the rest of the world. Thus the inhabitants of the Aral Sea area 'sacrificed themselves', not for the country alone but in the interests of the Cold War and Russian (Moscow) hegemony.

The arguments about the validity of the role played by the Australian Federal Government in the Snowy Mountain Scheme also reflect the intention of that Government to wrest power from the State Governments, which was justified in the name of national security. The Snowy Mountain Scheme was a complement for the centralization policy of the Federal Government, rather than for the purpose of national defence, which was used as the constitutional justification of the centralized project.

In the Australian case, the invocation of national security enabled the impasse between the Victoria and NSW Governments to be overcome. Water should be viewed as a national problem, but interstate rivalries and interests prevented the development of a national water policy. On the other hand, the Scheme made electricity available for the use of the Federal Government's capital, which was politically independent of the States. The Australian Capital Territory did not have its own independent electricity supply.

The efforts on the part of governments to achieve national security goals were probably specious or spurious in both cases. Government officials in high positions had regard to the goals mentioned by Ascher. The goals were more related to political advancement or advantage than the ostensible strategic goals. Hence the interests of central governments were the 'real matter' and reduced the chances of making changes in the system when required.

Furthermore, the terms of officials or politicians are limited (or finite). By contrast, the natural response of the environment to changes takes a long period of time. The 'time contradiction' encourages short-sighted policies and over-riding of the interests of the weak parties involved, who lacked suitable channels or media to influence the outcomes. The conflict between large-scale thinking and small-scale detail reflects the difficulties in being practical and accommodating the interests of all stakeholders. This is still a barrier to change in the direction of prudent action.

7.1.2 Common Interests and Special Interests

Clark has defined common interests (as regards water supply) as "those that are widely shared within a community and demanded on behalf of the whole community. Safe drinking water, for instance, is a demand made by nearly all communities and supported by their expectation that they are entitled to a safe, healthy environment" (2002, 13–15). He argues that it is difficult for policy makers to establish common interests, but it may be possible to do so by identifying special interests at the outset. During interactions and conflicts among special interests, which shape and share values in society, common interests should be clarified and secured (Clark, 2002, 13–15). His assumptions must rely on the precondition that there is sufficient and effective public participation.

More recently, Brunner and Steelman have stated that problems in natural resource management stem from the "inability to integrate valid and appropriate community interests when possible, or to balance them when necessary, to protect or advance the common interest of the community [as a whole]" (Brunner and Steelman, 2005, 9).

For water diversion projects, water usually flows from the less developed areas to areas with a high rate of economic development and a high density of population.[1] People in the receiving areas find it relatively easy to express their voice to governments or share the common interests with governments to some extent.

People in the areas from where water is being, or will be, diverted will suffer from loss

[1] This was not really the case in Australia, where the economic development occurred in the irrigation area, subsequent to the completion of the Snowy Scheme. And the Islamic southern states of the USSR were not areas of dynamic economic growth prior to the enlargement of the Aral Sea Project. On the other hand, in the Spanish case, the water transfer scheme was a suggested response to the problems caused by the burgeoning economic development in southeast Spain.

of certain amount of water and environmental changes and are much more likely to oppose the projects. Because their interests run counter to the interests of governments, their opinions may be likely ignored, either intentionally or unintentionally in the policy process However, had the USSR Government invited the Uzbek peasants to express their opinions, they might have been quite enthusiastic: doing their thing for the good of their nation and obtaining regular paid employment in an (ostensibly) modern high-technology agriculture. But the technical information might all have been supplied by 'Moscow'. This suggests the importance of empowering people at the grass-roots level by the provision of education and information. (This is easy to say, but very likely 'Moscow' itself did not have the appropriate information or foreknowledge at the time.)

The preconditions of forming a solid common interest are not easy to achieve. The conflict between the interests of the central group's and the wider interests are hard to reconcile. Achieving an overall balance of interests may be very difficult, or impossible, to achieve.

7.1.3 Checklist for Water Diversion Projects

What is the real purpose of any particular project? Today it is hard to give 'national defence' as a justification for some water diversion projects. Water shortage or stress is frequently used as an 'undebatable' reason. But in order to avoid the influence of self-interests in policymaking and produce a better planning of projects, a point-by-point checklist should be considered.

Direct Policy Orientation

A lack of water is, in most cases, closely associated with population growth and economic development, with the expectation of increased water demands in the future. Therefore, the first step is to diagnose what *causes* a water shortage in a given area, and which field it affects most. If it has resulted from dramatic increasing of household use, then the speed of urbanization may be too fast and should be altered by such actions as migration or water pricing policies, or even population control (as has been attempted in China). Also water conservation in cities should be taken into account, such as rain harvesting in residential areas, renovation of infrastructures, recycling, and other techniques. If industrial use predominates, more efforts should be put into improving water use efficiency in industry. In general, policy should be oriented towards consumption behaviour and to greater water saving.

Technologically Grounded Policy

If a water shortage is caused by several factors that make it hard to solve by policy-orientation alone, then it is time to find alternatives: for instance desalination or long-distance water diversion projects. Compared with the cost of other technological approaches that may be considered, water diversion projects may be attractive. But they should be directed by several precautionary rules.

Biswas *et al.* (1983, 23) has stated that long-distance water diversion projects should be built upon three kinds of system: physical, biological, and human. The physical system refers to natural entities like water quantity, water quality, land/soil and atmospheric implications. Biological systems encompass aquatic and terrestrial animals, and vegetation. Human systems include all activities involved with human beings, such as agriculture, transportation, manufacturing, resettlement, and political implications. He suggests that these three perspectives could be a checklist for water transfer projects. These three areas cover most perspectives related to long-distance water diversion projects, but it may be hard to balance the competing factors that they involve.

Economic Approach

How is water allocated after it has been diverted, so that it will not lead to *increased* water demand? How is the water to be priced and how should the price be set? How can one ensure the welfare of weak parties?

Biswas pointed out that massive water transfer costs, often calculated only on 'direct cost of transporting water', seldom take into account the costs for the water-source areas. However, the term 'direct cost' is not clearly defined by him. How much is the cost of building a canal or a pipeline? Is the direct cost only related to the project, which can be estimated as 'visible cost'—that is the cost of the materials and energy directly involved in construction work, wages, etc. (The term may be still quite vague, but at least it shows that the estimated cost usually concentrates on a 'material' approach.) Certainly there are other matters like opportunity costs, which he mentioned, and external costs, which are hard to quantify, or even recognise at the time of planning a diversion. How can one evaluate the total costs, especially with regard to environmental and social costs? A major task should also be to minimise or even place a cap on water consumption. In the area of water management, pricing water is regarded as the most effective way to limit the waste of water. But how does one set a price that takes the 'invisible costs' into account, while not leaving disadvantaged groups in a desperate situation, since they are worse off because of the rising price?

7.1.4 Countermeasure of Complexity and Uncertainty—Stakeholder Involvement

First, the results of water management usually impact on specific environments. In other words, the final outcome of water resource management directly affects people and environment at local levels. Stakeholder involvement promotes improved water strategies in a few aspects: most local stakeholders are 'interest-related', and usually they understand the problems involved. Local communities are most familiar with the local water conditions (though not necessarily in a 'scientific' way) and can recognise difficulties quickly. With their assistance, governments or other organizations should make sure that the objectives of a plan are necessary and that the plan is feasible. In addition, because local interests may directly gain (or lose) from, or be influenced by, a plan, it is crucial to them that it is well thought out and appropriate. Consequently, they have strong incentives to advocate plans that serve their interests and are able to see the process of a plan's implementation. If there is any deviation from the basic purpose of the plan, local stakeholders are likely to be able to detect it more easily than most governments and organizations, because they have a close relationship with end-users. Moreover, it is quite common for governments to 'enjoy' the positive accomplishments of a plan, ignoring feedback about its actual implementation. Consequently there may be no incentive for further improvement of the plan.

Next, technological innovation is frequently an important aspect of natural resource management, not least for water management. However, sometimes a project cannot perform as intended for non-technical reasons. Such problems occur, for example, when there is difference between a real situation and that of a simplified and standardized engineering model. Thus engineers need to try to narrow the gap between reality and their theoretical models, and local stakeholder involvement, and the input of people with special professional expertise, can assist towards water management plans being implemented smoothly, with minimum adverse effects. Owing to local stakeholders' knowledge, and their incentive to protect their own interests, they should be involved in the planning process.

Another factor is that the 'career approach' of engineers can lead to insufficient and inappropriate management of water resources.

> [o]peration and maintenance in water supply agencies has a low, and usually an inferior, profile as compared to the new construction and system extension. Thus for career minded engineers the route to top management positions is recognized to be through new construction and not operation and maintenance (Fennerty, 2006, 95).

The evaluation of staff performance is often based more on the quantitative aspects of their work than the quality of each specific piece of work. In natural resource management, it takes quite a long period of time for the environment to respond to a new policy or a plan and for the real outcome to be revealed. The long time involved is characteristic of environmental issues, water resource being no exception. But authorities cannot wait for sufficient time to assess the impacts of their policies and actions on the environment. They may prefer to start a new project rather than examine the feedback or undertake the necessary follow-up work. Furthermore, the linkage of promotion to quick work may cause staff to ignore the opinions of objectors, eventually resulting in conflict between residents and policy makers.

Public participation is "direct participation by non-governmental actors in decision-making" defined by Mostert and he explains that "'direct participation' includes many different activities, such as the opportunity to send written comments, referenda, water users' associations, mass demonstrations, legal actions, etc. (Mostert, 2003, 180)". For policy-making, government-organised public participation is much easier to form and more effective to influence decision-makers in a comparatively short period of time. However, to what extent, governments can take recommendations from non-governmental actors into consideration, and modify their policies accordingly, relies on the openness of the government, whether there is enough institutional supervision, and how much the modification of the policies can affect the interests of governments or their voters.

In such circumstances, stakeholders have to bring pressure to bear on government agencies and urge them to consider ideas from local communities, private companies, non-governmental organisations etc., which have interests in projects.

Stakeholder involvement requires participants not only from governments, but also local people, as well as environmental experts. Healy and Ascher (1995, 1) has noted that:

> [N]ew sources of information may increase emphasis on sustainable, multiple benefit use of resources, but they can also shift power away from non-expert actors, undermine rights arguments, polarize debates over appropriate resource use, and delay timely decision-making.

But even in circumstance where local stakeholders are involved (and they are excluded almost entirely in today's Uzbekistan), the battle with time still exist. The involvement of more parties prevents the leaders of water projects from the making of arbitrary decisions, but difficulties in forming a common vision and reaching agreement can lead to lengthy debates, thereby missing the right time to make decisions.

In that case, small-scale projects or group discussions are better than large ones, which need decentralization of power. More power should be given to local communities. Regarding water diversion projects, people in areas contributing water to other places should certainly have the right to be involved in decision-making processes, as well as the recipients.

It is impossible to find a 'one-size fits all' model for water diversion histories. However, it worth establishing guidelines for the analysis and evaluation of water-diversion projects and use them to help minimize the repetition of mistakes made in the past. Also from the different cases analysed, some manifest the failure of water division planning; some show the failure of implementing water diversion projects; and some raise the question of the quality of the management of water diversion projects. Through different results from water diversion projects, their general nature is explored revealing the 'ideological foundation' of water management. The aim is to help to examine future problems in regard to sustainable development.

7.1.5 Review of Water Diversion Cases

Each case examined in Chapter 4 has its own characteristics in demonstrating some problems in one or several particular areas of water diversion projects. The Aral Sea is a case that cannot be ignored in considering water diversions. It reveals how serious the consequences can be if a water diversion project are designed without attention to the environment or worse still if there is an intent to 'conquer nature'; and if it is implemented with total disregard to the well-being of local communities. However, more importantly, institutional barriers that hinder the affected region from efforts to make changes to rebalance water demand and water supply are the main lessons from the Aral Sea case. The Snowy Mountain Scheme in Australia well demonstrates the pertinence of policies on decentralisation, energy, and urban development, which all had impacts on the decision-making process. The NHP case was aborted at the first stage—the planning stage—because of its 'immaturity', which was demonstrated in several aspects: insufficient evidence to demonstrate that the project could be environmentally friendly; a financial bottleneck because the project did not obtain the financial aid from European Union that the Spanish Government (the one previous to that which holds power today) had expected; an Opposition that attacked the project to help it win an election; and the deleterious effects of the project for the water suppliers in northern Spain. The NHP did not take the five elements mentioned above into consideration. The CAP was a case that illustrates the importance of proper financial management, especially on the relationship among governments, contractors, and end-users.

It is clear from the cases examined that although each had its own characteristics there are general principles for water management policy. Those principles are formed based on the five elements stated in Chapter 3.

Stakeholder involvement in water resource management requires the removal of barriers of understanding between the different groups who will be involved or affected by a project. To some extent it can also be viewed as a change from a supply market to a demand market, concerned more with the need of users or customers, not planners or project managers who are working in a 'top-down' bureaucratic system.

However, while giving more regard to social impacts in environment problems, stakeholder involvement is hard to achieve in practice, and may be thought of by some as a 'luxury' in water resource management. Morrison (2003, 48) considers that the existence of a common vision for the whole of a working group is a crucial practical lesson learned in stakeholder involvement in water management.

The importance of a 'common vision' in water management does not mean that all stakeholders must think about the future in the same way. The problem raised here is that the inevitable competition of stakeholder interests leads to the difficulty of achieving a common vision. Even if all groups involved in a project have a mutual interest, their motivations for being involved may be diverse and not always mutually compatible. Each stakeholder may have different or even conflicting interests, which, however, affect the whole group. But in the absence of a common starting point, a project may be halted for a long time. Meanwhile the right time to begin the project passes; changes and concessions are made by one side only; or in the end nothing definite or satisfactory to all parties is achieved. Thus although it may not be impossible to reconcile the conflicts among different stakeholders, it takes time to realise a satisfactory outcome. This fact may not be satisfactory to either project makers or local participants. Project makers lose patience and make an arbitrary decision that adversely affects the desired result of the project, which may thus run the paradoxical risk of being anti-democratic (Ascher, 2001, 754). Local stakeholders who participate in the project are likely to feel that their opinions are not given enough attention and they lose confidence in the consultative process.

To address the difficulty of conflicting interests among stakeholders, one useful method is to start with small-scale programs that can be easily achieved. Compared with a very comprehensive program, small-scale programs are easier to understand and implement by all group members and a common vision can be developed more quickly. Even though small-scale programs might be criticized for lacking a holistic view, they are much more flexible in problem solving.

Different from stakeholder management, the concept of adaptive governance moves its focus to 'governance' rather than 'management'. It realises the political nature of the natural resources and encourages active community participations in natural resource decision-makings (Brunner and Steelman, 2005, 19; Bryner, 2006, 674). In relation to large-scale, long-distance water diversion projects, the idea of adaptive governance is highly significant. Often, such projects are initiated by governments and considering the enormous investment involved can only be done with the support of governments. To some extent, water diversion projects are political trade-off among different interest groups. But if a decision-making process is centralised in government, as occurred with the Aral Sea case, disastrous results may follow. A diversion project is not simply a matter of constructing pipelines or tunnels, etc. Just as importantly, it should involve both national and local interests, neither of which should ignore the other.

7.2 The STNWTP—More than a just a Water Diversion Project

7.2.1 Political Stability—First Priority

In Chapter 5, the process of policy making has been discussed, but without the crucial starting point: the feasibility study. The feasibility study for the STNWTP is an open-ended process, which means that there is no definite deadline for its completion that meets the idea of “touch the stone to cross the river”.[2] In other words, feasibility and monitoring studies have to be carried on throughout the planning and construction period, and plans should be modified whenever appears necessary. Adjustments should be made in the light of the results from previous feasibility studies, if and when new problems arise. However, it should have been fundamental for the project to have had a prior full-scale investigation, including the economic, social and environmental considerations, to verify the feasibility of the Project *before* the decision was made to proceed.

The STNWTP started from a bold ‘idealist’ concept and excessive confidence in human power to master the natural environment. Although officially, the preparation for the Project was to last for about fifty years, the investigation was not conducted continuously throughout this period. Some construction work on dams and reservoirs for the Project were completed in the 1960s, which resulting from the notorious *Great Leap Forward*.[3] From that time, until the end of *Cultural Revolution*, the normal order of the whole Chinese nation was disrupted, and research on the Project certainly was not the main issue during that period. After the political disturbances of the 1960s and 1970s, the key focus of the country shifted to economic growth in the 1980s and recovery from the political campaigns of the Maoist era. So the Project was not considered as urgent and realistic until 2000, when the Olympic Games for 2008 were put on the political agenda. Thus even though the preliminary work lasted fifty years, the pre-work of the Project was not adequate, especially when climate change and water conservation issues were left out of the process, or were not given due attention for long time. To take climate change into consideration in relation to the STNWTP should now be a major priority, both from the long-term perspective of water supply, and to protect the source areas of China’s two major rivers.

2 DENG Xiaoping’s idea of economic reform in China.

3 Although building dams and constructing reservoirs was set as the fundamental policy for water management after the establishment of People’s Republic of China, the *Great Leap Forward* greatly increased the number of water projects. The poor quality and huge number of dams and reservoirs became major worries of water management in China (*Scientific News*, 8 January, 2007).

Even without detailed and cogent proposals, the Project passed the fifth National People's Congress (NPC) in 1978 as one of the issues in the Government's 'Report on the Work of Government' (of which more than two thirds was about the success in defeating the 'Gang of Four'). At the fourth session of the seventh NPC in 1991, the STNWTP was included among the projects for the 8th Five-Year Plan (1991–1995). In October 1992, at the fourteenth National Congress of the Communist Party of China (in practice more powerful than the NPC at that time), the STNWTP was listed as one of the backbone trans-century projects for the whole nation, which confirmed its irreversible position. However, the full investigation of the present project only began as late as 1995, and only after 2000 was the three-route proposal finally agreed on and the preliminary research work on it started.[4] The aim of repeated mentioning of the STNWTP at the main meetings at the national level was to ensure the political status of the policy.

Although the Project was still only at a preliminary investigation stage, it was crucial for the Government to make sure the previously made decisions could be implemented in order to maintain the authority of the Government's decisions, which was considered as the foundation of the political stability—a key issue for China. Given the historical and political contexts, all actions taken by the Government were reasonable. After the Cultural Revolution, the whole country needed to recover from the class conflict and restore economic and social stability. But since there were no fundamental changes in the political system or the decision-making model, the system simply just carried on.

The South-to-North Water Transfer Planning and Designing Administration was reconstituted in 2000 and in 2001 WANG Shucheng, the Minister of Water Resource Management commented: "the South-to-North Water Transfer Project involves very complex technological, economic, social and environmental issues. Related preliminary work should be done under the organisation of the government. The project is a major

4 *History of the STNWTP*, official website of the STNWTP, http://www.nsbd.mwr.gov.cn/nsbd/history/

event as it relates to the whole future development of China" (WANG Shucheng, 2006, 48–49). His statement emphasised the governmental control of the Project and its significance for China's future development (but he said nothing about any possible negative consequences).

Questions of uncertainties such as whether there will be enough water to divert, whether the Project would be financially sound, etc. have been discussed in Chapter 6. Those questions are enough to cause disquiet about the future of the STNWTP. However, the Project is not only (as stated by the Government) a scheme to eliminate water crisis in the north China. More importantly, "it is the political and pragmatic arguments rather than those based on economic profitability or environmental impact that [have] justif[ied] the Government's decision to proceed with the project (Ghassemi, and White, 2007, 313)". The problem is that this project is seen as a 'political task'(*zheng zhi ren wu*) not as a water diversion project. A 'political task', in Chinese 'political-speak', means a task of high political significance that must be achieved at all costs. The use of this phrase reflects the earlier highly centralised economic system (before the economic reforms after 1978). However, the word is still used in official documents and speeches, though inappropriately because it does not imply consensual support for the policy but something more like a military command, putting collective interest beyond individual interest.

After fifty years of talking about the Project, and exposure to political propaganda, the general public accepted that it was for the good of the whole nation and should be undertaken. In order to guarantee political stability it is unlikely, therefore, that the Government will give up the Project, which would lead to doubts about the Government's decision-making, and would challenge its authority. Therefore, the STNWTP will almost certainly not be abandoned, despite its many uncertainties.

7.2.2 Environmental Supervision—Weak Management

The main tasks for SEPA (State Environmental Protection Administration of China) is to make policies, rules, regulations, and laws on national environmental protection; and to help the State Council prepare realistic environmental impacts assessments for the purpose of key economic and technological policies, and development planning. Standards must be set for national environmental protection rules, etc.[5]

The important task of preparing environmental feasibility studies is (or should be) undertaken by the SEPA. However, environmental impact assessments were mostly undertaken by local governments, research centres, and committees (such as the Yellow River Water Project Committee and the Yangtze River Water Project Committee, which were the main designers of the STNWTP).

The only assessment work related to the SEPA was done in 1995, when it approved the initiation of environmental impact assessments for the Central Route of the STNWTP in October that year. After that, no more environmental assessment was done until 2003, *after* the project had already started. In 2003, the SEPA issued guidelines for re-evaluating the environmental impacts of the Central Route's construction. But this time the SEPA was not directly involved in the process of evaluation (Berkoff, 2003, 22).

Besides the Central Route, no environmental impacts have ever been made public for the Eastern and Western Routes. The reason could be that for the Eastern Route, with its heavy pollution problem, the result of environmental impacts would inevitably count against the Eastern Route scheme—which is not what the Government wants. For the Western Route, the final decision on how to construct this difficult route has not reached by governmental officials and scientists. However, especially in view of possible climatic change (already evident) the Western Route is the one that urgently

5 Statement from the official website: http://www.zhb.gov.cn/dept/jgznjj/200404/t20040428_89743.htm

needs an environmental evaluation before commencement. The Western Route will be completed in a remote and largely untouched area in southwestern China. The ecosystem is much more fragile and sensitive to changes as compared with other areas such as middle the lower reaches of Yangtze River, which have been explored and settled for some five thousand years.

In the policy-making process of the largest water diversion project in China and also in the world, the SEPA has the responsibility and right to participant in the project to ensure that possible environmental costs have been taken into consideration. However, the SEPA has played a passive role in this case. As an environmental auditing governmental organisation at the highest level, the seemingly unconcerned attitude shown by the SEPA to the STNWTP has roots in the institutional structure of China's administrative system. The SEPA operates under the aegis of the State Council, and this institutional setting restricts its monitoring the effects of State policies. This is the dilemma for governmental agencies in China that are granted the legal power to identify, evaluate, and monitor policies' results but have no institutional support for them to do so.

Such a phenomenon may be even more evident at the local level. In the incident of water stoppage in Harbin in November 2005, when an explosion in a chemical factory created very serious pollution in the Songhua River and attracted world-wide attention, people complained that local governments prevented correct information from reaching the public and a 'white lie'[6] was given by the governmental officials. In fact, after the explosion, a statement from the Jinlin Environmental Protection Administration on 21 November falsely stated that there were no harmful chemical substances flowing into the Songhua River and causing water pollution (*Xinhua News*, November 2005).

[6] Initially the Harbin Government tried to cover up the truth by telling the public that the water supply was cut off for a thorough check of the supply system. After the truth that the Songhua River was heavily polluted after chemical explosions in Jilin province was revealed, ZHANG Zuo, the Provincial Governor of Heilongjiang said in a public speech that the erroneous information given to the public at the beginning was a 'white lie', because the Government was worried that the public could not handle the truth.

However, the situation was that the water in the Songhua had become grievously polluted. The level of the poisonous substance benzene in the river was more than a hundred times above the national safety levels (BBC News, 23 November 2005). And the pollution of the river was soon seen on television screens worldwide.

Why did the Jinlin Environmental Protection Administration make such an irresponsible statement and ignore threats to public health and safety? Although the Jinlin EPA is a subordinate organisation of the SEPA, in practice its power was less than that of the local government. Therefore it had to support the governmental decision, even when it was manifestly a wrong one. The case clearly revealed the inability of the EPA to give truthful and effective advice to the public (though presumably it advised the Government correctly).

Obviously, with the increasing importance for environmental protection, the SEPA should be more independent from the administrative system, and less affected by the governmental policies. Just possibly, the Harbin incident will prove salutary and there will be some future systemic changes.

7.2.3 Economic Project—A Chance to Get Rich?

One aim of the Project is to promote domestic economic demand. At the local level, it becomes a major task for local governments to bargain with the Central Government and try to maximise local benefits. Former Premier ZHU has averred that:

> [N]ow economic strength could sustain to carry out the project of water diversion step by step. At the same time, accelerating the building of some major basic installations will promote domestic economic demand, develop markets for traditional industries, as well as enhancing economically sustainable development (*People's Daily*, 12 May 2000).

Also Premier WEN has stated that the STNWTP will promote domestic economic demand, west-to-east electricity transmission, west-to-east gas transportation, south-to-north water diversion, railway construction on the Tibetan plateau, and the Three Gorges Dam on the Yangtze River. All these measures will increase domestic demand (WEN, 2002). In the Report on the Large-scale Influence of the STNWTP by the Centre of Development Study of the State Council, it has been estimated that the investment for this Project can promote a 0.22% increase in the GDP. From the Central Government to local governments, the STNWTP is seen not only as a water diversion project, but also an economic project that will provide greater employment opportunities and bring in more revenue. It is hard to deny that such an enormous project will have great impacts on markets related to the Project's construction. However, shifting the focus to the anticipated economic gain from the project *per se* will be dangerous, for it will surely intensify the conflict between the natural environment and economic development.

During my interviews with the local government officials especially in water source region for the Project, I found that they were more interested in economic benefits brought by Project. Some regions along the Central Route are less developed areas. Some local officials hope that by taking the opportunity of the building of the STNWTP they will be able to enrich themselves. There are two ways of promoting local economy by the Project: one is asking for directly financial aid from the Central Government or higher governments; the other one is to attract investors to invest money into industries related to the construction work of the STNWTP. The funding from the Central Government is limited, however, and has to be used for infrastructure construction. Investments from outside the areas concerned attracted by the Project—mainly in the building industry, transport, and tourism—can cause more environmental problems and will not necessarily lead to healthy and sustainable economic development in those regions. A senior official of the Chinese Committee of Reform and Development holds that this kind of development is unsustainable because the infrastructure construction does not increase the employment rate. The construction of buildings and roads can lead to an increase in GDP, of course. However, if new buildings are left vacant, and if no new employment is created, problems will accumulate. In the last five years, despite the rapid growth of the Chinese economy, new employment has declined.

7.2.4 A Pro-technology Society

Technology plays an important role in decision-making process in China. Compared with Western countries, in which politicians commonly have social science or law degrees, the majority of Chinese leaders after the 1980s have engineering or science backgrounds. Before the end of the 1980s, the Chinese leaders were promoted to party leadership as a result of their performance during war-time. They formed the first two generations of leaders in China. Although most of them did not have an education background in engineering or science, after the civil war, Chinese politicians adopted and adapted the Soviet model, which was enthusiastic about engineering projects to demonstrate the power and 'wisdom' (or skill) of human beings. Based on that fact, a positive attitude towards technology has long been a major factor in decision-making processes.

In 1987, the third-generation leadership group started to hold power. The composition of the leadership changed, but the pro-technology tend was strengthened. For example, JIANG Zemin (Former President of China from 1993 to 2003) has a mechanical engineering degree from Shanghai Jiao Tong University; LI Peng (Premier from 1987 to 1998) studied at the Moscow Power Institute and majored in hydroelectric engineering. His successor ZHU Rongji (Premier from 1998 to 2003) graduated from Tsinghua University with a degree in electric engineering. In the current fourth generation of leaders, President HU Jintao also graduated from Tsinghua University majoring in hydraulic engineering, and Premier WEN Jiabao graduated from the Beijing Institute of Geology as a structural geologist. Thus, in the core of China's decision-making group—the Politburo Standing Committee—currently nine members have backgrounds in engineering. There is no better example than China to display a close tie between science, technology, and politics. With their knowledge-background, the top level of Chinese leaders can readily understand technological and engineering solutions. Moreover, engineering projects and achievements are likely to have appeal to them.

Not only does the decision-making group at the top inclines towards 'technological fixes', but also water management officials have the same tradition of focusing on engineering projects. In fact, the translation that I have used for of Ministry of Water Resources is not accurate. According to its literal meaning of the Chinese words (*shui li bu*), it should be something like 'Ministry of Water and Hydraulic Resources', which has the connotation of hydraulics and hydropower. WANG Shucheng, the Minister of Water Resources, mentioned that water resource management in the Chinese education system actually refers to hydraulic engineering. He used the university where he graduated from—Tsinghua University—as an example that almost all courses are about how to build water projects. And students who have studied hydraulic engineering are the main source for governmental officials in the Ministry of Water Management. He concluded that water management in China has focused overwhelmingly on project-based management (WANG Shucheng, 2006, 3–4). So pro-technology decision-making groups have been the internal driving force for the planning and development of the STNWTP.

7.2.5 Social Impacts

Besides the resettlement problems, which have been discussed in Chapter 5, other social impacts likely to be brought about by the STNWTP are ignored or overlooked. Economic disparity is increasing in China, and has become a major social issue. The STNWTP will not alleviate these disparities. Rather, it is likely to exacerbate the tensions between urban and rural interests, and the rich and the poor. The Eastern and Central Routes are mainly intended to satisfy urban water demands and exclude agricultural use, which, however, accounts for nearly 64.6% of total water use (Ministry of Water Resources, 2005, 8). (The Western Route is not intended for urban use alone, but how and when it is to start is still an unresolved matter.) So, as far as the Eastern and Central Routes are concerned, water will be diverted to cities without benefiting rural consumers. But it is rural people who will have to be re-located and give up their land, probably with inadequate compensation.

One of the main slogans used for the STNWTP is: 'transfer(ring) clean water for the Capital'. In the 1950s or 1960s, the idea of making contributions to the Capital was almost the same as making contributions to the whole country. Everyone would feel proud of making such contributions. However, since then, the symbolic power of the term 'Capital' was weakened. Although its political influence is still dominant, in a sense Beijing is no more than one of China's mega-big cities. In such a circumstance, continuing the use of an outmoded slogan sends a wrong message to the general public. People now feel that they are being robbed and they question why they should sacrifice their water for the 'high and mighty' capital. These complaints come not only from people in the water-source areas, but also from people along the routes, who will also receive some water but will suffer disruption and loss of land as a result of the Project. Particularly when communication channels between local officials and local people are not functioning smoothly, misunderstanding of the Project is likely to exacerbate the conflicts between Beijing and other provinces involved in the Project.

7.3 Recommendations

Sustainable development should be emphasised in its own right in natural resource management and policy. In the case of water resources, it is time to call for institutional changes in management, ways of thinking, and methodologies for policy-making, regardless of the political system that is operating in any particular country. Things can go wrong in democracies due to lack of foresight (as in the case of the salination that resulted from over-irrigation in Australia using Snowy River water); or in command economies such as in the Soviet Union and its irresponsible actions in the case of the Aral Sea catastrophe. In Australia, a total management plan for the major waterways of the south-eastern Australia with unified Federal control over waters in Queensland, New South Wales, Victoria, and South Australia is at last under discussion in 2007. But this is coming far too late and should have been initiated many years ago. Therefore, a democratic form of government is no guarantee of rational water policies. It is not necessarily a panacea for everything.

The cases discussed in the present study were not selected with the intention of showing the negative sides of large-scale and long-distance water diversion projects. But all have had problems or weaknesses and Pearce (2006) has shown that virtually all large-scale schemes have run into trouble. Nevertheless, people find such schemes attractive and they are still commonly used to try to deal with water stresses.7 The Spaniards may yet try to revive their scheme. A huge Project is under discussion in India (Pearce 2006), and Kazakhstan is again calling for water to be transferred from Siberia (Poleyov, 2004). Water diversions may appear politically attractive, and can be represented as evidence of 'good governmental performance'. However, with increasing public awareness of environmental issues, controversies about large-scale water diversion projects will assuredly become fiercer in the future.

Discussion of large-scale, long-distance water diversion projects cannot ignore the role played by governments. They have strong political motivation, and the financial and the administrative capacity, to make large, inter-basin water diversion projects happen. But this means that the policy-making processes in water management, especially large water projects, must be given much closer attention by social scientists as well as engineers.

[7] In 2005 a proposal was put forward to divert water from the Kimberley Region of northwest Australia to Perth, the capital of Western Australia at the time of a State election. The Leader of the Opposition vowed to proceed with the Project regardless of whatever a feasibility study might reveal! But this was too much and his party lost the election.

For the Chinese case, the preparation for the STNWTP has, on the whole, not been adequate. First, institutional change for the Chinese water management system is crucial. The MWR should separate its role from hydraulic and hydropower project-oriented management to *water demand management*. The national body, SEPA, should be granted more power in the supervision of major water projects. The Central Government should issue new practical standards to evaluate local governments' performances in terms of environmental improvement just as much as economic growth. Assessment of the STNWTP should be performed by independent bodies rather than committees and institutes under the control of the Government. The members of such bodies should be suitably qualified at the technical level, politically and financially independent. Such groups are already available in Chinese universities. NGOs should also be involved to represent the interests of local people, who do not have a strong power base. But in China at present, such organisations are still in a fledgling state and are poorly resourced.

Research should shift to environmental evaluation and uncertainty forecasting (e.g. issues such as climate change), as well as engineering and economic discussions only. Such research can also be directed towards micro-perspectives, rather mega-water projects, considering patterns of water consumption, new technologies for water recycling, and ways of maintaining water infrastructures. In the case of climate change, it would be well to consider the Snowy Mountain Scheme. According to the section on Australia of the recent report by the United Nation's Intergovernmental Panel on Climate Change Report (2007), the water flow in the Murray–Darling Basin is likely to fall 10–25% by 2050 and 16–48% by 2100 (due to climate change).[8] (Attempts to reverse some of the Snowy River water into its original water channel may yet have to be reversed again to try to assist the Murray–Darling Basin.) If similar water declines occur in the Yangtze River system, the whole STNWTP strategy will be in jeopardy.

[8] As discussed on the ABC's '7.30 Report' on 29 March, 2007.

There are also roles for economists, as the issue of water pricing is a major consideration for the rational use of water resources; and any policy changes must also have an eye to the economic prosperity of the country. And demographics is a major issue in China intimately related to water demands. Education about water problems should be part of school curriculums. People must be taught the idea of living within limits. Strategies for limiting the development of Chinese cities are a major issue too.

How to secure river systems and also meet water demands for increasing populations and ever-expanding economies is not just an environmental problem. More importantly, it is a policy and management problem. As things stand at present, the Yangtze River is sixth on the list of the world's endangered rivers for reasons of pollution (WWF, 2007, 40). But it is Yangtze water that is to be transported to the north for the Eastern Route. China has a big problem.

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