UNIVERSITY OF PRINCE EDWARD ISLAND

CHALLENGES OF SUSTAINABILITY ON SMALL ISLANDS:

Case Study of Weizhou Island, China

by

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

SINGING PRAISES

I sing praises to the sea,
I sing praises to the waves,
I sing praises to the light,
I sing praises to the night,
I sing praise to the one,
the one who made you and me.

- Richard J. Fairchild (1995)

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ABSTRACT

In a society where development choices are predominantly shaped by monetary economic values, the well-being of the natural environment is neglected. Realizing the so called 'economic progress' could destroy the foundation for all life, and understanding the importance of a healthy ecosystem could assist societies to make better decisions when confronting economic development, and to preserve what we value the most about our homes.

This thesis looks at the current tourist and industrial activities, as well as future tourism development plans, on a municipal-administered small island - Weizhou Island. It then seeks to explore the impacts of these activities, and to help us understand how the natural well-being entails the opening of a wider range of possibilities for the expression of human civilization.

CHAPTER ONE – INTRODUCTION

Small Islands, Big Significance

View from Sesame Beach on Weizhou Island

John Donne tells me and doubtless it's true,
"No man is an Island, entire of itself..."
There's much to be said for his point of view;
One book seems sterile alone on a shelf.
Today, unaccompanied, I strolled the beach;
Islands were strewn to the far horizon,
Each in its solitude, each within reach,
Each in the separate sea it plies on.

Fruit of the mainland, each has its savor,
Part of a family, yet quite unique;
Always that difference, some special flavour,
Taunts you and teases, its onenesses pique.

Everything's seamless and all things sunder,
This is the burden, this is the wonder.

- Charles E. Wadsworth (1978)

The study of small islands, from genuinely interdisciplinary perspectives, can provide ecological and social models for larger societies, and for the planet as a whole. The world-renowned anthropologist Margaret Mead, in a speech in 1976, has persuasively underscored this:

> *We have, in small islands, the greatest diversity of ecological, cultural, and economic style that we have anywhere in the world. Furthermore, because these are island cultures, we actually have in them the closest thing to a model of the whole world... Easter Island was a good model of planet earth. Easter Island people got there and they knew they could never get away. They were there for keeps as far as they knew, and there was no one else who was ever going to come, so they had to make what they could have of the situation.*

Now we know that we are alone in the solar system and no other people are going to come to our rescue... We can study and analyse the behaviour of people on islands and their relationship to a known environment; we can understand an island because we can sail around it, fly over it, climb over it, and catalogue every tree and plant and insect.

- Margaret Mead (1976)

1.1 Island Futures as Microcosms of Our Global Future

Small islands are bounded systems, and represent a microcosm of the planet earth, which is also a bounded system on a planetary scale (Nagarajan, 2006). The bounded nature of islands has many aspects and presents a manageable unit of study. In fact, as Clarke (1990) explains, "small islands are, indeed, living laboratories wherein we can see the results of social, economic, and environmental experiments in ways that are not visible on larger land masses." As an example, Charles Darwin and Alfred Wallace were inspired by the Galapagos Islands to create the framework of evolutionary biology some 140 years ago. Ecosystem ecologists Robert H. MacArthur and Edward O. Wilson developed the idea of islands as natural experimental models with their *Theory of Island Biogeography* (MacArthur & Wilson, 1967); and physical anthropologists have continually returned to islands as microcosms for the study of human behaviour (Kirch, 1997). Systems analysis of islands was greatly advanced by UNESCO's Man and the Biosphere program in the 1970s studying the island systems of Hong Kong (Boyden, 1979), Fiji (Brookfield, 1980) and Gotland, Sweden (Zucchetto & Jansson, 1985).

The Man and the Biosphere studies were the first to examine islands by investigating the dynamics of modern human societies and the natural systems in which they exist. This research began to paint a comprehensive picture of the interaction between humans and nature, a project that otherwise would be a grandiose endeavour at a continental scale (Deschenes & Chertow, 2004). Excluding Greenland, islands have a combined land area of about 7,700,000 km^2 or about five percent of the earth's surface (Towle, 1985). Deschenes and Chertow (2004) further explain this island microcosm as the basis for significant advances in the natural and social sciences fields of study, such as evolutionary biology, ecosystem ecology and physical anthropology. Gale (n.d.) also comments that the limited land mass phenomenon of small islands is a gift of the small islands to the rest of the world, where positive experiments can become models, or otherwise, it can serve the purpose of a warning signal. Hence, the study of small islands becomes important for understanding larger landmasses, and the planet earth as a whole.

The case of the collapse of Easter Island in the southeastern Pacific Ocean is a small island example that serves the purpose of alarming other states. The islanders exhausted the island's finite natural capital, consumed their forest, and drove their plants and animals to extinction. They finally reduced their complex society to chaos in just a few centuries (Loret, 2003). The once paradise island of Nauru is yet another example. Prior to its 'discovery' in 1798, the island was completely self-reliant within the bounds of nature, sustained comfortably by plentiful fish, fruits, and a variety of other natural and cultivated crops. "In the absence of trade or other contact with the outside world, the people of Nauru developed a self-contained, durable society" (McDaniel & Gowdy, 2000). However, after rich deposits of phosphate were found in

1900, the island's fate was sealed. In just a century of mining, Nauru's once verdant interior, today lies devastated. Rees (2000) comments, "the story of Nauru may well be the story of the modern world writ small and fast". After all, the human economy is a subsystem of the ecosystem, where the limits to economic growth are primarily constrained by the limits of the host ecosystem, its absorptive and regenerative capacity.

Small islands as living laboratories can also demonstrate how an environment-conscious economy could benefit a society. Prince Edward Island in Canada carried out the 'Prince Edward Island Wind-Hydrogen Village Project', which tested the concept of using wind energy as the primary energy source to produce hydrogen to provide backup and primary electricity for industrial, farm and household needs, as well as hydrogen fuel for transportation solutions. "The prospective solutions for the project can be easily replicable in other islands or non-island communities", said Pierre Rivard, President and Chief Executive Officer of Hydrogenics Corporation. Mr. Rivard also stated that "Prince Edward Island provides an ideal microcosm model of the hydrogen economy" (Renewable Energy Access, 2005). This is an environment-conscious island community showcased to the world.

1.2 Small Islands' Development and Unique Characters

Since 1960, roughly 30 tropical and temperate islands across the five major oceanic basins have become politically independent (McElroy & Mahoney, 2000). McElroy (2003) has categorized the postwar history of such small islands as falling into two groupings. To different degrees, the first group has used this new-found

autonomy to create non-traditional activities such as off-shore finance and ship registries (Baldacchino & Milne, 2000). In the latter grouping, the remarkable transformation of tourism into the world's largest industry has brought the islands away from traditional agricultural activities and towards mass tourism and related constructive activities.

The impressive increase in the level of, and the impacts resulting from, small islands development has attracted a reasonable amount of interest in the academic community (Butler, 1993), and has created its own discipline of studies – island studies. Focusing attention upon the economy and politics of small islands are Armstrong and Read (2002), Baldacchino and Milne (2000), and Briguglio (1995). Those focused upon sustainability and environment include Butler (1999), Gössling et al. (2002), Sharpley (2000), and Beller et al. (1990).

While an island is generally perceived as a unit of land surrounded by water and finite, there is little consensus in the literature of island studies as to what precisely is an island. It is worthwhile, therefore, to discuss briefly the characters of islands and how these characters make an island an island and an object of study. Two opposite viewings exist. The first is the mainstream perspective of islands as isolated outposts in a vast ocean far from any powerful economic centers, have limited physical size, narrow range of natural resources, and face challenges in trade and economic development due to their location and transportation difficulties. From this perspective, small islands are also viewed as over-dependent on tourism for foreign exchange and have poorly developed infrastructures, limited funds and human

resources (McCarthy et al., 2001). This perspective, mainly from those who live on continents, is entirely based on the extent of the land surfaces that they see.

The second is what Hau'Ofa (1993) describes as a more holistic perspective in which things are seen in the totality of their relationships. He says that *kakai mei tahi* or just *tahi*, 'people from the sea', who had lived in the Pacific for over 2000 years viewed their world as 'a sea of islands' rather than 'islands in the sea'. He further argues that smallness is a state of mind, "their universe comprised not only land surfaces, but the surrounding ocean as far as they could traverse and exploit it...named stars and constellations that people could count on to guide their ways across the sea". He believes that there is nothing small about the world in which their ancestors lived in. Their world was "a large sea full of places to explore, to make their homes in, and to breed generations of seafarer like themselves. People raised in this environment were at home with the sea."

1.3 Study Purpose

This thesis argues that the current thinking of progress and approaches to development is flawed. I shall employ the case of Weizhou Island, a small island located in the Beibu Gulf[1] in China, to test the argument. Weizhou Island's title as the second most beautiful island in China brought tremendous tourism development activities in recent years, the destination management organization has also identified an ambitious future tourism development plan; and with the strong wave of economic

[1] The Beibu Gulf, formerly known as the Gulf of Tonkin, is a semi-enclosed bay with a flat bottom sloping gently from the northwest to the southeast. The Gulf covers a total area of 129 000 km^2. The Gulf on average is 38-meters deep except at the mouth, where the water is about 100-meters deep (Qi et al, 2003).

development spreading all over China, Weizhou Island with its rich natural resources could not escape being exploited. The current development activities have taken a toll on the natural environment of this small island.

The goal of this study is twofold. By elucidating the issues and problems caused by development activities that are taking place, I shall demonstrate that the current approach to development on the island is unsustainable, and is responsible for adverse impacts on the fragile coastal ecosystem. In addition, this research is designed to serve as a valuable lesson for island and continental communities elsewhere to seek out methods to better manage development affairs at both governmental and civilian levels, and to reach a more sustainable future in the end.

CHAPTER TWO - CONCEPTUAL FRAMEWORK

Where It All Began

Southwest Tip of Weizhou Island

Will they come again
To this lonely island?
Will they stay away
From their old homeland?
Will they come again
To this lonely island,
Across the rolling waves
To where it all began?

- Jimmy Rankin (1992)

2.1 Defining Sustainability

We must enable the earth to renew itself. We must aim to improve the material, intellectual and spiritual circumstances of peoples. And we must nurture the values which enhance human possibilities. Our ancients believed in the unity of all living things, and even of life and non-life. We must rediscover this sense of identity with and responsibility for fellow humans, other species and future generations.

- Indira Gandhi (n.d.)

The term 'sustainability' has been intensely debated by academics and professionals alike for over three decades. It has been researched, defined and re-defined numerous times, and even till today, there is still no definite consensus on what the concept means. Depending on one's perspective and priorities – government, local residents, tourists, entrepreneurs, it can be viewed as a philosophy, a strategy, a way of living, a responsible way of travelling or a marketing ploy. The concept has been discussed since the early 1970's (Gould, 2004), and there are five publications

and events that stand out as being the most influential in discussing it, namely: 1) *Limits to Growth* (Meadows et al., 1972), 2) *World Conservation Strategy* (IUCN et al., 1980), 3) *Brundtland Report* (Brundtland, 1987), 4) the Earth Summit, and 5) Barbados Programme of Action for the Sustainable Development of Small Island Developing States (Barbados Programme of Action) (UN,1994).

The early research in sustainability began with the publishing of the book by Meadows, Randers, and Behrens in 1972 entitled *Limits to Growth* (Murphy, 1998). Their work involved creating a computer model that analyzed global resource consumption and production. Also in the study, they looked at five factors affecting human society: industrialization, population, food production, natural resources, and pollution. Their study results created stirring conversation about resource use beyond the carrying capacity of the planet. Furthermore, their research predicted that if the present rate of growth, food production, industrialization, pollution, and depletion of resources were to continue without change, the planet would reach its limit of growth sometime within the next 100 years (Smith, 1995).

In 1980, shortly after the publishing of *Limits to Growth*, the International Union for Conservation of Nature and Natural Resources (IUCN) (currently the World Conservation Union), United Nations Environment Programme (UNEP) and the World Wide Fund for Nature (WWF) published the *World Conservation Strategy*. The strategy lays out 3 objectives: to maintain essential ecological processes and life support systems, to preserve genetic diversity, and to ensure the sustainable utilization of species and ecosystems (IUCN et al., 1980). It was then that the term

'sustainability' was first given currency, and later reinforced by the *Brundtland Report* (Tilbury et al., 2002).

The *Brundtland Report* (Brundtland, 1987), also known as *Our Common Future*, is where the term 'sustainability' first gained its formal political authority and international recognition. This report suggested that social equity, economic growth and environmental maintenance are simultaneously possible and important, and placed environmental issues firmly on the political agenda. The report provided the key statement on sustainability, which was later widely accepted and quoted:

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs and does not imply in any way encroachment upon national sovereignty.*

The *Brundtland Report* also suggested that international governments should meet to look at how to best reduce the effects of human activities on the environment for future generations. This led to the first Earth Summit, held in Rio de Janeiro, Brazil in 1992. At the Earth Summit – "unprecedented for a UN conference in terms of both its size and the scope of its concerns – the UN sought to help governments rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet" (UN News Centre, 2011). The Earth Summit "accelerated the process of awakening the world to the urgency of sustainable development and secured the beginnings of a process of international cooperation on development and environmental issues" (Tilbury et al., 2002).

Finally, the Barbados Programme of Action was the result of a global conference held in Barbados in 1994 to consider how small islands could face up to their special challenges. This document addresses the economic, environmental, and social developmental vulnerabilities facing islands; and outlines a strategy that seeks to mitigate those vulnerabilities. It was produced in 1994, and is remained one of the only international programmes specific to small islands.

2.2 China's Rising Involvement in Tourism

Although China is blessed with abundant tourism resources, including its long history, a civilization with notable achievements, varied natural endowments and diverse ethnic cultures, the country is a late entrant in the world tourism and travel market. China's Cultural Revolution over the 1966 to 1976 period left China with serious shortages of economic capital and backward economic conditions in many parts of the country (Zhang, Chong, & Ap, 1999). In response to deteriorating conditions, and with the goal of generating much-needed foreign exchange earnings, the Chinese government introduced the 'open-door' economic policy in 1978 (Tisdell & Wen, 1991). After recognizing the significant potential of tourism development and the contribution tourism could make to the country's national economic development, Deng Xiaoping and Chen Yun began to emphasize the development of tourism right away (Zhang, Chong, & Ap, 1999). In 1986, tourism industry was put into the national plan for social and economic development for the first time (Zhang, Pine, & Zhang, 2000).

Over the expansionary period of the 1980s and 1990s, most of the government's investments were allocated to physical improvements near cultural and historical sites (Liu & Wall, 2003). Domestic tourism was seen as basically involves a regional redistribution of national income and was not of much concern to the national government at first; priority was given to international tourism as it was a large source of foreign exchange. The domestic leisure needs of China's large population were only seriously considered recently when the Chinese, particularly in the eastern cities, started to enjoy more discretionary income thanks to a rapidly improving national economy and greater freedom to travel (Liu & Wall, 2003).

In the following decade, China experienced significant overall increases in tourist arrivals and foreign exchange earnings (Singh, 1997). Tourist arrivals from abroad increased from 1.8 million in 1978 to 41.5 million in 1993, while tourism receipts increased from 263 million to 4,683 million US dollars over the same period (Wen & Tisdell, 2001). This phenomenon suggested that the economic reforms resulted in spectacular economic growth and with this boom in tourism development, China achieved its economic goals (Wen & Tisdell, 2001). Today, the tourism industry is one of China's largest industries. According to China National Tourism Administration (CNTA) (2010), there were 126 million international tourist arrivals in 2009, and tourism receipts reached 39.7 billion US dollars. The number of domestic tourists was 1.9 billion, while tourism receipts amounted to more than one trillion Chinese Yuan (Yuan). In 2009, China enjoyed the fourth place world-wide as a tourism destination (Table 2.1) based on number of tourist arrivals, and the fifth place for tourism receipts (Table 2.2) (UNWTO, 2010).

Table 2.1 International Tourist Arrivals by Country of Destination

Rank	Country	International tourist arrivals (million)
		2009
1	France	74.2
2	United States	54.9
3	Spain	52.2
4	**China**	**50.9**
5	Italy	43.2
6	United Kingdom	28.0
7	Turkey	25.5
8	Germany	24.2
9	Malaysia	23.6
10	Mexico	21.5

Source: United Nations World Tourism Organization (UNWTO, 2010)

Table 2.2 International Tourism Receipts

Rank	Country	International tourism receipts (US$ billion)
		2009
1	United States	93.9
2	Spain	53.2
3	France	49.4
4	Italy	40.2
5	**China**	**39.7**
6	Germany	34.7
7	United Kingdom	30.1
8	Australia	25.6
9	Turkey	21.3
10	Austria	19.4

Source: United Nations World Tourism Organization (UNWTO, 2010)

Tourism creates opportunities for host destinations to benefit in economic terms as well as to create a commitment to conservation and sustainable development. At the same time, however, increased demands also create pressure on the ecosystem. Excessive numbers of visitors make it more likely that natural habitats will be at risk and cultural heritage could be ruined. China particularly faces this challenge. It is

expected that in the next twenty years, the country will encounter many challenges as it is forecasted to become the top tourist destination in the world (Basiuk, 2000).

2.3 Chinese Economic Development and Learning to Value Nature's Free Services

Many aspects of China's development had been eye-catching since its reform in 1978. Since 1979, China' gross domestic product (GDP) has been growing at an average of 9.6 percent (adjusted) per year, reaching 4.98 trillion US dollars in 2009 — the third largest economy in the world (World Bank, 2010). When it first opened its doors in 1979, the Chinese government began to realize that to fuel China's development, economic self-reliance would not be sufficient; rather they would have to reach out and seek trading connections with other nations, with the goal of turning China into an economically developed nation (Liang & Lauderdale, 2006).

The first test of the 'open-door' policy was the establishment of special economic zones (SEZs) as 'windows' for international trade and foreign investment. In 1979, Shenzhen, Shantou and Zhuhai in Guangdong province became the first three SEZs, and Xiamen in Fujian province became the fourth in 1980. The outcome of this trial project was successful in economic terms. Foreign currency holdings of Guangdong and Fujian in 1980 increased by six times compared to 1979 (Goss, 1988). The central government then quickly recognized the dramatic increase and granted similar preferences to Hainan Island and 14 coastal cities in 1984[2], to the entire

[2] Those cities are: Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong, Ningbo, Shanghai, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai.

coastal zone in 1988, to Shanghai in 1990, and to 21 additional (non-coastal) cities along the Yangtze River and in the northeast in 1992 (Shirk, 1994; Wang, 1996).

The 'open-door' policy increased China's trade with other nations at an unprecedented rate. Trade volume increased at an average annual rate of 15 percent from 1978 to 2003, and its share of total world trade increased from less than one percent to more than five percent, while its national ranking in world trade (merchandise) jumped from 32nd place in 1978 to third place in 2004 (after the US and Germany) (Lin, Cai & Li, 2003). The Chinese economy, unlike any other in the world, depends heavily on its exports. "Such a large trade volume is not necessarily a good thing for China, a nation with scarce per capita resources", says Hu in an interview (Fei, 2005), "exporting any goods would deplete large amounts of natural resources and threaten the ecological environment".

> *When in a world moving toward a state, where something as elusive as water could be owned and sold, where grain that did not even exist yet could be purchased, where so many aspects of the natural world were being rendered equal before the almighty dollar, it was easy to overlook what separated one thing from another. Commodities have a special ability to hide from view not just the work, the sweat and blood that went into making them, but also the natural capital, the soil, water, and trees, without which they would not exist* (Steinberg, 2002).

Most manufactured products use water during some part of the manufacturing and production process. In manufacturing and food processing industries, water can be used during fabricating, processing, washing, diluting, cooling or transporting a product or for sanitation needs within the manufacturing facility. It takes an estimated 8,000 liters of water to produce a single pair of leather shoes, and 2,000 liters for a cotton T-shirt (Waterwise, 2007). For every ton of rice produced, Chinese paddy fields expel 2,000 tons of water (Laurance, 2006). Despite the large volume of Chinese exports, China only makes less than five percent of the profit, and the majority of its exported goods are the products of cheap labour. Thus, China, with its low-cost production, is mired at the low end of the international scale for labour incomes, while the lion's share of the profits goes to multinationals and dealers (Fei, 2005).

The untold story behind China's economic boom is environmental pollution and ecological deterioration, both of which cost the Chinese people an extremely high price (Ling, 2005). The World Bank (2007) estimates that 350,000 – 400,000 people die prematurely each year due to respiratory illness triggered by air pollution. An additional 300,000 die from indoor air pollution, such as the fumes from coal-burning stoves and boilers; and 60,000 die from diseases ranging from cancer to diarrhoea connected with water pollution. In the period between 2000 and 2005, on average about 54 percent of the seven main rivers in China contained water deemed unsafe for human consumption (World Bank, 2007). The combined health and non-health cost of outdoor air and water pollution for China's economy comes to around $US100 billion a year (or about 5.8% of the country's GDP) (World Bank, 2007). Rural small and medium enterprises make up 49.6 percent of the national value-added industries.

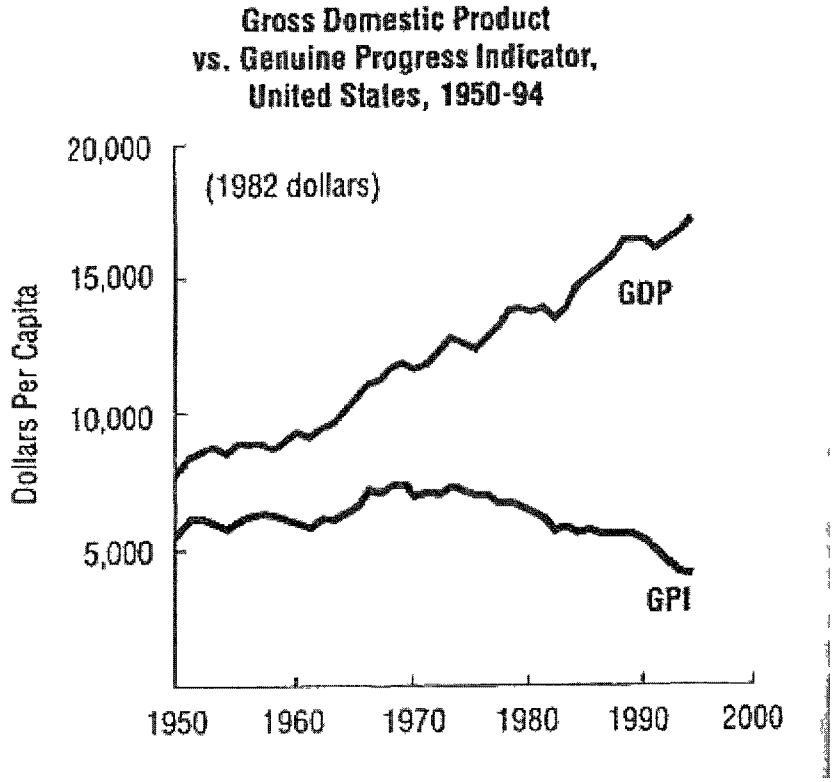
Among the 38 professions in which these enterprises are engaged, 33 are associated with serious occupational hazards, including acute poisoning. Some of the most hazardous professions include mining, metallurgy, construction materials, plastics, machinery, textile manufacturing, food industry, furniture-making, pharmaceuticals, and art manufacturing. More than 25 million workers expose to toxic and harmful materials (Ling, 2005).

The impact of economic activities on the ecosystem is cumulative and affects human survival. Severe environmental pollution eventually causes epidemics. Immunologists understand that China has already become the source of various such epidemics, for example, SARS in 2003 and the miserable bird flu in 2005 (Ling, 2005). Nature's "free" services form the invisible foundation that supports our societies and economies, yet our economies unwittingly encourage us to misuse and destroy nature because they undervalue its services (Abramovitz, 1997). Values are changing. Tradition is losing out to modern. Modern is being abused. The worst part is that ignorance remains bliss.

In fact, Abramovitz (1997) suggests that we can do a better job of reflecting the values of nature, and by doing so, better maintain ecosystem services and processes. Standard indicators such as GDP have not been good at measuring environmental or human well-being. The Genuine Progress Indicator (GPI) is a new tool that, unlike the GDP, gives a more complete assessment of well-being by counting household and community work, and subtracting for depletion of natural habitat, pollution costs, income distribution, and crime. (It does not, however, reflect the value of nature's services except when they are lost.) The following figure shows

the growth of GDP in the United States from the 1950 to 1994, and the contrasting GPI, which has been declining since the 1970s (Cobb, Halstead, & Rowe, 1995).

Figure 2.1 Gross Domestic Product vs. Genuine Progress Indicator, United States, 1950-94



Source: Cobb, Halstead, and Rowe (1995).

> *We can no longer assume that nature's services will always be there free for the taking, therefore we must become more cautious than ever and forward-thinking before taking any actions that could disrupt natural systems. We can rarely determine the full impact of our actions. The consequences for nature are often unforeseen and unpredictable. We can neither practically nor ethically decide what*

future generations will need and what they can survive without (Abramovitz, 1997).

The government of China's understanding of sustainable development has been stated as follows:

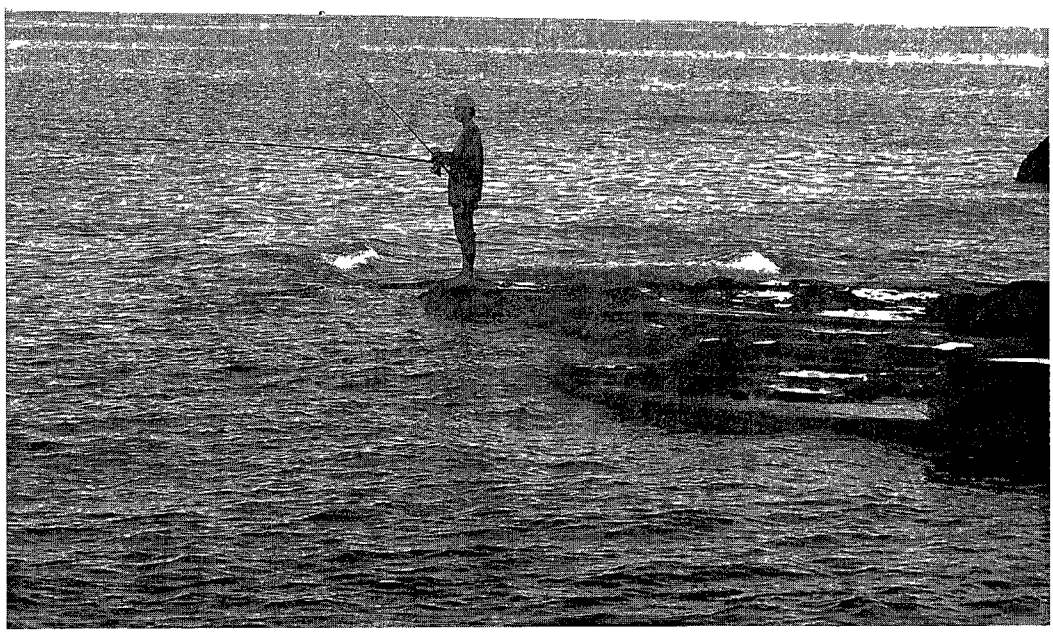
> *Social and economic developments are the cornerstone of sustainable development. Experience in history has led us to believe that sustainable development cannot be attained when the populace is plagued by backwardness and poverty. China must firmly give priority to the primary task of developing her national economy so as to alleviate poverty and improve the living standards of the people. Economic development, as the nation's central task, is essential to raising social productivity, improving the competence level and living standards of the people, and achieving sustainable management of natural resources and protection of the environment. Economic development constitutes the material foundation for any national undertakings in the country, and is a fundamental guarantee to achieving the co-ordination of the population, resources, environment, and economy* (Administrative Center for China's Agenda 21, 1997).

That having been said, small islands dot the seas of China and conjure numerous associations ranging from tropical tourist paradises to isolated outposts. Along the coastal Guangxi, in the Beibu Gulf, there are 651 islands and islets each

with an area of more than 500 m^2 (Yu & Mu, 2004). Weizhou Island, the case study destination, is one of these islands, and its resources are being exploited to fuel the country's economic development. The islanders paid and continue to pay a dear price for the exploitation of the resources; we will take a closer look at the case study in chapter four.

CHAPTER THREE – RESEARCH METHODOLOGY

Living the Island Way



Fishing on West Side of Weizhou Island

3.1 Research Paradigm

The central purpose of this study is to employ Weizhou Island as a case study to discuss the challenges of sustainability on small islands. This is done through an examination of the island's natural capitals; the present oil, aquaculture and tourism developments; as well as the destination management organization's future tourism plan for the island. Qualitative analysis was deemed the most appropriate method to use given the exploratory nature of the research. Without a doubt, qualitative approaches have a history of use in travel and tourism research within certain disciplines (Decrop, 1999). Secondary data and first-hand observations are the main vehicles of inquiry used in this study. Basic quantitative analysis is also used to aid in the presentation and interpretation of study results.

In order to receive the most accurate information about, and a true feeling for the studied island, I travelled to and lived on Weizhou Island for six consecutive weeks. As Mead (1976) says, "We can study and analyse the behaviour of people on islands and their relationship to a known environment; we can understand an island because we can sail around it, fly over it, climb over it, and catalogue every tree and plant and insect." This was the case for Weizhou Island. During the six weeks, I went about every corner of the island, observed what is happening, and obtained first hand information in the field.

In an effort to limit personal and methodological biases, triangulation is used wherever possible. Triangulation is broadly defined by Denzin (1978) as "the combination of methodologies in the study of the same phenomenon". Jick (1979)

further explains: "by adopting triangulation, organizational researchers can improve the accuracy of their judgments by collecting different kinds of data bearing on the same phenomenon". Four basic types of triangulation can be identified – data, method, investigator and theoretical (Denzin, 1978). In this study, the first two types are employed. Data triangulation is carried out by using both primary and secondary sources of information. Primary sources are the researcher's observations; secondary sources are complementary, including academic literature and official documents. Method triangulation is performed by using multiple methods to study a single problem – this study employed collection of documentary evidence, site observation, and quantitative interpretation of some of the study results.

3.2 Site Selection Rationale

Reasons for the selection of the study site are twofold. First, under the influence of China's economic development and urge for natural resources, Weizhou Island, which primarily depended on farming and fishery for a living, is now undergoing intensive and diverse industrial development. Meanwhile, given Weizhou Island's temperate climate and recognized beauty, tourism has also grown to become a major industry on the island in the past decade. These two trends have the potential to deteriorate the ecosystem, which parallel the contradictions incurred in China's rapid development. Weizhou Island is a manageable unit of study given its limited size, yet its economy is large and diverse enough to be considered a microcosm of coastal China, and a site from which we can learn about issues that affect the world in large. For these reasons, I chose this island as a study site.

A transdisciplinary and integrated approach is used in conducting the study of Weizhou Island. This study uses a lens that takes into consideration of the sustainable future of the island rather than immediate economic interests. Weizhou Island is the result of mainstream economic development of a type, which 'progresses' at the expense of a deteriorated natural environmental condition. Weizhou Island's ecological predicament is a microcosm of the greater Chinese coastal environment.

3.3 Strengths and Weaknesses of the Research Design Methodology

This study employs secondary sources and observations to evaluate the existing industrial and tourism developments on Weizhou Island. While the information collected and presented in this study is believed to be factual, reproducible and objective, a consideration of the study design's potential weaknesses and strengths is, nevertheless, important.

Given the fact that most of the scientific and academic papers were only available in Chinese, I have contributed in translating these academic documents from Chinese to English, and therefore broadened the availability of the Weizhou Island literature resources in the English language. This study is strengthened by the use of triangulation, in terms of both data sources (primary and secondary) and collection methods (literatures and observations), to limit possible personal and methodological biases.

One weakness was that a few have studied about Weizhou Island in the past, relatively little is known, and written resources on this island were difficult to obtain.

It was imperative that some adaptive approaches be built into the research design to make up for this weakness. One fact that needs to be pointed out is that Weizhou Island is a town administered by Beihai city, which is located on the mainland, decision-making government agencies are not present on the island. This is also true for China National Offshore Oil Corp., the corporate offices of which are located in another province. For these reasons, no interviews could be conducted with government or industry leaders.

CHAPTER FOUR – CASE STUDY - WEIZHOU ISLAND

Small 'Paradise' in the Far East

Rural Village on Weizhou Island

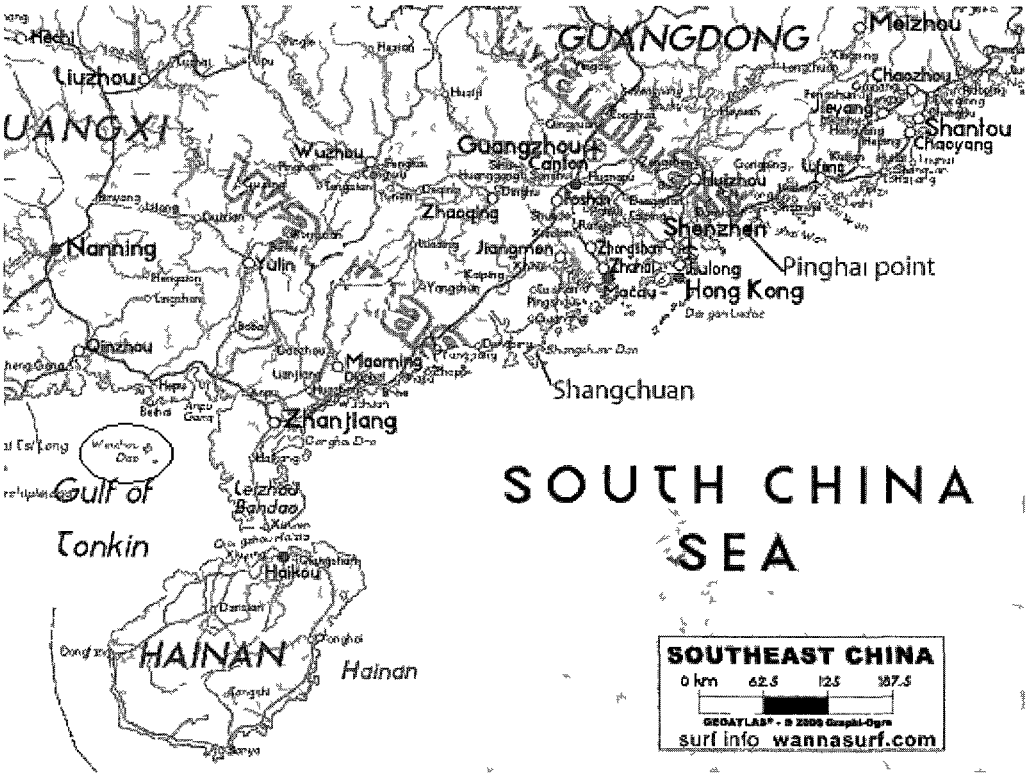
Adventurous evergreen
tropical rain forests
Free animal lives in
wildlife sanctuaries
Cultivated paddy fields
symbol of prosperity
Wonderful Island of paradise
a place of serenity

- Hemakumar Nanayakkara (n.d.)

4.1 Weizhou Island Location and Government

Weizhou Island is located in the north of Beibu Gulf, west of Leizhou Peninsula, south of the city of Beihai, Guangxi Zhuang Autonomous Region (Guangxi) and east of Vietnam (109°04′46′′-109°08′30′′E, and 21°00′30′′-21°04′20′′N) (Liang & Li, 2002) (Figure 4.1, the highlighted round is Weizhou Island). The island covers a total land area of 24.98 km^2, and is home to 15,900 islanders (Lao, 1995). Distance from Weizhou Island to the closest mainland city of Beihai is 36 nautical miles. Formed of Quatemary Period volcanic rocks and lavas, Weizhou Island is the youngest and the biggest volcanic island in China, and the biggest island of Guangxi.

Figure 4.1 Weizhou Island Location



Source http //www seanews com tr/article/ACCIDENTS/48755/Soon-Bee-II

Xieyang Island, with a total land area of 1.89 km^2, and coastline of 5.7 km, lies 9 km southeast to Weizhou Island (109°12′-109°′13E, and 20°54′-20°55′N). This is where a spectacular view of the setting sun can be seen, hence the name Xieyang Island. ('Xie' in Mandarin means slantingly setting, where 'Yang' means the sun). Together the two islands have gained the nicknames of Greater and Lesser Penglai[3].

Given Weizhou Island's small population, there are merely two elementary schools and one junior high school, students wish to pursue further studies after junior high school need to go off island. An overwhelming majority of Weizhou islanders are farmers and fishermen who were born and lived on the island all their lives, a small number of islanders run local businesses, such as restaurants and convenient

[3] Penglai is the abode of immortals in Chinese fables

stores. Based on my observations, neither do the islanders engage with government, nor involve themselves in community activities. There is unquestionably a lack of community participation in the planning and carrying out of development activities. No non-governmental organizations or non-profit organizations are present on the island.

Administratively, Weizhou Island is a town of Haicheng district, which falls under the jurisdiction of Beihai city in the Guangxi Zhuang Autonomous Region. The municipal government of Beihai is responsible for Weizhou Island; the government agencies are all located in Beihai, but not on the island. The Tourism Management Commission of Weizhou Island is on site and directs everyday tourism operations. Guangxi covers an area of 236,700 km^2; it is the 9^{th} largest administrative division of the country, and the 10^{th} largest by population. Guangxi's GDP in 2004 was 332 billion Chinese Yuan; it ranked the 17^{th} nation wide. However with a GDP per capita of 6,790 Yuan, it is the 28^{th} out of the 31 administrative divisions of the country (Guangxi Statistics, 2005). Guangxi is therefore considered as an economically less developed region of the country. Weizhou Island's GDP per capita in 2004 was 3974 Yuan, an almost 50% lower than that of the Guangxi's already low figure (Guangxi Statistics, 2005). It is clear that Weizhou Island was very little economically developed.

4.2 Land and Sea Environment

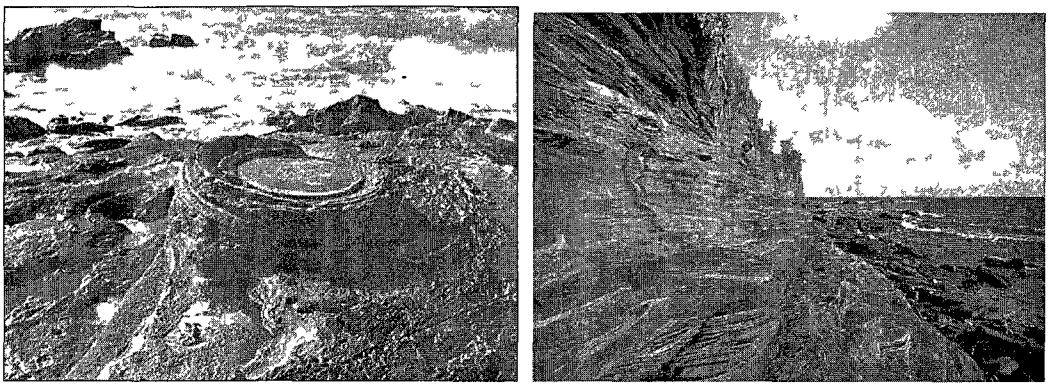
Weizhou Island has a sub-tropical climate; its annual average temperature is 23.2°C. The month with the highest temperature is July (28.8°C), and the lowest is

January (15.2°C). Its average annual precipitation is 130 cm, which mainly occurs from June to September. Weizhou Island's annual average sunlight is 2252.9 hours, equal to 6.2 hours per day. July has the longest hours of sunshine (253.8 hours), which is an average of 8.5 hour per day (Lao, 1995).

Weizhou Island has unique geology. It was formed by the underwater accumulation of rock during the eruption of Quaternary basalt magma, and different geomorphologic structures on the island were formed in a long-term process of geological evolution. It is shown by various studies that the geomorphologic structures on the island are of the following forms: volcanic, running water and abrasion, marine accumulative, coral reef, marine accumulative-alluvial, gravity and artificial (Qi et al., 2003). Amongst all the forms, the abrasion, marine accumulative, coral reef and volcanic are the most prominent.

The abrasion forms for instance, are developed along the south coast of the island where sea cliffs are as high as 30-50 m, and abrasion platforms are as wide as 20-70 m and comprise 35 sea caves of various sizes. Marine sand levees are substantial along the north coast of the island. These are 100-2000 m in length and 40-700 m in width. Based on their time of formation, shape, and spatial distribution, the sand levees are divided into old, middle-aged and new levees which were formed in 6,900-4,000 years BP (before present), 3,100-2,200 years BP and 2,000-1,200 years BP respectively (Qi et al., 2003). The southern part of the island features examples of volcanic topography, which includes walls and terraces formed by rocks that were melted and compressed in a volcanic eruption. The colourful sights of marine-eroded caverns, hills, pillars and terraces create an ocean fairyland.

Figure 4.2 Weizhou Island Topography



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Twenty five percent of Weizhou Island is covered by forest, which mainly consists of *Casuarina*, and *Acacia confuse* (Tourism Management Commission of Weizhou Island, 2007). Virgin native forest is no longer present on the island; the secondary vegetation consists of scattered shrubs, including cactus, *Grewia biloba, Miscanthus floridus*, and Indian stringbush root. Vines include *Streptocaulon griffithii,* Asian *Tetracera,* wild grape, and *Cassytha filiformis.* Native trees that may be found include mulberry, *Ficus virens*, and campho (Tourism Management Commission of Weizhou Island, 2007).

One hundred and eighty five kinds of terrestrial vertebrates are found on the island, which belong to 4 classes, 20 orders, and 50 families. There are 6 kinds of frogs, 6 kinds of ophidians (snake-like reptile) and 7 kinds of saurians (lizards) (Tourism Management Commission of Weizhou Island, 2007). Every year in April and September, Weizhou and Xieyang Islands are also important stopover sites for large numbers of migratory birds (Zhong & Fu, 1991). 'Weizhou Island Bird Nature Reserve Management Center' and 'Weizhou Island Bird Nature Reserve Police Station' were created on the island in 1991 to protect the habitats and breeding areas

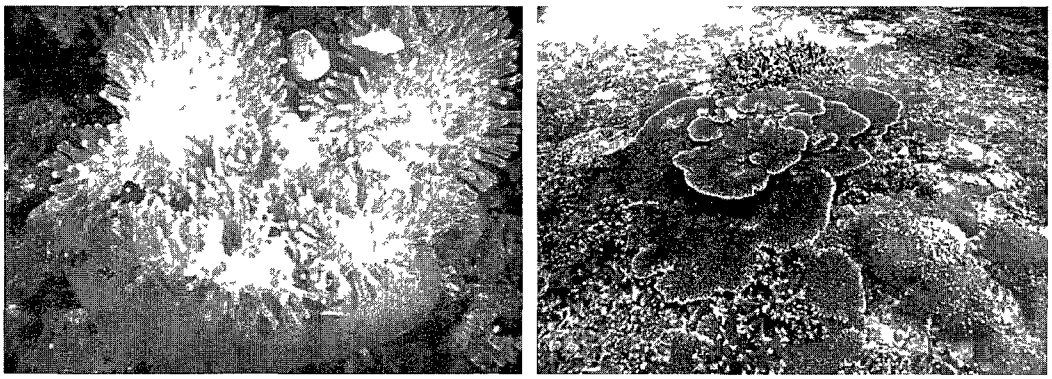
of migratory birds. Seventeen orders, 42 families, and 178 species of birds are found (Weizhou Island Bird Nature Reserve, 2007), amongst which, two are first-grade, state-protected species: the black stork and the Chinese merganser; and 24 are under second-grade state protection (Weizhou Island Bird Nature Reserve, 2007).

Although Weizhou and Xieyang Island are located in the sub-tropical zone, they are bordering the tropical zone. Whether on the mainland or in the sea, there is a good mix of tropical and sub-tropical life-forms evident on the islands. According to Zhong and Fu (1991), in the territorial sea around the two islands, there are 263 genera of aquatic (swimming) organisms, including 223 species of fish. There are also 832 genera of bottom-dwelling marine organisms, among which are 151 species of polychaete worms, 153 species of bottom-dwelling fish, and 4 species of algae. In addition, there are 244 genera of molluscs; 207 genera of other shellfish, 68 genera of echinoderms, and 5 other species. The most important economic marine resources are prawn, fish, pearl mussel, green crab, and sea cucumber. Marine mammals include two first-grade, state-protected species that are, also unique to China — the manatee and Chinese white dolphins. Along the coast of the 128,000 km^2 of marine waters surrounding Weizhou Island, 37 percent of China's mangrove forests and rare seagrass beds also grow.

Amongst all marine life-forms on Weizhou Island, one of the most worth mentioning is the coral reefs. Coral reefs in China include fringing reefs found in southern China's coastal waters and around offshore islands. On some 128 atolls in the South China Sea, corals coverage area is about 30,000 km^2 (Zhao et al., 1999). The Weizhou Island coral reef is the largest coral ecosystem having the greatest

number of species in the north of the Beibu Gulf. These reefs form a colourful belt on the north, east and southwest sides of the island, and together they have gained the reputation as an "underwater park".

Figure 4.3 Weizhou Corals



Source : http://place.ytrip.com/article/d-24139/ and http://www.weizhoudao.cn/scenerydetail.asp?id=7

The forming of the coral reefs in Weizhou Island is closely related to the island's unique geology. Weizhou Island shallow sea coral reefs mainly grow at depths of 2-13.4 m underwater along the north, east and southwest coasts. The reefs are well developed along the north and east coast of the island where reef flats are 400-1025 m wide. Reefs along the southwest coast are also fairly well developed; reef flats there are 20 to 475 m wide, and the coral growing zones are 50-215 m wide (Liang & Li, 2002).

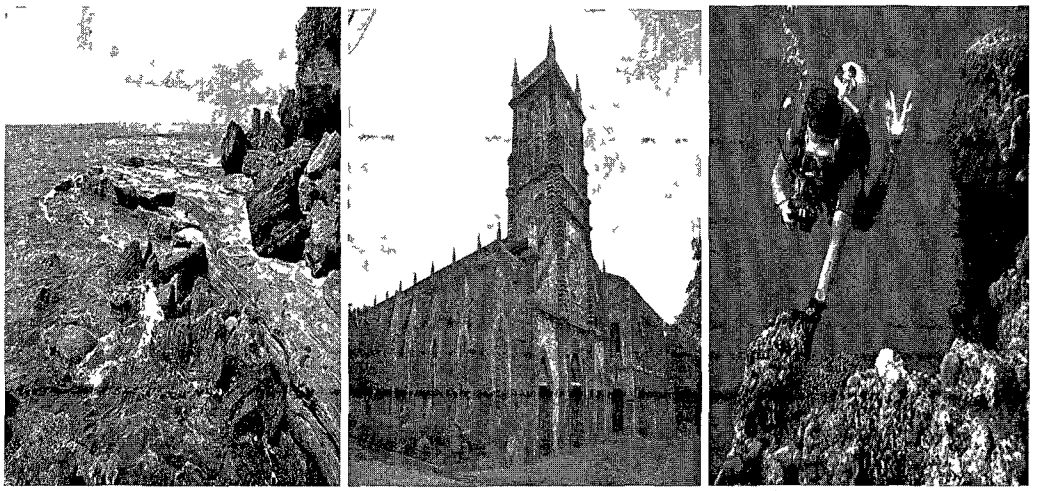
Table 4.1 Width of Various Landscape Units in the Weizhou Island Coral Reefs

Location	**Width of each landscape unit (metre)**				**Reef distribution water depth (metre)**
	Sand bar	Sand beach	Reef flat	Coral zone	
North of Houbeitan	440	130	1025	600	2 – 12.5
Southwest of Dishuicun	100	215	475	215	2 -10.5

Source: State Oceanic Administration (2000)

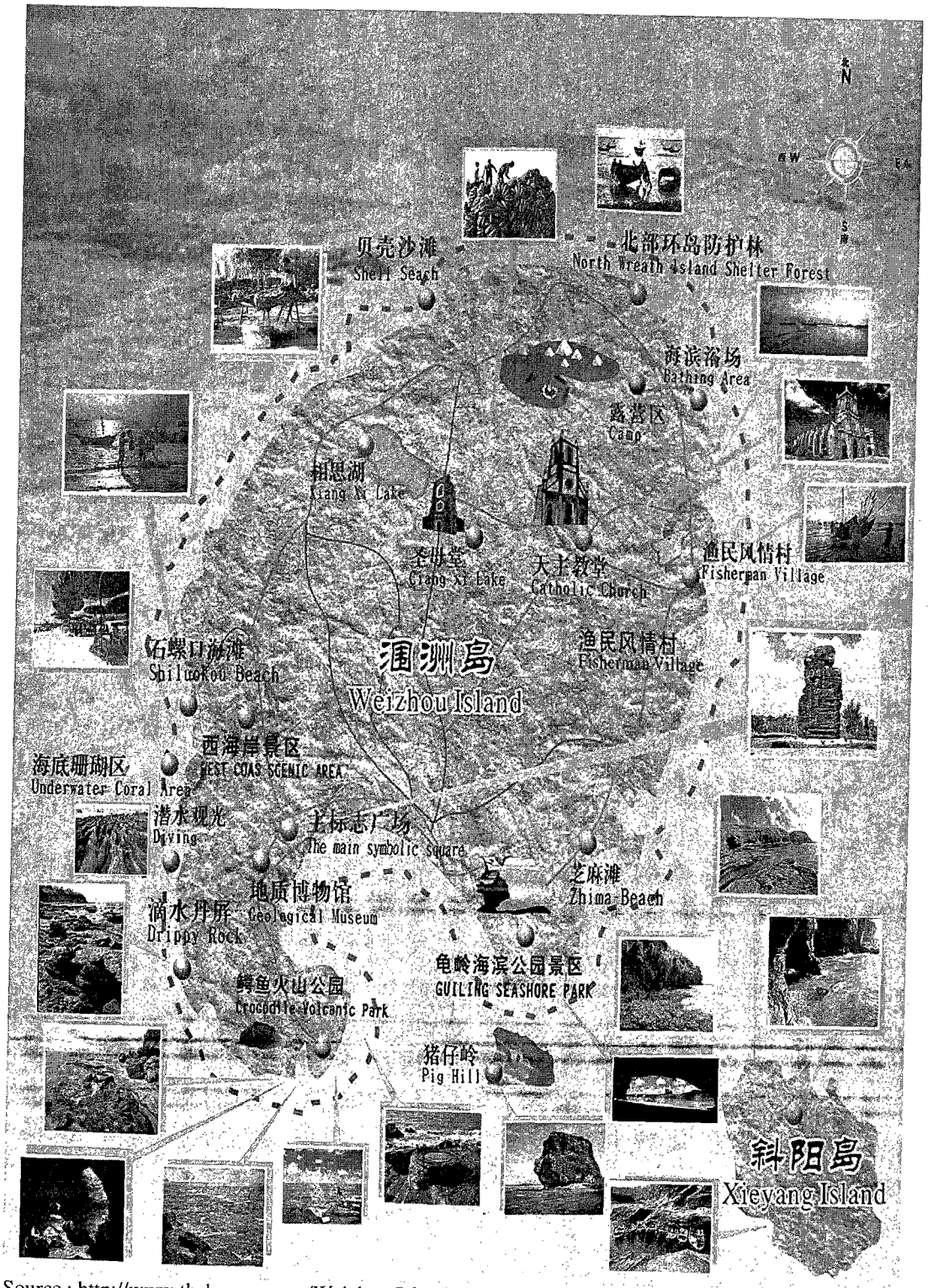
The entire island is a national geopark, where the remains of many volcanic eruptions have created magical scenery including crater harbours, volcanic rocks, volcanic lava, and fracture layers in radical forms. Waves and tidewater erosion have formed the unique marine abrasion landscape of sea caves, trenches, wave-cut niches, columns, and platforms. A 400-year history has also left Weizhou Island today with an exceptional cultural landscape. For example, the 'San-Po' temple was built in 1738 by the Matsu culture along the south coast of the island. The French Renaissance Revival gothic style 'Weizhou Island Catholic Church' was built between 1853 and 1863, and the 'French Catholic Goddess Church of Weizhou Island' was built in 1882. Moreover, the blue sea, azure sky and temperate climate of Weizhou Island make it a suitable destination to visit all year round. Finally, the incomparable coral reefs, aquatic life forms and migratory birds create opportunities for aquatic and bird watching activities. As seen from above, Weizhou Island has rich tourism resources, which make Weizhou Island an attractive destination (Figure 4.4 and 4.5).

Figure 4.4 Weizhou Island Tourism Resources



Source: http://www.17u.com/expert/webshop/view_othernews_79477_6048.html, http://home.becod.com/space-7065-do-album-id-594 html, and http://www.bhtour.cn/blog/Log/?/ID/132 html

Figure 4.5 Weizhou Island Travel Indicator Map



Source : http://www.thebwgroup.eu/Weizhou-Island.aspx

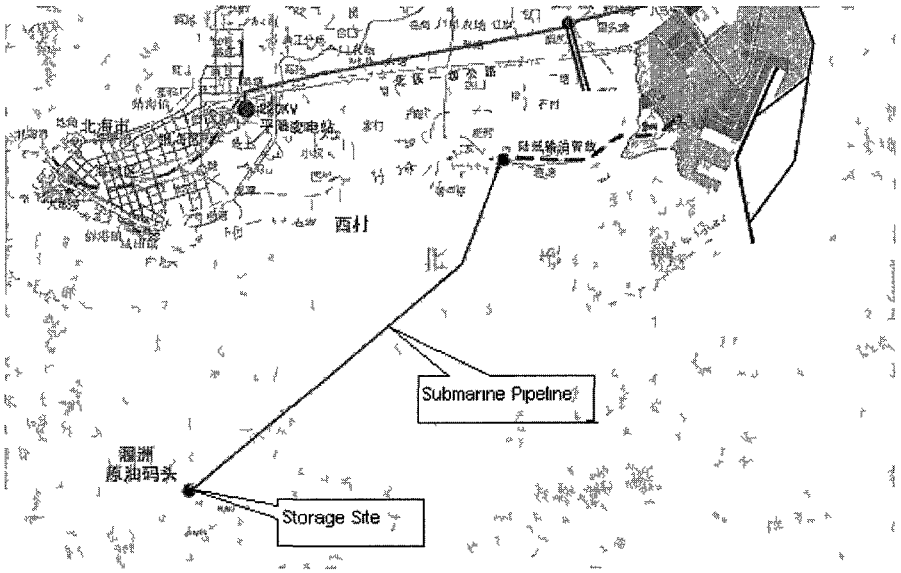
4.3 Oil Industry

Tremendous amount of natural resources is required to fuel China's enormous economic activities. Figures from the General Administration of Customs (2010) show that China's imported oil in December 2009 reached 21.3 million tonnes, pushing the country's total oil imports in 2009 to 204 million tons. The imported crude oil accounted for 52 percent of total oil consumption, whereas the country produced about 190 million tonnes itself.

Rich natural gas and oil deposits were discovered on Weizhou Island in 1998. Immediately following the discovery, numerous platforms were built and oil wells were drilled in the Weizhou waters. Once the oil has been removed, an equal amount of fresh water is injected into the reservoir to replace the oil. This fresh water cannot be recovered, and is therefore removed from the hydrological cycle (Petroleum Production, n.d.).

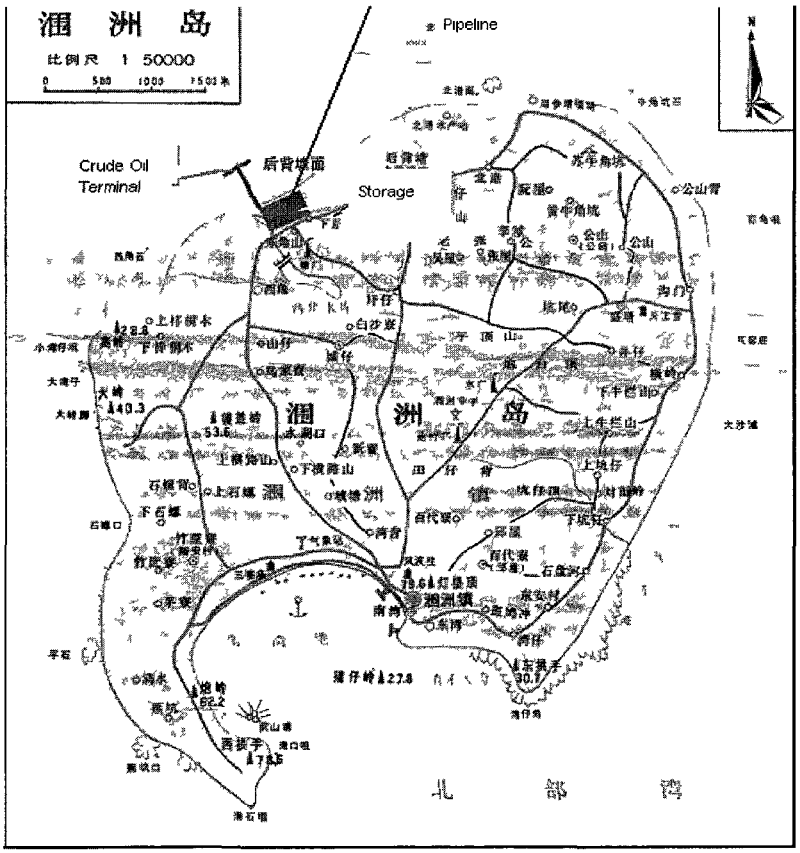
China National Offshore Oil Corporation saw a need to expand its extraction operation, in 2009; the Weizhou Island Crude Oil Terminal and Associated Projects were completed on the island. The projects consist of a complex of a crude oil terminal, a storage depot and a submarine transportation pipeline. Total investment of the projects was 2.15 billion Chinese Yuan (Figure 4.6 and 4.7) (Beijing Novel, 2009). In Figure 4.6, the small island in the left bottom corner is Weizhou Island, the dark point on the island is the crude oil storage depot, and the solid line is the pipeline taking crude oil to the mainland of Beihai. Figure 4.7 is the close up showing the location of the Weizhou Island crude oil terminal. The rectangle on the island indicates the crude oil depot, and the one out in the sea is the terminal.

Figure 4 6 Regional Location Map of Weizhou Island Crude Oil Terminal and Associated Projects



Source (Beijing Novel Environmental Protection Co Ltd , 2009)

Figure 4 7 Close up of Weizhou Island Showing the Location of the Crude Oil Terminal and Associated Projects



Source (Beijing Novel Environmental Protection Co Ltd , 2009)

In the development and operational phases of these projects, air, noise, and solid waste pollutions were generated from materials transportation and spills, emissions from combustion of light diesel, and noises from crane ships, tugs, excavators, loaders, bulldozers, and all other construction machineries and transport vehicles. Some 409 tonnes of industrial and 108 tonnes of domestic garbage were produced, and waste water from washing vehicles, and other construction related pollutions were generated. It also resulted in adverse impacts on the terrestrial and marine ecosystems. More than 15 ha of *Casuarina* shelterbelts were cut down to make room for the crude oil depot site. This resulted in a permanent loss of biomass of1582.71 t/yr, and a permanent loss of forest stock volume of 316.61 m^3. The clearance of forest land within Weizhou Island Bird Nature Reserve also reduced the habitat of Weizhou migrating birds and other wildlife.

Submarine pipeline construction caused terrestrial vegetation destruction of 17.88 ha. This destruction was mainly done to farmland vegetation and woodland. It resulted in a one-time loss of biomass of 280.08 t, a permanent biomass loss of 0.11 t, and a permanent loss of forest stock volume of 46.51 m^3. Furthermore, the installation of foundation pipes caused the loss of benthic organisms, where the installation of submarine pipelines affected an area of 66000 m^2 and involved a volume of 3.57×10^4 m^3 of reef blasting. Finally, the suspended sediments produced from reef blasting caused a serious impact on water quality and fishery resources (Beijing Novel, 2009). Tables in Appendix B summarizes the energy and water consumption, emissions, sewage discharge, noise emissions, solid waste and heavy metal emissions linked to the Weizhou Island Crude Oil Terminal and Associated Projects.

To mitigate the impact of typhoons on the storage and transportation of crude oil from the oil wells, an oil and gas terminal treatment plant was built on the island. This plant treats 2 million tonnes of oil yearly and 430,000 m^3 of natural gas daily (World Energy Finance Network, 2009). It solved the island's power supply issue by providing liquefied gas. On one hand, this terminated the cutting of trees for firewood, and played a positive role in protecting the island's vegetation. On the other hand, this terminal treatment plant has brought far more than just liquefied gas. It has also brought environmental damages, such as the tremendous extraction of crude oil, harmful pollutants, and oil spills.

Weizhou Island's oil industry has placed tremendous pressure on one of the most scarce and precious resources – fresh water. Huang and Shen (2002) note that Weizhou Island fresh water resources are extremely scarce, instances arise frequently when islanders and livestock compete for fresh water; 8,750 islanders face drinking water quantity problems. Weizhou Island's fresh water depends on the natural filtration of rain water through its special geological structure which is similar to an 'egg shell'. It is an isolated and complete hydro-geological system floating in the sea, and the greatest thickness of underground water is around 170 m. When excessive extraction occurs, the internal and external pressures will lose balance, the 'egg shell' will be squeezed and broken, and results in seawater intrusion. Islanders then risk losing the resource that is necessary for existence.

Numerous reasons account for the scarcity of Weizhou Island's underground water. Firstly, industrial and agricultural fresh water usage is excessive. Industrial usage is mainly by Weizhou Island's oil industry, which uses solely fresh water for its

entire production. Total fresh water consumption in 2003 was 0.18 x 10^4 m^3/d (Shi et al., 2003). Secondly, there is an absence of sound fresh water extraction regulations. Wells are dug without unified planning; they are randomly and aimlessly dug, unreasonably arranged, with an overly high density, and often located too close to the sea. Long term excessive pumping of underground water has caused seawater intrusion in many wells; they are abandoned as a result (Shi et al., 2003). In addition, there is a lack of reservoir, irrigation system and other water management projects. Weizhou underground water is recharged mainly though natural rainfall. The island has only one small stream and an undersized reservoir with an area of merely 5.5 m^2 (Shi et al., 2003).

Pollutants produced during the oil recovery process are extremely harmful to Weizhou's marine environment. High concentrations of a number of pollutants, such as hydrogen sulphide, are found in water 500 m north of platform W12-1A. Drill cuttings dumped on the seabed have covered it like a carpet, producing toxic sulphide and creating anoxic conditions that kill some benthic fauna (Wang, 2006).

Weizhou Island's first oil spill was discovered on August 16, 2008. A 3 km long belt of filthy, greasy oil covered the originally white sandy beaches and the oil penetrated a few centimetres into the sand. The offshore platform or submarine pipeline were suspected to have caused this accident (Xinhua News, 2008). This oil spill contaminated a wide area; even the city of Beihai located 36 nautical miles away, was stained with oil.

Figure: 4.8 Oil Spill in Weizhou Waters

Source http //www ynet com/view jsp?oid=42854805

Another oil spill was discovered 7 days later. This time grease increased dramatically compared to the first incident. The sea surface 5 m from Shiluokou beach on the southwest of the island was completely covered by oil, presenting an immediate threat of harm to coastal fisheries. The observed destruction resulting from this incident was the mass mortality of cultured conches, and damages to fishing equipments. The prominent damage to landscape was also devastating. Tar-like oil waste covered volcanic rocks and beaches, and Weizhou Volcanic Geopark was also seriously affected (Sohu News, 2008). The potential long-term effects on biodiversity could be even more serious. Oil poisons the sensitive marine and coastal organic substrate, and interrupts the food chain on which fish and sea creatures depend, and on which their reproductive success is based. Wildlife other than fish and sea creatures, including mammals, reptiles, amphibians, and birds that live in or near the ocean could also be poisoned by oil waste. The hazards for wildlife include toxic effects of exposure or ingestion, injuries such as smothering and deterioration of

thermal insulation, and damages to their reproductive systems and behaviours (Water Encyclopaedia, n.d.).

4.4 Aquaculture and Illegal Fishing

Nine primary countries and regions in the world breed young abalone. Mainland China's cultured young abalone production reached 4,500 metric tonnes in 2002, while the production of Japan, United States of America, South Africa, Australia and all other parts of the world (excluding Taiwan[4]) totalled 1,200 metric tonnes. China is therefore the world's largest young abalone breeding base (Sina News, 2004). Young abalone breeding technology was developed in Japan in the 1960s. Since that time, farms have entered and left South Korea, Taiwan, Fujian, Guangdong and Hainan provinces of China.

In 2003, the Beihai government, which administers Weizhou Island, initiated the 'Attract Aquaculture Investment Projects'. This new wave of development of Weizhou Island's marine potential introduced the breeding of young abalone, sea cucumber and scallop to the island. The arrival of these aquatic activities brought serious damages to Weizhou water quality, as well as the death of coral reefs and fish species. Weizhou will be the last stop on China coast for young abalone breeding. Every breeding base loses its original fertility in a 3-5 year period; after that, the industry will move to another piece of unpolluted water where people are willing to accept it.

[4] Taiwain cultured abalone production was 3,000 metric tonnes in 2002. Its output was 2.5 times the total production of the rest of the world, except mainland China.

In the waters where many young abalone and sea cucumber aquaculture farms are located, given the impacts of the bait thrown in by aqua farm workers and the oil spills from ships, water quality is poor. Without sufficient sunlight, the algal symbionts of coral reefs cannot photosynthesize and transform carbon and nutrients into organic matter, which is the nutrient supply corals depend on. Therefore, corals are poorly developed in these waters. Moreover, the bait launched into aquaculture sites attracts coral reef fish. As fish lose their dependency on the reef environment, the original food chain becomes deficient (Dong, 2006). In the process of breeding young abalone, aqua farmers use a large quantity of nitrofuran metabolites and chloramphenicol – chemicals to control bacterial growth in poor water quality. Nitrofuran metabolite is a kind of antibiotic (furazolidone tablets) that is carcinogenic if consumed in large quantity over the long term. Pools for breeding young abalone are built on the seaside. Within 3 to 4 months, the young are ready to be sold, and water in the pools is discharged back to the sea without any treatment. When all of the scallops of Weizhou Island's scallop breeding farms suddenly died in April 2004, fishermen suspected that the discharge of waste water from the abalone farms located close by was the cause of the sudden death of the scallops. The discharge of untreated water further exacerbates the poor living environment for many marine species.

The breeding of young abalone began in Weizhou waters in the second half of 2003 as one of the 'Attract Aquaculture Investment Projects'. With an initial investment of 10 million Chinese Yuan, this industry was expected to have an annual output valued at 4.6 million Chinese Yuan (Sina News, 2004). A one-acre young abalone farm produces at least 3 million young abalones. In 2004, each one-acre farm earned a net income of 900,000 Yuan (Sina News, 2004). Nevertheless, a 5 acre farm

provides job opportunities for only about a dozen islanders. The 20 Yuan per day salary is also considered slight, compared to that of a tricycle driver who does a tour of the island in 3 hours and earns 40-50 Yuan. Weizhou islanders benefit minimally from the breeding of these aquatic products; however, an irreversible change to the sea, on which they have been living for generations, is quietly taking place.

In addition to abalone farms, a large number of web and cage cultivation sites for various species of fish and shellfish also contribute to a heavy burden of organic suspended particles, which poses a great danger to coral communities in the coastal waters (Li et al., 2004). Many fishing practices on Weizhou Island are destructive, such as the use of cyanide, over-fishing, capture of juvenile fish and blast fishing. Researchers believe that destructive fishing practices are one of the biggest threats to coral reef ecosystems (Moore & Best, 2010). Homemade bombs used in blast fishing not only kill fish but also destroy the calcium carbonate coral skeletons (Fox et al., 2003). It takes at least 5 to 10 years to recover from a single blast (Fox & Caldwell, 2006). Widespread and frequently practiced blasting in Weizhou waters transforms the reef ecosystem into a continuous carpet of unstable rubble. The impact associated with destructive fishing is that it leads to an instant decline in fish species diversity and quantity (Raymundo et al., 2007).

4.5 Emerging Tourism

Weizhou Island was unknown as a tourism destination to the outside world until January 2004 when the Ministry of Land and Resources approved the establishment of Weizhou Island as a national geopark. In October of the following

year, it was elected as the second most beautiful island in China by the *Chinese National Geography* Magazine; and in May 2006, the Chinese Photographers Association and the Beihai municipal government co-hosted the 'Chinese Celebrated Island – Weizhou Island International Photography Contest'. Through these effective promotional activities, an image of Weizhou Island as a tourism destination was quickly created; its reputation was also on the rise. Once it was recognized as a tourism destination, local authorities promulgated the decision on "accelerating the development of tourism", which placed tourism as a pillar industry for economic development.

Statistics from the Tourism Management Commission of Weizhou Island (2007) show that Weizhou Island experienced rapid development over a two year period, from almost zero tourism services and facilities prior to the recognition as a tourism destination, to 6 hotels and motels with 260 beds, and 17 restaurants having the capacity to serve 1,500 people by 2005. There were also 5 tour buses, 6 minibuses, and more than 120 three-wheeled motorcycles introduced. Diving companies also increased from one to three, and none of these companies is owned by a Weizhou islander. Weizhou Island's booming tourism industry fuelled a local consumer market and provided employment opportunities for islanders. From January 2004, when the island was first approved as a national geopark to December of the same year, Weizhou Island received over 135,000 tourists, and tourism revenue achieved 20.25 million Yuan, a 33% and 35% increase over the same period of the previous year respectively (Beihai Municipal Government, 2007). During the 2006 Spring Festival and May 1st Labour Day one-week national holidays alone, tourism income reached more than 3 million Yuan, and sales at souvenir stalls at scenic spots soared to 10

times more than usual (Beihai Municipal Government, 2007). Tourists numbered 250,000 in 2008, and more than one thousand islanders are now engaged in tourism services. Today, tourism has developed into a comprehensive system with a coordinated development of various amenities related to sightseeing, food and beverage service, and accommodations. At present, nearly all tourists are domestic visitors with very few from abroad. The current clientele is the general public, although the industry aims to attract higher spending consumers in the future. This is discussed in more detail below in the 'Future Tourism Development Grand Plan' section.

Interaction of Tourism and the Environment

Even though the current tourism performance on the island stimulates optimism in economic terms, it has already caused problems for the island's ecosystem. According to the UNDP-GEF-Government of China Project on 'Biodiversity Management on Coastal Areas of China's South Sea', Weizhou and Xieyang Islands' globally significant reef ecosystems face major threats from tourism activities. The project found out that corals are being removed for the aquarium trade and for sale as souvenirs. They are also used as construction materials, and damaged from diving activities. Solid waste discharged to sea from tourism operations is another cause of coral death (State Oceanic Administration, 1996).

Based on Huang et al. (2009); Yu et al. (2004); and Liang and Li (2002), the two main causes that lead to the degradation and destruction of Weizhou reefs are the impact of human activities and climate change. As the scope and intensity of human

activities increase, and global climate continues to warm up, coral reef ecosystems are facing an unprecedented threat. The preliminary view of the possible mass mortality of Weizhou corals caused by those two factors are as follows:

Firstly, human activities have induced poor water quality in marine habitats. Weizhou Island lacks appropriate sewage treatment facilities to cope with its rapid tourism growth, so a large quantity of sewage is discharge to sea without any treatment. The untreated waste water discharged to sea damages reefs because it increases the concentration of nutritive salts that promote the outbreak of algae, which eventually kills reefs. Secondly, the increasingly popular and accessible recreational diving also takes a toll on the well-being of Weizhou coral reefs. Poor diver etiquette, including inexperience at controlling buoyancy, improperly secured gear, photography flashes, and blasts from fin kicks are the main causes of diver-induced damages to reefs.

Moreover, the use of Weizhou corals as building materials, souvenirs, decorations and ornamental aquarium animals, is yet another cause for reef destruction. In the Drippy village alone, over one thousand tonnes of corals are smuggled out every year (Huang et al., 2009). On one beach that stretches for several kilometres in Shiluokou near the northern harbour fisheries station, the excavation of coral debris is going on the open. Tourism and trade-triggered smuggling is a major cause of the death of a large number of reefs in Weizhou coastal waters.

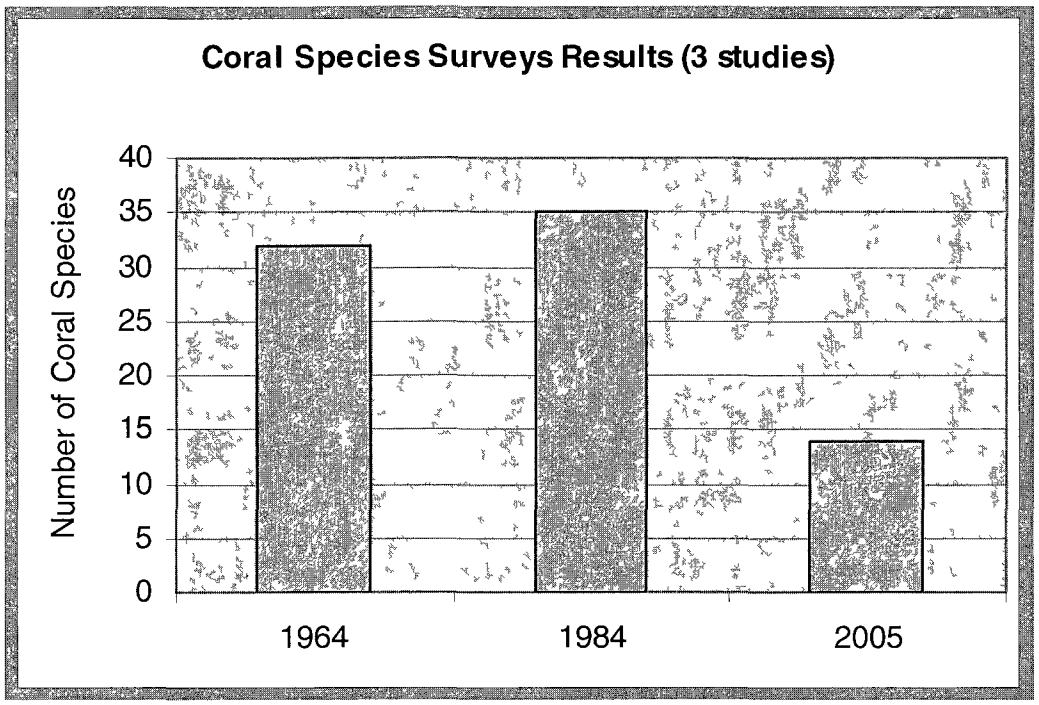
Finally, measurements of Weizhou's sea surface temperature (SST) of the latest forty-two years showed a pattern of 3-4 year and 7-8 year fluctuating cycles,

that were almost synchronous with global warming, especially since the late 1980s. Small but prolonged rises in sea temperature force coral colonies to expel their symbiotic, food-producing algae, a process known as bleaching (Markey, 2006). On Weizhou Island, the warmest months impose a thermal stress on the development of reefs because water temperature reaches the upper limits for reef development. Climate change, rising of sea temperature makes reefs more vulnerable. The following section provides evidence of coral degradation by examining results of the three coral surveys.

4.6 Coral Species Surveys

The key laboratory that tracks the sustainable use of marine biological resources in the study area is the South China Institute of Oceanology of the Chinese Academy of Sciences. They carried out the 2005 survey, 'Status and Conservation Strategies of the Coral Reef in Weizhou Island'. The survey identified 5 families, 10 genera and 14 species of corals in the waters of Weizhou (Huang et al., 2009). Similar studies conducted by Zou, Zhang and Xie (1998) in 1964 recorded 8 families, 22 generas, and 32 species, and in 1984, 8 families, 23 genera and 35 species. (Table 4.2) (See Appendix A for the list of species of hermatypic coral in Weizhou waters from all three surveys.)

Table 4.2 Coral Species Surveys Results (3 studies)



Compared to the results of the two previous surveys in 1964 and 1984, the 2005 survey showed a significant reduction in reef species. The 14 species of coral recorded in the 2005 survey are fewer than half of those noted in past studies. This considerable reduction in coral reef species in part reflects that there have been great changes in Weizhou's marine environment in the past 25 years. Furthermore, the survey reported only sporadic distribution of coral reefs, indicating that the area of reefs is also greatly reduced. Reefs on the northeast and southeast coast have almost disappeared all together (Huang et al., 2009). In the areas where there are intensive human activities, particularly in the southern part of the island (between the geological museum and volcano), water quality is extremely poor and the average reef coverage is merely 2.83% (Huang et al., 2009).

The survey of 2005 revealed that on average, 31.4% of the reefs are dead; while in the northern harbour shallow water area, the proportion of dead reefs reached as high as 91.3%. In the Drippy Rock and southern harbour shallow water zones, the death rates have reached 51% and 39.7% respectively. However, the coral mortality rate in deeper water zone (3 - 5 m) is much less, indicating a greater degree of reef damage in the shallow water (Huang et al., 2009).

4.7 Future Tourism Development Grand Plan

The growth of tourism activities has brought quick and easily earned revenues. Realizing the benefits, the Tourism Management Commission of Weizhou Island, has rapidly shifted Weizhou Island's mainly agriculture-based economy to tourism services. With this principle in mind, the government of Haicheng District, Beihai city has come up with a grand development plan for the island.

In the grand plan, the goal is to increase tourist numbers from 250,000 in 2008 to 2 million by 2015. The island is to be divided into ten development zones: Nanwan Volcanic Scenic Zone, Zhuzheliao Resort (recreation), Shipanhe Resort (sports), Island Folk-Custom Zone, Xiangsihu Biopark, Beigang Eco-Resort, Pingdingshan Tourist Service Area, Weizhou' New Town, Nanwan New Town, and Xieyang Island Research and Exploration Zone. In some of these zones, several developments are projected.

The Nanwan Volcanic Scenic Zone is one of the principal development zones. It is comprised of a Volcanic Geopark, which contains a volcanic museum, a

lighthouse, a trestle bridge along the cliff, and an observation terrace. The Nanwan Yacht Club will be the center which provides services for a majority of the aquatic sports. Main construction projects are: a club (3,000 m^2), a yacht dock, a bathing beach, a water sports center, and 15,000 m^2 of luxurious villas. Activities that could be carried out are: yacht tours, sailing, motorboating, and water parachuting. The Nanwan Tourist Service Center area will include the upgraded Weizhou town, a 1 km seaside commercial street, 1.2 km seafood and beverage street and the restored San-Po temple. Also in this zone, there is Guiling Coastal Park, which consists of a trestle bridge and an observation terrace. Cliffs are as high as 30 to 40m at this park; it is intended to be the home base for rock climbing.

The Zhuzheliao Resort Zone mainly caters to recreational activities. It consists of five sectors. The Zhuzheliao Recreation Center is to be multifunctional, hosting a 24.46 hectare horse racing track, a 11.6 hectare amusement park, a 10.02 hectare go-cart track, a 7.5 hectare outdoor sports ground (volleyball, basketball, and badminton facilities), a 6.21 hectare children's playground, a 20.77 hectare of green space, and an observation terrace. The Zhuzheliao Eco Resort will have a resort hotel (with a show square for performances of island folk customs), a bathing beach, a beach playground (beach volleyball, beach badminton, beach soccer, etc.), and a sightseeing tower. This is also where the Undersea Garden Museum will be built. A diving training base and diving sightseeing facilities will also be installed here. Dippy Rock Park will share the site. The Subtropical Biopark will incorporate sightseeing, exhibitions, performances and other functions. Some of the major projects to be built at the biopark include: a coral aquarium, a marine resources ecological exhibition hall, a small cinema, a folk custom park, and a native plants botanical garden.

The Shipanhe Resort Zone uses up another 113.19 hectares. It consists of two main projects: a golf club, and the Sesame Beach Resort. The 18-hole golf course will occupy 100.6 hectares of land, and the club itself and service center will occupy another 6,500 m^2. The Sesame Beach Resort is to provide upscale leisure services for high spending consumers. It will also serve as the golf course hotel facility. Major construction projects at the Sesame Beach Resort are a mountain resort and a sea viewing square. The mountain resort has 500 beds, and occupies an area of 18,000 m^2, while the sea viewing square will occupy another 1,200 m^2.

The Island Folk Custom Zone is located around Shengtang village, with an area of 341.6 hectares. Given the characteristics of the landscape and the spatial distribution of interesting features, this zone is divided into an island village area with a religious and cultural theme, an island leisure resort, and a rural tourism area. Owing to the western religious influence, ninety percent of the Weizhou islanders are Catholic. The Tourism Management Commission plans to fully utilize this local tradition to develop this area as a European architecture themed village. Main construction projects are: a windmill square, restoration of the Catholic Church, and island village renovations and restoration. A coastal leisure holiday villa complex of 43,000 m^2 is to be built in the island leisure resort area. A time-share mode of operation has been adopted for these villas.

The local authorities believe that the simple structure of Weizhou Island's agricultural economy, growing only rice and bananas as the main agricultural crops, falls short of the requirements of poverty alleviation; therefore an adjustment to the planting structure and a tilt to the tourism industry is needed. In the rural tourism area,

it is planned to introduce superior agricultural varieties on approximately 120.36 hectares of flat land. A focus is placed on developing tourism oriented, high yield paddy field and vegetables, both to achieve greater food self-sufficiency, and allow visitors to experience idyllic island sceneries. Changing the agricultural structure and increasing the amount of tourism-related, high quality, high yield cash crops will not only enrich the visitors' experience by actively involving them in farming, but also raise islanders' incomes considerably.

The Xiangsihu Biopark occupies an area of 409.19 hectares. Given the characteristics of this particular zone, it is divided into Xiangsihu migratory bird park and subtropical secondary forest. The Xiangsihu migratory bird park consists of 132.19 hectares of wetland, and 4.5 km of trails. In the subtropical secondary forest, a tropical plant breeding base will occupy 197.44 hectares, and the principle activities that will take place there are sightseeing, science popularization and education.

The Beigang Eco-Resort Zone is located in a dense forest area. It is a zone dedicated to development of cottages, a campfire performance square, and a beach. This zone will be where tourists can spend the day sun bathing, enjoy the show by the campfire at night and sleep in the cottages to the sound of waves. Cottages will occupy 36,000 m^2 and the campfire performance square will occupy another 2,000 m^2.

The Pingdingshan Tourist Service Area is located near Pingdingshan in the middle of Weizhou Island; it is expected to occupy 37.97 hectares. The main function of this service area is to provide tourist reception, shopping, leisure, food and beverage, and entertainment services. The main construction projects are: a folk-

custom performance square, Weizhou food and beverage street and a heliport. This will be where tourists receive the most comprehensive tourism services. The performance square will occupy 3,600 m^2, and the heliport will use 7 hectares of land.

The Weizhou's New Town comprises Beigang port, Beigang new town and the petrochemical base. The entire former Weizhou town was located at Nanwan, where land use was cramped, and functions chaotic. The plan is to disperse the old Weizhou town over two sections: the Beigang new town and Nanwan. The Beigang port will be the main port serving tourists. The petrochemical base is already established; it aims to be the electricity and gas supply base of Weizhou Island.

Finally, the Xieyang Island Research and Exploration Zone has well preserved tropical and subtropical secondary vegetation dominated by *Acacia confusa* and cactus. Its marine erosion landscape is also in its natural state; this has set the scene for Xieyang Island as an excellent destination for eco, adventure and scientific expedition tourism.

In the 2009 Guangxi Tourism Work Conference, the Guangxi government revealed plans to develop Weizhou Island as a world-class international island destination. After an on-site visit in February 2009, the China National Tourism Administration research group made important recommendations for the further development of the island. The Beihai municipal government is to invest no less than one billion Chinese Yuan for the development of the Beihai and Weizhou Island tourism industry which is scheduled to be completed by 2015 (Weizhou Island Network, 2009).

Despite all the seemingly glorious projects in the grand plan, when speaking of tourism development, especially on small islands, the concept of carrying capacity is not to be neglected. The concept, as defined by Chamberlain (1997), is "the level of human activity an area can accommodate without the area deteriorating, the resident community being adversely affected or the quality of visitor's experience declining". This identifies the fact that carrying capacity is the point at which a destination starts experiencing adverse effects as a result of over-development and excessive visitors. The overall biophysical carrying capacity needs to be taken into consideration.

As its name implies, "biophysical carrying capacity" deals with the extent to which the natural environment is able to tolerate interference from tourists and other existing human activities. It is also used with reference to ecological and physical parameters, and the capacity of resources, ecosystems and infrastructure (Coccossis & Mexa, 2004). The amount of resources used to carry out the grand tourism plan of Weizhou Island, as well as the impacts that will be imposed on the environment from potential tourists, will be a great challenge for Weizhou Island's biophysical environment. However, carrying capacity is difficult to calculate; often times it only becomes apparent once it has been surpassed. Repeatedly, deterioration of the environment is a one-way street. Once it is seriously damaged, there will simply be no way back.

4.8 Summary of Case Study

Since the oil industry, tourism development and aquaculture & illegal fishing have been introduced on Weizhou Island in the late 1990s, these development

activities have transformed the island from a lush, green covered paradise island to an industrial landscape with much less green space and seriously degraded inshore marine ecosystems. In these years, Weizhou Island has experienced a complete transformation in its natural environment.

The results found by this research study are devastating. Weizhou Island coral reef species surveys revealed that the number of coral species has declined and in shallow waters, the coral mortality rate is as high as 91.3%. On average, a third of the reefs have died over only 1-2 years. Diving, sale of souvenirs, curio and aquarium trade, discharge of sewage and untreated pond water from aqua farms, warming ocean temperatures and destructive methods of fishing are the principle treats to Weizhou's coral reefs. To make room for oil storage and treatment facilities, hectares upon hectares of forest land were cleared, and it resulted in tremendous permanent loss of biomass. Developments on Weizhou Island are not sustainable is reflected by the ever increasing difficulty of fresh water supply. Presently, the oil industry consumes two million tons of fresh water yearly, which exacerbates the already scarce fresh water supply. Close to nine thousand Weizhou islanders face a crisis in receiving fresh water.

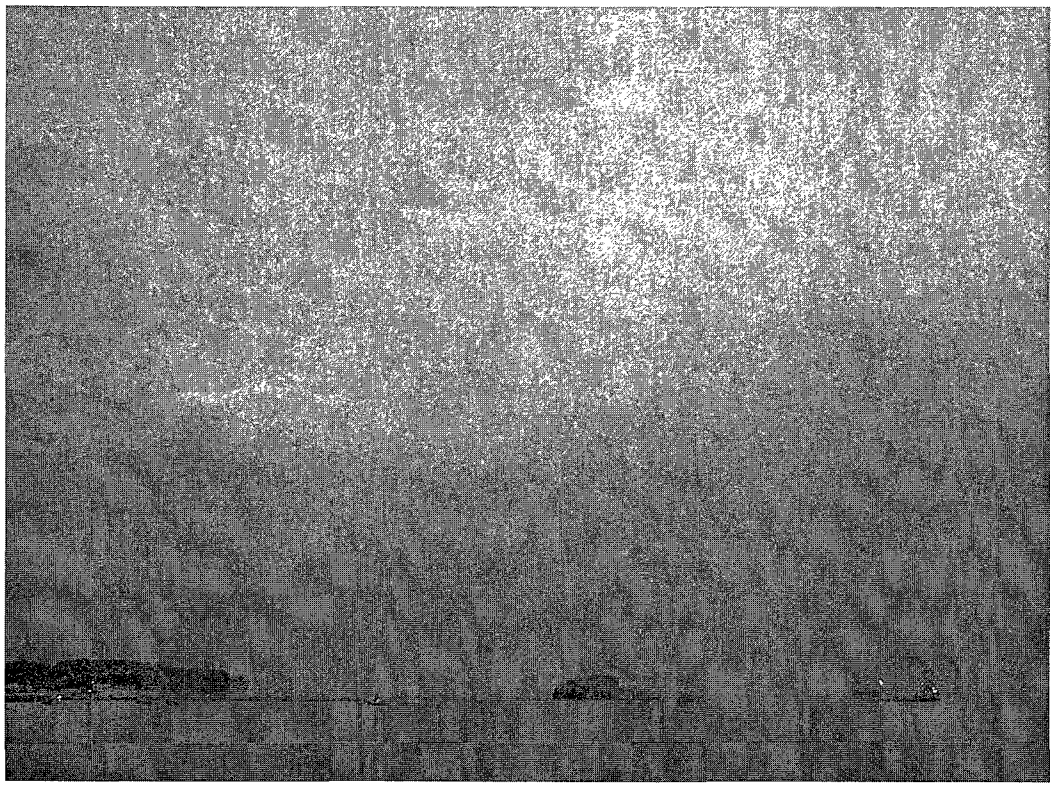
In terms of the economic condition of the Weizhou islanders, tourism is the sector that provides the most opportunity for and engages the greatest number of islander labourers. Tourism employees increased from a few hundreds to more than a thousand in a decade. Income has slightly increased for those who drive three-wheeled motorcycle tours of the island, sell souvenirs/local commodities at attractions and on the streets, and run local restaurants and small family-operated

accommodation facilities. However, larger businesses, such as all three diving companies and all aquaculture farms, are owned and operated by non-Weizhou islanders. These non-Weizhou owned businesses provide very few economic benefits for the islanders.

The authorities have made a grand tourism development plan, with the intention of cashing in on the popular and growing industry. In this plan, ten major development areas and projects were laid out, covering many aspects of the industry, including food and beverage, accommodation, transportation, sightseeing, shopping, and entertainment. These projects cover every corner of the island territory and aim to attract 2 million tourists. It may all sound promising to the local authorities, but to what degree the island could support such grandiose development was not considered and studied.

CHAPTER FIVE – CONCLUSION

Weizhou Island as Microcosm



Weizhou and Piggy Island

No man is an island, entire of itself;
Every man is a piece of the continent,
A part of the main.
If a clod be washed away by the sea,
Europe is the less,
As well as if a promontory were...
Any man's death diminishes me,
Because I am involved in mankind,
And therefore never send to know for whom the bell tolls;
It tolls for thee.

- John Donne (1624)

The central conclusion found by this study is that the current thinking of progress is flawed and unsustainable, and it is especially challenging in an island context. As part of the booming Chinese economy and tourism industry, Weizhou Island, in the past decade, was transformed from a farming and fishery based economy to a fully exploited and developed industrial and tourism oriented one. The planning and management of the island is concentrated on immediate economic benefits, at the cost of sacrificing the very basic elements that support life, not realizing that, without nature's services, Weizhou Island could be a deserted island.

The hope for the future of Weizhou Island lies in current and potential social and political developments at local and national scales. Sustainable development on Weizhou Island should be government-led, and community-participated, and international-aided if available. Government sustainable development laws should be in place to set out a purpose and provide guidelines that society in general is called upon, and required to fulfill. In the meantime, communities at the local level are the entities that will participate and carry out the concrete tasks. They should do so in accordance with their own social, economic and environmental characters. In the

following three sections, we look at the legal instrument now taking shape at the national level, the need for local participation and finally recommendations for local actions drawn from field experts.

5.1 National Sustainable Development Law - Circular Economy Promotion Law

China has grown to be one of the world's most significant economic powers, which has also brought serious natural resource depletion and environmental pollution. Damages to natural resources and environmental pollution have become increasingly evident in recent decades and decision-makers have come to realize the seriousness of the situation. Whereupon, the government declared 'environmental protection' to be a fundamental national policy, and adopted 'sustainable development' as a national development strategy. It also promulgated a series of laws related to the protection and management of coral reefs (for example, the State Law of Marine Environment Protection, and the State Management Regulation Preventing Coastal Engineering Projects from Marine Environmental Damage and Pollution issued in 1983 strictly prohibit coral destruction by any coastal engineering activities (Chen, 1997)). Amongst all the laws, the Standing Committee of the 11th National People's Congress passed China's most comprehensive environmental legislation of recent years, the *Circular Economy Promotion Law of the People's Republic of China* (Circular Economy Promotion Law), which took effect on January 1, 2009.

The Circular Economy Promotion Law consists of 7 chapters and 58 articles, which deal with: General Principles, Basic Management Rules, Reduction, Reusing

and Recycling, Incentive Measures, Legal Liabilities, and Supplementary Provisions. It is an important piece of legislation, which highlights government efforts to encourage development of a sustainable economy in China. The Standing Committee added the word "Promotion" to the law's title in its third and final reading as a way of emphasizing the role of the law in encouraging sustainable economic development (Faegre & Benson, 2009).

The purposes of the law are to promote the development of the circular economy, to increase efficiency of the resources utilization, to protect and improve the environment and to realize sustainable development. The term 'circular economy' used in the law refers to "reducing, reusing, and recycling activities conducted in the process of production, circulation and consumption" (Circular Economy Promotion Law, 2008). The law also states, "development of China's circular economy shall be propelled by the government, led by the market, effected by enterprises and participated in by the public" (Circular Economy Promotion Law, 2008). This mandate is to be factored into industrial, economic and social planning at every level of government.

The law's mandates for reduction, reuse and recycling are extremely broad and encompass every facet of the Chinese economy. It touches, in principle, upon packaging enterprises; dismantling and disposal process of electric apparatus or electronic products; water-saving technologies, techniques and equipment in industrial enterprises; oil processing; steel, non-ferrous metal, coal, electric power, petroleum processing; chemical industry; building materials, building construction and demolition; paper-making, printing and dyeing; small, light and recyclable products

for construction use in architectural design and construction industry; water, fertilizer and pesticide-saving, planting, cultivating and irrigating technologies in agriculture; energy, water, material, environment-friendly products use in catering, entertainment, hotel and other service industries; use of tap water for road cleaning and planting; planning of industrial parks; and production and distribution of one-off consumption goods.

The law also offers incentives to foster sustainable economic development. It directs provincial, autonomous regions and municipal governments to establish funds especially for the development of the circular economy, and to support the research and development of new technology and information products. Tax preferences are offered to industrial activities promoting the conservation of energy, water and materials. Other economic incentives include financial institutions giving priority to loans and other credit supports to businesses that are in line with national industrial policy on energy, water, land, materials, and comprehensive utilization of resources. In procurement and other programs that disburse government funding, preference is supposed to be given to products that reflect the priorities contained within the Circular Economy Promotion Law.

This law applies to every facet of the Chinese economy at every level of government. Beihai government, which administers Weizhou Island, is required to apply the law into the planning, development, and the management of industrial and tourism activities, that are currently and about to take place on the island. Beihai government should reassess the grand tourism plan against the principles outlined in

the law, and meanwhile, develop effective ways of reducing the impacts of byproducts from its aquaculture and oil industries.

5.2 Planning at the Local Level and Community Participation

To carry out effective tourism planning at the local level, Weizhou Island should refer to the *Guide for Local Authorities for the Development of Sustainable Tourism* (UNWTO, 1999), and Local Agenda 21. Both guides provide advice that would allow Weizhou Island to plan for sustainable tourism in accordance with the local social and economic situation, population characteristics, available resources, environmental condition, and major difficulties and obstacles.

A development strategy planned with sustainability in mind, especially if the process includes local participation, can provide direct benefits that might offset pressures from other less sustainable uses of natural resources. It can also serve as a catalyst for economic growth. The strategy should be to enhance Weizhou islanders' influence in the development of community-based tourism, as this is a way to overcome or minimize negative effects of tourism in a remote, rural area (Thullen, 2001), and to increase the number of tourism ventures that involve community benefits. This can be achieved by involving the islanders in a planning forum, encouraging private ventures to establish dialogue and share revenue locally, and securing community rights over resources. The appropriate form of community involvement should be decided locally, and government policy should aim to encourage flexible and dynamic developments.

Finally, there are some technical considerations for planning at the local level. The UNWTO has designed planning techniques and methodologies, which have been used successfully in many regions. Some of the methods include (Verezi, 2001):

- Participatory planning techniques;
- Environmental and social impact assessment;
- Economic cost-benefit analysis techniques;
- Marketing and promoting techniques;
- Visitor management and interpretation techniques;
- Environment management systems (EMS) and the application of environmentally-sound technologies;
- Carrying capacity analysis;
- Indicators of sustainable tourism development; and monitoring techniques;
- Limits of acceptable change;
- Tourism optimization management model; and
- Integrated and cooperative approaches involving the perspective and expectations of all stakeholders, and targeting related economic activities in the area.

5.3 Fresh Water Solutions Tailored to Weizhou Island

Given the current fresh water resource scarcity on Weizhou Island, reasonable and sustainable use and conservation of underground water resources must be taken into account. To support the continuous survival of Weizhou islanders, some of the

initial measures and recommendations by Shi et al. (2003) and Wang (1999) are as follows:

- Adopt joint supply of both underground and surface water. Domestic water use can use underground water, but there should be strict control of utilization of underground water for agricultural irrigation. Surface water can be used for this purpose;
- Treat used water. Construct water treatment facilities and use untreated water for flushing toilets. Then it can be treated at the sewage treatment plants, and finally be used for irrigation;
- Adjust agriculture structure. Develop water-saving agriculture, improve irrigation and water conservancy facilities and promote the use of drip irrigation;
- Restrict the development and size of water consuming industries. Water consuming projects should be handled with caution or be eliminated. Meanwhile, increase the repeated use of industrial water and reduce water consumption by existing businesses;
- Encourage water conservation, and implement a special water rate for business that are heavy water consumers. Strengthen people's awareness of water conservation through education; moreover, implement economic means to promote planned water usage;
- Improve soil and water conservation. Create a large number of wetlands to increase water storage and water-retention capacity. Especially in the wet season, this will maximize the prevention of soil erosion and reduce evaporation, and increase underground water recharge;

- Build water reservoirs. This will not only increase Weizhou Island's amount of available surface water storage capacity to better meet the demand of industrial and agricultural water use, but will also increase the amount of underground water recharge, and raise the water table;
- Rationalize the extraction of underground water. Weizhou Island's underground water is thick in the middle and thin on the sides, therefore, main extraction drillings should be arranged in the centre of the island. Extraction should also be intermittent. This will help to maintain the original, natural state of homeostasis of underground water, and will prevent sea water intrusion; and
- Manage the application of chemical fertilizer and pesticide. In particular, eliminate untreated discharge of industrial waste water.

The recommendations provided here are broad and touch everyday household water use, agriculture and industries use, water extraction, treatment and reservoir building. The solutions are comprehensive and if implemented successfully, they can realize effective and valuable change to the current crisis. However, it requires active and close cooperation with the government. Stricter fresh water use policies need to be put in place, initial investment made in water treatment facilities, and the adjustment of agriculture structure, creation of wetlands and building of reservoirs need to be pursued. Although there are obstacles to overcome, recommendations presented here provide fresh water opportunities and hope for Weizhou Island.

5.4 Conclusion

Challenges for island development pointed out by Clark (2009), such as, peripherality in relation to centers of decision making and limited diversity of natural resources are precisely some of the challenges facing Weizhou Island. Hectare upon hectare of forest land was cleared to build facilities for crude oil extractions, biomass decreased enormously, birds and wild animals lost their habitat; coral reefs destroyed from constructing oil transport pipeline, marine environment polluted from waste generated and discharged without treatment; fresh water massively used to replace equal amount of oil extracted. Breeding of young abalone and other type of aquaculture greatly reduced the fertility of Weizhou waters, coral system dramatically weakened. To fully implement the grand tourism development plan, tremendous amount of land and fresh water resources is required. Already more than half of the islanders are facing drinking water problem, the construction of tourism facilities and the two million tourists that are expected by 2015 will undoubtedly further jeopardize Weizhou Island's fresh water crisis. The building of the projected tourist facilities takes away limited arable land. The development activities on Weizhou Island are exercised at the expense of its natural capital.

Over the course of the writing of this thesis, I have demonstrated that the current thinking of 'progress' on Weizhou Island is unsustainable, and it places Weizhou Islanders' livelihood at stake. Furthermore, with no evidence of effective sustainable development policies and regulations, coupled with an apparent lack of community or civil society participation, sustainability on the island is exceedingly challenging. Nevertheless, solutions exist for Weizhou Island. The concept of a circular economy as developed in the national development strategy advocates the

improvement of resources productivity and eco-efficiency. Along with more engaged local participation, and implementation of experts' fresh water management recommendations, Weizhou Island could alleviate potentially ecological damages.

On the other hand, if current thinking of 'progress' continues without fundamental change, change to understand and realize that human society is only part of the ecosystem, and we depend on the health of the ecosystem for our own well-being. Weizhou Island, any island, and any continental area could risk destroying the ecosystem and losing the very basic elements that support life. One way or another, Weizhou Island, a small island nested in the large Chinese economic development setting, currently serves as an example of unsustainable development, and a lesson for all.

Appendix A List of Hermatypic Coral Species in Weizhou Waters (3 studies)

Family	Species	2005	1984	1964
Poritidae	*Porites andrewsi*			+
	Porites lutea	+	+	
	Porites pukoensis		+	
	Goniopora duofasciata			+
	Goniopora sp	+		
	Goniopora columna	+	+	
Faviidae	*Platygyra sp*	+		
	Platygyra crosslandi			+
	Platygyra daedalea		+	+
	Echinopora sp	+	+	
	Cyphastrea serailia		+	+
	Favia speciosa		+	+
	Faviasp	+	+	
	Favia rotumana		+	
	Favia matthaii			+
	Favites halicora	+	+	
	Favites sp	+		
	Favites abdita	+	+	+
	Goniastrea aspera		+	
	Goniastreasp	+	+	
	Goniastrea yamanarii			+
	Goniastrea retiformis		+	
	Leptastrea transversa		+	
	Leptastrea purpurea			+
Agariciidae	*Pavona sp*		+	
	Pavona decussata	+	+	+
	Pavona frondifera			+
	Pavona varians			+
Acroporidae	*Anacropora tapera*			+
	Acropora humilis		+	+
	Acropora millepora	+	+	+
	Acropora pulchra	+		+
	Acropora cytherea		+	
	Acropora formosa		+	
	Acropora pruinosa		+	
	Acropora Brueggemanni		+	
	Montipora monasteriata		+	+
	Montipora foveolata			+
	Montipora hispida			+
	Astreopora Myriophthalma			+
Merulinidae	*Hydnophora exesa*		+	+
Dendrophylliidae	*Turbinaria undata*			+
	Turbinaria irregularis		+	

	Turbinaria peltata		+	+
	Turbinaria frondens			+
	Turbinaria stellulata			+
	Turbinaria elegans			+
	Turbinaria mesenterina		+	+
Oculinidae	*Galaxea fascicularis*	+	+	+
	Galaxea astreata		+	+
Fungiidae	*Halomitra pileus*		+	
	Podabacia crustacea			+
Pectiniidae	*Echinophyllia aspera*		+	
Siderastreidae	*Psammocora contigua*		+	
	Psammocora			+
	Profundacella			
Mussidae	*Acanthastrea echinata*		+	
	Lobophyllia hemprichii		+	
Total		14	35	32

Source: *Status and Conservation Strategies of the Coral Reef in Weizhou Island* (Huang et al., 2009)

Appendix B Beihai Weizhou Island Crude Oil Terminal and Associated Projects Environmental Impacts Report

Energy and Water Consumption of Weizhou Island Crude Oil Terminal and Associated Projects

	Unit	Consumption		Total
		Crude oil terminal	Crude oil depot	
Energy	10^4 kwh/yr	9.8	4707	4713.8
Water	10^4 t/yr	4.26	0.19	4.45

Emissions Summary of the Weizhou Island Crude Oil Terminal and Associated Projects

Pollutant source	Pollutant	Source strength	Concentration
Combustion of flue gases 8900 m^3/h	SO_2	0.08kg/h	6.7mg/m^3
	NO_x	0.13kg/h	11.0mg/m^3
	Flue gas dust	0.048kg/h	5.4mg/m^3
Hydrocarbon emissions	Non-Methane Hydrocarbons (NMHC)	54.499 t 13.058 kg/h	

Heavy Metal (Zinc) Emissions of the Weizhou Island Crude Oil Terminal and Associated Projects

Pollutant	Source strength
Zinc	Zinc dissolution rate is 232 kg/yr, A single dissolution rate of zinc anode block is 246g / yr

Sewage Discharge Summary of the Weizhou Island Crude Oil Terminal and Associated Projects

Pollutant source	Output	Main pollutants	Concentration	Destination
Ship engine room waste water	3265 m^3/yr	Petroleum	Before treatment: 2000 ~2000, after: 15	Sewage treatment plant
Sanitary sewage	1645.5 m^3/yr	Chemical oxygen demand (COD) Biological oxygen demand (BOD_5) NH-N	40 ~ 300	Sewage treatment plant, discharge according to standards
First rain drainage	30832 m^3/yr	Petroleum	50	Sewage treatment plant
Tank cleaning	300 m^3/yr	Petroleum	300	Sewage treatment plant

Noise Emissions of the Weizhou Island Crude Oil Terminal and Associated Projects

Source of noise	Source strength
Oil tanker whistle	100~110 dB(A)
Pumps	80~85dB(A)
Diesel generator	98 dB(A)
Aeration blowers, diesel-driven fire pump, fire pump regulator, foam pump, sewage pumps, rain water pump, freshwater pressure pump	85~93dB(A)

Solid Waste of the Weizhou Island Crude Oil Terminal and Associated Projects

Pollutant source	**Amount of pollutants（t/yr）**	**Treatment and disposal methods**
Oil sludge, diesel, etc from sweep-line operation	Small amount	Handled by companies specialized in hazardous waste disposal
Sanitary garbage	23	Garbage from ships is handled by companies specialized in hazardous waste disposal. Garbage from international ships from infected areas shall be quarantined and disinfected by port authorities, to meet the relevant requirements, and then managed by local sanitation authorities. Garbage from non-infected areas is collected and disposed by local sanitation authorities.
Industrial garbage	46.8	Handled by companies specialized in hazardous waste disposal
Residue from tank cleaning	17.5	Handled by companies specialized in hazardous waste disposal
Sewage treatment plant sludge	35.32	

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