

Climate Change and Health Training Manual



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MODULE 1

Introduction & Orientation

Introduction and Orientation

【Training Objectives】

1. Help the trainees learn trend and cause of climate change and its health impacts.
2. Help the trainees understand the joint programme and be aware of the goal and content of this workshop.

【Text】

1. Climate change and its impacts

1.1 What is climate change?

Climate, affinitive with the development of human society, is one of the key components of environment and natural resources.

The emission of greenhouse gases from anthropogenic source is increasing dramatically with the development of economy and the improvement of living standard, which is leading to climate change. IPCC issued the Fourth Assessment Report on Climate Change in April, 2007. According to the Report, Global surface air temperature has increased by 0.74°C over the last 100 years (1906–2005). The warming rate over the last 50 years is more significant than ever. The temperature will rise 0.2°C per decade in the following 20 years (*IPCC climate change 2007*).

It is estimated that surface temperature of the earth will increased by $1.1\text{--}6.4^{\circ}\text{C}$ at the end of this century (*China's Scientific & Technological Actions on Climate Change*). China is one of the countries which affected by climate change seriously. *National Assessment Report on Climate Change* points out that in the background of global warming, the climate in China has also undergone a significant change in the past 100 years which was in the same trend of global climate change. In the recent 50-100 years, the annual average surface air temperature was increased by 1.1°C and $0.5^{\circ}\text{C}\sim 0.8^{\circ}\text{C}$ respectively, which was higher than the global temperature increase.



1.2 Why is global climate changing?

Although human is managing to improve the efficiency of energy, the total energy consumption keeps increasing, from 5.559 billion tons of oil equivalent in 1990 to 7.645 billion tons of oil equivalent in 2004. Carbon dioxide emissions let out by fossil fuels is the major cause of climate change. Greenhouse gases produced by human being are increasing at an alarming speed. For about 10,000 years before the industrial revolution, the atmospheric abundance of CO₂ was constant less than 280 ppm (ppm = number of molecules of the greenhouse gas per million molecules of dry air). Since the late 1700s, atmospheric CO₂ has increased by 36%. The latest analysis of data from the WMO-GAW Global Greenhouse Gas Monitoring Network shows that the globally averaged mixing ratios of CO₂ have reached new highs in 2006 with CO₂ at 381.2ppm (WMO, *Greenhouse gas bulletin 2007*). Consumption of CFCs and HCFCs is decreasing in recent years, however, the stratospheric ozone can be fully restored for a long time (*Global Environment Outlook, 2007*).

1.3 Impacts of climate change on human

Global warming has become an irreversible trend, and will become more serious in the near future. Humanity will have to bear the disastrous brought about by the climate change. Water shortage, quick melting of ice in the North and South poles, disappearance of some of the island caused by Sea-level rise, rainstorm, drought, heat wave and other extreme weather will occur frequently, biological chain has been disrupted and the infectious diseases will prevail. The marine survey found that the changing speed of the Earth is various and non-linear. Global Risks 2007 issued on the World Economic Forum mentioned that the Climate change will become one of the world's most serious challenges in 21st century. Natural disasters caused by global warming may lead to large-scale migration in some areas, energy shortages, economic and political turbulence over the next few years. Climate warming is the changing of climate zone, Tropical border will be extended to sub-tropical and temperate regions



will become part of the sub-tropical. It is estimated that the global average temperature rised 1 degree Celsius, the weather to bring about over 100 km

Climate change will affect human health and well-being through a variety of mechanisms. Altered weather patterns (temperature, precipitation, sea-level rise and more frequent climate extreme events) can impact human beings directly and influence on the morbidity and mortality of the related diseases. On the other hand, human beings are exposed to climate change indirectly

through changes in water, air and food quality and changes in ecosystems, agriculture, settlements and the economy.

Climate warming caused a lot of danger to human health and this can not be over uniform. Population living in developing countries, especially those who live in islands, drought area, mountains and crowded coastal regions, seem more vulnerable to climate change. Africa is the tropical infectious diseases, parasitic diseases regions of high, particularly the largest origin of the virus. With the warming of the temperate regions, So that the infection or carry disease pathogens (especially viruses), insects and rodents to expand the distribution of the region, Each year against the extension of the deadline so that the spread of these diseases is possible. Another result of climate warming is expanding of the scope of the suitable for the growth of animal breeding environment for media time and space, so that can expanding the breeding season of bacteria and viruses. The most direct impact of Global warming on human health is the extreme heat generated by thermal effects, it will become more frequent and more widespread. Due to intensity of high temperature heat wave and the increase of duration, the Morbidity and mortality of heart and respiratory disease were increased. And the impact of heat wave on the health in city is much greater than in suburbs and countryside. As the global climate warming, the number of day's high temperature in summer will increase by obviously and the frequency and intensity of high temperature and heat wave will increase by with that. In 2003 summer, the heat wave have swept the globe once again, First, India, Pakistan, and then in Europe, China, more than 1,000 people were killed by heat wave in India. (*Lu Chen and Xie Pu, 2003*) .With the increased of temperature and heat waves, the morbidity and mortality of heart disease and high blood pressure patient increased. (*Chen Hu et al. 1999*) .

2. Introduction of the joint programme of climate change and its health impacts

2.1 The Spanish MDG fund

On 18 December 2006, UNDP and Spanish Government made an agreement to program €28 million over the next four years through the UN system, towards key Millennium Development Goals (MDGs) and related development goals in select countries. This agreement paved the way for the establishment of the UNDP/Spain MDG Achievement Fund (MDG-F) which was launched in the first quarter of 2007. The specific goals of this fund include gender equality, women's right, development of economic and private sectors, culture and development, prevention of conflict and establishment of peace, etc. The first theme aim launched in 2007 was environment and climate change.

2.2 UN-China climate change partnership framework

After submitting the application, UN-China climate change partnership framework was ratified in December, 2007. Chinese government and UN agencies in China were sponsored US\$12 million to conduct work in the field of climate change, environment and energy. This joint programme was supposed to begin in 2008. The joint programme has been developed by the nine UN Agencies in coordination with the respective counterpart Ministries/National/Local Agencies, scientific community, and the private sector, and under the coordination of the UN Theme Group on Energy and Environment, the Ministry of Commerce (MOFCOM) and the Office of National Climate Change Coordination Committee at the National Development and Reform Commission (ONLGCC/NDRC).

The joint programme, building on previous work and experience, aims at: a) incorporating the National Climate Change Strategy guidelines into national policies and legal measures, delivering a shift in climate change policies and policy enforcement, b) improving local capacities and partnerships for financing technologies transfer and replicating innovative technology models and c) ensuring vulnerable communities' adaptation to climate change impacts. The joint programme will address three major areas: (1) climate change policy, (2) mitigation, and (3) vulnerability assessment and adaptation.

2.3 The joint programme of climate change and its health impacts

China's efforts to date in vulnerability assessment and adaptation have been much less than those in mitigation. Yet, the government has begun to emphasize the importance of these areas. It is estimated that climate change will have a great impact on human health, mostly in countries like China with poor environmental health systems in rural areas. In the health sector, a key planning document is the National Environment and Health Action Plan (NEHAP, adopted August 2007), which focuses on the relationship between environmental factors and human health impacts in China in order to recognize, evaluate, and better manage various environmental factors related to human health and ultimately promote people's health. The NEHAP refers specifically to mainstreaming climate change considerations into control policies for all major health sensitive climate outcomes (such as water stress/desertification, flooding, dust storms, smog, etc.) and enhancing capacities to adapt to climate change. China has not yet conducted a national assessment of the potential impact of climate change on human health. There is a need to support China and the international community to better understand human health vulnerabilities and study adaptation and mitigation strategies (see module 2). Therefore, the health-based joint programme entitled "policies and capacities developed to manage environmental health issues from climate change" was approved. WHO coordinates this joint program at international level. At the country level, the Ministry of Health (MOH) will be the projects' key focal point.

Goals of the joint programme

The programme will help develop capacities to implement climate change aspects of a new National Environment and Health Action Plan approved in November 2007. The Plan identifies the need to establish monitoring and health risk assessments related the risks to health posed by climate change. The overall strategy will be to facilitate a transfer of knowledge and skills that will enable the strengthening of environmental health risk managing functions in China among various agencies, especially in the health sector. The component will include development of a knowledge-base of good practice in environmental health management and improvements to policy and practice related to climate change mitigation and adaptation measures that could be used widely by municipalities and local and regional authorities.

Outputs of the joint programme

Enhanced Institutional Capacity to manage Environment and Climate Change Risk to health at national and provincials.

Effective local action plans to protect human health from climate change and other environmental health risk considered by local authorities and in the framework of the NEHAP.

Strengthened capacity to assess and respond to key Environmental Health risks, and identify the health aspects of Climate Change mitigation policies.

Enhanced capacity for monitoring, analysis and reporting progress on Environmental Health and in vulnerability to climate change health impacts.

3. Training on climate change and public health

According to the overall arrangement of the joint programme, Institute for Environmental Health and Related Product Safety, China Center for Disease Control and Prevention (IEHS, China CDC) had finished the drafts of two reports, *Environment and Health Management for Climate Change—Governance and Management* and *Health Impacts, Adaptation Strategies and Research Priority of Climate Change in China*. The two reports expatiated status and trend of climate change, health impacts, adaptation measures, environmental health management system in China and international experience of environmental health management. Also the reports pointed out what should be improved in environmental health to adapt to climate change in China at the base of comparison of international and domestic management. Based on the two reports, IEHS has accomplished this training manual, with the help of experts from Office for Disease Control and Emergency Response, Institute for Nutrition and Food Safety, Institute for Communicable Disease Control and Prevention of China CDC. In order to enhance institutional capacity to manage environment and climate change risk to health at national and provincials, national workshop on EH Management, strategy and leadership with a focus on climate change and two regional workshops will be organized. Provincial leaders and

professionals who will be trained in national workshop will become trainers in the regional workshops. This manual is expected to be used on the national and regional workshops.

Who will be trained?

Local leaders of health bureaus;
professionals from local centers for disease control and prevention;
professionals from local health inspection bureau;
and other persons from climate-related sectors.

Main goal of the training

After the training, it is expected that trainees will learn knowledge on status and trend of climate change, health impacts and adaptation measures. Trainees will be aware of the international and domestic trend of environmental health management and researches and will understand more about work that should be emphasized in the future.

Content of the training

Overall content of this training includes,

- ✧ Introduction and orientation (Module 1);
- ✧ Strategic planning and management for climate change & health (Module 2);
- ✧ International experience of adaptation measures (Module 3);
- ✧ Impacts on vector-borne diseases of climate change (Module 4);
- ✧ Impacts of Thermal Stress on human health (Module 5);
- ✧ Climate change and water supply (Module 6);
- ✧ Air pollution change due to climate change and its health impacts (Module 7);
- ✧ Quick response of public health in extreme climate events (Module 8);
- ✧ Impacts of climate change on nutrition and food safety (Module 9);
- ✧ Review and assessment (Module 10)。

【Video】

An inconvenient truth.

【Exercises】

1. Does climate change have any impact in your region?

2. Has your region been involved in any programme related to climate change?

If the answer is yes, please show your efforts to response to the health impacts due to climate change.

【Recommended readings】

National Environment and Health Action Plan (2007-2015),

<http://www.ccchina.gov.cn/WebSite/CCChina/Upfile/file198.pdf>

China's National Climate Change Programme,

<http://www.ccchina.gov.cn/WebSite/CCChina/Upfile/file189.pdf>

China's Policies and Actions for Addressing Climate

Change, <http://www.ccchina.gov.cn/cn/NewsInfo.asp?NewsId=14983>

MODULE 2

Environmental Health Management Systems for Climate Change in China

Environmental Health Management Systems for Climate Change in China

【Learning Objectives】

1. An understanding of the strategies of adaptation to climate change
2. An understanding of the importance of health in the development of adaptation and mitigation policies and programs
3. An understanding of the need and mechanism to strengthen the environmental health system as an adaptive strategy
4. An understanding of NEHAP

【Text】

1. Strategic Management for Climate Change and Health

Participants of the regional workshop on climate change and human health, held in Bali, Indonesia from 10 to 12 December 2007, jointly developed a regional framework to guide regional and national action towards reducing the potential burden of disease linked to the effects of global warming and climate change.

There is a growing, but still limited, political commitment to integrate health considerations into efforts to mitigate and adapt to climate change at national and international levels in the Region. Also, there is also insufficient awareness among the general public about climate change and its impact on health. The availability of relevant hydro-meteorological, socioeconomic and health data is limited and available data are often inconsistent and seldom shared in an open and transparent manner. Furthermore, there is insufficient capacity for assessment, research and communication on climate-sensitive health risks in many countries, as well as insufficient capacity to design and implement mitigation and adaptation programmes.

There is an urgent need to incorporate health concerns into the decisions and actions of other sectors while they plan to mitigate and adapt to climate change, to ensure that these decisions and actions also enhance health. The objectives are as follows:

1.1 To increase awareness of health consequences of climate change

Governments, through relevant agencies, should:

Undertake studies on the health implications of climate change and share information to understand how to promote changes in individual and corporate behaviours that mitigate climate-related health risks, while protecting and promoting health.

Enhance political commitment and strengthen institutional capacity and arrangements to achieve adaptation and mitigation goals.

Facilitate national working groups, nongovernmental organizations and civil society to develop coordinated mitigation and adaptation plans by including relevant sectors, regions and disciplines.

Develop awareness-raising programmes and learning resource materials to educate and engage a broad range of stakeholders, including local communities, health and other relevant professionals, and the media on the potential health impacts of climate variability and change and on appropriate measures to reduce climate-sensitive risk factors and adverse health outcomes.

1.2 To strengthen health systems capacity to provide protection from climate-related risks, and substantially reduce health system's GHG emissions

Governments, through relevant agencies, should:

Develop and implement national action plans for health that are integrated into existing national plans on adaptation and mitigation to climate change.

Develop integrated strategies to incorporate current and projected climate change risks into existing health policies, plans and programmes to control climate-sensitive health outcomes, including integrated vector management, and health risk management of disasters.

Strengthen existing infrastructure and interventions, including human resource capacity, particularly surveillance, monitoring and response systems and risk communication, to reduce the burden of climate-sensitive health outcomes. Key concerns vary by country; common concerns include vector borne diseases, air quality and food and water security.

Provide early warning systems to support prompt and effective responses to current and projected health burdens. In order to achieve this, national and regional climate forecasting information, including climate change projections, should be fully utilized.

Implement adaptations over the short, medium or long term; be specific to local health determinants and outcomes of concern; and facilitate the development of community-based resource management. The costs and benefits of different interventions should be determined.

1.3 To ensure that health concerns are addressed in decisions to reduce risks from climate change in other key sectors.

Governments, through relevant agencies, should:

Develop integrated strategies to incorporate current and projected climate change risks into existing policies, legislation, strategies and measures of key development sectors to control climate-sensitive health outcomes. Examples include the promotion of public and non-motorized transportation, clean energy and disaster risk management.

Facilitate the health sector to actively participate in national communications to the United Framework Convention on Climate Change (UNFCCC), and include health issues as the core elements in the negotiation process.

Ensure active health participation in the national climate change team.

2. Strategies of Adaptation to Climate Change

2.1 China National Climate Change Programme

Addressing climate change as the priority areas of China's environment and health work, it aims at strengthening the capacity to deal with climate change. The Chinese Government has always attached great importance to climate change. In 1990, the State set up to deal with climate change-related institutions and established the National Climate Change Coordination Group to strengthen the leadership of addressing climate change in 1998. In June 2007, the Leading Group of National Response to Climate Change and Mitigation and Energy-saving Work was set up, which is composed of the State Council Premier Wen Jiabao as the group leader and the relevant ministries' leaders of the National Development and Reform Commission, Ministry of Health, Ministry of Science and Technology, Ministry of Environmental Protection, Ministry of Agriculture, Ministry of Foreign Affairs, Ministry of Water Resources, the Chinese Academy of Sciences, Ministry of Communications and other related ministries and agencies serve as members.

On May 30, 2007, the Premier of State Council, Wen Jiabao presided over the executive meetings and stressed to adhere to the scientific concept of development as guidance, to combine responding to climate change with implementing the sustainable development strategy, accelerating the construction of resource-saving and environment-friendly society and innovative country, to integrate it in the national and regional plan for national economic and social development, effort to control greenhouse gas emissions, and continuously improve the ability of adapting climate change, to promote a coordinated development of the economy, population, resources and the environment and contribute to the international community etc.

In June 2007, according to the *United Nations Framework Convention on Climate Change*, China formulated the *National Climate Change Program* which made clear the objectives, principles, priority areas and policy measures to China in 2010 to slow down and adaptation to climate change made a positive contribution.

2.2 Policies and Actions to Adapt to Climate Change

China actively applies policies and takes actions to adapt to climate change in natural ecological systems such as agriculture, forestry and water resources, as well as ecologically fragile areas like coastal zones and regions, and has achieved positive effects.

2.2.1 Agriculture

The state has made great efforts to establish and improve a law regime for agriculture to adapt to climate change, including the Agriculture Law, Grassland Law, Fisheries Law, Law on Land Management, Regulations of Responses to Major Emergent Animal Epidemics, and Regulations on Grassland Fire Prevention. The state has strengthened construction of agricultural infrastructure and capital construction of farmland water conservancy, enlarged irrigation areas, improved farmland irrigation and drainage efficiency and capability, and promoted dry farming and water-saving technologies, making agriculture better able to deter and mitigate natural disasters and increasing overall agricultural productivity. Through the "Seed Project," China is cultivating stress-resistant varieties of seeds with high yield potential, high quality and specific abilities of resistance to drought, water logging, high temperature, diseases and pests.

2.2.2 Forests and Other Natural Ecosystems

For years, China has made great efforts to protect forests and other natural ecosystems by formulating and enforcing relevant laws and regulations, such as the Forest Law, Law on the Protection of Wildlife, Law on Water and Soil Conservation, Law on Prevention and Control of Desertification, Regulations on Conversion of Farmland to Forests, Forest Fire Prevention Regulations, and Regulations on Forest Diseases and Insect Pest Prevention and Control. The state is now working hard to draw up laws and regulations on the protection of nature reserves, wetlands and natural forests, and pushing forward the all-round implementation of a national program of eco-environment development and protection.

2.2.3 Water Resources

China has worked out and enforced laws and regulations in this regard, including the Water Law, Flood Control Law, and Regulations on River Administration. It has formulated and completed the program of flood control on major rivers and other

water-conservancy programs, and has set up an elementary law regime and a program on water conservancy commensurate with China's conditions, and established an elementary flood-control and disaster-alleviation system for major rivers and a water-resource allocation and protection system. Meanwhile, great efforts have been made to control soil erosion. By the end of 2007, China had made efforts to bring soil and water erosion under control over an area of one million sq km, thus effectively protected the soil and water resources and improved its eco-environment.

2.2.4 Coastal Zones and Coastal Regions

In accordance with the Marine Environment Protection Law, Law on the Use and Administration of Sea Areas, General System Development Plan for the Air-Sea Interaction, among others, China has worked out the objects and contents of a system to deal with climate change in marine areas, established a decision-making mechanism and a coordination mechanism of comprehensive management, thereby striving to slow down and adapt to the adverse impacts of climate change. Work is also done to increase the capability of the coastal zones and coastal regions to adapt to climate change. Through investigations and researches, China has strengthened study on air-sea interaction to deepen the understanding of air-sea interaction, and has initially formed an all-dimensional observation network pertaining to the marine environment, thus improving its capability to control and prevent marine disasters.

3. Environmental and Health Management System in China

3.1 A Model for Chinese EHMS

According to the basic characteristic and management foundation of the Chinese environment and health problems, there has gradually formed the government as the main body, social groups and non-governmental organizations as the bridges, businesses and public participation and many other common support, that is, "government leadership with public participation," the environment and health work situation(see Figure 2-1).

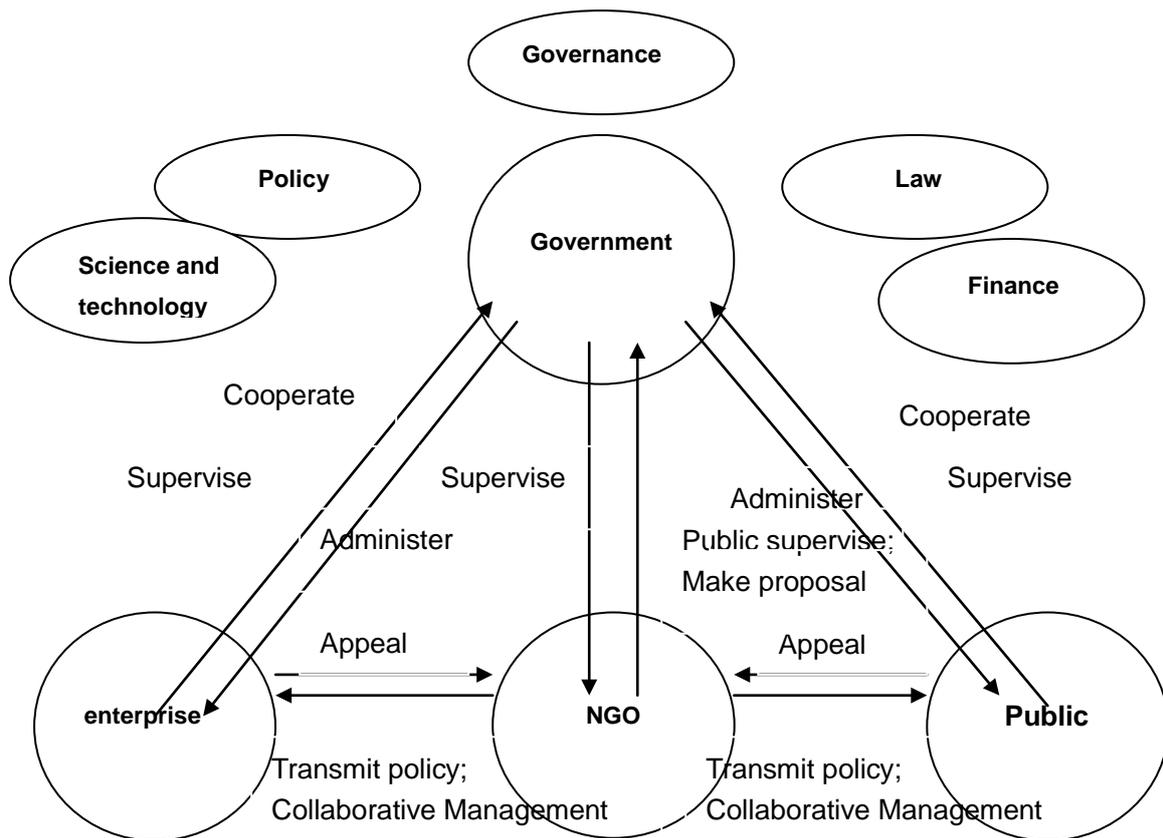


Figure2-1: Government leadership with public participation

3.2 The Functions, Mechanisms of cooperation of China Environment and Health Management relevant Department

Environment and health issues relate to health, meteorology, environmental protection, finance and overall consideration and reform of the national economy etc. multi-sectors and fields. The each department has management and technical advantages in their respective fields and there is also inevitable to the existence of overlapping functions inter-departments. So it's own way of any single department will inevitably lead to a decline in managerial effectiveness and waste of resources.

In November 2007, the state officially launched the "China National Environment and Health Action Plan" (2007-2015) (Hereinafter referred to as "Action Plan") which jointly signed by 18 ministries and commissions. The "Action Plan" as the first programmatic document of the Chinese environment and health areas, which clearly puts forward the basic principle of "Cooperation and integrated arrangement among sectors", pays particular emphasis on the importance of departmental collaboration, and points out in 2007 ~ 2010 to set up a national environmental and health organizations, to set up a comprehensive national environmental coordination

mechanisms. Moreover, to defines the division of duty on environment and health supervision among 18 departments in accordance with their respective administrative functions, which provided the institutions and mechanisms guarantee for our country's environment and health work.

On Jan 31, 2008, the national environment and health leading group was set up. At the same time, there were three levels organizations--Joint Office, Expert Consulting Committee, and Theme Workgroup, so as to ensure that the efficient operation of the different levels of the organization and the smooth and effective implementation of environment and health work.

3.3 The Role of Enterprises, Social Organizations, the Public in Environmental Health Management

The development of environment and health cause, not only relies on the Government, but also relies on the active participation of the enterprises; social organizations and the public, to give full play to its social role. On the one hand, enterprises, social groups and the public should cooperate with the Government in environmental and health-related work. On the other hand, they also should give supervision, advice and suggestions on the relevant work of the government, and positively reflect their own aspirations, so as to better protect their own environment and health rights and interests, and promote the sustainable development of environment and health protection.

3.4 International Communication and Cooperation in Environment and Health Area

The Chinese Government has always attached great importance to carry out international cooperation, actively engaged in promoting the signing of "the United Nations Framework Convention on Climate Change" and the "Kyoto Protocol", and conscientiously fulfilled the international obligations. In 1992, Chinese government approved the establishment of China Council for International Cooperation on Environment and Development (CCICED). CCICED as a high-level advisory agency composed of national and international high-level leaderships and experts in the field of environment development, which is responsible for exchanging the successful experience and researching the major problems on this field. In December 2005, China attended the 2nd environment and health high-level meeting of South-East Asia and Asian countries to discuss the "Environmental Health Charter for Regional Cooperation "for Asian countries. As a guiding document in collaboration on environmental and health field of Southeast Asia and East Asian countries, it played an important role on establishing the priority areas in environmental health. Besides, China joined in the "Global Outbreak Alert and Response Network" of World Health Organization and the network mainly focus on international infectious disease

outbreaks. There is great significance in strengthening the international cooperation in the field of environment, climate change and health, and promoting the job-related development.

4. National Environmental and Health Action Plan

China National Environment and Health Action Plan: CNEHAP (2007-2015) as the first programmatic document in this respect, put forwards to establish coordination mechanisms on environment and health, and in accordance with the administrative functions and powers of relevant departments to carry out a specific division in the responsibility of supervision and management of the 18 departments in environment and health areas (see Figure 2), which provide the guarantee of the institutions and mechanisms for China's environment and health work. In addition, the “Action Plan” also put forward the framework of ideas and the stage goal of the national environment and health work in 2007 ~2015, and six concrete action strategies, which are of great significance in guiding the national environment and health work to scientific development and promoting sustainable and health development of the economic society.

4.1 Objectives

4.1.1 General Objectives

To improve legal, administrative and technological supports for environment and health activities, to control harmful environmental factors and their impacts on health, to reduce the incidence of environment-related diseases, to protect people’s health, to promote the achievement of the restricting targets set in the State Outline of the 11th Five-Year Plan and UN Millennium Development Goals, so as to ensure the sustainable and coordinative economic and social development.

4.1.2 Staged Objectives

2007-2010: To fully establish a comprehensive environment and health cooperation mechanism, to develop the institutions for pushing forward the coordinative conduction of the environment and health work, to build the risk assessment system of health hazards caused by environmental pollution, to complete the comprehensive assessment of the existing laws, regulations and standards on environment and health, to propose the requirements of building systems of relevant laws, regulations and standards, to complete a national survey on the current situation of environment and health, to fulfill the research and demonstration of an implementation plan for the monitoring network of environment and health, and to strengthen the scientific research on the assessment of environmental pollution and health safety.

2010-2015: To carry out research, development and revision of laws and regulations

on environment and health, to perfect the system of environment and health standards, to expand the environment and health managing team and laboratory technical capacity, to basically accomplish the setting up of monitoring networks and information-sharing systems of environment and health, to realize the effective integration of environmental factors and health effects monitoring and information sharing, to perfect the risk assessment, forecasting and pre-warning of environment and health, to realize the multi-departmental collaborative emergency response to the public urgent events caused by environmental pollution, and to basically achieve a good situation that all social sectors participate in environment and health work .

4.2 Action Strategies

4.2.1 To Establish and Perfect Laws, Regulations and Standards on Environment and Health

To perfect laws, regulations and relevant standards on environment and health,

4.2.2 To Establish Environment and Health Monitoring Networks

To conduct real-time and systematic monitoring of environmental pollution and its health hazards, to make timely and effective analysis of health effect and damage resulted from environmental factors, to keep abreast of the developing trends of environmental pollution and its health impact, so as to lay the scientific basis for the government to formulate effective intervention strategy and measures.

To establish monitoring networks on drinking water safety and health, monitoring networks on air pollution and health, monitoring networks on soil environment and health, monitoring networks on extreme weather events and health and monitoring networks on public place sanitation and biological safety in special places.

4.2.3 To Strengthen Pre-warning of Environment and Health Risks and Emergency Handling

To carry on risk evaluation, risk pre-warning and emergency incidents handling effectively, to upgrade the capacity of risk prediction, and emergency handling, so as to avoid or reduce serious environment and health hazards.

To conduct environment and health risk evaluation, to strengthen pre-warning of environment and health risks, to strengthen capacity building on health emergency incidents handling.

4.2.4 To Develop National Systems of Information Sharing and Services for Environment and Health

Information is an important foundation of environment and health activities. In providing strong support for decision making, management and research based on the full use of information, the guarantee of sound information sharing and management is needed.

To develop systems of information sharing and services, to establish environmental and health monitoring databases, to improve information sharing mechanisms and information issuing institutions.

4.2.5 To Perfect Technical Support Capacity on Environment and Health

To master the status of state environment and health, to conduct researches on priority issues according to current situation, to strengthen scientific and technical innovation and achievement conversion, so as to provide strong technical support for environment and health activities.

To carry out the survey on current situation of environment health impact. To conduct nationwide surveys of the major environmental factors and environment-related health damage, to identify basically the types, extents, characters and distribution of health damage caused by environmental pollution, and master the spectrum of diseases caused by environmental pollution, in order to provide scientific basis for environment and health action implementation.

To conduct researches on safety evaluation and responding measures of environment and health. According to national and international requirements and the developing trend of environment and health, to carry out the following basic and applied researches as soon as possible: researches on human health effects of climate change, basic researches on environment and health, and researches on Traditional Chinese Medicine (TCM) intervention to health impacts of environmental pollution, researches on techniques for evaluation of environmental pollution impacts on health, researches on environment-related disease burden assessment systems and analysis of financial requirement of environment and health.

To strengthen capacity building on techniques and professional contingents. According to functions of environmental and health monitoring networks, the setting of monitoring sites, and the requirements of investigations and researches which need to be implemented urgently, to further strengthen the building of laboratory facilities, equipments, and the on-site monitoring means, to improve the monitoring capacities of priority pollutants and key indicators of human health so as to ensure the smooth implementation of the major investigations and researches. To regulate and expand

the professional technical teams, to promote the development of relevant disciplines and improve higher education and personnel trainings for providing personnel and knowledge reserves for the environment and health work, and to upgrade the technical supporting capacities of environment and health on the whole.

4.2.6 To Strengthen Propaganda and Communication on Environment and Health

To carry out public propaganda and extensive communication in order to raise the common awareness of environment and health practice, to strive for supports from various sectors, ensuring the effective implementation of policies and measures on environment and health. To strengthen social propaganda and education and to conduct active national and international communications.

5. Gap Analysis

For a long time, environment and health always were considered as one part of environment or health department and managed respectively. Even in such a management background, a great deal of effective measures were still carried out by government and the whole society in the field of environment and health, and a wealth of practical experience on the management of environment and health also has been accumulated. "National Environment And Health Action Plan" issued in 2007, which manages the environment and health as a whole factor, means the establishment of true environment and health management system. China's long-time practical experience in the field of environment and health, as well the new define of "environment and health" in the "National Environment and Health Action Plan", are both to lay a strong practical foundation and supply a theoretical basis for the better development of environment and health management system.

From the implement of NEHAP, the mechanism of collaboration has been made an agreement among national government agencies, but the fulfillment is not very well. Other mechanisms of collaboration between national government and local government and between national government and communities have not been established yet. From 2007, there are many detailed works have been implemented under the NEHAP. Air monitoring, climate change, water and disease monitoring network has been established and make a great progress. Now this network was established among some pilot cities. Next step, the network will be enlarged to whole country. Based on the spread of networks, the NEHAP will be promoted to LEHAP as well.

Climate change and human health is one of the important works in NEHAP. The implement of climate change and human health work is the foundation of policy decision. In fact, in China, we have never developed the country wide assessment of climate change and human health. There are no related contents in the two main

policy documents of climate change “Chinese Government White Paper” and China’s National Climate Change Program. We should make great effort on climate change and human health in future to make complement of our policy documents.

As the first step of climate change and human health work, air pollution, climate change and human health network have been established. In 2004, the Institute for Environment Health and Related Product Safety (IEHS) of the China Disease Prevention and Control Center began to carry out the air pollution, climate change and disease monitoring work and established eight monitoring demonstration centers on a national scale. And through collecting and monitoring the meteorological data, air pollution data, as well as the data on the death of residents, the chronic obstructive pulmonary disease and coronary heart disease of elderly patients, the signs and symptoms monitoring of respiratory disease of pupil etc. to establish the dynamic database of China's climate change, air pollution and the health of residents and analyze the relationship between the interaction of different types of weather, air pollution and climate change and the death and acute, chronic diseases of the residents. This is of great significance for establishing and improving the monitoring network of China's climate and health. At the same time, the State have also stepped up the monitoring and forecasting of high-temperature heat waves, floods, droughts, storms, dust storms, cold waves and other extreme weather and climate etc. to improve the climate and health monitoring network.

There is no doubt that environment and health management even is a newborn management field in China. Although a scientific blueprint of China's environment and health management has been drawn in "National Environment and Health Action Plan", some contents in it are still not been implemented due to many factors, such as no enough policy, no a sound legal, no comprehensive scientific and technological support and so on. Especially, the foundation of the work related climate change and impact on health is weaker, and environment and health management system needs to be improved yet. Though NEHAP has the climate change and health as a priority field, demands to improve the level of work related to environment and health, and enhance the ability to cope with climate change. Face to this absolute new field, however, the practice of coping with climate change and impact on health in China is so lack to need to advance related work in the future. So, many challenges are in front of China both in the aspects of perfecting the environment and health management system, and mergering climate change and health into the environment and health system.

6. Adaptation Strategies to Health Impacts Due to Climate Change

6.1 The monitoring system of health impacts of environmental and climate change

In China, monitoring system about environment, climate change and health is including the environmental monitoring system established by environmental

protection departments, the meteorology monitoring systems established by Meteorology Bureau and disease surveillance system belong to health sector. Environmental monitoring systems established by the Ministry of Environmental Protection of China are mainly include automatic air monitoring system (113 cities), Sandstorm monitoring network, acid rain monitoring network, surface water environment monitoring network and near-shore marine environment monitoring network. Meteorological service system has been basically formed after year's efforts by China Meteorological Administration and constituted by weather forecasting, climate prediction, weather modification, drought monitoring and forecasting, lightning defense, agriculture, meteorology and ecology, the development and utilization of climate resources, etc.

China's disease surveillance system established by the Chinese Center for Disease Control and Prevention is focused on infectious diseases, causes of death, public health emergencies, high-temperature heat stroke cases, health risk factors, vector biology, and disaster prevention information network for monitoring and reporting.

In 2004, the Institute for Environment Health and Related Product Safety (IEHS) ,China CDC, launched the air pollution monitoring pilot which are running in 8 cities now. The main tasks are to establish the dynamic database of climate change, air pollution and human health and analysis the health effects of the death, acute and chronic diseases affected by different climate types, air pollution and climate change even under the interactions.

6.2 The early-warning and forecasting system

The influence of the weather upon health can be prevented in some extent. Establishing the meteorological indexes system and the forecast model, as well as conveying the most precise meteorological information to the public quickly, then taking corresponding preventive measures immediately, that will minimize the public property loss to the least. To reduce the health impact of Heat wave, many countries have built up Heat Watch Warning System, and thus lead to less mortality and mobility of the heat-related disease. In China, The works have been done on monitoring and early-warning are mainly as following:

- ✧ Life index and healthy index forecasting
- ✧ Heat Watch Warning System
- ✧ Ozone warning system
- ✧ Early warning system of extreme weather events

6.3 Capacity building of response to public health emergencies

The global climate change brings various threats to human healthy and takes great public health problems at the same time. So the emergency responses to climate change also come to be an important way to measure the working ability of the

national public health. In 2003, the outbreak of SARS in China exposed lots of problems of the emergency ability of Chinese public health system. Therefore, the government of China has taken powerful measures to improve the public health emergency system.

On May 2003, *'The Regulation on the Urgent Handling of Public Health Emergencies'* was carried out by the State Council. On January 2005, *'The National Emergency Response Program for Public Incidents'* was promulgated. In 2004, CPHP (Center of Public Health Preparedness) was established in China CDC. On January 2006, Ministry of Health established the expert advisory committee of public health emergency events which was formed by public health experts to further improve the warning and emergency treatment work of emergency events comprehensively.

6.4 Researches on health Impacts of climate change

With the pressure gradually increasing posed by climate change, China is stepping up efforts to carry out the research on impact of climate change on infectious disease. Till now in China, some studies have been carried out on the relationships between temperature and cardiovascular, cerebrovascular diseases, respiratory diseases, tumor. But on the whole, Health impact assessment of Climate Change is mainly focused on agriculture, water resources, natural ecosystems and coastal zones, while little work has been done to assess health impacts and the effects on air quality of climate change. There are many researches of health effect about single meteorological factors, but combined effects about many weather factors have less study. In addition, atmospheric pollution, meteorological factors and health are closely related, and whether air pollution has played the interaction function on the health effects of meteorological factors and as well as the extent of the impact are not clear. Due to the relative lack of scientific research and the limitations of capacity on scientific understanding, there are still a great degree of uncertainty on the climate change impact assessment methods and results. More work should be strengthened on case studies about the regional adaptation to climate change, and on expanding the research areas, strengthening studies on extreme weather, climate events and putting forward practical and adaptive responses. To further clarify the relationship between the climate change and population health, and provide a basis for intervention measures, adaptation and vulnerability assessment, the mechanism of research or epidemiology studies on public health are needed to be strengthened.

6.5 Enhancing Public Awareness in Addressing Climate Change

China has produced large numbers of publications and audio-video products on climate change, set up dedicated TV weather channel and an information database to disseminate knowledge about climate change through the mass media. It has held the "International Forum on Climate Change and Science & Technology Innovation," and hosted many large-scale international seminars with topics such as "Climate Change and Ecosystems" and "Bio-diversity and Climate Change." Since 1992, China has

staged 18 sessions of National Energy Conservation Publicity Week in succession.

The Chinese government attaches great importance to the development of a recycling economy, and advocates such economy throughout the country. In recent years, with vigorous development of the recycling economy as focus, the government has launched a series of educational and publicity activities in order to root the idea of a recycling economy deeply in the people's minds and create a sound social atmosphere.

China will further enhance education and training in order to better deal with climate change. Knowledge about climate change will be included in basic education, higher education and adult education, with the focus being place on fostering among youngsters the awareness of climate change and a sense of participation in relevant activities. It will conduct training courses and seminars on climate change for government agencies, enterprises, consultation institutes, scientific research staff and communities, so as to improve their understanding of the importance and urgency in dealing with climate change, and encourage them to undertake their social responsibilities in an active manner.

【Case Study】

Case #1

On February 20, 2009, Waterworks in Yancheng City of Jiangsu Province, the raw water was polluted by phenolic compounds, which resulted in choking off supply of water in a large area of urban and affecting the production and living of 20 million people.

After pollution, Yancheng city party committee and government launched the emergency pre-proposal, opened the back-up water and began to investigate sources of pollution. Earlier in the day, the EPA in Yancheng preliminarily identified the cause was that a chemical plant which located in the upper reaches of water sources discharged sewage.

The same day, the members of the National General Headquarters, Ministry of Water Resources, Ministry of environmental protection and other departments were sent to Yancheng to investigate the matter.

The sanitation monitoring Department of Yancheng very quickly found that the contaminant of raw water of drinking water was phenolic compounds.

After the situation simmered down, we come to observe this matters, it can be said that there are consolations and unease. The gratifying things are that the local government in Yancheng rapidly launches the emergency mechanism. At the time of the suspension of water supplies, the whole city can orderly operated and there is no trader to bid up the prices in some relevant things. Besides, the communication between the government and media is more open, so they don't deliberately hide the relevant information. Compared with plenty of much larger public events, there are

many worthy of recognition respects on the health emergency incidents handling of Yancheng Government.

The things of unease are that the wrecker concerned this water pollution is not a first offender in pollution of water resource aspect. The chemical plant had been reported and fined because of discharging sewage. However, this is a business, after suffered punishment, it still ignore the relevant laws and regulations. On the one hand, it reflects that the business leaders lack the legal awareness and social responsibility. But, on the other hand, it also reflects that the local environmental protection department and other agencies' work is still relatively crude, and don't further strictly require the regulated organizations.

The even more worrying is that the Yancheng' governance for environmental pollution——action can not keep up with cognition. According to a Xinhua journalist reported that there are relatively dense small chemical plants near the water source of the Water Works in the West of Yancheng, which obviously is the root cause of water pollution. Even if there are some historical reasons for setting up these chemical plants, the heavier pollution-intensive enterprises round the water sources, in the event of accidents, millions of households certainly will be affected. It is said that local government has already planned to transfer these chemical enterprises, but has not been put into action, resulting in the pollution case.

Analysis

First of all, the environment and health problems related to many fields, multi-sector. To strengthen collaboration on the basis of definitude the duty of the department, it will be of great significance in properly resolving the environment and health problems.

Secondly, to improve and enhance the assessment and pre-warning of environment and health risk, to improve the capacity of the multi-sectoral coordination and emergency handing, it will be of great significance in emergency handing.

Thirdly, the enterprises as an important main body of China's market economy, their social responsibility is related to scientific development, social harmony. It is of great significance for the overall coordination and sustainable development of economy and society, and the achievement of the environmental and health protection goals.

In addition, the cooperation and supervision of the public also plays an important role in social harmony and stability, sustainable development.

Case #2

In July 2007, a health test results of a city's public places for some large-scale central air-conditioning ventilation system shows that: the amount of dust accumulation duct only 18.26 percent pass rate, the highest dust duct value of 530g/m² (standard value of ≤ 20 g/m²), more than 26.5 times the standard value; the total number of bacteria in the air passing rates of 21.48 percent, the total number of bacteria supply the highest

value of 6389cfu/m³ (standard value of ≤ 500 cfu/m³), more than the standard value of 11.5 times; the total number of fungi in air-conditioned air supply for the 37.65% pass rate, the total number of fungi in the air the highest value of 1922 cfu/m³ (standard value of ≤ 500 cfu/m³), more than 3.84 times the standard value.

City in July to October of 2006, the results of monitoring some large public places, central air conditioning ventilation system health indicated that: the total number of bacteria in air for the 33.33% pass rate, the total number of fungi in air for the 60.00% pass rate, cooling water Legionella qualified rate of 33.33%. In 2007 between July to November, the results of monitoring public places for some large-scale central air-conditioning ventilation system health indicated that: the total number of bacteria in air to 21.21 percent passing rate, the total number of fungi in air to 48.48 percent passing rate, cooling water Legionella qualified rate of 42.42%.

Analysis

While already have promulgation of "Three One Act regulations" to central air conditioning, but survey data indicate that the present system of central air conditioning standards hygiene remains low, but also faced a larger problem on the management all over the city, The reason of current management of central air conditioning is that the norms are not mandatory implementation, so enforcement on place existing a larger problem. And current efforts on publicity are not enough, which lead to a negative attitude on the central air conditioning of a variety of maintenance and maintenance work. Therefore, we should step up publicity and improve the current two-pronged management approach to change the current status of pollution in central air conditioning.

【Exercises】

In 2007, "National environment and health action plan," the introduction of clear responsibilities of relevant departments to strengthen the collaboration between the Department, but the current work, the department of communication between the question must still exist, the enthusiasm to participate in the department also uneven, how to further effectively improve the efficiency of the department in collaboration, please talk about your views.

【Recommended Readings】

National Plan of Action on Environment and Health (2007-2015)

The first "Chinese Environment and Health Awareness Week" kick-off ceremony

<http://www.landlist.cn/2008-10-15/2150898.htm>

The development of Chinese non-governmental organizations (Associations)

<http://www.ngocn.org/?action-viewnews-itemid-108>

Enterprises should be in accordance with the law society to assume responsibility for the protection of the environment

http://www.cepf.org.cn/hjzr/zrgx/200701/t20070122_100032.htm

The context of corporate social responsibility fund

http://www.crcf.org.cn/sys/html/lm_128/2007-10-26/142511.htm

Henk-Bekedam: corporate social responsibility contributes to achieve a harmonious society

<http://finance.sina.com.cn/hy/20070126/16173286737.shtml>

Second China International Forum on Corporate Social Responsibility opening - Chinese and foreign officials discussing corporate social responsibility

http://www.crcf.org.cn/sys/html/lm_1/2007-08-23/160818.htm

Chinese Government attaches great importance to encourage enterprises to fulfill their social responsibilities

<http://chinawto.mofcom.gov.cn/aarticle/by/bz/200805/20080505564522.html>

"National Climate Change Programme "

"Policies and Actions to Adapt to Climate Change"

The status quo of China's industrial development and environmental protection countermeasures and suggestions

<http://www.goepe.com.cn/js/detail.php?id=876>

The environment and health work,
2005 http://www.mep.gov.cn/tech/hjjk/200607/t20060726_91372.htm

"China's Environmental Status" ,2007

<http://www.zhb.gov.cn/plan/index.htm>

Ma Xiaowei, attended to celebrate World Health Day and the China / WHO Project on Climate Change and Health started

<http://61.49.18.102/newshtml/21524.htm>

Chen Zhu: To explore the impact of climate change on the health effects of residents interventions

http://cn.chinagate.cn/health/2008-04/08/content_14513861.htm

MODULE 3

Strategic Planning and Management for Climate Change & Health: Adaptation Plans

Each of the following Icons is used throughout the module to indicate a specific activity:



The Link Icon – indicates the availability of all power points that support this training manual module accessed by clicking on the link provided



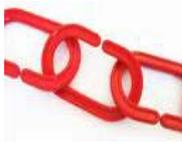
The Power Point Icon – indicates the relevant power point used for training purposes



The Exercise Icon - indicates that you participate in a group exercise.



The Literature Icon – request you to refer to a specified reading



The Link Icon – provides access to supporting materials.

Strategic Planning and Management for Climate Change and Health



All Power Points used to support this training manual are available by clicking this link.



Power Points Slides 1 & 2

Learning Objective	Outcome
To provide introduce strategic frameworks necessary to address the impacts of climate change on health	An understanding the strategic context for the development of adaptation and mitigation policies and programs.
To provide an understanding of the criteria to use to assess a population's vulnerability to on-going climatic exposure	An understanding and application of assessment criteria for vulnerable populations in the context of climate change impacts to human
To introduce basic knowledge on the implementation of adaptation planning approaches	An understanding of adaptation planning approaches/actions for vulnerable populations at National and Provincial levels

Strategic Management and Planning for Climate Change and Health



Power Point Slide 3

Introduction

The Intergovernmental Panel on Climate Change 2007 Report (IPCC 2007) has indicated that, after global assessments of observable climate changes, anthropogenic activity is impacting upon physical and biological systems. As a result, regional climate changes with subsequent impacts for human health are becoming more evident.

Climate Change poses a direct threat to achieving all of the MDGs.



Power Point Slide 4



Exercise 1 – For each of the following MDG Goals identify potential impacts of climate change;

MDG	Potential Impacts of Climate Change
<p>Goal 1 Eradicate extreme poverty and hunger</p>	
<p>Goal 2 Achieve universal primary education</p>	
<p>Goal 3 Promote gender equality and empower women</p>	
<p>Goal 4 Reduce child mortality</p>	
<p>Goal 5 Improve Maternal Health</p>	
<p>Goal 6 Combat HIV/Aids, Malaria and other diseases</p>	

<p>Goal 7</p> <p>Ensure environmental sustainability</p>	
<p>Goal 8</p> <p>Develop global partnership for development</p>	



Exercise – Typical Answer Sheet

Present and future health impacts of climate change on populations are projected by the IPCC Report 2007 in terms of -

- a population’s vulnerability to on-going climatic exposure, and
- the capacity of governing bodies to plan **adaptive**, as well as **mitigating** measures.

Observable impacts upon natural and human environments indicate a need for governments to assess regional and local **adaptation responses**. The IPCC 2007 Health Report (Confalonieri et al., 2007) states that economic development and growth alone will not ensure adequate protection for populations against climate change related disease and injury.

Rather, the manner in which the benefits of economic growth are distributed across the areas of –

- education,
- health care and
- public-health infrastructure

will critically impact the future health of populations.

Projected climatic impacts indicated by the IPCC 2007 Health Report (Confalonieri et al., 2007) suggest an emerging trend of on-going risks to human populations. These risks are projected to be important in the areas of -

- malnutrition and disease, as well as
- injury related deaths.

The IPCC 2007 Health Report cites that current impacts upon human populations through changing weather patterns will continue to be seen as a result of –

- temperature changes,
- greater levels of precipitation,
- sea-level rise, and
- increased frequency of catastrophic events.



Power Point Slides 5 & 6

A National Strategic Response (adapted from WHO 2008)

Participants of the regional workshop on climate change and human health, held in Bali, Indonesia from 10 to 12 December 2007, jointly developed a regional framework to guide regional and national action towards reducing the potential burden of disease linked to the effects of global warming and climate change.



The WHY?

There is a growing, but still limited, political commitment to integrate health considerations into efforts to mitigate and adapt to climate change at national and international levels in the Region. Also, there is also insufficient awareness among the general public about climate change and its impact on health.

The availability of relevant hydro-meteorological, socioeconomic and health data is limited and available data are often inconsistent and seldom shared in an open and transparent manner. Furthermore, there is insufficient capacity for assessment, research and communication on climate-sensitive health risks in many countries, as well as insufficient capacity to design and implement mitigation and adaptation programmes. There is an urgent need to incorporate health concerns into the decisions and actions of other sectors while they plan to mitigate and adapt to climate change, to ensure that these decisions and actions also enhance health. By promoting the use of non-motorized transport systems (e.g. bicycles) and fewer private vehicles, greenhouse gas emissions would be reduced, air quality would improve and more people would be physically active. Such an approach would produce associated benefits (i.e. reduce the burden of disease while lowering greenhouse gas emissions) and needs to be promoted.



Power Point Slide 7

RECOMMENDED ACTIONS

Objective 1: To increase awareness of health consequences of climate change

Governments, through relevant agencies, should:

1. Undertake studies on the health implications of climate change and share information to understand how to promote changes in individual and corporate behaviours that mitigate climate-related health risks, while protecting and promoting health.
2. Enhance political commitment and strengthen institutional capacity and arrangements to achieve adaptation and mitigation goals.
3. Facilitate national working groups, nongovernmental organizations and civil society to develop coordinated mitigation and adaptation plans by including relevant sectors, regions and disciplines.
4. Develop awareness-raising programmes and learning resource materials to educate and engage a broad range of stakeholders, including local communities, health and other relevant professionals, and the media on the potential health impacts of climate variability and change and on appropriate measures to reduce climate-sensitive risk factors and adverse health outcomes.



Power Point Slide 8

Objective 2: To strengthen health systems capacity to provide protection from climate-related risks, and substantially reduce health system's GHG emissions

Governments, through relevant agencies, should:

1. Develop and implement national action plans for health that are integrated into existing national plans on adaptation and mitigation to climate change.
2. Develop integrated strategies to incorporate current and projected climate change risks into existing health policies, plans and programmes to control climate-sensitive health outcomes, including integrated vector management, and health risk management of disasters.
3. Strengthen existing infrastructure and interventions, including human resource capacity, particularly surveillance, monitoring and response systems and risk communication, to reduce the burden of climate-sensitive health outcomes. Key concerns vary by country; common concerns include vector borne diseases, air quality and food and water security.
4. Strengthen public health systems and disaster/emergency preparedness and response activities, including psychosocial support, through increased collaboration and cooperation across sectors. This should include documentation, sharing and evaluation of the effectiveness of local knowledge and practices.
5. Provide early warning systems to support prompt and effective responses to

current and projected health burdens. In order to achieve this, national and regional climate forecasting information, including climate change projections, should be fully utilized.

6. Implement adaptations over the short, medium or long term; be specific to local health determinants and outcomes of concern; and facilitate the development of community-based resource management. The costs and benefits of different interventions should be determined.

7. Establish climate change focal points or mechanisms within national health institutions to ensure the implementation, monitoring and evaluation of health mitigation and adaptation actions and ensure that health issues are adequately addressed in these actions.

8. Establish programmes through which the health sector substantially reduces GHG emissions; by doing so, it could also serve as a best practice model for other sectors.



Power Point Slide 9

Objective 3: To ensure that health concerns are addressed in decisions to reduce risks from climate change in other key sectors.

Governments, through relevant agencies, should:

1. Develop integrated strategies to incorporate current and projected climate change risks into existing policies, legislation, strategies and measures of key development sectors to control climate-sensitive health outcomes. Examples include the promotion of public and non-motorized transportation, clean energy and disaster risk management.

2. Facilitate the health sector to actively participate in national communications to the United Framework Convention on Climate Change (UNFCCC), and include health issues as the core elements in the negotiation process.

3. Ensure active health participation in the national climate change team.



Power Point Slides 10& 11

Mitigation and Adaptation Planning

In addition to the need to improve China's environmental health system as to a means to respond to the impact of development in general and the compounding effects of climate change (module 8) is the need to specifically address climate change impacts via development of both mitigation and adaptation plans.

In mitigation plans it is often referred to as 'avoiding the unmanageable' – referring to

the long term impacts of continued emissions of greenhouse emissions and associated increases in temperatures to a point where if left uncontrolled there are catastrophic consequences health and well- being. In response China like all others are seeking ways to reduce greenhouse gas emission levels through a wide variety of measures. It is critical that the Health sector demonstrates a commitment to actively participate in the mitigation of greenhouse emissions by reducing its own carbon footprint and becoming an advocate for intersectoral policies which not only do the same but also have co-benefits for public health. There are many opportunities to reduce energy consumption or change energy sources which can produce significant health benefits.



Power Point Slides 12 & 13

Exercise 2 – In small groups discuss possible strategies where co- benefits for public health can be achieved through reduction of greenhouse emission both within the health sector and across sectors.



Power Point Slides 14 & 15

Adaptation planning is often referred to as ‘Managing the Unavoidable’ Here the science of climate change indicates that even if all greenhouse emissions were reduced to zero tomorrow, we are still going to feel the impacts of existing increases over the next 20-30 years. Hence we need to develop measures to adapt.

“The best way to address climate-change impacts is by integrating adaptation measures into mainstream sustainable development and poverty-reduction strategies.” SEG, Confronting Climate Change 2007, p 82

This leads the UNFCC and many others to agree that a most effective adaptation measure is to improve environmental risk management, reduce the pressures on natural resources and increase the social well-being of the community particularly the poor.



Power Point Slides 16 & 17

China’s Climate Change Action Plan has incorporated two interlinked strategic approaches to address climate change. In relation to health these include;

- Strengthening public-health and environmental management systems against all climate-linked changes – discussed in module 8 and often referred to as improving the overall ‘**adaptive capacity**’ and includes improvements to the following: governance and institutions, human resources, information and skills and , infrastructure technology and economic resources.

- Identifying key strategic specific issues commonly at both the national and local levels in the form of an **Adaptation Plan**

Adaptation Planning will now be the focus of the remainder of this module.

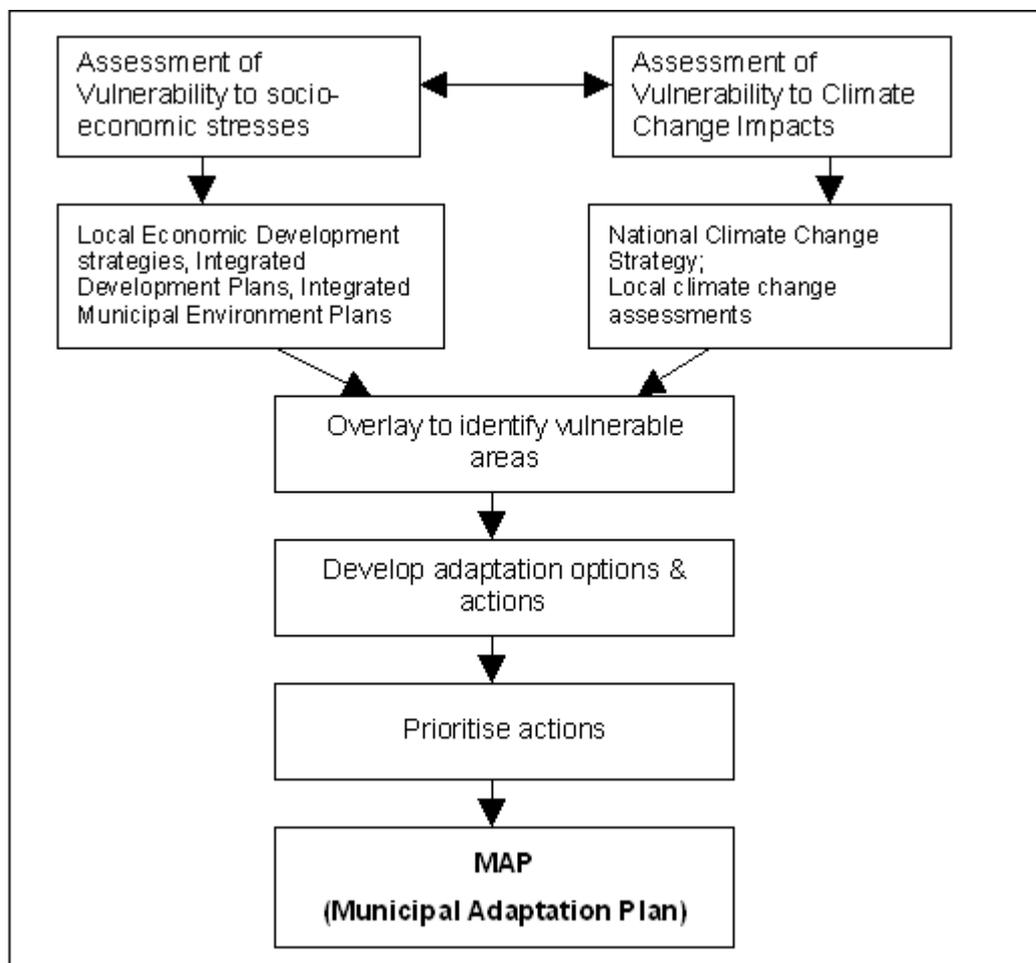
What might an adaptation plan look like?

Within many sectors at both national and local level, the design and implementation of many adaptation plans are largely still in early planning or draft phases.



Power Point Slide 18

The various stages of development may look like something like this for a local (Municipal) Adaptation plan: (see following diagram)



This example illustrates the various stages of development that need to take place prior to implementing an adaptation plan. The development stages incorporate the key steps to building an local adaptation plan. The vulnerability assessment stage may include looking at a population’s vulnerability in terms of the projected socio-economic and health effects of climate change impacts. These are looked at in the context of the national, regional and/or local government policies already in place.

The assessment stage includes a process of consultation with each of the various stakeholders. Stakeholder knowledge and experience are important contributions to the vulnerability assessment stage. It is through this process that the areas of vulnerability are ultimately identified and assessed. Adaptation actions are then determined in response or in anticipation of the risks identified. Ultimately an adaptation plan detailing each of the stages, along with the actions to be implemented, is drawn up.

Experiences In Australia



Power Point Slides 19 & 20

The National Climate Change Adaptation Framework in Australia uses adaptation planning in dealing with unavoidable impacts of climate change. This framework was initiated by the Council of Australia Governments in 2006, and is offered as a guide for decision-makers across a range of jurisdictions within Australia for a five to seven year period.

The major focus of the Australian framework is to -

- assist decision-makers in understanding the risks of climate change impacts and
- support the incorporation of adaptive measures into policy across all vulnerable sectors.

As such, this framework essentially aims to:

1. provide a supportive structure for decision-makers with practical tools to assist in managing the risks associated with climate change impacts;
2. provide centralised information on climate change impacts along with vulnerability and adaptation options;
3. provide climate change projections and scenarios at regional level;
4. generate knowledge to understand risks to water resources and human health;
5. work with stakeholders in key sectors to develop strategies; and
6. assess possible adaptation for vulnerable regions across Australia, (such as the Murray-Darling Basin, and drying regions of eastern Australia).

Areas of action for adaptation planning relating to human health within Australia identified by the Australian framework are -

- 1) research on climate change impacts on physical and mental health, and identify key vulnerabilities,

- 2) identifying the capacity of the public health system, emergency services and health disaster management policies to plan and respond to vulnerabilities,
- 3) incorporate potential climate change health risks into community and public health education programs,
- 4) develop and implement heat wave warning and response systems,
- 5) an increased focus on research on climate change and health by National Health and Medical Research Council.

However, in Australia, these strategies have yet to be fully implemented, although recognition of already existing public health interventions, such as mosquito control and vaccination programs, as well as weather alert systems, are seen as a starting point for adaptive strategies.

Top – Down and Bottom Up Approaches

Adaptation plans within a range of sectors may look different to other plans. This may be due to factors such as incorporating features that target vulnerabilities specific to the identified population and/or region. You will see some examples of how these differences are incorporated into adaptation plans throughout this module.

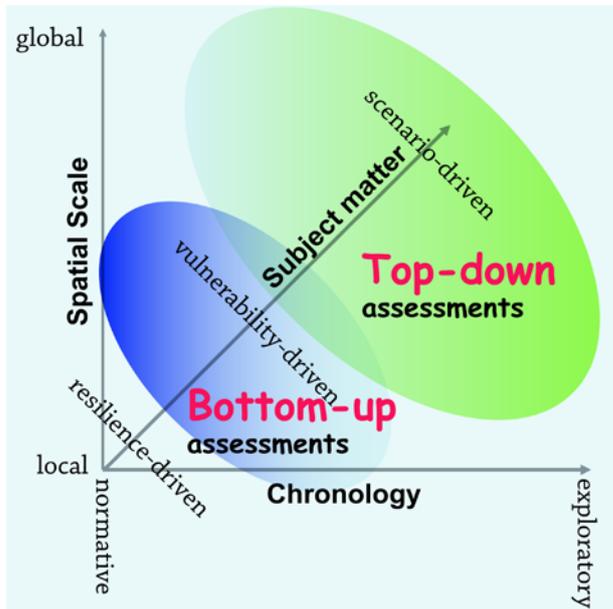
Useful methodologies include top – down and bottom up approaches – both are meant to be linked to provide an integrated approach to assessment of climate change impacts. The strength of so called ‘top- down’ methods which include use of modelling and scenarios is their use in highlighting the bio-physical impacts of climate change however these models have been shown to be weaker in highlighting human interactions or are found by some to be more complicated and time consuming.

The ‘bottom –up’ strategies build on local coping mechanisms including indigenous knowledge and technologies and the capacity and coping mechanisms of local institutions. This type of strategy is better at incorporating human and economic dimensions particularly livelihood and intersectoral relationships but weak on incorporating impacts of future climate change.



Power Point Slides 21- 24

(Xianfu Lu 2006)



Power Point Slides 25 & 26

Examples of Adaptation Planning Frameworks

An example of a framework for adaptation planning is given by the United Nations Development Programme. The major focus for its Adaptation Policy Framework centres around four major principles.

These include:

- 1) an adaptation to short-term climate variability and extreme events that provide a basis for reducing vulnerability to on-going and longer term climate changes.
- 2) recognition that adaptation occurs at different levels within society.
- 3) adaptation policies and measures should be assessed in a developmental context
- 4) equal importance given to utilising both an adaptation strategy and a stakeholder process to implement adaptation planning.



Power Point Slides 27-32

The five stages of the United Nations Development Programme's Adaptation Planning Framework are tabled with the following objectives:

1. Scoping & Designing an Adaptation Project

Objective: Ensuring that a policy, plan or project at any scale or scope is well-integrated into national policy planning and development processes. The purpose is to put in place an effective plan so that adaptation strategies, policies, and measures can be implemented effectively.

2. Assessing Current Vulnerability of Development Objectives to Climate

Objective: Establishing the baseline. Where does the system stand today with respect to vulnerability to climate risks? What are the factors that determine current vulnerability? How successful are efforts to adapt to current climate risks? Current methods for coping with climate risks should be built upon in the policy, plan or project, and existing factors of vulnerability addressed.

3. Assessing Future Climate Change Risks to the Development Objective

Objective: Focusing on the analysis of scenarios of future climate, vulnerability and socio-economic and environmental trends as the basis for understanding future climate risks. The policy, plan or project design should consider both current as well as future risks and vulnerability.

4. Formulating an Adaptation Strategy

Objective: In response to current and future vulnerability and risks, policy options and measures should be identified and selected, and from the options, a cohesive, integrated policy, plan or project strategy developed.

5. Continuing the Adaptation Process through Monitoring and Evaluation

Objective: Involves implementing, monitoring, evaluating, improving and sustaining initiatives launched by the adaptation policy, plan or project.



Power Point Slide 33

Issues and international experiences in developing an adaptation plan are explored in an introductory manner detail in the following processes and issues;

1. Conducting a Vulnerability Assessment
2. Consulting with Stakeholders
3. Building an Enabling Capacity
4. Barriers to Adaptation Planning

1. Conducting a Vulnerability Assessment



Power Point Slide 34

Vulnerability assessment differs from traditional approaches of impact assessments
Impact assessment selects a particular environmental stress of concern (e.g. climate Change) and seeks to identify its most important consequences for a variety of social or ecosystem properties.

Vulnerability assessment in contrast selects a particular group or unit of concern (e.g. landless farmers, tropical forest ecosystems, coastal communities, development sectors) and seeks to determine the risk of specific adverse outcomes for that unit in the face of a variety of stresses. Vulnerability in this context is a function of exposure and sensitivity. A good introduction to development of your own vulnerability assessment can be sourced at another training support resource: <http://cses.washington.edu/db/pdf/snoveretalgb574ch8.pdf> . or This provides a detailed set of questions aimed to guide you through the assessment process and is summarised here.



More in depth training material can be accessed on this disc- Click Link Icon



Power Point Slides 35 & 36

Vulnerability to climate change is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

Vulnerability is a function of:

- o The character, magnitude, and rate of climate variation to which a system is *exposed*;
- o Its *Sensitivity*; and
- o Its *adaptive capacity*

$$Vulnerability = f(\text{exposure}, \text{sensitivity}, \text{adaptive capacity})$$

These terms bear some clarification:

Exposure – refers to the extent a system comes into contact with climatic conditions – often the higher the exposure the higher the sensitivity

Sensitivity- relates to the degree to which systems are affected by changes

brought about by climate change. A typical ‘sensitivity analysis’ will ask questions such as ;

- Is the system subject to existing stress?
- Will Climate Change cause the demand for a resource to exceed its supply?
- Does the system have limiting factors that may be affected by climate change?
- What is the ‘impact threshold’ associated with the system?

Adaptive capacity describes the ability of built, natural and human systems to accommodate changes with minimum impact. Key questions to ask here;

- Are the systems able to accommodate change in climate?
- What barriers are there to a systems ability to accommodate changes?



The article by Downing and Patwarhan provides a very useful in-depth discussion on the concept of vulnerability <http://www.undp.org/gef/05/documents/publications/apf-technical-paper03.pdf>

They emphasis the varying definitions of ‘vulnerability’ and emphasis the use of the term in poverty and development literature with its focus on social, economic and political considerations where vulnerability relates to social units (people) or systems rather than bio-physical systems alone and implies that vulnerability integrates across a range of stressors and a range of human capacities. For example local communities already under economic stress will have a low level of adaptive capacity and high sensitivity to climate change.



Power Point Slide 37



To explore the vulnerabilities to climate change and response options 24 Regional assessments were undertaken as part of the international project Assessments of Impacts and Adaption’s to Climate Change (AIACC) - the full report of which excerpts are used here can be found at: www.aiaccproject.org .



The report emphasised the following;

“Vulnerability studies take a different approach from investigations of climate

change impacts, which generally emphasis quantitative modelling to simulate the impacts of selected climate change scenarios on Earth systems and people. In contrast , vulnerability studies focus on the processes that shape the consequences of climate variations and change to identify the conditions that amplify or dampen vulnerability to adverse outcomes. The climate drivers are treated as important in vulnerability studies, but drivers related to demographic, social, and economic and governance processes are given equal attention. Consequently, existing vulnerabilities to current climate variations and extremes are examined for the insights they can provide regarding vulnerability to future climate change. A motivation for this approach is that it can help to highlight where interventions might reduce vulnerability most effectively.” p3

The protocol adopted for the AIACC study was to develop ‘domains’ of climate change vulnerability that corresponded to systems that are important to human well-being - these were ; **natural resources , coastal areas/small islands, rural economy and food security and human health.**

The second phase in the project was to rank the outcomes of concern for each domain using High/ Medium and Low levels based on the 1) potential to exceed coping capacities of affected systems, 2) the geographic extent of damages, 3) the severity of damages and 4) the persistence or reversibility of the impacts.

Finally step 3 of the protocol the climatic and non climatic factors that create conditions of vulnerability to the outcomes of concern within each domain – in cases where the climatic and non-climatic drivers combine to strongly amplify vulnerability the potential for high level concerns being realised is greatest.

The following table is adapted from this study and illustrates for water resource vulnerability how the use of the process and outcomes for some of the cases studied



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Water Resource Vulnerabilities from AIACC Case Studies

Level of Concern	Outcomes of Concern	Climate Drivers	Other Drivers	Case Study (extract)
	Water Scarcity that threatens food security	-Regional decrease in rainfall and more variable rainfall -More frequent severe drought	-High and growing water demand - High dependence on subsidence or small scale rain fed crop farming	-North Dafur -Sudan -Mongoloa -Mexico etc

High			<ul style="list-style-type: none"> - Land degradation -High Poverty rate -Insufficient investment in rural development -Lack of social safety nets - Governance Failures 	
Medium	<ul style="list-style-type: none"> -Losses from reallocations of water - Non-violent conflict among competing water users 	<ul style="list-style-type: none"> Regional decrease in rainfall and more variable rainfall -More frequent severe drought -Changes in timing of runoff and water availability 	<ul style="list-style-type: none"> -High and growing water demand - Extensive land use changes - Pollution from industrial, agriculture and domestic - Poor performance of water institutions 	<ul style="list-style-type: none"> -Western China -Philippines -South Africa etc
Medium	<ul style="list-style-type: none"> More frequent flood events that increase loss of life and damage to infrastructure , loss of crops 	<ul style="list-style-type: none"> Increase in heavy rainfalls 	<ul style="list-style-type: none"> -Growth in populations in flood prone land -Poorly managed land use change including clearing and filling of wetlands Ineffective disaster prevention and warning systems 	<ul style="list-style-type: none"> -Argentina -Thailand -Philippines etc
Low	<ul style="list-style-type: none"> Losses to water users from localised temporary water 	<ul style="list-style-type: none"> Seasonal Droughts 	<ul style="list-style-type: none"> Effective management , planning and policies for water 	<ul style="list-style-type: none"> -Philippines -Western China

	fluctuations		demand	etc
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China Case Study Exercise (extract from Yin 2006)



Access here the Full Heine River Basin Analysis Report



Power Point Slide 39

The Heihe River Basin

The Heihe River Basin is located in a region with the latitude of 35.4–43.5°N and the longitude of 96.45– 102.8°E. Figure 2 is a map of the study region. The study area is the second largest inland river basin in the arid region of north western China. The basin includes parts of two provinces (Qinghai and Gansu) and Inner Mongolia Autonomous Region. With an area of 128,000 square kilometers, the basin accommodates about 1.8 populations living in 11 counties, three small size cities, and five prefectures. The region is composed of diverse ecosystems including mountain, oasis, forest, grassland, and desert .Heihe River flows from a headwater on Qilian Mountain area to an alluvial plain with oasis agriculture ,and then enters deserts in Inner Mongolia, representing the upper, middle, and lower reaches of the basin, respectively. The total distance of the Heihe River is 821 kilometres.



Heihe River Basin has a typical arid and semi-arid continental climate, characterized by low and irregular rainfall, high evaporation and eminent drought periods. The basin can be divided into three typical climate zones following the altitudinal gradient. In the southern slope of the Qilian Mountain, the climate is wet and cold with a mean annual precipitation ranging from 300-500 mm. In the middle reach, the climate becomes much dryer and the mean annual precipitation is only 100-200 mm. In the lower reach, the average annual precipitation is less than 60 mm, which is one of the driest areas at the same latitude on Earth (Digital Heihe River Basin URL: http://heihe.westgis.ac.cn/heihe_en/hhHeiHeiAll.htm).

Great temporal variations in temperature and precipitation also exist over the Heihe River Basin with mean annual rainfall ranging from 30 to 860 mm between winter and summer. About 50-70% precipitation is recorded during the summer. Mean daily temperature ranges from -14°C to 3°C in January and from 11°C to 27°C in July (Gansu Meteorological Bureau, 2000).

Heihe River Basin is a poor region in China with harsh environment and fragile ecological systems. The region is critically short of water and arable land, deficient in educated, technical and scientific personnel, and far from even domestic markets. The major economic sector in the region is agriculture, and irrigation is crucial for crop production. The leading crops are wheat, potatoes, and corn. The oasis agriculture relies on irrigation by the Heihe River and its tributaries. While the Basin has fostered the development of much oasis agriculture in the middle reach, rangeland farming in the upper reach and herdsman in the lower reach, towns, small hydropower plants, a large number of rural communities, and government agencies, climate stresses have imposed considerable economic, social, and environmental impacts.

With a resource based economy, the study region is very sensitive to climate. People in the basin are facing substantial and multiple stresses, including rapidly growing demands for food and water, large populations at risk to poverty, degradation of land and water quality, and other issues that may be amplified by climate change.

Drought is one of the main climate disasters in the basin, with characteristics of high frequency and significant damage. For example, droughts occurred in the middle reach about 50% of the time since 1951. During drought years, while the precipitation volume of May and June is remarkably lower than the mean, the annual evaporation remains from 2,000 to 2,650 mm (Chen and Qu, 1992). Under climate change conditions, periods of drought are likely to become more frequent and severe, and water shortages may increase water use conflicts. Land degradation problems and limited water supplies restrict present agricultural production and threaten the food security of the region. Climate change may cause negative impacts on food and fibre production in the region (Shi, 1995). In addition, decreases in water availability and food production would lead to indirect impacts on human health. Kang et al.(1999) suggested that spring out flow at the mountain outlet would be increased while summer flow would be declined in 2030 under climate change scenarios. Irrigation demand in the summer accounts for more than 70% of the total agricultural water consumption in the region.

This seasonal shift of water supply will affect agricultural production considerably.

There is already some evidence of changes in the trend of the past 50-year observed temperature, with a more significant rise in Qilian Mountain area. During this period, annual average temperature has increased more than 1°C in Sunan County and 0.9°C in upper mountain areas. The Qilian Mountain glaciers have already been undergoing a rapid retreat with a rate of about one meter annually. The region depends on the glaciers as important natural reservoirs for water supply. The water supply mainly comes from the spring melting of glaciers (Cheng, 1997). Water supply declining has already affected land resources with large areas of farmland undergoing desertification (Gansu Meteorological Bureau, 2000; Digital Heihe River Basin URL).

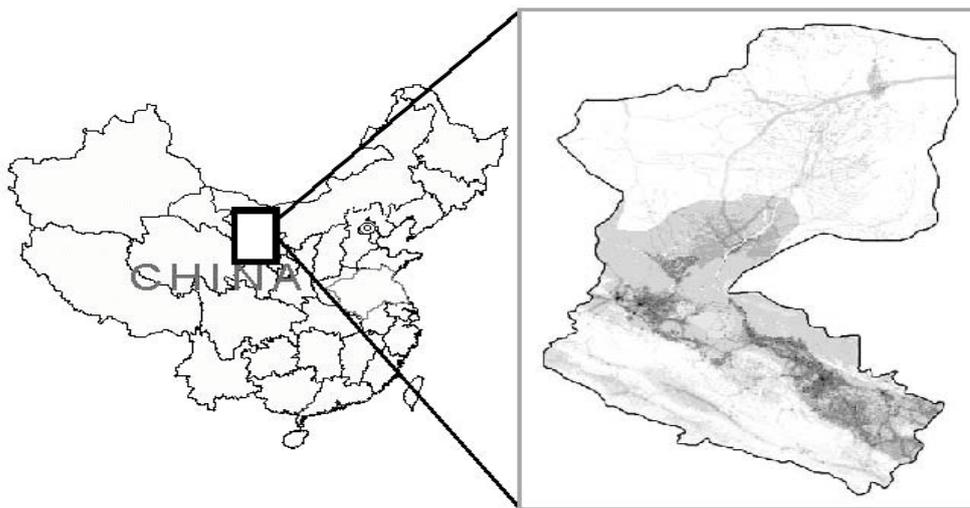


Fig. 1.2: Map of the Heihe River Basin with approximate population distribution shown in shades of grey (black is higher population density)

Now using the AIACC approach described above in five groups construct vulnerability tables for 1) Water 2) Land 3) Ecosystem and Biodiversity 4) Rural Economy and 5) Health Vulnerabilities indicating your assessment of **High/ Medium or Low Impact**

2. Consulting with key stakeholders



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Stakeholders are any individual, group or organisation who may have an interest in achieving a successful adaptation outcome for their community/region. Stakeholder groups and/or individuals can be a valuable resource for access to collective knowledge and experience. They may include customers or clients, individuals or groups living in an identified region or neighbouring regions, visitors to the region, suppliers and service providers, regulatory agencies and authorities, and political or special interest groups who share a common interest. It is important to identify the main or key stakeholder groups for your particular region or population.



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Stakeholder Identification Exercises

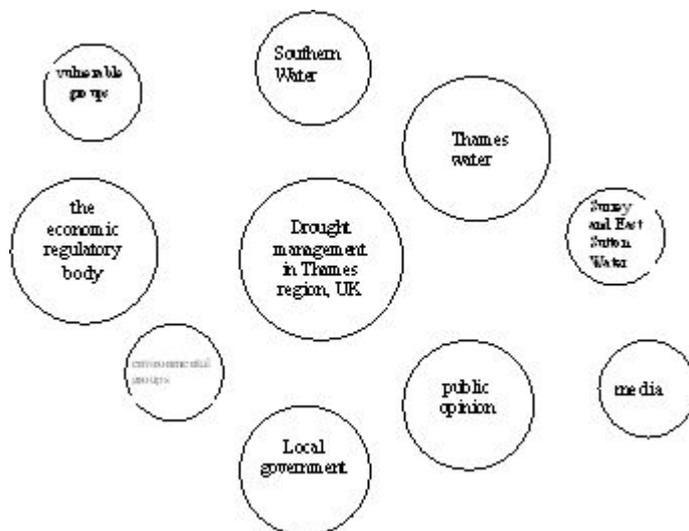
excerpt from:

[http://wikiadapt.org/index.php?title=Stakeholder analysis and engagement#Who is a stakeholder.3F An introduction to stakeholder analysis.](http://wikiadapt.org/index.php?title=Stakeholder%20analysis%20and%20engagement#Who%20is%20a%20stakeholder.3F%20An%20introduction%20to%20stakeholder%20analysis)

Chapati/ Institutional Diagramming

The aim of this exercise is to enable you to identify the institutions and individuals that have a legitimate stake in the outcome of a decision or project. The term ‘chapati’ comes from the use of differently sized round circles which indicate the importance of each organisation to the community. The relative position of each circle to the central circle (the issue) indicates their accessibility. A variation on the diagram includes drawing straight lines between organisations where the relationship is good and dotted lines where the relationship is difficult.

Creating the diagram is only the first step. The discussion (including where there is disagreement in the group) resulting from the diagram should reveal much more.



Links between the stakeholders could also be made to give more information about how strong or clear ties are e.g. a thick line (strong ties), a thin line (weaker ties) a dotted line (risk of sabotage) etc.

Box Diagram

This uses a simple matrix to help you to group stakeholders according to their

importance with respect to the issue and their ability to influence and coerce the other stakeholders. e.g.

		Importance	
		High	Low
Influence	High	Most important stakeholders - the process will fail without them	Important stakeholders – try to engage them
	Low	Important stakeholders – try to engage them	Stakeholders with a negligible effect on the process – can be ignored

How do you involve stakeholders?

Ravetz, (1997) states ‘policies for managing sustainability will be effective only if they have the moral support of the great mass of people’. This suggests that participatory processes should be used as a way to democratise science and empower citizens. Others see it more as a way to inform policy making and as advising in decision-making processes. van Asselt et al, (2001) describe four possible goals of participatory processes:

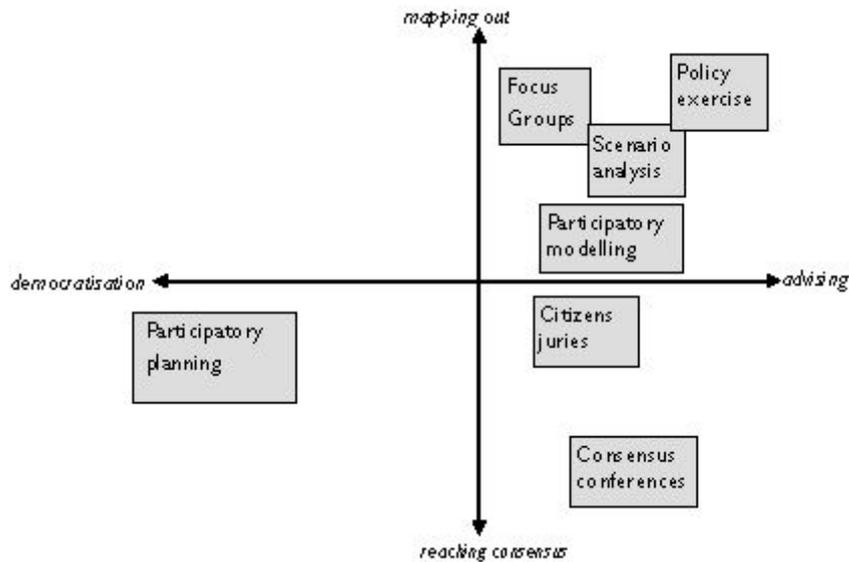
Mapping out diversity – ways to discover the diversity of opinion on a subject or test reactions to a strategy in a contained environment

Reaching consensus – methods that seek to define one option or decision

Democratisation – methods that enable participants to use their own knowledge and experience to create options for tackling (policy) issues that directly concern them.

Advising – methods which are used to reveal stakeholder’s knowledge, values and ideas that are relevant to the process of decision-making

The figure below gives a categorisation of participatory methods (van Asselt et al (2001)). This focuses on participation imposed by scientists. The upper left quadrant is empty as these techniques are more associated with participatory processes organised by stakeholders themselves. The position of the techniques as the goals may be defined differently by different users.



Stakeholders each have different information and perceptions of an issue. In looking at the impact of climate change in an area and how people might adapt local people have valuable knowledge about the locality, the history, who are the most vulnerable and how they have coped in the past. Scientific knowledge is needed e.g. in the case of arsenic contamination in Bangladesh. Scientific techniques were required to identify the problems and a knowledge of the geology of the land but it was human factors that made the problem. Understanding these human factors, and lay people's perceptions of the problem, will lead to the solution.

Useful

reading http://www.aiaccproject.org/meetings/Trieste_02/trieste_cd/Stakeholders/tp2_draft_7oct.doc



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Glicken, identifies 3 types of information:

Cognitive: based on technical expertise, presented by scientists in factual arguments about issues such as the extent of damage, methodologies

Experiential: based on personal experience and common sense

Values-based: based on perceptions of social value, moral codes, the 'goodness' of a particular activity

The process of stakeholder participation does not substitute lay knowledge for scientific knowledge but uses them differently. Citizens, interest groups and business, for example, are participants who express values, preferences and contribute to the non-scientific knowledge. Representatives of governmental institutions and scientific experts are not always actively involved in the process. Their roles differ according to the techniques used. For example by providing information via a report or testimony or being actively involved in the discussions as full participants.

Participatory process in Canada

Indigenous communities within Canada are an example of a community with a unique collective knowledge and experience. As such, Canadian Indigenous communities have been identified as having unique concerns about climatic changes that impact upon their relationship with the natural environment. While the natural environment often acts as a supply of traditional food supplies, it also yields traditional insights into the impacts of climate changes and adaptive capacity.

Short term funding was provided to assist the Inuit organisations and First Nations –

- build awareness amongst their communities, as well as
- participate in on-going discussions relating to climate changes and its impacts.

Other collaborative efforts in Canada involving

- provincial (regional), and
- territorial governments

initiated programs to fund research on adaptation and change impacts that would inform adaptation decision making.

One such program conducted collaboratively between the provinces of Alberta, Saskatchewan and Manitoba, and the Government of Canada, was the Prairie Adaptation Research Collaborative (PARC) (Environment Canada, 2006).

Issues common to the three provinces were identified as –

- water resource management,
- recurring drought and
- frequent episodes of severe flooding.

Adaptation research has been conducted into

- non-commercial food supplies,
- biodiversity and
- terrestrial ecosystems within the Saskatchewan province.



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Exercise - Explore each of the specific features that require planning in relation to impacts of climate change for an identified vulnerable population. Drawing again on the case study on the **Heihe River Valley**

Include the following in your exploration:

Who will be the key stake-holders involved in assessing your identified population's vulnerability to climate change impacts?	What is the collective experience and knowledge you are likely to draw upon in assessing future conditions and needs for your vulnerable population? Match this against each stakeholder listed.	What are the current and future needs of this population likely to be? When listing these, identify which are likely to be 1/current or 2/future needs.

3. Building & Enabling Adaptive Capacity

Incorporating the Precautionary Principle into adaptation planning

Lessons gained from adaptation plans already implemented in Canada, for example, indicate that utilising an *Anticipatory Adaptation* or *Precautionary Principle* planning approach prior to a predicted climate change impact ensures a 'no-regrets' outcome.



Power Point Slides 44-46

The Precautionary Principle ensures that planning for adaptation to climate change impacts provides:

1. a benefit to the community regardless of any anticipated climate change occurring.

In contrast to the precautionary principle, a *Reactive adaptation* approach is implemented in

2. response to a climate event that has already caused health risks to a community.

However, successful adaptation planning must also recognise that

3. adaptation actions may not exclude all negative impacts,

but rather, the impacts of climate change will be

4. less damaging as a result of adaptation planning.

Therefore, adaptation planning should aim to

5. reduce the impacts of climate change risk to human health and the environment.

Enabling vulnerable communities to *build* adaptive capacity through an integrated approach



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- A Canadian example - Enabling Capacity

Policy development in Canada around an intergovernmental adaptation framework seeks to provide an enabling environment for adaptation planning. This approach provides access to information and tools needed for an integrative climate change planning process. Aspects included in the development of an enabling policy of adaptation are;

- developing appropriate adaptation tools,
- including risk management;
- integrating adaptation into long-term investment and planning;
- enhancing industry-government-stakeholder partnerships in the development of adaptive instruments and
- increasing knowledge and understanding through a research agenda that includes vulnerability assessments of Canadian populations.

The current adaptation response to climate change effects in Canada encompasses planning both anticipatory adaptive activities as well as reactive adaptive activities. Anticipatory adaptation approaches sought to minimise the observed effects of climatic changes, while reactive adaptation responded in a more spontaneous manner to these effects. However, this approach recognises that adaptation will not act in

response to climate change factors alone, but inclusive of a range of associated factors.

These include recommendations relating to -

- increases in heatwave-related deaths,
- air pollution-related disease,
- vector and rodent-borne diseases and allergic disorders,
- shellfish contamination, and regional impacts on northern Canadian populations.

As such, adaptive recommendations include –

- infectious disease monitoring,
- emergency management plans,
- early warning systems,
- land-use regulation,
- water and wastewater treatment facilities upgrade, and
- implementing measure to reduce heat-island effects.

The range of systems vulnerable to climatic changes across Canada indicates the need to implement numerous adaptation measures targeting various areas of vulnerability (Lemmen, Warren, Lacroix, & Bush, 2008). These include recognition of risks to human health through a diverse range of climatic impacts as changes in ice and snow cover, river and sea levels, as well as increases in the number of heat waves, forest fires, storm-surge flooding and coast erosion.



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Exercise - In a discussion, differentiate the **anticipatory adaptation** approaches from the **reactive adaptation** approaches outlined in this example. Discuss how each of these may contribute to an **enabling** environment for **building** adaptive capacity in the **Heihe River Valley**

<u>Reactive adaptation action</u>	<u>Anticipatory adaptation action</u>	<u>Enabling environment</u> → → _	<u>Building adaptive capacity</u>
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4. Barriers to adaptation planning



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Some of the lessons learnt from Canada's experience have provided insight into various impediments to implementing adaptive policies and planning. Some of these include:

- Limitations in awareness across all sectors of the public/private community;
- Unavailability of adequate and localised information;
- Inadequate decision-support tools specifically targeting adaptation planning (most relate to mitigation planning);
- Finding a balance between facilitating adaptation planning through regulation and disadvantaging innovation and enterprise;
- Costs to private sector of innovation and competitive disadvantage wrought through stricter legislative codes and standards;
- Lack of integration and co-operation between all sectors of government (local, national and international), private industry, the research community and the civil sector;

However, Canada has also shown that some of these impediments may be overcome, through:

- Identifying the specific barriers to adaptation action
- Revising legislative codes and standards to minimise disadvantage
- Maintaining and strengthening the knowledge base
- Synthesising and sharing knowledge
- Reviewing and contributing to international initiatives.



Power Point Slide 53



Exercise – Identify any limitations/barriers you foresee as impeding adaptation actions for the **Heihe River Valley**. Match these with an appropriate adaptation action in the following table.

Adaptation Action	Limitation/Barrier

What strategies might be implemented to overcome these limitations?

Limitation/Barrier	Strategy



Individual Task - Using a *structured frame-work* develop an adaptation plan for your identified population/community/region. In your plan ensure you address each of the key factors:



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Provide a **vulnerability assessment** of the risk factors for your identified population/region.

Which **stakeholders** will you consult with in this process? What knowledge and experience do they bring to the process?

What adaptation actions will you implement to **build capacity** in your community?

Which of these will be

- anticipatory and/or
- reactionary adaptation actions

that will help to build an enabling environment in your community/region?

What tools will you use in providing an *integrative* approach in your adaptation plan.

Also, include strategies for overcoming any *limitations* to adaptation actions outlined in your plan.

Finally, discuss briefly how you will re-view your adaptation plan to ensure it continues to be effective in limiting risk from changing climate change impacts for your community.



Useful On-line Resource materials:

- COAG. (2006). *National climate change adaptation framework*. Canberra: Council of Australian Governments. - See Annexe #1 for framework outline.
http://coag.gov.au/coag_meeting_outcomes/2007-04-13/docs/national_climate_change_adaption_framework.pdf
- Confalonieri, U., Menne, B., Akhtar, R., Ebi, K. L., Hauengue, M., Kovats, R. S., et al. (2007). *Human health. Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth*

Assessment Report of the Intergovernmental Panel on Climate Change.
Cambridge, UK: IPCC.

<http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter8.pdf>

- SMEC Australia. (2007). *Climate Change Adaptation Actions for Local Government*. Canberra: Australian Greenhouse Office, Department of the Environment and Water Resources.

<http://www.climatechange.gov.au/impacts/publications/pubs/local-government.pdf>

MODULE 4

Impacts of Climate Change on Infectious Diseases

Impacts of Climate Change on Infectious Diseases

【Learning objective】

1. To realize the impacts of climate change on communicable diseases and the prevention and control measures at present.
2. To discuss at the situation of global warming, the Department of Health has achieved the experience and shortage which acquired in dealing with prevent and control infectious disease and protect human healthy , as well its next working priorities.

【Text】

In recent years, the distribution of infectious diseases was spreading more and more globally, with the acknowledged reasons of more frequent migration due to the increasingly developed traffic, excessive use of antibiotics and poor public health infrastructures in the developing countries. But, people had neglected an important factor that was global warming.

Climate change is one of important factors to influence the spread of infectious diseases. Climate change may disturb the regional weather form and ecological balance, so that it can have kinds of effects on human health. Among the health effects of climate change, one of the most important is the effects on the transmission of the infectious diseases. Climate change will directly or indirectly affect the transmission process of many infectious diseases especially vector-borne diseases such as malaria, schistosomiasis and dengue fever.

1. The Impacts of Climate Change on Global Infectious Diseases

1.1 The Impacts of Climate Change on Current Infectious Diseases

- ◆ The current three main prevalence trends of the vector-borne diseases (another name of ‘Arbo Infectious Disease’) are that new kinds of diseases are increasingly emerging or discovered, prevalent regions are increasingly expanding, and the prevalence frequency is increasingly rising.
- ◆ Climate change can directly affect the disease transmission by changing the geographic distribution of medium organisms (medium for short), accelerating the reproducing and shortening the incubation period of pathogens.
- ◆ The borderline of tropic may reach to the subtropics and parts of the temperate zone may become subtropical zone as the climate warming. It’s generally known

that the Africa with tropical climate was the high prevalence area of communicable diseases and parasitic diseases and the candle of vector-borne diseases and water-borne diseases. The warming of the temperate areas will expand the distribution of insects and rodents with pathogens, prolong the harmful period, expand the growing and breeding season of the bacteria, viruses and parasites, and make the related diseases prevalence possible.

- ◆ The precipitation has also obviously changed as the same time of global warming. Flood disaster has frequently happened in recent years. Climate warming would induce extreme weather events such as cyclone and flood which might trigger the outbreak of some vector-borne diseases.
- ◆ Large of data revealed that the vector-borne diseases in the whole world had shown an increasing trend in recent years. So far, 100 kinds of arbovirus that had been found have the ability to induce human or animal diseases. IPCC predicted that global climate change maybe would affect the transmission of arbo parasitic diseases, virosis and bacteriosis, especially bring stronger prevalence of malaria, schistosomiasis, dengue fever, plague and so on.
- ◆ It's reported by WHO that the deaths of vector-borne diseases and water-borne diseases accounted for 5.67% of the total death. (see Table 4-1)。

Table 4-1 The global death number of vector-borne and water-borne diseases

Disease	Total Deaths
Diarrhoeal diseases	1,797,972
Malaria	1,272,393
Trypanosomiasis	47,774
Chagas disease	14,470
Schistosomiasis	15,371
Leishmaniasis	51,134
Dengue	18,561
Japanese encephalitis	13,957
Total	3,232,051
% of all deaths	5.67%

1.1.1 Malaria

Malaria is the most serious vector-borne diseases in the world. The transmission of malaria is the result of interaction among host (human), pathogen (plasmodium) and medium (anopheles). The distribution and transmission of malaria is related with temperature, rainfall and humidity.

The temperature and rainfall affect the reproducing of anopheles and the growth of anopheles in plasmodium .The rainfall and humidity affect the propagating and zone distributing. The malaria generally spreads in the region that it's isotherms to 16°C in winter, and when the temperature below this, the plasmodium will not be able to develop. When temperature between 20 °C ~27 °C, the latency period of plasmodium in vitro shorten significantly. Thus, the temperature and humidity are the most important factors that affect the spread of disease. The climate factors increase the vaccination rates of plasmodium, speed up the breeding of anopheles, and become the most important reasons for the outbreak outside of the endemic regions of the malaria.

- ◆ 1/20 of the world populations were suffered from malaria and there were 350 million new cases and 2 million people died from malaria (see Fig 4-1) .

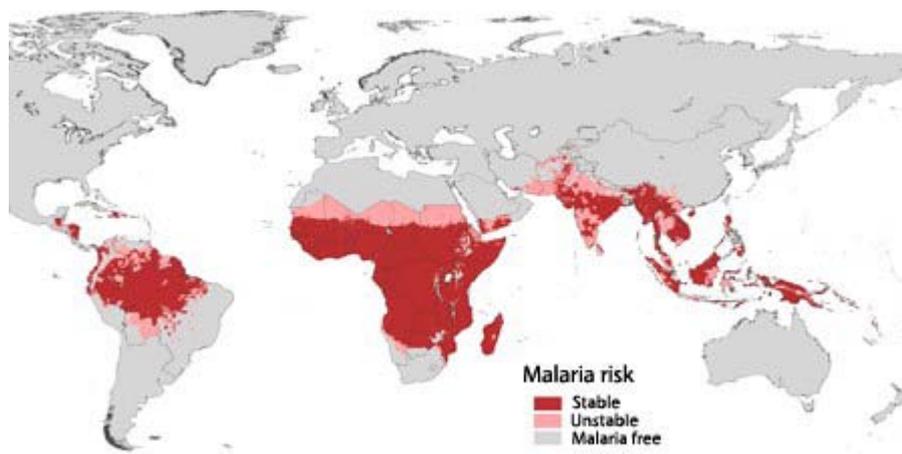


Fig 4-1 Global distribution of malaria

- ◆ As prediction by the General circulation model (GCM), the global mean temperature will increase by 3 to 5 degrees centigrade by the year 2100, malaria suffered population will increase twofold in tropical regions and more than 10-fold in temperate regions.
- ◆ The malaria cases will be increasing by 50 ~ 80 million each year, and approximately 4.5 ~ 6 billion people in the world will lived in malarious areas in the last half of 21 Century.

1.1.2 Schistosomiasis

Schistosomiasis is another important vector-born disease and the distribution of it is closely correlated with temperature, light, rainfall, humidity etc. Temperature and

light affect the propagation of intermediate host of the schistosomes — the breeding of water-snails, the hatch of miracidium and the development of schistosomes in body of water-snails. Rainfall and humidity determine the distribution of the breeding place of water-snails.

Snails (see Fig 4-2) are the intermediate host of schistosoma, mainly due to the expansion of irrigation systems, the prevalence rate of schistosomiasis has been increased in the dry warm areas. It is estimated that, the water shortage in many agricultural areas and the increase in irrigation water may cause the region to increase the risk of potential. At the same time, the warmer climate affects the infection and development of the schistosome in snails. In winter, the infectivity of cercariae in snails is in the dormant period, and the infectivity almost disappears. Therefore, if the temperature rises, in the year, the spread of schistosomiasis will extend the time.



Fig 4-2 Intermediate host of schistosoma - snails

- ◆ The latest model predicted that, by 2050, as a result of climate change will increase five million cases of schistosomiasis.

1.1.3 Dengue fever

Dengue fever as one of the arbovirus diseases is more affected by climate change. Dengue fever is acute infectious disease which induced by albopictus transmitting the dengue virus. It is mainly distributed in some tropical and subtropical countries and zones.

Epidemiological studies show that temperature is an important factor of impacting on the transmission of dengue fever. The temperature goes up and then the latent time of virus in mosquitoes become shorter, the frequency of mosquitoes biting people increased. But with the global becoming warmer and warmer, the distribution scope of mosquitoes that transit dengue fever may expand, so the distribution scope of dengue fever may expand (the mosquitoes that can transmit dengue fever will be

killed by frost and constant low temperature).

- ◆ Currently, the dengue virus spread in tropical areas between the 30 degrees north latitude and 20 degrees south latitude (see Fig 4-3). Therefore, the trend of climate warming can lead to the distribution of insect and disease spread to the higher latitudes or higher elevation areas.

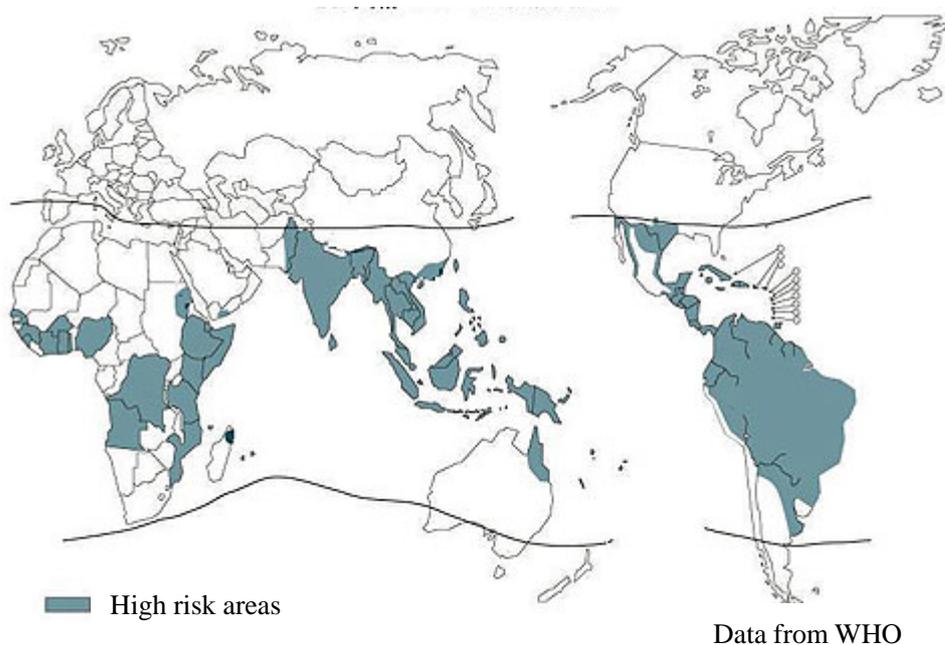


Fig 4-3 World distribution map of dengue fever in 2007

- ◆ From the beginning of the 1970s, the dengue fever of American States revived and the dengue hemorrhagic fever / dengue shock syndrome (DHF / DSS) began to emerge.
- ◆ Since 1998, dengue fever had become the second most important tropic infectious disease and malaria is the first one. And it showed endemic prevalence trend in Southeast Asia.
- ◆ According to current estimates that, the world more than 5 million people infected with virus each year, 400,000 cases of dengue haemorrhagic fever reported. Thereinto, dengue haemorrhagic fever with shock (DSS) cases, if the lack of proper treatment, the mortality will be as high as 40% ~ 50%. But fluid-supplement therapy in a timely manner, there will be a significant drop in mortality.

1.1.4 Plague

Plague is natural focus disease and it is caused by *Yersinia pestis* infection, in general, plague through the rodent fleas that exist in the wild or domestic rodent transmits to human beings. The number and density of host (mouse), medium (fleas), and the activity of *Yersinia pestis* involves a number of factors. The climate change and it's

caused the variation of the ecological environment inevitably bring a certain impact on the host or the media, thereby, it affects the changes in epidemic law of plague.

- ◆ plague brought great disaster to humans in the past, and even some figures to show that than 20 million people died of plague in the Middle Ages more (see Fig 4-4).

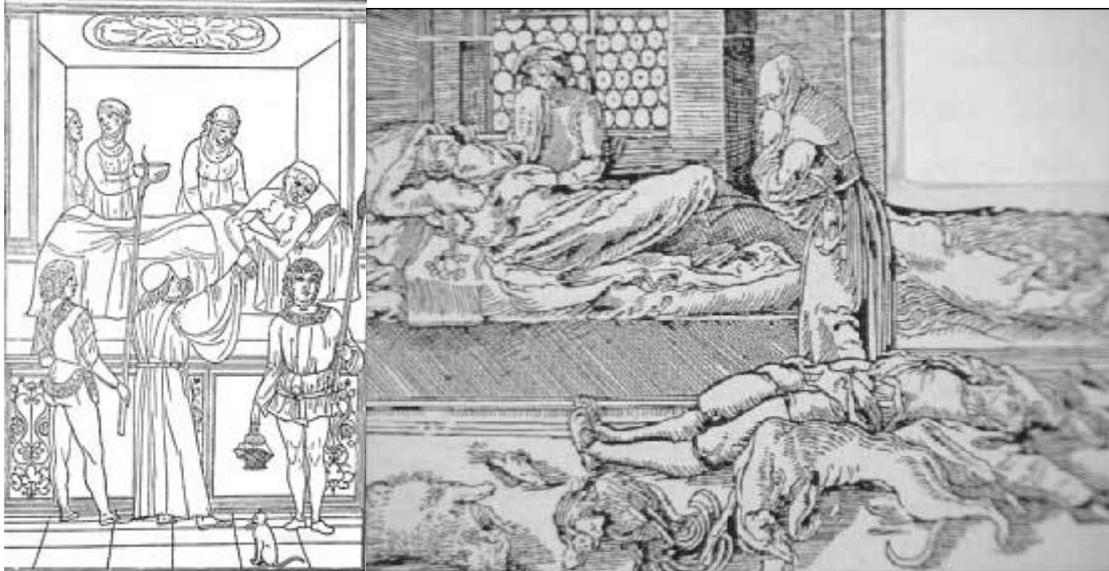


Fig 4-4 Plague swept across Europe in the Middle Ages

- ◆ Since 1990s, the world plague began to active once again.
- ◆ The plague is still popular among groups of rodents in nature. In Asia, parts of Africa, the United States and South America reported cases of human plague each year. Many studies suggest that the association between the prevalence of plague and the climate change.
- ◆ There some research analyze the relationship between climate change and the prevalence of plague in New Mexico Areas of the United States, and 55% of human plague cases of the United States have occurred in this area. Research reveals the association between precipitation and the incidence of human plague.
- ◆ The study of Stenseth etc. found that the rise of the prevalence of plague among rats has connection with the warm spring and humid autumn. Exceeding the threshold, the rise of 1°C would increase the morbidity of the spring from 0.0077 to 0.0122, increased about 59%; the increase in precipitation in autumn would increase the morbidity from 0.0110 to 0.0118, only higher about 8%

1.2 Climate Changes Probably Bring about New Infectious Disease

It's not neglectable that:

- ◆ The new species must appear as the same time as part of the old extinct induced by climate change. The change of species may break the existent situation of viruses, bacteria and parasites and make new variation.

- ◆ Global warming accelerates pathogen reproduction and spreading speed and scope. It may bring about some aberrance of viruses and produce some viruses which we do not know how to prevent. As a result of long-term and short-term climate change can act on the pathogens, media and hosts, so that the climate change will affect the survival and variations of pathogens, the change of the activity areas. The pattern of spectrum of infectious diseases and epidemiological characteristics will change, and that will cause the emergence of new pathogens and new infectious diseases and affect the incidence and prevalence of infectious diseases.
- ◆ The climate warming and melted glaciers will release many frozen viruses such as smallpox virus, various peculiar flu viruses and some unknown viruses.

2 The Impacts of Climate Change on Chinese Infectious Diseases

2.1 The Impacts of Climate Change on Vector-borne Diseases

Vector-borne communicable disease is also a serious public health issue in China and the occurrence accounted for 5 to 10 percent of the total communicable disease cases every year and the deaths occupied 30 to 40 percent of the total deaths of communicable disease.

There are more than 500 kinds of arbovirus around the world, and 100 kinds of them have the ability to induce human or animal diseases. In appropriate circumstances, the arbovirus can cause the outbreak-related diseases.

Climate change will affect the prevalence of the vector-borne disease, which mainly involved in changing the regional distribution of entomophilies, increasing the reproduction speed and invasion power of the entomophilies, and shortening the extrinsic incubation period of pathogens. In our country, the vector-borne disease that affected by climate change includes malaria, schistosomiasis, dengue fever etc.

2.1.1 Malaria

- ◆ The changes of temperature and rainfall due to the global warming will affect the original distribution of malaria. Climate warming brought warm winters in many areas so that malaria may spread to the higher latitude and higher altitude regions.
- ◆ The epidemic region of malaria is mainly in the south of north latitude 45 degrees. The Tibetan Plateau occupying 1/4 of land in China is in high altitudes and cold with no malaria.
- ◆ The incidence rate of Malaria in China has showed the increasing trends since 2000, it reached to 3.55 per 100,000 by 2007, which was the 1.83 times of that of in 2000.

2.1.2 Schistosomiasis

- ◆ The changes of temperature and rainfall due to the global warming will affect the original distribution of schistosomiasis.
- ◆ The epidemic areas of schistosomiasis in China are distributed in 413 cities/counties of 12 provinces (cities, autonomous regions) in or to the south of the Yangtze river drainage basin. These provinces are including Hubei, Hunan, Jiangxi, Anhui, Jiangsu, Zhejiang, Yunnan, Sichuan, Fujian, Guangdong, Guangxi and Shanghai. The areas where water-snails exist add up to 14 billion square meters. There are 11.61 million infectors and a hundred million people who are endangered by schistosomiasis in the areas.
- ◆ First the potential impacts of global climate warming on the spreading of schistosomiasis will enlarge the epidemic area by the water-snail moving to the north. Meanwhile the epidemic extent of origin epidemic area will be enhanced. In recent years, endemic situation of Yangtze River Valley tends to diffuse and new endemic areas are found constantly. The epidemic counties/cities of schistosomiasis spread to 449 in 2007 which increased by 7.4% than those in 2001.

2.1.3 Dengue fever

- ◆ China's Hainan Province occurred the large-scale epidemic of dengue fever in the early and middle of the 1980s. Hainan is not the epidemic area of dengue fever now. But if the temperature increased by 1~2°C with the global climate warming, it is estimated that Hainan will be suitable for the spreading of dengue fever all the year. So Hainan may become epidemic area of dengue fever.
- ◆ In recent years, the geographical epidemic areas of dengue fever have been expanded north to Guangdong and Guangxi.

2.1.4 Plague

- ◆ The temperature and precipitation are more sensitive two factors to reflect climate change. China has used the drought and waterlogged index, and cold and warm index to study the historical plague epidemic intensity and inter-annual climate change, and the results of analysis showed that the close relationship between the climate change and the prevalence, transmission intensity of plague. The research is of the referential significance in the early warning studies of the plague epidemic.
- ◆ In our country, the epidemic situation of plague have shown an upward trend, the new foci County increase, part of the resting plague foci re-active, and the epidemic scope of animal plague gradually expand. The epidemic situation of plague close to the city, densely populated areas.

- ◆ At present, the plague foci distributes in the 19 provinces, autonomous regions and 286 counties (cities, flags), and the foci area are 1,150,000 square kilometers. Each year, our country in 400~420 counties of 24 provinces, autonomous regions and municipalities to carry out the plague monitoring, establish around 1200 monitoring points, and the area of monitoring are about 150,000 square kilometers.
- ◆ In September and October of 2004, China's Qinghai Province and Gansu Province took place the plague and caused the enormous losses of the local people's lives and property.

2.2 The Impacts of Climate Change on Water-borne Diseases

With the global climate warming, the frequency of flood and drought is increasing. Drinking water is contaminated, so the threat of cholera, typhoid and hepatitis rise. The difficulty of preventing enteric infectious diseases will be enhanced because of the crowding of several pathogens in extensive water body.

Climate warming will also increase the sea surface level and temperature which induce an increased morbidity of water-borne diseases such as cholera. For instance, the cholera epidemic in our country expanded 2 provinces northward in 1994 and 1995, respectively. It is still epidemic in these areas nowadays. (see module 6)

3. Adaptation Measures

Chinese government has taken great attention on the control and prevention of infectious diseases.

- ◆ To implement the infectious disease prevention and control laws and regulations, as well as "sustainable control" strategies

Chinese government has established a series of related policies, regulations, and infectious disease prevention and control measures, such as "Infectious Diseases Prevention and Control Law", " Regulation of Schistosomiasis Control" and so on, these provide a policy basis for infectious disease prevention and control of our country. In addition, in recent years, the "comprehensive management" strategy and "sustainable control" strategy depending on bio-vector are of important significance for controlling vector-borne disease, protecting the sensitivity of the environment and the media. Thus, in the premise of the comprehensive management, through the joint efforts of all aspects, to implement the bio-vector sustainable control strategy is an important manifestation of carrying out the scientific development concept, and achieving the harmonious development of man and nature.

- ◆ To conduct the infectious diseases surveillance and bio-vector surveillance

To actively conduct infectious disease surveillance and bio-vector surveillance, China CDC had launched the key infectious diseases surveillance system since 2004.

Besides, the bio-vector surveillance which continuously and systematically collecting vectors such as rats, mosquitoes, flies and cockroach with scientific method for a long time, then in time analyzing the kind, quantity, distribution and seasonal changing etc., provide the information basis for health service departments and center for diseases control and prevention to establish, implement, assess and adjust strategies and measurements of relevant infectious disease prevention and control.

◆ To develop scientific research on impacts of climate change on infectious diseases

To organize and carry out the research on climate change impacts on infectious diseases, mainly include ecological investigation, experimental investigation, spatial statistics and time-series models, which is the basis of forecasting the effects of climate change on infectious diseases prevalence. Besides, carrying out a series of relevant ecological studies, biological experimental investigation studies and so on is of great significance for promoting research in the field.

◆ To participate in international exchanges and cooperation in the impacts of climate change on relevant infectious diseases

In the context of globalization, the prevention and treatment of infectious diseases should be dependent on the deep and effective cooperation between countries and regions. In 2003, the outbreak of SARS reminded the international community to strengthen international cooperation in the field of public health. Our governments summarized experiences and lessons, strengthened cooperation with the international community in the field of infectious diseases, informed epidemic situation in time, coordinated and management the prevention and control of the disease, and carried out effective cooperation and studies in scientific research field. The acts play an important role in the prevention and control of infectious diseases. In 2006 and 2008, the Chinese Preventive Medicine Association and the Chinese Center for Disease Control and Prevention co-hosted two "the International Forum on Sustainable Control of Bio-vector ", set up a "global warming, environmental change and vector-borne disease " special topics on the second forum, and the scholars from all over the world exchanged the research results that climate change affected occurrence and control of bio-vector and related infectious diseases, that has improved our country's capacity of coping with the climate change and preventing and controlling vector-borne disease. In 2008, the National Institute for Infectious Disease Control and Prevention of the Chinese Center for Disease Control and Prevention established the "Tuanshan International Forum", which is of great significance in promoting China to carry out international academic exchanges of infectious diseases.

4. Gap Analysis

With the global warming, the geographical environment, biome, species density and distribution of vectors will vary, then the occurrence, development and prevalence of vector-borne diseases will also change. So there are still some limitations on research

to climate change and other related changes using the traditional perspective and research methods. Therefore, under the situation of global climate change, predicting the developmental tendency of vector-borne diseases by dependable mathematical models is not only the important task for diseases control and prevention, but also the key research field of climate change impact on epidemic. At present, Chinese scholars gradually undertake researches on the impacts which global warming brings about on vector-borne diseases, but we will still confront with many problems currently.

◆ Lack of research tools

On the one hand, vector-borne diseases are diverse in China. It is necessary to further research biological and the ecological characteristics to make sure how to establish and make use of mathematical models to predict the various regulations of disease transmission. On the other hand, there are a lot of uncertain factors involved into pathogens, vectors and environments. To set up the model between the climate and vector-borne diseases, many problems need to be resolved. So the prediction models of multifactor need to be established urgently. Moreover, assumptions some models based on also need further verification.

Further to understand the relation among the pathogens of vector-borne diseases, the biological and ecological characteristic of vectors and the climate change variety; introduce the more advanced mathematical models to improve predicting level; reinforce the interdiscipline researches of different subjects such as GIS, RS, biology, ecology, epidemiology and meteorology, etc; and actively carry out the research on potential threat and control techniques of vector-borne disease, that are of great significance in establishing the relevant prediction model.

◆ The monitoring indicators need to be perfect

At present, China's monitoring indicators of prevention and control of infectious disease include: the occurrence of infectious diseases, prevalence, and the factors of affecting its occurrence and prevalence; the infectious diseases that occurred abroad, at home had not yet occurred, or the new infectious diseases of domestic. Some indicators associated with infectious diseases are not within the scope of monitoring.

Thus, on the basis of improving original monitoring indicators, to draws on the experience of the United States and other countries, and carry out the unconventional monitoring, such as the sale of the prescription and non-prescription medicines, clinic and hospital course and so on. That also has great significance in improving the monitoring indicators with the prevention and control of infectious diseases.

◆ Lack of talents and the comprehensive quality need to be improved

There includes the talents of the infectious disease prevention and treatment, and interdisciplinary remote sensing talents etc.. At present, in the field of prevention and treatment of infectious diseases, China's disease prevention and control institutions at all levels, there commonly exists that lack of the prevention and control professionals and the comprehensive quality need to be improved. Especially in the filed of the

prevention and control of vector-borne disease, the problem that lacks of professionals is more prominent. In addition, the brain drain is also an important problem in the area.

Thus, on the basis of perfecting personnel training system, to strengthen the team building and improve comprehensive quality in the field of the infectious disease prevention and control, and introduce the relevant technical personnel, that are of great significance for the prevention and control of infectious diseases.

【Case Study】

The Impact of Climate Change on Aedes Albopictus and the Spread of Disease

The Ecological Characteristics of Aedes Albopictus Mosquito is the most important medical insects, it can spread many kinds of diseases. Aedes albopictus as one of important medium insects, in abroad, it is known as the Asian tiger mosquito. It usually breed in small water containers in the yard (including basins, jar, miniature landscape, seeper of plastic membrane), plant containers (including tree holes, bamboo, seeper of leaf axil) and special containers (including waste tires, seeper of construction site) and so on, the complex environment. It is ‘water container-type’ mosquito and commonly called ‘piebald mosquito’.



Aedes Albopictus

The Impact of Climate Change on Aedes Albopictus Mosquito are insects of complete metamorphosis and they are born in the water pre-adult stages. When the rainfall increases, it can increase the number of mosquito breeding ground, breed the larvae in great number, increase population, and increase the possibility of outbreak of

infectious diseases, such as dengue fever etc.. The *Aedes albopictus* larvae are same as other mosquito larvae. There usually have a certain temperature range suitable for the growth of *Aedes albopictus* larvae, and there exist the most appropriate temperature of development, the most appropriate temperature of survival and the biological most suitable temperature for the larvae. In general, the most appropriate temperature for the development of mosquitoes is around 28 °C. Then the temperature increased further, although the development speed is able to increase, the individual are small because of the speed up of body's metabolism. Lowering temperature from about 28 °C, the growth slowed down as a result of metabolism decreases. In addition, the relative humidity does not directly affect the changes of larvae, but can affect the survival time of adults. In the 70% ~ 80% relative humidity, the vampire and spawning of mosquitoes are most active, and thus indirectly affect the dynamic changes of larvae.

Aedes albopictus is mainly distributed in the tropical and subtropical of Asia, and some temperate regions. In recent years, as a result of climate change and well-developed transport system, its distribution area are gradually expanding, and in abroad, it have arrived in the Americas, Europe, the African continent and other regions. It widely distributed in China, north from Shenyang of Liaoning, northwest to Baoji of Shanxi, southwest to Tibet, south to Hainan Island and the Xisha Islands, and south of the 34 parallel of north latitude is common. The minimum temperature of restrictions on the distribution of *Aedes albopictus* is the average 0 °C isotherms of the coldest month (January in the northern hemisphere). The potential distribution area expands when the temperature increases. There studies suggest that the lowest temperature of the spread of dengue fever virus is 20 °C, and the popular range may expand to the high-latitude regions when the temperature rises.

The Impact of Climate Change on Mosquito-borne Diseases At present, in china, the main mosquito-borne diseases include malaria, epidemic encephalitis B and dengue fever. *Aedes albopictus* as the important medium of dengue fever, epidemic encephalitis B and other mosquito-borne infectious diseases, understanding the impact of climate change on the distribution, reproduction, and so on is of great significance in the prevention and control of mosquito-borne diseases.

Dengue fever and dengue haemorrhagic fever (DF/DHF) is arbo virus disease that the most widely distributed and the largest number of incidence in recent years. On a global scale, the *Aedes aegypti* is the main medium of DF, though the medium role of *Aedes albopictus* is smaller than the *Aedes aegypti*, in the absence of *Aedes aegypti* areas, the *Aedes albopictus* can become a sole or main media of the popular of DF. Such as, in 2001, the DF epidemic in the Seychelles, Japan and Hawaii Island was that caused by the *Aedes albopictus*, and the *Aedes albopictus* also played an important role in dissemination and prevalence of DF in rural areas of Asia.

Epidemic encephalitis B is an important mosquito-borne infectious disease. At present, through wide virus isolation, experimental transmission, the host survey and

epidemiological investigation, we now have known that *Culex tritaeniorhynchus* is the main medium of epidemic encephalitis B in China, the *Aedes albopictus*, *Culex pipiens pallens*, *Culex quinquefasciatus* take second places. Studies from abroad indicate that *Aedes albopictus* are able to infect, disseminate and transmit the epidemic encephalitis B virus by the nit.

【Exercises】

1. Please list the local major vector-borne disease, and attempt to discuss the possible positive and negative impacts of climate change on its pathogen, vector, host, etc..
2. What actions do China has taken for the impact of climate change on infectious diseases? How to deal with?

【Recommended Readings】

WHO web site on the theme of climate change and health

<http://www.who.int/globalchange/climate/en/>

Katrin Kuhn, et al. Climate to Predict Infectious Disease Epidemics, WHO/Communicable Diseases Surveillance and Response/Protection of the Human Environment/Roll Back Malaria. Geneva, 2005.

MODULE 5

Impacts of Temperature Change on Human Health

Impacts of Temperature Change on Human Health

【Training Objectives】

1. To learn the impacts of temperature change on human health and the measures for disease control and prevention;
2. Under the background of global climate warming, to explore the experience and insufficiency that health sections have acquired in protecting human health to response to temperature change.

【Text】

1.Global general situation of temperature change

According to IPCC “Climate Change 2007: Synthesis Report”, Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) given in the Third Assessment Report (Fig.5-1). The linear warming trend over the 50 years from 1956 to 2005 (0.13 [0.10 to 0.16]°C per decade) is nearly twice that for the 100 years from 1906 to 2005.

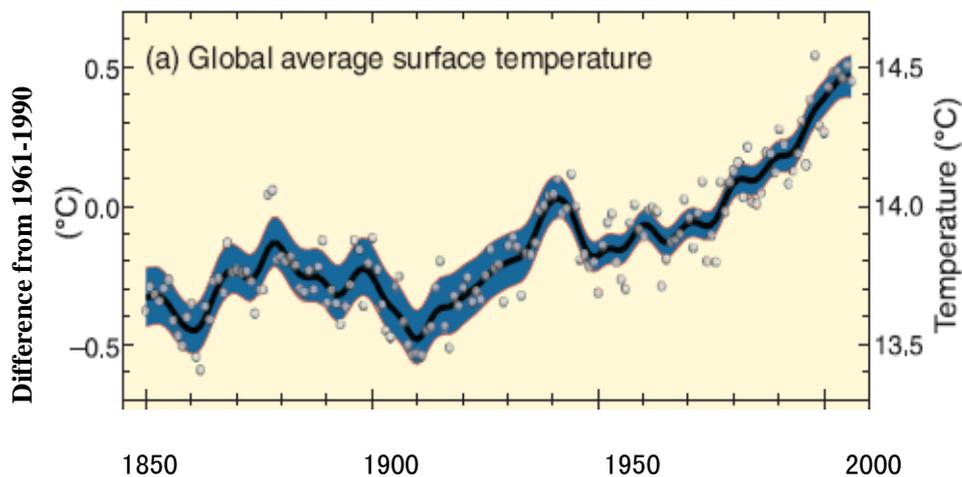


Fig 5-1. Observed changes in (a) global average surface temperature

Note: All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties

2. Chinese situation of temperature change

Territory of China covers large latitude and longitude extension over East Asia. The highest plateau, Qingzang Plateau, stands towering in the west, and the Pacific Ocean bordered on the east. Therefore, characteristics of climate vary from region to region in China. However, climate change in regions shows similar trend and the trend is statistically significant only in temperature. Instrumental observations of temperature during the 20th century showed a significant warming trend. It is $0.58^{\circ}\text{C}/100\text{a}$ according to maximum and minimum temperature records on the stations in China, for the period of 1905~2001, and $0.58^{\circ}\text{C}/100\text{a}$ based on blending the observational data with proxy data in west China for the period of 1880~2002. The latter is almost the same as the averaged for the globe (Fig.5-2).

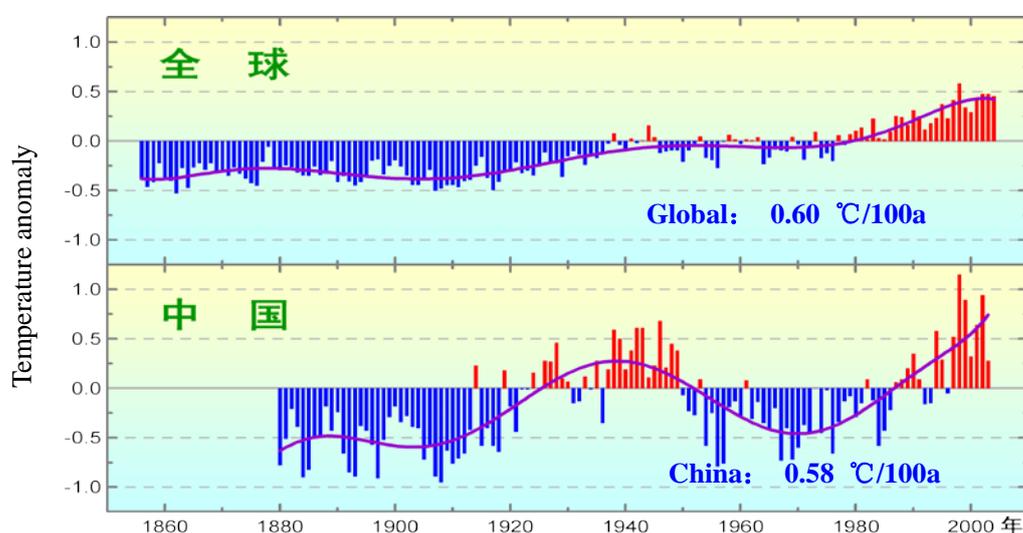


Fig 5-2 Comparison of temperature change between China and Globe

3. Impacts of temperature change on human health

WHO's report shows that climate change has impacted on the human health. 100,000 people died of it, until 2030, the number of death will up to 30,000.

At present, we have done some studies on the relation between the climate factor and diseases, such as cardiovascular diseases, respiratory diseases, psychosis diseases, which are related to climatic condition. It is reviewed briefly as follow:

3.1 Impacts of temperature change on total mortality

The effect of elevated temperature on mortality is a public health threat of considerable magnitude. Every year, a large number of hospitalizations and deaths occur in association with exposure to elevated ambient temperatures (Mackenbach JP et al., 1997; Faunt JD et al., 1995). Generally speaking, the graph of the relation of air

temperature to total mortality shows shape of “U”, V” or “J”. There are seen the increase mortality following higher and lower temperature. From 1998 to 2003, the Institution for Environmental Health and Related Product Safety, of China CDC carried out environmental surveillances in Nanjing, Guangzhou, and Ha’erbin which have great difference in daily maximum temperature and diurnal temperature range (Fig.5-3).

The result indicates that the mean daily mortality show the U shape distribution(Fig 5-4), when daily average temperature decreased at some degree, with daily mean temperature decreasing, mean daily mortality gradually increased in winter; In the contrary, when the daily average temperature rises to a certain extent, with daily mean temperature increasing, mean daily mortality obviously increased in summer.

From 1980 to 1989, the study was done on the relationship between daily maximum temperature and total mortality in summer of Guangzhou, Shanghai (Wang et al.,1997), and the results showed that the mortality (number of death) significantly increased with the increase of the daily maximum temperature when temperature reached a certain degree (Fig.5-5). The critical temperature at which the mortality increased significantly was both 34°C in Guangzhou and Shanghai. And these values are close to the critical temperature of New York, Chicago and Detroit, about 32—33°C (Tan et al., 1994). This value will not have great change in various areas; therefore it has biological meanings to a certain extent.

To sum up, the relationship between temperature level and mortality outcomes has been well established, Typically, a U-shaped relationship between mortality risk and temperature level is observed with mortality risk decreasing from the lowest temperature to an inflection point and then increasing with higher temperature. Very hot and cold days appear to exert a cumulative effect upon mortality. The relationship may be different for areas with different weather patterns, latitudes, air pollution levels and prevalence of air-conditioning systems.

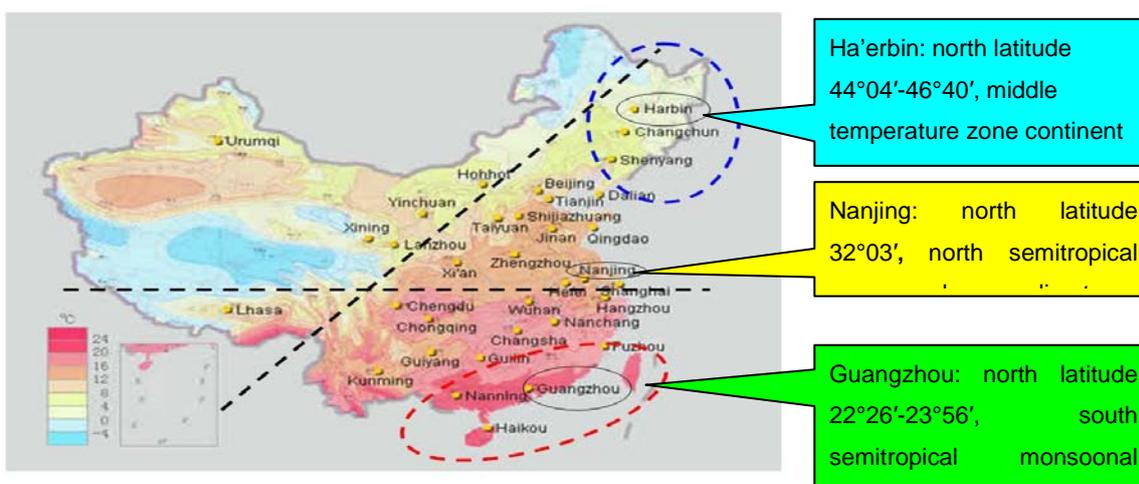


Fig.5-3 the distribution of daily average temperature in China

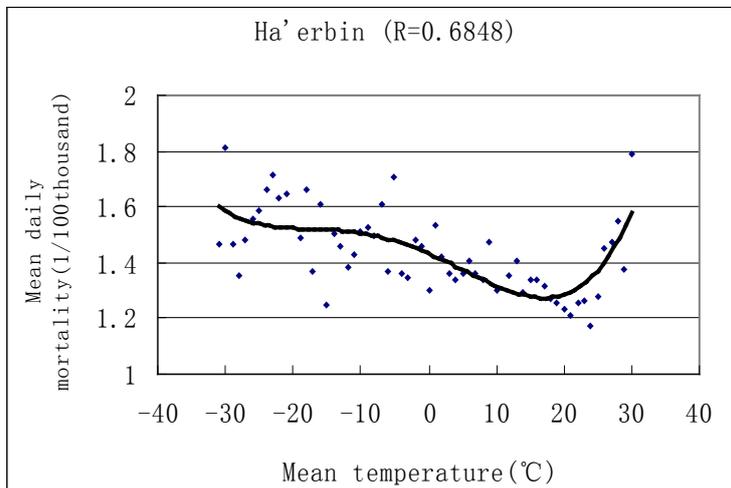
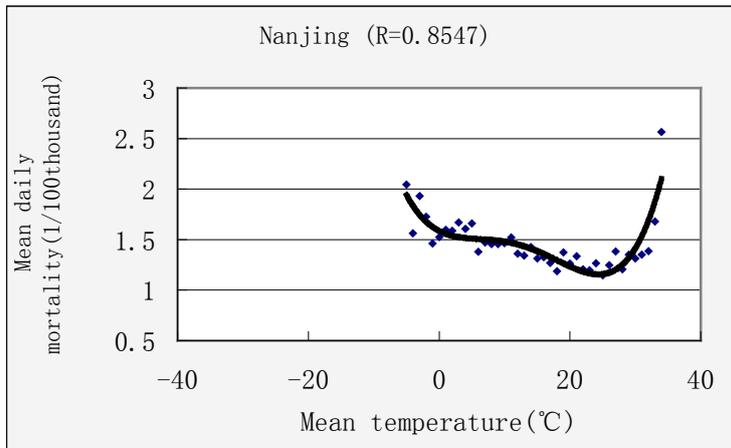
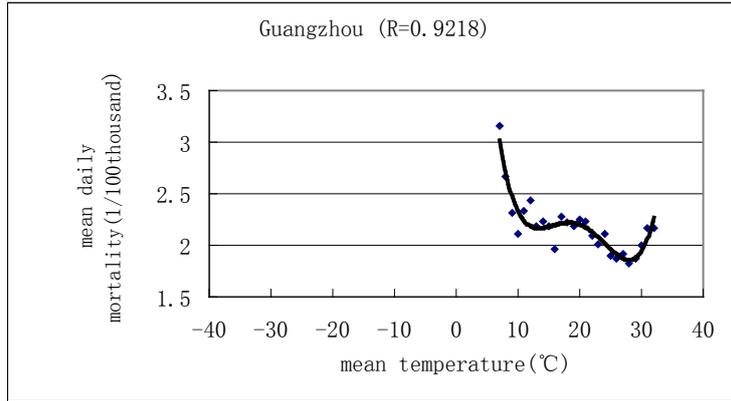


Fig.5-4 Relation between daily average temperature and mean daily mortality in 3 cities from 1998 to 2003

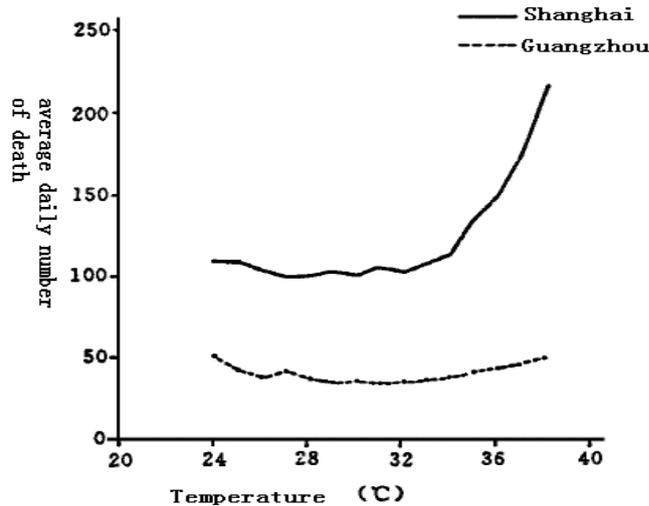


Fig.5-5 The relation between average daily total mortality and daily maximum temperature in summer (1980—1989)in Guangzhou and Shanghai

3.2 Impacts of temperature change on cardio-cerebrovascular diseases

As we know, meteorological condition may trigger cardio-cerebrovascular disease onset and death. Many researches found that: the graph of the relation of temperature to the incidence and mortality of cardio-cerebrovascular shows shape of “U”, V” or “J”. There are seen the increase incidence and mortality following higher and lower temperature (Table 5-1).

Recent years, under the background of global climate change, some scientists in China have begun to explore other meteorological indicator associated with global climate change which may be related to a variety of health outcomes. For example, diurnal temperature range (DTR) which suggests within-day variation in temperature, defined as the difference between maximal and minimal temperatures within 1 day, may be a novel risk factor for death. Guohai Chen et al considered that DTR is a risk factor for acute stroke death independent of the corresponding temperature level. And there are relationship between DTR and stroke mortality (Chen et al.,2007) .A semi-parametric generalized additive model (GAM) was used to assess the acute effect of DTR on mortality after controlling for covariates including time trend, day of the week (DOW), temperature, humidity, and outdoor air pollution. Haidong Kan et al found that A 1 1C increment of the 3-day moving average of DTR corresponded to a 1.86% (95% CI 1.40–2.32%) increase in cardiovascular mortality, and DTR in relation to mortality stratified by the temperatures above (warm days) or below (cold days) the inflection point of 23°C. For the cold days, a 1°C increase of the 3-day moving average of DTR corresponded to 1.76% (95% CI 1.23–2.28%) increases in cardiovascular mortality; for the warm days, an increase of 1°C DTR corresponded to 1.91% (95% CI 0.83–2.98%) increases in cardiovascular mortality.

Table 5-1 Typical research on temperature and cardio-cerebrovascular

Country(city)	Result	Reference
Brzail (St. Paul)	The CVD curve was a U-shaped, showing higher value for cold stress than for heat stress.	Goncalves F L T et al., 2007
France	Rates of events decreased linearly with increasing atmospheric temperature. A 10°C decrease was associated with a 13% increase in event rates (P<0.0001) (studied temperature range: Tmin -14.5°C, Tmax 11.2°C) ;	Danet S et al.,1999
Russia (Siberia)	Compared to high temperature (≥ 13 (°C), low ambient temperature (≤ -2°C) (RR=1.32 CI 1.05-1.66) was an important predictors of ischemic stroke occurrence, while mild mbientmbient temperature(RR=1.52 CI 1.04-1.66) was an important predictors of intracecerbral hemorrhage.	Feigin V L et al.,2000
China (Beijing)	The incidence of acute coronary heart disease began to be higher than the baseline as weekly average temperature was lower than 6°C, and it increased with the weekly average temperature decreasing.	Liu Fang et al,2005
China (Taiwan)	A U-shaped relation was observed between temperature and mortality from coronary artery disease and cerebral infarction. The range corresponding to least deaths from coronary artery disease (26-29°C) and cerebral infarction (27-29°C) was higher than that in countries with colder climates. In the elderly, the risk of cerebral infarction at 32 was 66% higher than that at 27-29°C; the risk increased by 3& middot;0% per 1& deg;C reduction from 27-29°C. The risk of coronary artery disease at 32°C was 22% higher than that at 26-29°C; below 26-29°C, the risk increased by 2.8% per 1& deg;C reduction. Mortality from cerebral haemorrhage decreased with increasing temperature at a rate of 3.3% per 1°C.	Pan et al.,1995
United States (107cities)	In summer 1987 the average increase in cardiovascular deaths due to a 10°F increase in temperature was 4.7%. By summer 2000, the risk with higher temperature had disappeared (0.4%). In contrast, an increase in temperature in fall, winter and spring was associated with a decrease in deaths,	Barnett A G et al.,2007

3.3 Impacts of temperature change on respiratory diseases

Some studies showed that temperature have effects on the onset and death of respiratory diseases. Analysis was done on the relationship between the maximum temperatures and the total mortality of respiratory diseases in summer of Guangzhou, Shanghai and Nanjing. The results showed that mortality of diseases significantly increased with the increase of daily maximum temperature, when daily maximum temperature increased to a certain extent. In Guangzhou ,Shanghai and Nanjing, the critical temperature at which the mortality increased significantly was respectively 36°C、35°C、33°C (shown in fig.5-6, 5-7, 5-8. It is consistent with our study in Nanjing, Guangzhou, and Ha'erbin.

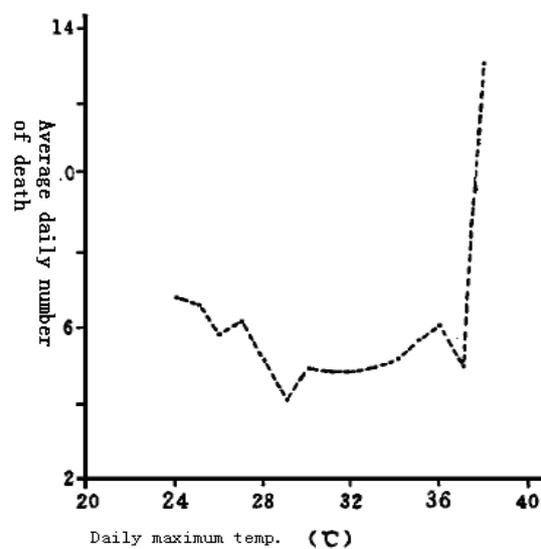


Fig.5-6 the relation of average daily mortality of respiratory diseases and daily maximum temperature in summer in Guangzhou

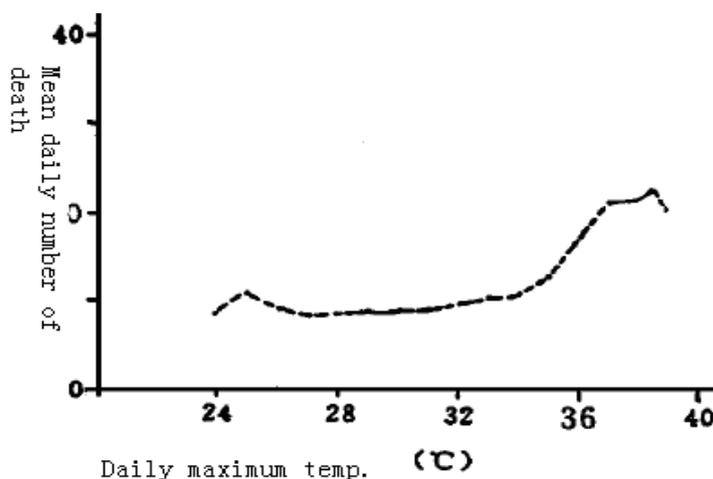


Fig.5-7 the relation of average daily mortality of respiratory diseases and daily maximum temperature in summer in Shanghai

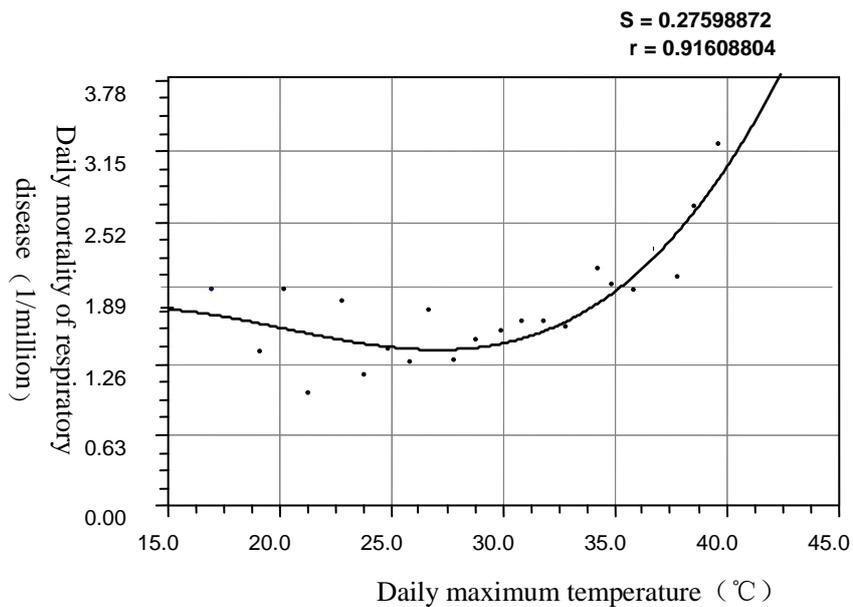


Fig.5-8 the relation of mortality of respiratory diseases and daily maximum temperature in summer (1994—2003) in Nanjing

Research by Li Zhibin et al established the regression equation which suggested the relationship between meteorological factors and various respiratory diseases (table 5-2), and found that there are close relationships between upper respiratory tract infection and average temperature, chronic bronchitis and lowest temperature, cor pulmonale and lowest temperature, bronchial asthma and average humidity/average temperature ratio, and spontaneous pneumothorax and average humidity/average temperature ratio(Li et al.,1994). In addition, study by Zheng Yang showed that the negative relativity between the rising of Beijing air temperature(temperature range:15°C ~ -4°C) and the incidence of a disease of pediatric respiratory tract, (rs= -0.530, p < 0.01) (Zheng, et al.,1999). Yinchang Shan et al analyzed the cases data for ten years in Weifang and found that there are good correlation between daily temperature range and respiration diseases (r=0.8633) , the number of inpatients with respiration diseases increased with daily temperature range increasing(Shan et al.,2002).

3.4 Impacts of temperature change on other diseases

·Mental diseases Climate change has not only an impact on physiological function but also on mood, it can change the status of psychosis. Because climate change indirectly affects the function of the thermoregulation centrum of underthalamencephalon, mood and gonad regulating centrum, this can result in schizophrenia.

Table 5-2 The relationship between meteorological factors
and various respiratory diseases

Disease	regression equatation	multiple correlation coefficient	partial correlation coefficient	residual error	variance ratio	regression variance significance test
upper respiratory tract infection	$y=0.7710373-0.102455x_2+3.2435\times 10^{-3}x_2^2$	0.33598	0.18092	0.5391	22.4594	F=13.320 P<0.01
chronic bronchitis	$y=1.3897-0.1667813x_3+5.050534\times 10^{-3}x_3^2$	0.24156	0.21336	0.8216	10.937	F=8.986 P<0.01
cor pulmonale	$y=2.353261-0.2509448x_3+6.69801\times 10^{-3}x_3^2$	0.23185	0.22637	1.2561	10.027	F=12.595 P<0.01
episode of bronchial asthma	$y=-0.3528557+0.1760956x_2/x_1$	0.1954	0.1951	1.9972	14.053	F=28.066 P<0.01
spontaneous pneumothorax	$y=-0.533275+0.2260038x_2/x_1$	0.1811	0.1811	3.8528	11.999	F=46.230 P<0.01

x_1 : average temperature, x_2 : average humidity, x_3 : lowest temperature

The studies indicated that the occurrence of schizophrenia was linked with seasons, air temperature, air pressure, relative humidity and mean hours of sunshine(Gao et al.,2003).. Annual temperature change was consistent with morbidity of psychosis. Every year from the end of summer to winter, with reducing temperature, morbidity of diseases decreased, the studies in Wuhan, Chongqing and Guangxi proved this (Chen et al., 1999).

Injury and toxicosis High temperature direct affects the people's mood and psychology, high temperature easily results in fatigue, worry and irritation, and increases various accidents, even increases the rate of crime, for example, during the heat wave in July 2003, the datum of Beijing's first aid show that rising the accidents had relationship with high temperature. Meteorological factors affect the people's response time and speed, and affect work efficiency and cause the accidents.Jin Yinlong et al in Guangzhou, Nanjing and Ha'erbin found that when the daily maximum temperature increased at a certain degree in summer, with increasing daily

maximum temperature, average daily mortality of injury and toxicosis significantly increased.

·Status of human population health Climate warming causes the extreme hot weather, high temperature and high humidity causes the disorder of body's function. So, heatstroke more and more severe threatens the human health. In 2003, 900 subjects were random sample selected in Guangzhou, Nanjing and Ha'erbin, 300 subjects in each city. The questionnaire survey was carried out, in order to learn the status of residents' health in the summer. The result showed that the occurrence of stroke was mostly consecutive high temperature days in July and August. the occurrence rate of stroke in Nanjing was highest (4.7%). High temperature in summer can result in the occurrence of subclinical symptoms besides stroke, for instants, fatigue, aggravated diseases, and disturbed sleep and so on.

3.5 Heatwaves and health

Many studies on heatwaves have been carried out in the world, but so far there is no standard international definition of a heatwaves. China Meteorological Bureau suggests heat warning should be promulgated when the daily maximum temperature is above 35°C (Tan et al., 2004).

Global climate warming is likely to be accompanied by an increase in the frequency and intensity of heatwaves, as well as hot days in summer. Extreme summer heat's impact on human health may be exacerbated by increases in humidity. The direct impacts of heatwaves on human health are the increasing of morbidity and mortality. Also high temperature can make germina, bacteria, parasites and allergen more active as well as damage people's spirit, immunity and resistance. There is more than 100 thousand person's death due to climate warming all over the world. In the recent several decades China have consecutive suffered from broiling summers in 1988, 1990, 1994, 1998, 1999, 2002 and 2004. Some reports indicated that heat waves could bring thousands of excessive deaths every year. For example, in 1988, 1488 deaths were ascribed to heat waves in Nanjing and Wuhan (Mao et al., 1989) And in 1998 Shanghai suffered from the most severe heatwaves in the recent several decades, the deaths during heatwave were 2 to 3 times of those during not heatwaves, especially, the mortality of the elderly aged 65 and over increased even more. Heatwaves will do great harm to infants, too. Besides the direct effects such as heat stroke and death, heatwaves can result in cardiovascular, cerebrovascular and respiratory diseases. It is reported that the mortality and incidence of heart diseases and hypertension will increase with the climate warming.

Take Nanjing (Located in the lower reaches of Yangtze River; Nanjing is one of the three furnaces cities in China with sweltering and wet weathers in summer. It belongs to the typical inland upland climate and often suffers from heat waves) for example. Study by Jin Yinlong et al in Nanjing found that In the year with more hot days, standardized mortality was relatively higher and the correlation coefficient was 0.832 (Fig.5-10).

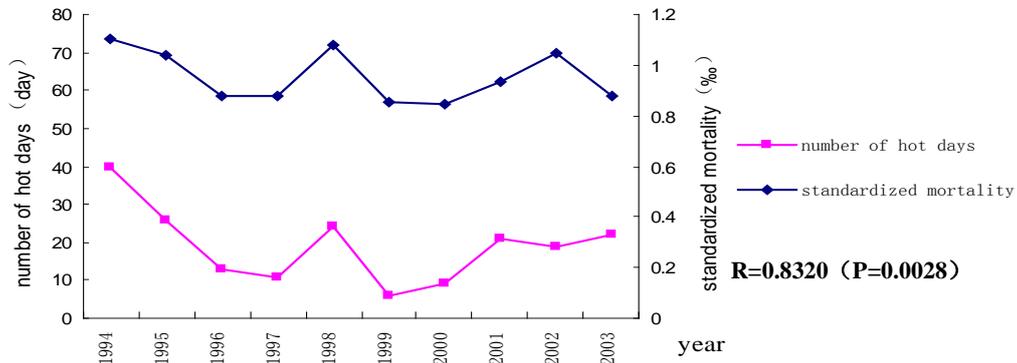


Fig.5-10 Relationship between numbers of hot day and the standardized mortality in every summer from 1994 to 2003

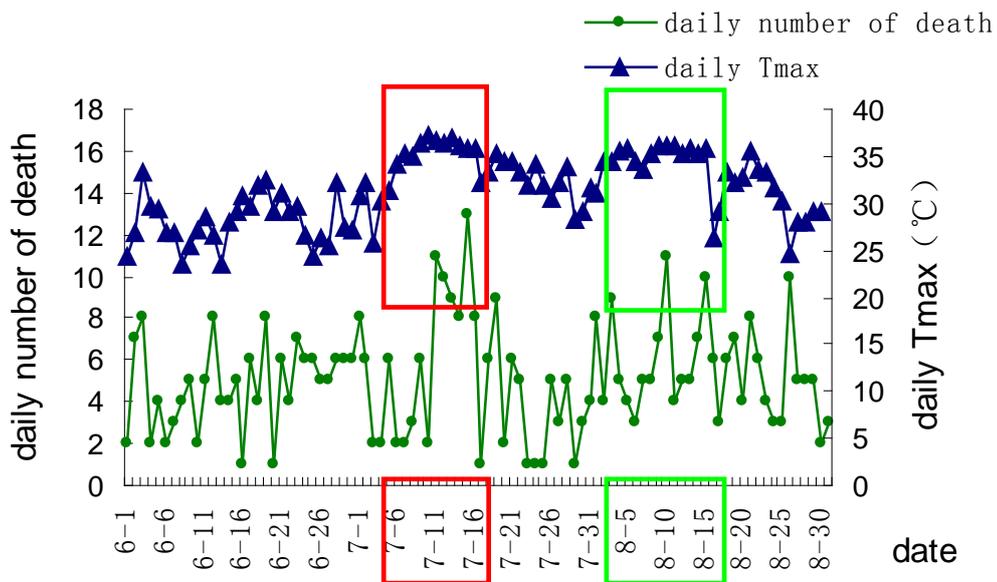


Fig.5-11 the relationship between daily maximum temperature and daily number of death in 1998

In the 10 years from 1994 to 2003, the ratio of average daily excess deaths in hot days to those in not hot days was 1.17, and the excess deaths in summer accounted for 2.5% of all the summer deaths of 10 years. In 1998, the excess deaths accounted for 11.3% of total number of deaths in the whole summer. There are two death peaks from July 6 to 16 and from August 4 to 15, with the first death peak greatly higher than the second. And in correspondence with this, Nanjing was also suffering from heat waves. From July 6 to 16 and from August 4 to 15, the average daily maximum temperature respectively was 35.6°C and 35.2°C with the highest temperature respectively being up to 37.2°C and 36°C (Fig. 5 -11), and the mortality for people

aged 60+ was much higher than that of others. For people aged 60+, the mortality variation was similar to those above, and two peaks of mortality ($p < 0.05$) were observed, but those of other ages were not (Fig. 5-12). It may indicate that the elderly aged 60+ were more sensitive to heat waves. All these may suggest that high temperature increase number of death, at the same time; people have heat endurance and adaptability in a certain degree.

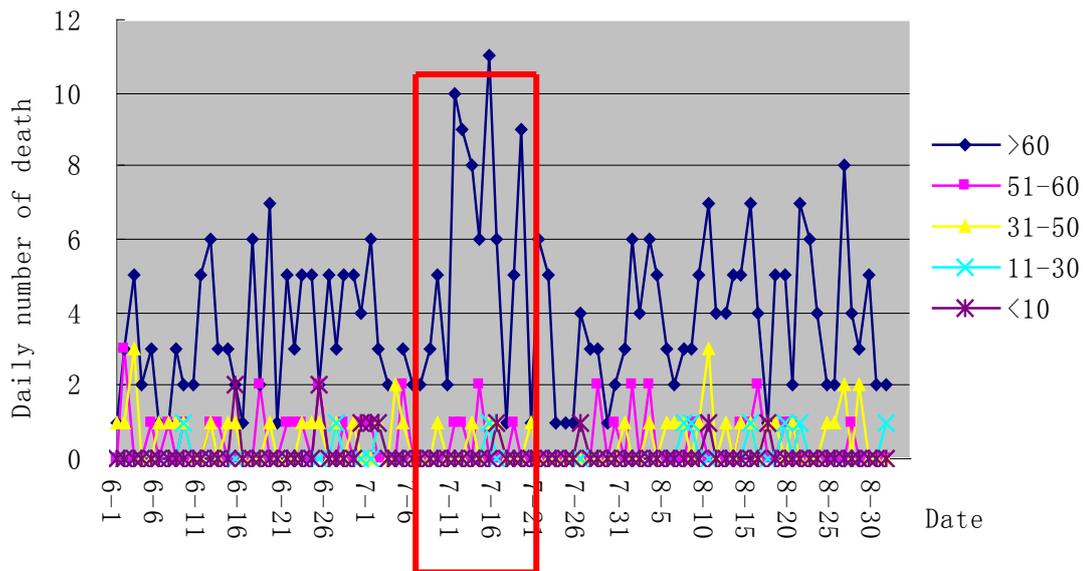


Fig. 5-12 the relationship between daily maximum temperature and daily number of death by age in 1998

4. Adaptive strategies and suggestions

People escape many climate-related extremes by using a wide range of physical and social adaptation measures. Seasonal changes in our clothing and lifestyles, the design of our buildings and other structures, and behavioral, social and economic adaptations have allowed us to remain generally healthy and comfortable except under the most extreme weather and climate conditions. Nevertheless, future climate changes will force people to deal with conditions beyond the range of historical experience. The adaptation strategies and measures related to the temperature change are mainly as follows:

4.1 Establishment of early warning and forecast system

4.1.1 Heat and cold early warning system

In china, according to the change of temperature, the government release three-level early warning signals include yellow signal, orange signal and red signal (see Module 8).

The system forewarns the different weather only from the perspective of air temperature and didn't take other meteorological factors and their influences on human health into account, whose guiding significances for protecting human health to adapt to climate change is very limited.

4.1.2 The early-warning and forecast system of heat wave

Many cities all over the world release the high temperature or heat wave alarm. Supported by WMO/WHO, Shanghai meteorological bureau and Health department cooperated with Delaware University of America to develop a health monitoring and early-warning systems of heat wave in Shanghai, the system's satisfying result of heat wave monitoring and early-warning ability.

Once the early warning of heat waves was released, people could reduce effectively the potential impacts of heat waves by adopting various adaptive measures. The public could receive the heat waves alarm by media such as broadcasting stations, television stations and newspapers. When the heat waves come, the public should try to arrange their activities in the coolest time of one day and at the shady and cool places. The public health department and media should enhance the education of the knowledge related to the heat waves especially for the risk population who are apt to affect by heat waves, which propagandizes how to defend against heat waves and protect people's health; The hospital and community service sections should make sufficient preparations. The departments of power supply and water supply should ensure the supply of electricity and water during the alarm period of heat waves; the residents should prevent sunstroke by turning on the air-conditionings, staying under the cool environments, slowing down the pace of work, reducing or canceling violent activities, and so on.

4.2 Develop the related policy

4.2.1 *The United Nations Framework Convention on Climate Change* and *Kyoto Protocol*

the Government of China has actively participate in the process of addressing climate change of International Community and fulfilled the obligations of the < United Nations Framework Convention on Climate Change> and the <Kyoto Protocol>, so play an active role in international cooperation.

4.2.2 *China National Climate Change Program* and *China's Policies* *and Actions on Climate Change*

On May 30, 2007, the Premier of State Council, Wen Jiabao presided over executive

meetings, the meetings considered and decided on the promulgation of the <China National Climate Change Program>. On October 29, 2008, the Chinese Government promulgated the <White Paper: China's Policies and Actions on Climate Change>, which comprehensively introduce the policies and efforts of China response to climate change, as well as the progresses and results of implementation of the <China National Climate Change Program>. It will have important guiding significance of response to climate change.

4.2.3 China National Environment and Health Action Plan (2007-2015)

Recent years, to adapt to climate change and promote the national work about environment and health, Ministry of Health together with other 17 Ministries have signed < China National Environment and Health Action Plan> and put the priority to the impact of climate change on health. In the < China National Environment and Health Action Plan> ,it is pointed out: To study the human health effects of climate changes in urban and rural areas in our country, especially the effects on various provincial and regional incidence of diseases which are sensitive to climate changes, to exploit and establish pre-warming systems of climate changes and health, emergency responding plans and related methods and techniques, to assess the effectiveness of the pre-warning systems and other intervention measures.

4.2.4 Other related policy

To further implement the Scientific Outlook On Development and further carry out "The State Council's decision on strengthening the work of energy saving" (The State Council issued [2006] 28), and to promote the use of air-conditioning scientifically, so that the use of energy resources could be economically, the emissions of greenhouse gas could be reduced and eventually the environment could be protect effectively, The General Office of The State Council issued a notice about some related problems on the strict implementation of the temperature controlling standards of public buildings' air-conditioning, the notice inform that, all units in public buildings, including the state organs, social organizations, enterprises, and individual industrial and commercial households (some special units, such as hospitals, and some approved users thanks to the specific requirements on temperature in the production process, are excepted), the indoor air-conditioning's temperature settings is not lower than 26 degrees Celsius in summer and not higher than 20 degrees Celsius in Winter.

4.3 Develop health education and improve the public awareness

Recent years, Chinese government have been strengthening education and propagation of the impacts of climate change on ecosystems and human health, Add the contents about climate change in the teaching, and through various media,

strengthen the publicity, education and training on the globe climate change, encouraging public participation to enhance the public awareness of protecting the global environment and climate, guide people to establish a life style and consumption mode that helpful for reducing greenhouse gases emissions and to learn about the direct and indirect effects of climate change on human health, to promote social and economic development.

5. Suggestions on future possible climate change adaptation responses to identified impacts in China.

5.1 Using scientific research methods and developing researches on the impact of climate change on temperature change

Using gradually more reasonable design and (or) statistical model. e.g. the time series using general additive models(GAMs) and the time-stratified case-crossover design; to explore the relationship between temperature and human health more accurately, other confounders(like relative humidity, air pollution, etc.) should be considered.

5.2 Strengthening the mechanism research and establishing gradually the monitoring system of impact of temperature change on health to establish the scientific and reasonable forecast system and provide the basis for taking effective intervention measures.

5.3 Strengthening multi-section, interdisciplinary cooperations and communications.

【Case study】

Case study on snowstorm and freezing disasters response

Global climate change is an indisputable truth, with the global warm, the frequency of extreme weather and climate events has been changing, under this background, the world is in the frequency period of the extreme weather and climate events, including the frequent attacks of the extreme snowstorm and freezing disasters. From January 2008, most parts of southern China and the eastern of northwest China emergence extreme weather such as continuing large-scale low temperature, rain, snow and extreme cold weather since the founding of state. The extreme weather disasters affected an extensive area, lasted for a long time, disaster intensity. There have 20 provinces (autonomous regions and municipalities) and Xinjiang Production and Construction Corps affected to varying degrees all of the country. Low temperature of frozen snow disasters give a great damage to the power and transport facilities, at the same time it give a great damage to people's lives and property, and caused substantial losses to industrial and agricultural production. In the towns of disaster area, water, electricity, gas pipeline (Net) and communications infrastructure has been damage to

varying degrees, the lives and safety of the people has being seriously threatened. According to the Ministry of Civil Affairs initially approved, the disaster caused a total of 129 people were killed and 4 people missing, 1,660,000 people were transfer placement peremptorily, 485,000 houses were collapsed and 1,686,000 houses were damaged. The total economic loss is up to 151.65 billion Yuan in direct.

The response of health departments:

- In the disaster area , the health administration departments and medical and health institutions at all levels strengthen the job duty to strictly enforce the 24-hour duty system and class system with Leaders
- The health administration departments at all levels take the initiative to strengthen communication with the meteorological department, civil aviation, railways and other departments, access to information accurately, improve the linkage mechanism between departments and implement contingency measures related to hygiene in time
- In the disaster area , the health administration department at the province levels implement weekly administration system, disaster hygiene emergency work in this region, such as disaster, disease, injury, disease and epidemic should be reported to the Health Emergency of the Ministry of Health in week
·the health administration departments at all levels were high concerned about the work of Health protection and the preventing and cure of diseases to the stranded passengers due to the disaster
- In case of passengers being stranded in places such as stations, airports, terminals, other personnel-intensive and rescue scene places, group medical team to send roving medical and health services to ensure that passengers, rescue workers, the sick can receive timely treatment
- Organize health supervisors went into temporary shelters for affected people to the strengthen the inspection and supervision of the food, drinking water to prevent the occurrence of food poisoning case

【Exercises】

1. Experience and insufficiency that health sections have acquired in protecting human health to response to temperature change.
2. Priority of next work on protecting human health to response to temperature change.

【Recommended readings】

China's National Assessment Report on Climate Change. Science Press, 2007/3/27

China Climate Change Info-Net <http://www.ccchina.gov.cn/cn/>

Chinese Climate Change Network <http://www.ipcc.cma.gov.cn/cn/>

Liu fang, Zhang Jinliang, Lu chen et al. The relationship between temperature and the incidence of acute coronary events in Beijing: a time-series approach. *Environ. Health*, 2005, 22(4), 252-255.

Tan Jianguo, Huang Jiaxin. The impact of heat waves on people health and the research methods, *Climatic and Environmental Research*, 2004, 9 (4):680-684

DANET S, RICHARD F, MONTAYE M, et al. Unhealthy effects of atmospheric temperature and pressure on the occurrence of myocardial infarction and coronary deaths. A 10-year survey: the Lille-World Health Organization MONICA project. *Circul*, 1999, 100(1): E1-E7.

Haidong Kan, Stephanie J. London, Honglei Chen, et al. Diurnal temperature range and daily mortality in Shanghai, China. *Environmental Research* 2007

MODULE 6

The Impact of Climate Change on Water Resource and Public Health

The Impact of Climate Change on Water Resource and Public Health

【Learning Objectives】

1. To provide an understanding of national and international studies which referred to the impact of climate change on water quality and water-related health problem.
2. To provide an introduction to current prevention and control measures for safe drinking water and public health against climate change and to discuss necessary future measures.
3. To provide an understanding of local vulnerability and the impact of climate change on drinking water and health in the future.

【Text】

1 Impact of climate change on water resource

With global warming, atmospheric circulation and the process of hydrological cycle will accelerate. The quality and space distribution of water resource will be effected directly. As the result of the impact of climate change, the region, time and inter-annual distribution of precipitation will be greater imbalance. At the same time, the quality of fresh water also could be decline due to the increase of water temperature. The impact of climate change on water scarce, water quality and the frequency and strength of flood and drought will brought about a greater challenge of water resource management system, especially in the regions with weak water management which are more vulnerable when climate change brought a negative impact.

1.1 The impact of climate change on the distribution of global water resource

Climate change causes extremes in weather patterns which are most visible through changes in global temperatures and precipitation. These extremes greatly influence the quantity of water. Increased temperatures accelerate evaporation, causing melting of mountain glacier, and arctic ice as well as snow line shifting. Globally observed decreases in snow and ice are consistent with rising temperatures. Satellite data since 1978 show the annual average Arctic sea ice has shrunk by 2.7% (2.1% -3.3%) per decade, with larger decreases in summer of 7.4% (5.0% - 9.8%) per decade. Currently, the rising of sea-level in global was at a speed of about 1.7 mm per year. It will result in groundwater salted in larger area, the reduction of freshwater and acceleration of

the erosion of the coastal zone, and the increase of flood risk. Globally, from 1900-2005, rainfall has increased significantly in Eastern parts of North and South America, Northern Europe as well as Northern and Central Asia. While during this same period, rainfall declined in the Sahel, the Mediterranean, Southern Africa and parts of Southern Asia.

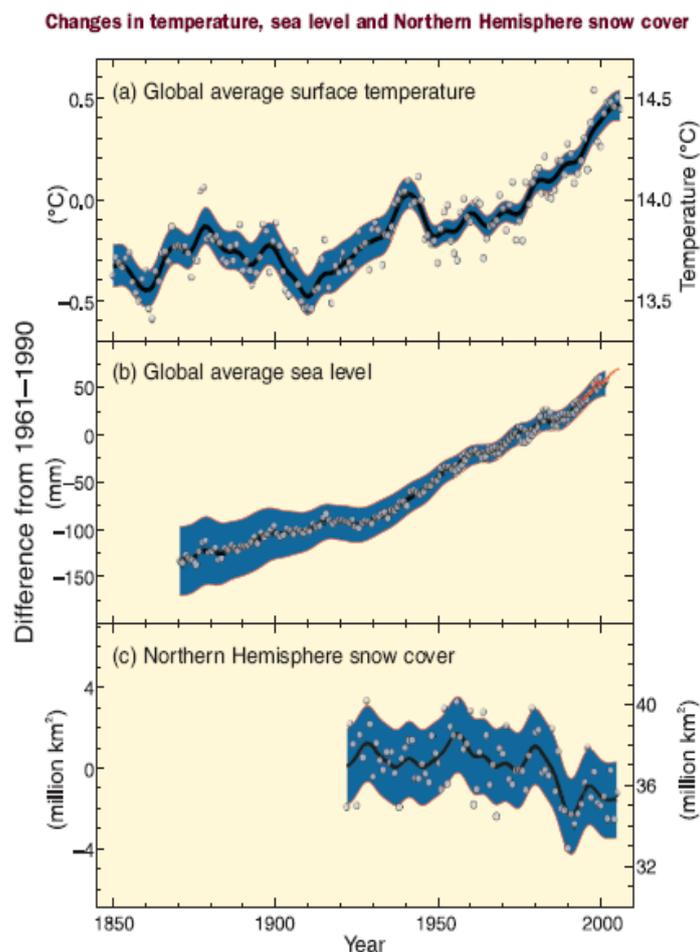


Fig 6-1. Global temperature, average sea level and Northern Hemisphere snow cover

Since 1850, some data can be observed as following according to the global surface temperature information-measuring (a) global average surface temperature change, (b) changes in global mean sea level, (c) the Northern Hemisphere snow cover change between March and April , all changes in the difference are relative to the corresponding average data been measured between 1961 and 1990. The smooth curves of figure 1. shows a decade averages, the dots shows annual means. Shaded areas means uncertainty interval obtained by comprehensively analyzing and estimate of the known uncertainties (a and b) and time series (c). The blue and red in Figure(b) respectively shows tide gauge data and the satellite monitoring data.

More and more evidence shows that climate change is likely to have effects on the hydrological system as following:

✧ Because through-flow of rivers water supplied from glaciers and snow increase

and the largest flow in the spring advance, and some hydrological systems have been affected, the warming of rivers and lakes impacts its thermal structure and water quality;

- ✧ In terrestrial ecosystems, the study shows that: the timing of the events in spring put forward and plant growth and animal activity move toward the poles and high altitude all are related to the recent warming. In some marine and freshwater systems, some studies showed that, the migration and change of a large number breeding scope of algae, plankton and fish are related to the rising of the water temperature and the changes in ice cover, salinity, oxygen content and circulation;
- ✧ Existing research results indicate that the occurrence frequency of heavy precipitation events in most areas will significantly increase in the future, while the average precipitation in some areas will be reduced. More frequent and more severe floods and droughts will have a negative impact on sustainable development, and the resulting flood risk has posed a serious challenge to the entire community, including the protection of infrastructure and water quality;
- ✧ Possibly up to 20% of the world's population will live in the flood and rivers increased areas until the 80's in the 21st century. In the coastal zone, salinization of groundwater increased and sea-level rise would exacerbate the shortage of water resources.

1.2 The impact of global climate change on water quality

The change of the distribution and quantity in water resources as well as impact the changes of the water quality, and the quality and quantity of water closely linked with each other. Climate change lead to that the global distribution pattern of water become more and more unstable, more and more natural disasters (floods, typhoons and drought) in turn pose a threat to water quality, as shown in Figure 6-2:

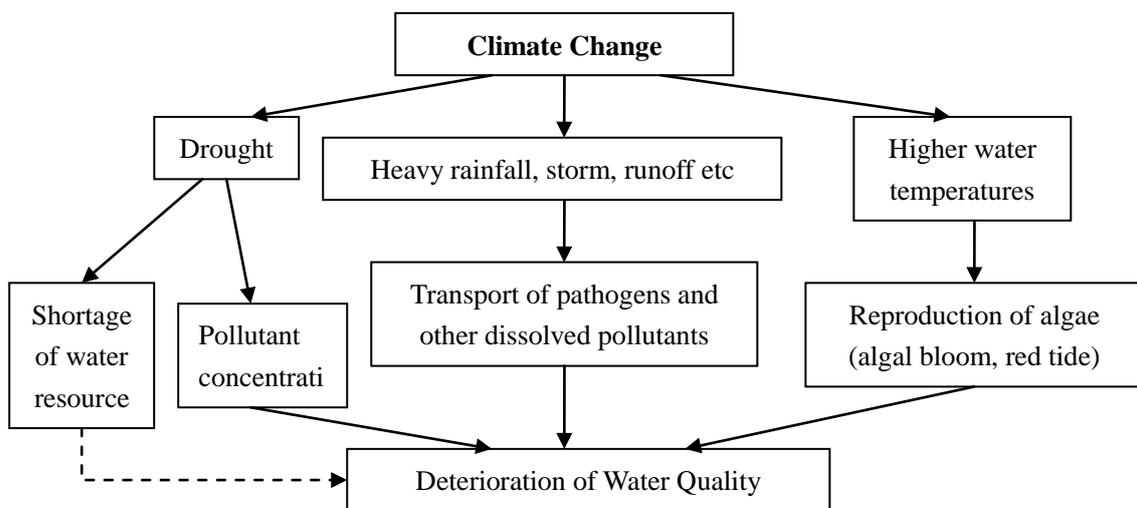


Fig 6-2. The impact of climate change on water

1.2.1 The intensity of precipitation increased by climate warming will lead to deterioration of water quality, because the heavy precipitation strengthen the spread of pathogens and other pollutants (eg. pesticides) in surface water and groundwater, as well the erosion, the dissolved of adsorbed pollutants, such as phosphorus and heavy metals. In addition, frequent heavy rains could cause the sewer system, water supply and sewage treatment plants frequently work overload, resulting in the dilute ability of pollutants reduced, and the higher concentration of pollutants, including pathogens.

1.2.2 The deterioration of water quality will worsen in the overall run-off areas (for example, in many semi-arid areas). The study showed that after climate warming, some regions of the world as a result of increased evaporation, water flow tends to reduce, so that the existing pollutants in the river has been "concentrated", and this increased the existing level of pollution of rivers, especially in dry seasons (Arnell, etc., 2004). At the same time, the rising of the water temperature, also will increase the solubility of heavy metals in the form of sedimentation, and promote the pollutants sedimentation in rivers re-dissolve and release, so that deterioration of water quality. In addition, the drought can lead to a lack of fresh water resources, especially the severe drought in some areas, and may lead to people were forced to the develop and use the back-up or poor quality water resources.

1.2.3 At the same time, higher temperatures will further affect the physical, chemical and biological characteristics of the fresh water lakes and rivers, and have an adverse impact on many freshwater species, community composition and water quality. Warming may lead to the rising of the lake water temperature, thereby reduce the oxygen concentration and increase the sediment release of dissolved phosphorus, causing eutrophication, algae propagation, and caused water bloom or red tide.

1.3 Impact of Climate Change on Water Distribution in China

Climate change has already caused major changes in water resource distribution in China. Over the past 40 years, a decreasing trend in runoff has been observed in the main rivers of China; namely, Haihe, Huaihe, Yellow, Songhuajiang, Yangtze, and Pearl River. There is evidence suggesting an increase in the frequency of hydrological extreme events which predicts droughts in the North and floods in South of the country.

1.3.1 Impact on River Runoff

The results of significant analysis show that since the 1950s, particularly from 1980, the runoff of the six major rivers measured was in a downward trend. The runoff of Haihe River valley had obvious reduction when comparing the runoff before and after 1980. Since 1980 it has decreased 40-70%. As shown in Figure 6-3.

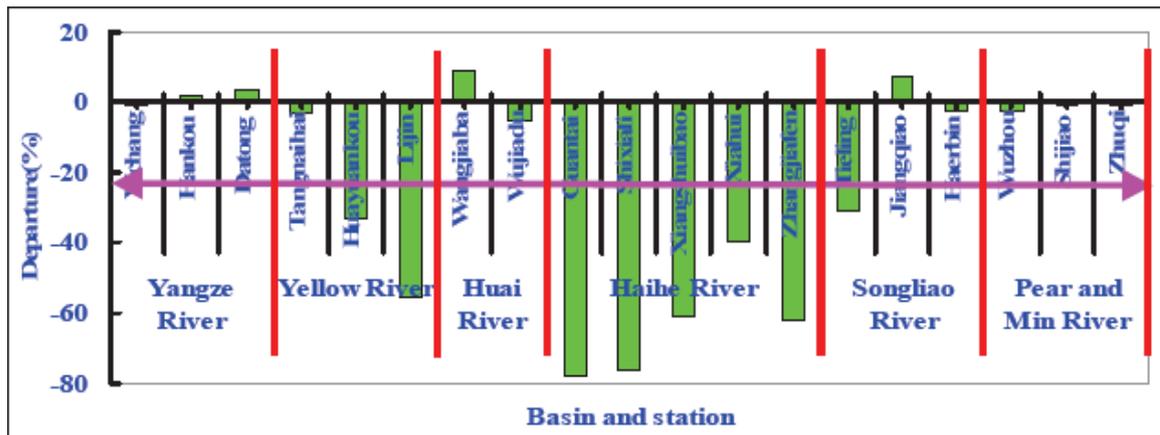


Fig 6-3 Annual runoff change comparing 1981-2004 to 1950-1980

With decreasing trend in most of rivers

Remarkable decreasing: Haiheriver, Yellow rive, Liao river

Slight decreasing: Huaihe, Songhuajiang, Pearl, upstream of Yangtize

Slight increasing: down-stream Yangtize, upstream of Huaihe

Many studies support the conclusion that the runoff change of major rivers may attributed to climate change and climate variability. But whether the run-off changes in the past was the response to global warming or global climate change is still unclear. But the fact is that runoff reducing causes lasting drought in the North. All of this will make the situation of the lack of water resources even more serious, which in turn will make further deterioration of water quality and safety of drinking water more difficult to protection. Because of storm surges, floods, heavy rainfall and so on, drinking water may be polluted by all kinds of intestinal pathogens or other pollutants, and the incidence of water-borne diseases will increase greatly

1.3.2 Impact on Precipitation

As global warming lead to higher rates of evaporation and rainfall, high temperatures, storms and other extreme events will become more frequent, more precipitation will occur in a short period of time, hence the intensity of rainfall will increase. Recently, some studies have pointed out that in China the extreme precipitation is becoming longer and stronger. The average intensity and the extreme precipitation values have increased. And there are more extreme precipitation events, especially in the 1990s, the proportion of extreme rainfall trends increased (CNCCP, 2007). There are frequent floods in some areas, particularly since 1990, the Yangtze River, Pearl River, Songhua River, the Huaihe River, Taihu Lake, both for the Yellow River floods occurred repeatedly.

1.3.3 Snow, land ice and sea-level

Since the 1950s, the coastal sea level in China has risen by an annual 1.4 mm ~ 3.2mm. The climate change and the rising of sea-level has have effect China's coastal zone. Storm, floods, heavy rainfall, drought and other extreme weather events have caused more obvious disasters in the coastal areas. Also Northwestern region is both more dry and hot, while the ice grades in the Bohai Sea and the Northern part of the Yellow Sea will drop. The glaciers area in the Northwest has been reduced by 21%, Tibet's permafrost has thinned in 4 m ~ 5m, at the most,

surface of some inland lake in plateau higher, and southwest in China, Qinghai and the Sanjiang Plain wetlands area reduced with functional declining (CNARCC, 2007)

1.3.4 Forecast future trends

According to “China’s National Climate Change Programme” published in 2007, June, the trend of global warming in China will further intensify in the future. Projections by Chinese scientists indicate that:

- ✧ Precipitation in China will possibly increase during the next 50 years, with a projected nationwide increase of 2~3% by 2020, and 5~7% by 2050. The most significant increase might be experienced in the southeastern coastal regions;
- ✧ The possibility of more frequent occurrence of extreme weather/climate events would increase in China, which will have immense impacts on the socio-economic development and people’s living; In Southern China, there will be more and more rainy days, particularly in the western region of Fujian and Jiangxi, and southwest of Guizhou, Sichuan and some areas in Yunnan. There will be heavy rain and the climate trends to worse. On the other hand, the forecast also shows that the future will increase the intensity of typhoons. China will likely be affected by stronger typhoons.
- ✧ The arid region may also expand and intensify. The arid areas in China will probably become larger and the risk of desertification might increase.
- ✧ The sea level along China’s coasts will continue to rise and the glaciers in the Qinghai-Tibetan Plateau and the Tianshan Mountains would retreat at an accelerated rate, and some smaller glaciers will disappear.

1.4 Impact of climate change on Water Quality in China

China has built automatic water quality monitoring stations on Songhua River, Liaohe River, Haihe River, Yellow River, Huaihe River, Yangtze River and Pearl River and so on, which can carry on the real-time continuous monitoring and the long-distance monitoring to the water quality. According to our country monitors on seven big river system's 183 rivers and 376 cross section, it indicated that the water quality of Pearl River, Yangtze River is better, that of Yellow River and Songhua River is poor, pollution in Haihe River, Liaohe River and Huaihe River is worse. The main contamination index is the BOD, the permanganate index, the ammonia nitrogen and the petroleum class. In recent years, with the improve of system on monitoring water quality, The implementation of water conservation measures are effective, the overall quality of China's seven major river systems have been improved accordingly.

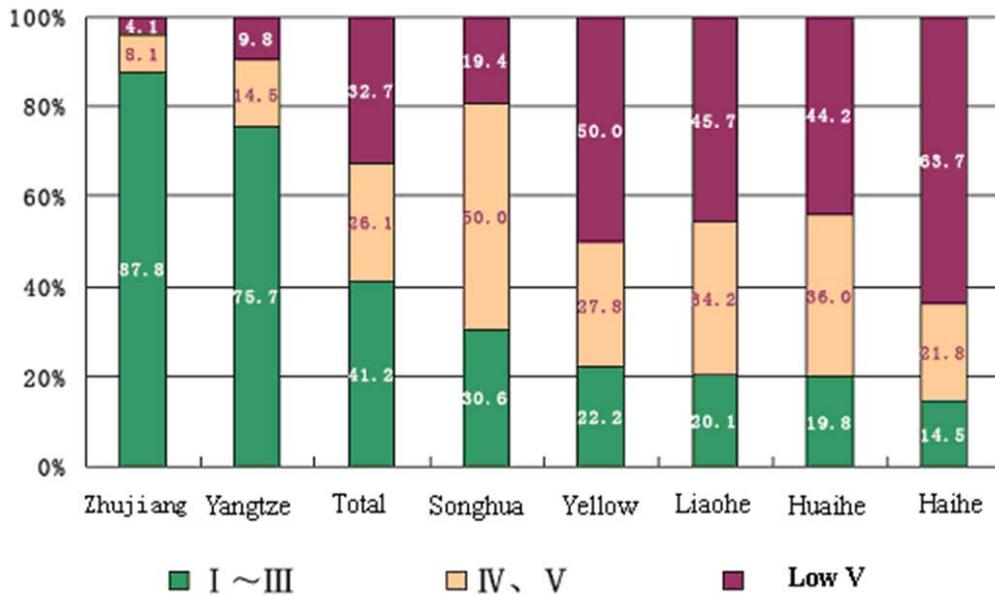


Fig 6-4 Water quality in Seven major River in China ,2002

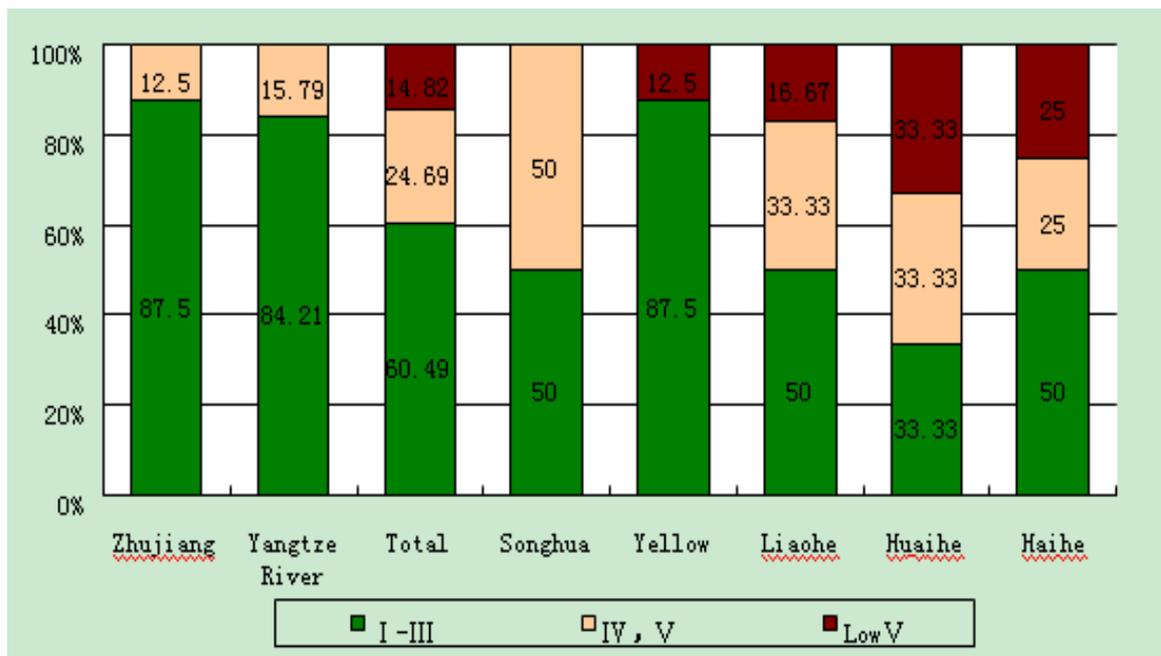


Fig 6-5 Water quality in Seven major River in China ,2009

1.4.2 Eutrophication and cyanobacteria

In local areas, climate change may have adverse effects on the quality of lakes and rivers. In the summer of 2007, there were successive outbreaks of cyanobacteria in lakes and rivers, such as Tai Lake in Wuxi, Chaohu Lake in Anhui, Dianchi Lake in Yunnan, East Lake in Wuhan and so on. Take the outbreak of cyanobacteria in Tai Lake as an example. It was said that global warming was the main reason. Because of global warming, the average water temperature in Taihu Lake was 19.56 Celsius in

April 2007, which is the highest temperature it had been in the past 25 years. In addition, less rainfall had provided fitting conditions for algae outbreaks.

Due to the impact of climate change, higher water temperatures in freshwater lakes and rivers impact the physical, chemical, and biological characteristics of the water resulting in adverse effects on many freshwater species, communities and constituents. Some



Fig 6-6 An outbreak of cyanobacteria in Taihu Lake

research has shown that eutrophication of lakes and red tide is caused by the increase of nitrogen, phosphorus and other nutrients in water. In particular, phosphorus pollution is the limiting factors of the eutrophication. Climate change has impacted the biogeochemical cycles of nitrogen, phosphorus and other nutrients, especially through influencing the precipitation changes, so the situation of non-point source pollution worsens. With climate warming, microbes in the soil will be more active, resulting in declining soil fertility, leading to the excessive use of fertilizer such as nitrogen, phosphorus; on the other hand, they also led to the acceleration of nitrogen, phosphorus and other chemical fertilizers in the water body. Therefore, the climate change will lead to further exacerbation of the eutrophication of lakes and red tide of oceans finally

1.4.3 Natural disasters destroy water supply system

Because of the climate change, extreme climate events occur more frequently which lead the increment of natural disasters (such as flood and drought). Natural disasters may destroy water supply system and then threaten water quality. The scale of water supply system is very small and the system is very poor in western areas or some rural areas, so, these areas are more susceptible to be affected by extreme climate events and the quality of drinking water will be declined.

1.4.4 Others

Because of the climate warming, sea levels raise. This results in coast erosion and seawater invasion, and it also leads to large scale of sea water encroachment, which results in serious water pollution and the aggravation of the shortage of fresh water resources. Exploiting underground water for a long time may lead to the decline of groundwater level and gradual exacerbation of water quality.

2. Impact of climate change on water-related health

Global warming and its impact on water and the environment are indisputable. The impacts of climate warming on the distribution and quality of surface water, may lead to flooding, destruction of underground drainage systems, water shortage, and a collapse of basic hygiene. In turn, they will cause epidemics of diarrhea (including cholera and dysentery), especially in places of poor health facilities. Many bacteria and viruses can cause diarrhea, which can survive in water for several months, particularly in warm weather conditions. Pathogens spread more easily under greater and heavier rainfall, which will cause an increase in diarrhea cases, in particular of poor health facilities.

2.1 An International Perspective

According to the statistics of WHO, there are more than 1.7 billion people without adequate access to safe drinking water, more than 30 million people without adequate sanitation and in the third world an average of 2.15 million people are killed daily by water-borne diseases. According to the World Health Organization (WHO) reports, it estimates that about 4 million annual dysentery cases, of which about 94 percent are caused by unsanitary water and water-related health conditions. Around the world, 1.5 million children die of diarrhea each year. Most of them are less than 5 in developing countries.

The rise of temperature and the frequent of extreme climate events have resulted in an increase in natural disasters such as floods and droughts. Natural disasters exacerbate health concerns and uproot health national healthcare infrastructure. Floods, storm and other extreme weather events may easily led to deterioration of normal clean water. The confluence of drinking water and sewage may pollute the well and surface water at the same time and led to the risk of water-borne disease. Especially in the densely populated low-lying areas, the prevalence of such diseases will be a greater risk. Meanwhile micro-organisms can be rushed into the valley and accumulate in the coastal regions. In 1997-1998, El Nino led to serious floods in Peru, Ecuador, Argentina and Uganda. The average daily rainfall in these areas was as high as 75-125 mm along with the surrounding atmosphere and ocean temperature changes, the incidence of water-borne diseases highly increased.

In South Pacific region, there is a positive correlation between an average temperature and the incidence of diarrhea. Another example is in Latin America and the Caribbean. There are different climate zones in this area, so it is more vulnerable to climatic natural disasters. From 1970 to 1999, 70 percent of natural disasters were related to the specific topography and the climate of this area and flooding was the most serious and the key disaster. In addition to topography, densely populated also compounded the vulnerability to the climate change. In this area, about 60 percent of the population inhabited in coastal areas and 70 percent of 77 large cities located in seaside region. 30 natural disasters including typhoon, flooding, drought, tsunami and

so on happened from 1970 to 1999. These natural disasters potentially increased the incidence rate of waterborne diseases through various forms.

2.2 A National Perspective

Due to global climate change, the occurrence of extreme climate events increase and drought and flooding caused by uneven distribution of precipitation and abnormal changes in temperature occurs more frequently. The impacts of climate warming on the distribution and quality of surface water, may lead to flooding, destruction of underground drainage systems, water shortage, and a collapse of basic hygiene. Because of the poor health facilities of China, it is easier to give rise to the eruption and prevalence of water-borne infection.

2.2.1 Casualties caused by extreme climate events such as flooding and drought

According to the statistical data of flooding from 1950 to 2003, 4962 died of flooding in annual national average level. Along with the construction of the system of flood control projects, the number of casualties caused by floods was gradually reducing over the nearly 20 years. Some areas of southern often subjected to severe flooding rains, for example, a catastrophic flood happened in Huai River drainage area in 2007. According to incomplete statistics, 119,150,000 people were affected, 652 people died of the flooding and direct economic loss was up to 52,500,000,000. At the same time, drought is also a major problem in China. According to statistics, before 1949, drought occurred once every 2 years in average. In the last 50 years, it is said that drought tends to increase gradually, especially since 1990s, the drought-hit region expands from the traditional northern and western regions to some wet areas in the south and east. In 2000, there is severe drought in most regions in China, resulting in more than 4,000 million hectares of crops affected, with total destruction of 8,000,000 hectares, and led to more than 300 county-level cities and towns were forced to limit time-limited water supply. More than 2600 million people in total were affected. Serious drought happened in Sichuan and Chongqing in 2006 caused 18,870,000 people had drinking water problem, more than 3.2 million hectares of crops affected, 7.127 million hectares of areas without output and direct economic loss was up to 1.5 billion yuan. In the same year, varying degrees of drought occurred in Hubei, Hunan, Guizhou, Yunnan, Shaanxi, Gansu, Ningxia and Qinghai. 8.889 million people had drinking water problem, 4.297 million hectares of crops affected with total destruction of 747,000 hectares, direct economic loss was up to 11.51 billion yuan.

2.2.2 Impact of climate change on water-borne diseases

At present, the researches on the impact of climate change on public health related to water are limited. Then, there is a brief introduction of several common water-borne

diseases in China. More related information about the impact of climate change on water-borne diseases can be found in module 4 Vectors and Health.

1) Cholera: Climate change, such as warming, increased rainfall, frequent floods, storms and rising sea levels, may cause cholera outbreak. In our China, Cholera is still popular. In 1994 and 1995, the epidemic areas of cholera, expanded to two provinces northward, respectively.

2) Schistosomiasis: In China, it is believed that the North boundary area for a Schistosomiasis epidemic is latitude $33^{\circ} 15'$. Climate changes caused by global climate warming, such as the rise of minimum air temperature of winter and the increased rainfall, made the snails were possible to move northward. At the same time, large-scale water conservancy projects which divert water, from the South to the North, may also make snails in the water moved northward. Therefore, Schistosomiasis could spread northward, expanding its regional scope, while increasing its prevalence in areas already endemic.

3) Leptospirosis: Jiangxi is the most serious provinces of Leptospirosis epidemic with higher incidence rate over the years. Many researches show a certain relation between the incidence of Leptospirosis and the average temperature from 1973-1998. And this suggests that with the climate warming, the survival of Leptospirosis will be possible in some regions which were originally unsuitable, allowing the scope of Leptospirosis to expand.

4) Typhoid: Typhoid, which often show sporadic outbreak, mainly are caused by drinking water and food contamination. Since 1951, China has had reports of Typhoid epidemics. The highest peak of epidemic was recorded in 1959, and the incidence rate was 31152/100 000. There were subsequently two small peaks, the incidence rate was 25199/100 000 and 13146/100 000 in 1970 and 1992 respectively. In 2002, the incidence of typhoid fever dropped to the lowest recorded level (3181/100 000). It indicated that climate change, causing warming and leading to an increase in rainfall, drinking water pollution, all indirectly results in the outbreak and spread of typhoid epidemic.

2.2.3 Others

Climate change leads to the rising of air and water temperatures, the excessive growth of algae and plankton. In recent years, the cyanobacteria occurring frequently in China, there are many lakes and river systems are facing the problem of microcystin(MC) which is proved to be a carcinogenic promoting agent. Therefore, the drinking water and aquatic products polluted by microcystin (MC) are huge threat for human health. Microcystin (microcystin, MC) exposure may cause liver damage. Studies have shown that the abnormal liver enzyme indicators of crowd serum, is not only due to infection by the hepatitis B virus, but also to the pollution of MC in drinking water. A survey focusing on the relationship between drinking water polluted by MC for long-term and primary liver cancer (PLC) increased morbidity show that

the PLC incidence rates were 100.13/105 and 4.28/105 respectively for people drinking ditch water and well water. And water sample analysis shows that MC in ditch ponds was significantly higher than that of well water.

3. Adaptation Measures

In China, there is not only a lack of water resources, but also a fragile water resources system, often subjected to severe floods and/or drought, which only furthers water systems vulnerability. The impacts of climate change will alter water quality and supply, in turn supply, demands, and management will also change.

3.1 Improve Water Resources Management Systems through Related Policy Frameworks

Regarding climate change and water resource management, some planned adaptations are already occurring on a limited basis in the international community, address renewable technologies and strategies, such as, expanded rainwater harvesting; water storage and conservation techniques, water reuse, desalination, water-use and irrigation efficiency, safety drinking water and improvement of sanitation. All of which are supported by key policy frameworks, including National Policies on Water, Integrated Water Resource Management, and Water-related Hazards Management.

In order to protect water resource and make sure drinking water safety, five ministries of the State Council jointly issued the city safety drinking water protection planning (2006-2020). Besides, there is a series of Laws, Regulations and Standards below which support this notion.

- ✧ *Law of the People's Republic of China on Prevention and Control of Water Pollution* (amended February 2008).
- ✧ *Environmental Quality Standards for Surface Water (GB3838-2002)*
- ✧ *Integrated Wastewater Discharge Standard (GB8978-1996)*
- ✧ *Hygienic Standard for Drinking Water (GB5749-2006)*
- ✧ *Measures Concerning Supervision of Drinking Water (in 1996)*

3.2 The program and construction of water conservancy infrastructure

In order to deal with problems such as climate change, flood calamity, uneven distribution of water resource, and so on, and strengthen the programming and construction of water conservancy infrastructure, as well as water resource controlling project(reservoir), irrigate field construction and rebuild, there are several water resources projects being carried out, such as, the Three Gorges Project Corporation and South-to-North Water Diversion Project. They are guaranteed scientific

management of freshwater, optimized the distribution of water resource, and ensured can be better coped with flood and drought.

The total distribution of South-to-North Water Diversion Project is: divert water from the Yangtze River upstream, midstream and downstream in order to adapt to the development needs of the northwest, north China, that is, the West line, the midline and the east line of South-North Water Diversion Project. South-North Water Diversion Project at the eastern, central and west three water diversion lines. After the completion, it will linked with the Yangtze, Huaihe River, Yellow River, Haihe form the overall pattern of China's water resources that is "three vertical and four horizontal, the deployment of the North and the South East and West each other relief".



Fig 6-7 the total distribution of South-to-North Water Diversion Project

3.3 Surveillance and

Investigation of Drinking Water

From 1983 to 1988, the National Organization of Patriotic Health and the Ministry of Health in carrying out a national drinking water quality and water-borne disease investigation, published the "Atlas of China's Drinking Water."

In 1992, China implement rural drinking water quality in the health monitoring, through the efforts of more than ten years, initially establish the monitoring network of China's rural drinking water quality.

July 2006 -2007 in November, the National Patriotic Health Campaign Committee, the Ministry of Health jointly organized a investigation of national rural drinking water and sanitation status, so carry out large-scale survey research aimed at rural areas drinking water and sanitation. Chinese Center for Disease Control and Prevention technical guidance of rural water (Water-improving Center) and the Ministry of Health Statistical Information Center take for the technical work to guide the investigation. Survey in 31 provinces, autonomous regions and municipalities and Xinjiang Production and Construction Corps, using a stratified random method, totally investigating 657 counties, 6590 villages, 65839 families. Survey content includes the basic situation of the rural drinking water, drinking water sample testing, lavatories rebuilding and excreta disposal in rural areas and the release of rural waste, sewage and so on.

In 2007, the Ministry of Health organized the monitoring experimental network of

urban drinking water health, the Chinese Center for Disease Control and Prevention on Environment and health related products is responsible for the safety of technical work, selecting Beijing, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Hunan and Guangdong seven provinces and cities pilot projects, establishing drinking water quality monitoring and water-borne diseases surveillance spot, including the municipal water supply treated water units, peripheral water and secondary water supply quality monitoring, self-built water supply facilities, the local Water-borne disease-related data collection and water-borne disease surveillance. In August 2008, urban drinking water health monitoring network increase including Hebei, Jilin, Fujian, Sichuan, Chongqing, Gansu, Qinghai and Ningxia Hui Autonomous Region, the expansion of the pilot regions to 15 provinces and municipalities.

In February 2008 the National Patriotic Health Office is responsible for organizing the Monitoring of National Rural Drinking Water Quality Health, Chinese Center for Disease Control and Prevention of rural water-improving technology center provides technical support. In 31 provinces, municipalities and autonomous regions and Xinjiang Production and Construction Corps of the county to select a representative monitoring points and to carry out monitoring of drinking water quality, and monitoring of infectious diseases, through the surveillance network of infectious and the surveillance network of all causes of death, so as to collect the information of water-borne diseases occurrence of epidemic-related disease in rural areas.

4. Gap analysis

4.1 Strengthen the influence of water resources and related health effect caused by climate change

A large number of weather observation and forecasting record evidence that the fragility of the world's freshwater resources are likely to be have a strong impact by climate change. However, the future impact of climate change on the hydrological system is very difficult to quantify. Further study of the current hydrological changes' detection and attribution, especially it is necessary to study the water resources change and extreme events impact factors. On the other hand, we know about the impacts of climate change on water quality and on human health problems, so it must be strengthened, in particular the impact of climate change on extreme weather events. In recent years, there has been carried out a number of internationally study, such as based on the El Nino events and climate-related research, attempting to look at the relationship between rain / flooding and infectious diseases. In China, related research is still limited, the current research in this field is mainly related to the relationship of climate change (temperature and humidity) and water-borne diseases (such as schistosomiasis, cholera, leptospirosis, etc.). In-depth study the influence of climate change on water resources and related health effects, and it is very significant for the scientific management and rational deployment of water resources, the assurance of

drinking water security and the promotion of human health.

4.2 Lack of the perfect information shared system

Further developing the research work of climate change on water resources and health effects will need multi-disciplinary and multi-sectoral cooperation and the sharing of information resources. Take the water quality monitoring in China as an example, the Ministry of Construction, Ministry of Water Resources, Environmental Protection Department and the Ministry of Health segregate the duties in accordance with its level of the water quality monitoring, such as sharing information, but the system is still not perfect, because it is lack of appropriate information exchange platform, mainly related to the lags behind legislation of sharing information resources in China, technical standards are imperfect, some departments of local information is still in a limited extent. In recent years, China's information technology construction has made significant progress, but the development and utilization of information resources is still far behind the network infrastructure and application systems. All of these have constrained the development and utilization of information resources, as well as the exert of comprehensive benefits of information technology. For these problems and difficulties, both need to attract further attention.

4.3 Pay attention to the impact of climate change on China's water resources, take action actively

Water resources and quality in China has been affected by global climate change. And there is a series of new issues which require attention, a positive response. In recent years, precipitation has reduced in some regions of China. Drought occurs from time to time because of surface water lack. In these arid areas, especially in some cities, groundwater is more and more important as the main sources of water. And excessive exploitation and use of groundwater, coupled with reduced groundwater recharge, results in a series of potential water quality problems. For example, in some coastal areas, because of excessive extraction of underground water, the level of groundwater dropped, which results in seawater intrusion and alkalization of groundwater. Meanwhile, groundwater may be polluted by a variety of chemical substances due to wall leakage as the result of excessive extraction. The industrial wastewater, domestic wastewater may infiltrate underground aquifers seeping in wells, pits and rivers. The industrial wastes and emissions, urban garbage and solid waste can seep into groundwater after leaching by rain or surface water, then lead to deterioration of groundwater quality. To deal with these problems, the exploitation of groundwater should be limited reasonable. In addition, the monitoring of groundwater quality is important to carry out actively.

【Case Study】

Water Cellar for Mothers

" Water cellar for mothers " is a concentrated water supply project, which is a charitable project launched by China Women's Development Foundation in 2001. The project focuses on helping people of the western region, especially women to get rid of poverty and backwardness from serious water shortages.

1. Issues with rural drinking water security in arid areas

1.1 Extreme shortage of water resources

Due to natural and historical reasons, water scarcity is extremely serious in the areas of the Loess Plateau in northwest China including Gansu, Ningxia and northern Shaanxi area. Take Ningxia for example, the per-capita quantity of the water resources there is less than 200 cubic meters, which is about 1/12 of the average per-capita quantity in China 2200 cubic meters. In those areas, people built containers in the ground for rain water collection, known as the cellar. Almost people and animals have to use water entirely from the limited rainfall. Without sufficient funds for hardening the cellar inside with concrete, the collected water will soon leak.



Fig 6-8 Collect rain water for live in arid

1.2 Poor water quality

The production and life use all depend on the cellar and small pools to harvest rainwater, but this kind of water is relatively turbid, more sediment, heavier mud smell, in some places the ammonia nitrogen, total phosphorus, chemical nitrogen, the amount of coliform bacteria, turbidity and pH value of cellar water are serious overweight. So it is hard to match the drinking water standards and the water quality is extremely critical.

1.3 The impact of climate change

Global climate change will affect the north-west. So in the region, the phenomenon may occur frequently that drought in long-term and heavy precipitation in short-term. The fragile ecological system in Northwest region will deteriorate in the further with serious water and soil loss.

2. Adaption Measures

2.1 Cellar reconstruction

China Women's Development Foundation has implemented a "Mother Water Cellar" project among the community to raise money for the dry areas of the north-west to build concrete structures cellar, making use of roof, yard, ditch slope, etc. effectively collect the limited rainwater for basic drinking for a year.

2.2 Carry out water quality monitoring

As for the drought, the water supply and quality for rural residents and the drinking water safety has been a great threaten. The water quality is a critical factor to affecte the gastro-intestinal infections and other water-borne diseases. Carrying out health monitoring is the important measures to control water quality conditions and to prevent and control related disease.



Fig 6-9 Water cellar for mothers

2.3 Popularize the build and use of cleaning water facilities

Through the use of water purifier, it can lessen sediment, water become clear transparent, improve water condition, reduce disease and is conducive to physical and mental health.

2.4 Community participation, multi-sector cooperation

As a public welfare project mother cellar in the drive of local comprehensive anti-poverty office, and it has played an important role in setting up the development platform, leading the development of local economy. This has not only to resolve the issue of water problem in mountain areas, but more importantly is funding mother cellar as a leader, forming a new three-dimensional multi-sectoral linkage pattern to help the poor among water conservancy, agricultural committee, health and other departments.

【Exercises】

1. To discuss climate change and the causal relationship between natural disasters, such as how global warming led to an increased risk of flooding.
2. Please describe in their own region will occur what types of extreme weather and that is due to changes in temperature or precipitation, or both? If there has corresponding local measures?
3. Is conserve water recognized and effective implemented in your city / province?
 - a. If so, who has been involved in?
 - b. If not, do you think what kind of person / organization / institution will be important stakeholders to participate in local water conservation organizations and the Steering Committee?

【Recommended readings】

Forum on Climate Change and Science and Technology Innovation
2008:http://www.most.gov.cn/shfzs/sfdtxx/200806/t20080604_62180.htm

The committee of National Assessment Report of Climate Change. 2007: China's National Assessment Report of Climate Change. Sciece Press.

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Tong GQ. Impact of climate change on water resource and sanitation in future [J].Express Water Resources &Hydropower Information,2007,24:15-18.

Ren GY. Climate change and water resource in China[M]. China Meteorological Press,2007.

Zhang JY, Zhang SL, Wang JX,et al. Study on runoff trends of the six larger basins in China over the past 50 years[J]. Advances in Water Science, 2007,2:230-234.

MODULE 7

Climate Change and Air Quality

Climate Change and Air Quality

【Learning objective】

1. To provide an understanding of the impact of climate change on air quality and air-related health problems.
2. To provide an introduction to current prevention and control measures for air quality and public health against climate change and to discuss necessary future measures.

【Text】

1. Climate change and air quality

1.1 The impact of air quality on the climate change

According to the Fourth Assessment Report (2007) of the Intergovernmental Panel on Climate Change (IPCC), climate change is really true and the key reason leading to global warming is the mankind's activity. Human-caused climate change has resulted primarily from changes in the amounts of greenhouse gases in the atmosphere, but also from changes in small particles (aerosols), as well as from changes in land use.

Human activities result in emissions of four principal greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and the halocarbons (a group of gases containing fluorine, chlorine and bromine). These gases accumulate in the atmosphere, causing concentrations to increase with time. Significant increases in all of these gases have occurred in the industrial era (Fig.7-1). With economic development, global greenhouse gas (GHG) emissions due to energy consumption (Fig.7-2,7-3) have grown quickly, with an increase of 70% between 1970 and 2004. Carbon dioxide (CO₂) is the most important anthropogenic GHG. Its annual emissions have grown between 1970 and 2004 by about 80%. Energy Information Administration (EIA) U.S. prognosticate that world marketed energy consumption and carbon dioxide emissions are projected to increase by 50 percent from 2005 to 2030. From 1994 to 2004, the annual average growth rate of GHG emissions in china is around 4%, and the share of CO₂ in total GHG emissions increased from 76% to 83%.

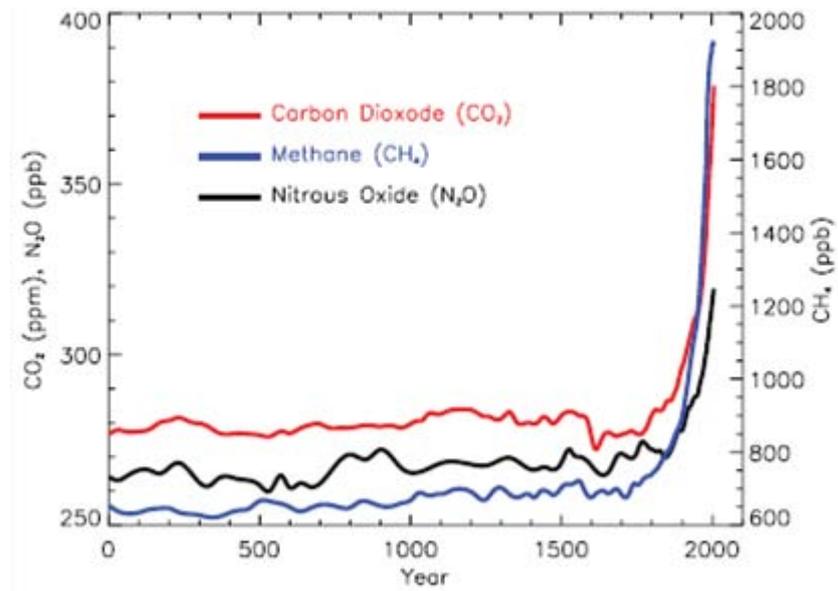


Fig.7-1. Atmospheric concentrations of important long-lived greenhouse gases over the last 2000 years

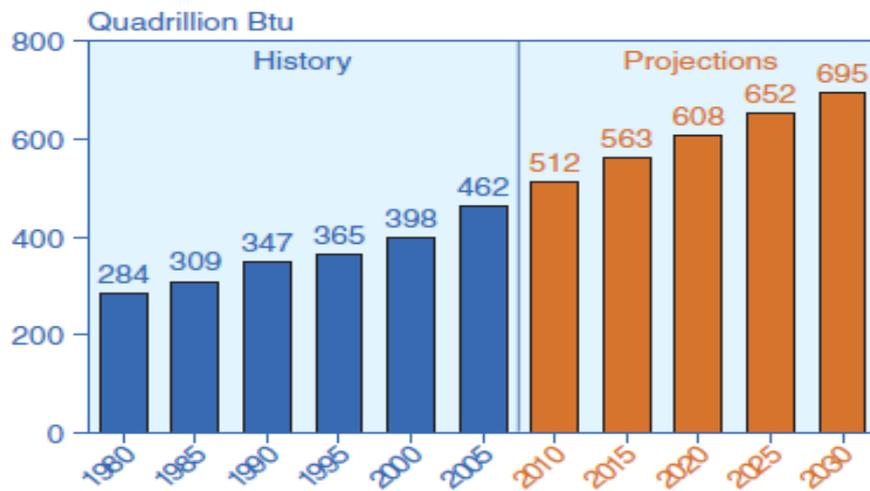


Fig.7-2. World marketed energy consumption, 1980-2030

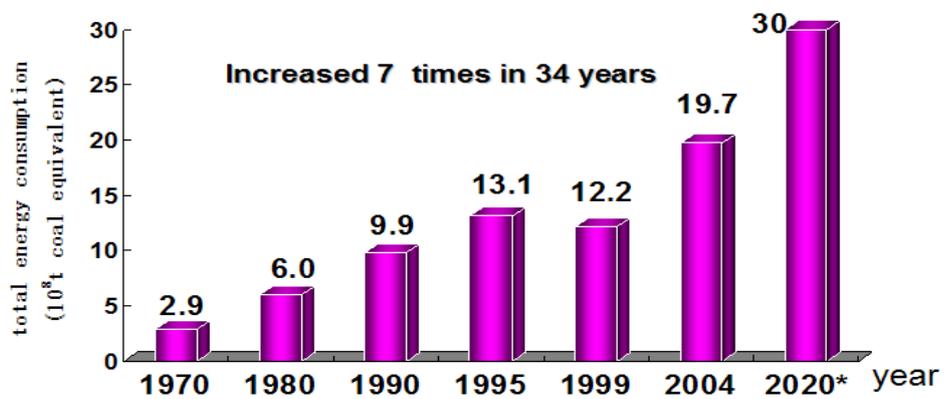


Fig.7-3. The total energy consumption in China from 1970 to 2004

Fossil fuel and biomass burning have increased aerosols containing sulphur compounds, organic compounds and black carbon (soot). Human activities such as surface mining and industrial processes have increased dust in the atmosphere, which impact the concentration of aerosol. Aerosol particles influence radiative forcing directly through reflection and absorption of solar and infrared radiation in the atmosphere.

The Sun powers Earth's climate, radiating energy at very short wavelengths, predominately in the visible or near-visible (e.g., ultraviolet) part of the spectrum. Roughly one-third of the solar energy that reaches the top of Earth's atmosphere is reflected directly back to space. The remaining two-thirds is absorbed by the surface and, to a lesser extent, by the atmosphere. To balance the absorbed incoming energy, the Earth must, on average, radiate the same amount of energy back to space. It radiates primarily in the infrared part of the spectrum (Fig. 7-4). Much of this thermal radiation emitted by the land and ocean is absorbed by the atmosphere, including clouds, and reradiated back to Earth. This is called the greenhouse effect. And thus have an impact on climate change.

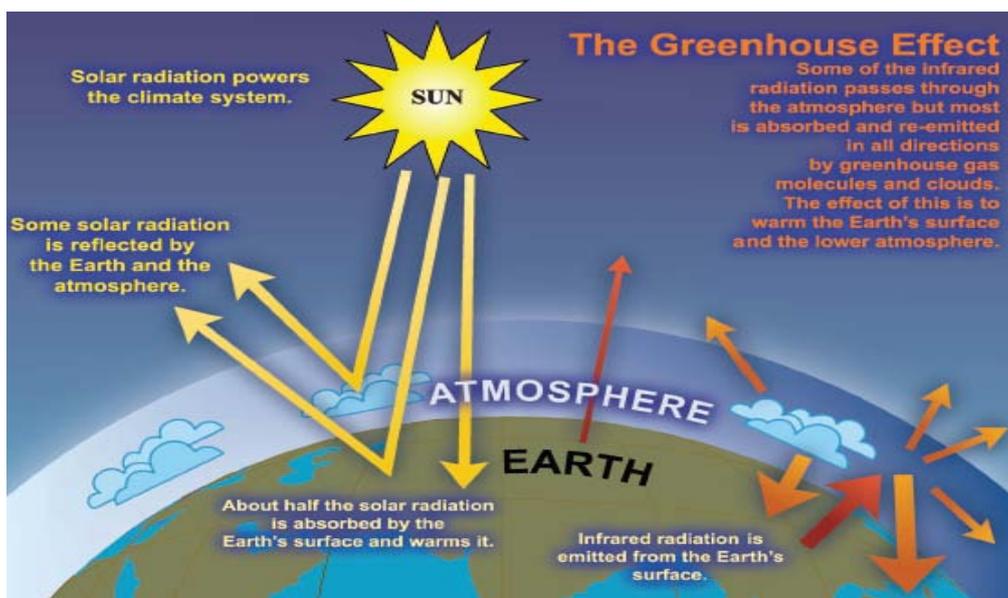


Fig.7-4. An idealised model of the natural greenhouse effect

1.2 The impact of climate change on the air quality

Air pollution is an important factor for the global weather conditions and climate change, greenhouse gases, aerosols and cloud cover are the main reasons for climate change; However, climate change, in turn, also has a certain impact on air quality. Climate change could affect local to regional air quality through changes in chemical reaction rates, boundary layer heights that affect vertical mixing of pollutants, and changes in synoptic airflow patterns that govern pollutant transport.

Climate change could affect both average and peak air pollution levels. For example,

background concentrations of ground-level ozone (a pollutant that irritates the lungs and makes breathing difficult) are expected to increase over mid-latitudes due, in part, to higher temperatures, whereas intense smog episodes are projected to become more frequent during summer months as a result of climate change. Global warming will exacerbate the surface evaporation, the ability of atmosphere to maintain the moisture will be enhanced; this will affect the concentration of air pollution through rainfall wind speed, humidity and other weather conditions. Higher summer temperatures are also likely to increase energy consumption for cooling, thereby adding to pollution emissions. Emissions from power plants increase substantially during heat waves, when air conditioning use peaks. Weekday emissions of nitrogen oxides (NO_x) from selected power plants in California more than doubled on days when daily maximum temperatures climbed from 75°F to 95°F in July, August, and September of 2004.

1.2.1 The impact on the ozone

1) The impact on the stratospheric ozone

The ozonosphere can gather the heat source in the stratospheric and obstruct the radiation of the sun's rays under 29A°. It is important for mankind and creature. The existence of the ozonosphere affects directly the temperature structure of the stratospheric. So the ozonosphere is very important for maintaining the climate stabilization and the existing living environment in the world. The excess emission of greenhouse gases can damage the ozonosphere which can protect the plants and animals on the earth from hurting by ultraviolet light. As shown in Figure 7-5, the amount of stratospheric ozone has decreased over the past few decades, particularly in the Antarctic. The largest decreases since 1980 have been observed over the Antarctic during the spring.

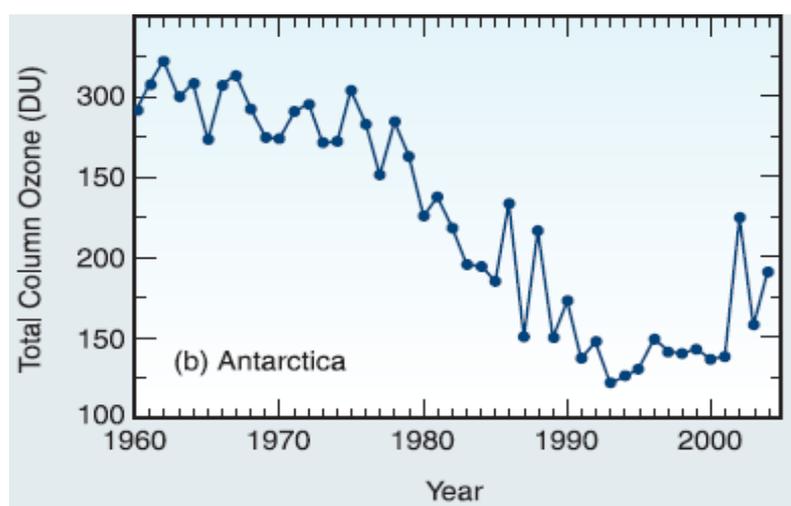


Fig.7-5. October mean total column ozone measurements from the Dobson spectrophotometer at Halley, Antarctica

The phenomenon of the ozonosphere low valley in the sky of Qinghai-Tibet Plateau in summer has drawn great attention of the world. If let it be, the sky of the world ridge will appear the third ozone hole in the world following the South and North Pole.

2) The impact on the ground-level ozone

Ground-level ozone is both naturally occurring and, as the primary constituent of urban smog, is also a secondary pollutant formed through photochemical reactions involving nitrogen oxides and volatile organic compounds in the presence of bright sunshine with high temperatures. Temperature, wind, solar radiation, atmospheric moisture, venting and mixing affect both the emissions of ozone precursors and the production of ozone. Because of warming, the concentrations of ground-level ozone are increasing in some regions. There is a direct correlation between temperature and O_3 level(Fig.7-6).

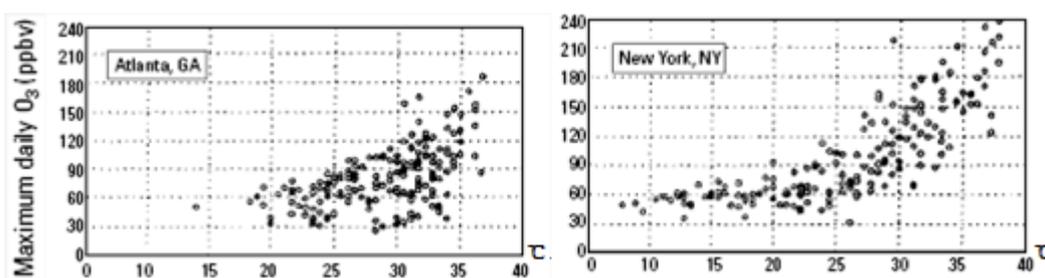


Fig.7-6. Maximum daily O_3 concentrations in Atlanta, and New York, versus maximum daily temperature, May-October, 1988-1990

1.2.2 The impact on the concentration of air pollutants

Concentrations of air pollutants in general and fine particulate matter (PM) in particular, may change in response to climate change because their formation depends, in part, on temperature and humidity. Air-pollution concentrations are the result of interactions between variations in the physical and dynamic properties of the atmosphere on time-scales from hours to days, atmospheric circulation features, wind, topography and energy use. Some air pollutants demonstrate weather-related seasonal cycles. Weather at all time scales determines the development, transport, dispersion and deposition of air pollutants, with the passage of fronts, cyclonic and anticyclonic systems and their associated air masses being of particular importance. Air pollution episodes are often associated with stationary or slowly migrating anticyclonic or high pressure systems, which reduce pollution dispersion and diffusion. For example, certain weather patterns enhance the development of the urban heat island, the intensity of which may be important for secondary chemical reactions within the urban atmosphere, leading to elevated levels of some pollutants.

Use of the average concentration of pollutants with the meteorological in the ground data in 2004 at the same period of Zibo, Shandong Province, China, it showed that: The concentration of air pollutants and the surface pressure had good positive

correlation, The concentration of air pollutants and the ground temperature had good negative correlation, The concentration of air pollutants and the rainfall amount had good negative correlation, especially PM₁₀.

1.2.3 The impact on the sandstorms

Changes in wind patterns and increased desertification may increase the long-range transport of air pollutants. Under certain atmospheric circulation conditions, the transport of pollutants, including aerosols, carbon monoxide, ozone, desert dust, mould spores and pesticides, may occur over large distances and over time-scales typically of 4-6 days. China is one of the countries which affected by sandstorms seriously. Sandstorms usually occur in north China, especially in the northwest, climate conditions such as drought, temperature and wind have impact on the dust storms. For almost half a century, the scope of the sandstorms impact in China decreased(Fig.7-7). Typical strong storms in north China reduce nearly half a century, Meteorological records show that the increase or decrease of spring winds accord with the increase or decrease of dust storms in nearly 40 years. but storms are showing a tendency to increase in recent years, which may be related to the continuing drought since 1997. Study in Beijing has shown a great relationship between air quality decline and sand storm. Sand storm won't have any great impact on the concentration of SO₂ and NO₂, but leads to the daily average concentration of PM₁₀ rapidly rise, causing serious air pollution.

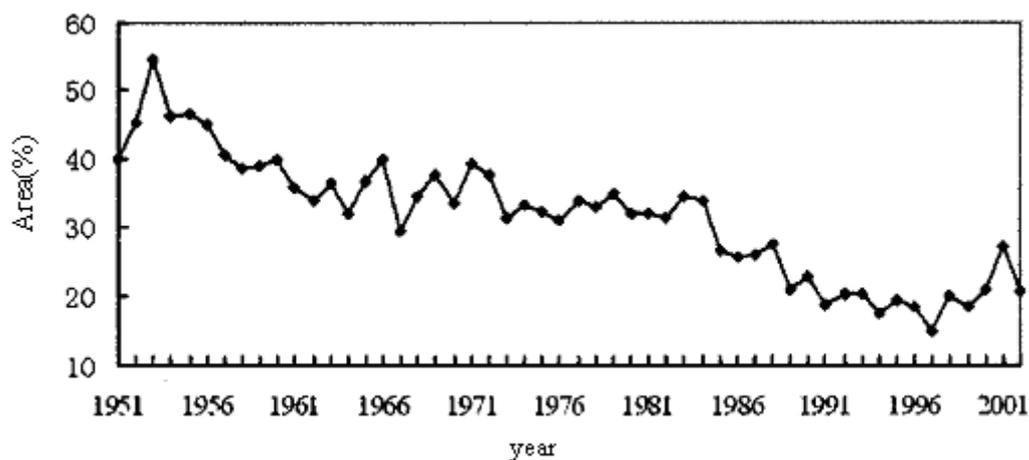


Fig.7-7. The change of sandstorms effect in 1951-2002

1.2.4 Other impacts

In some regions, changes in temperature and precipitation are projected to increase the frequency and severity of fire events. A number of researches show that the climate change will cause a longer fire season and more extreme fire weather, which make more fire activities. Especially fires in boreal forest will increase significantly. Forest and bush fires cause burns, damage from smoke inhalation and other injuries.

Toxic gaseous and particulate air pollutants are released into the atmosphere, which can significantly contribute to acute and chronic illnesses of the respiratory system. Pollutants from forest fires can affect air quality for thousands of kilometers. Fig. 7-8 is a satellite image showing long-range transport of smoke over 1000 km (620 miles) from northern Quebec, Canada, to the city of Baltimore MD, on the east coast of the U.S. A corresponding time series of PM_{2.5} concentrations in Baltimore clearly shows the impact of this event (Fig. 7-9).

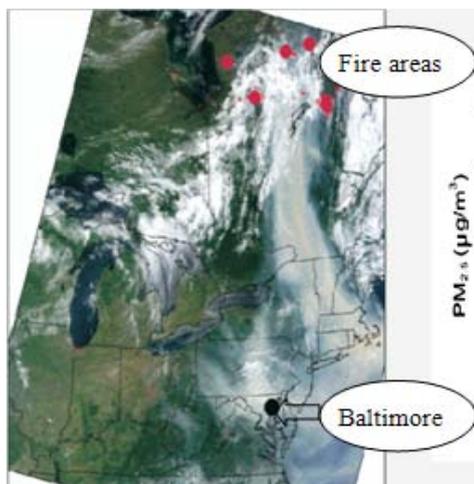


Fig.7-8 Satellite image
Baltimore

taken July 7, 2002, 10:35

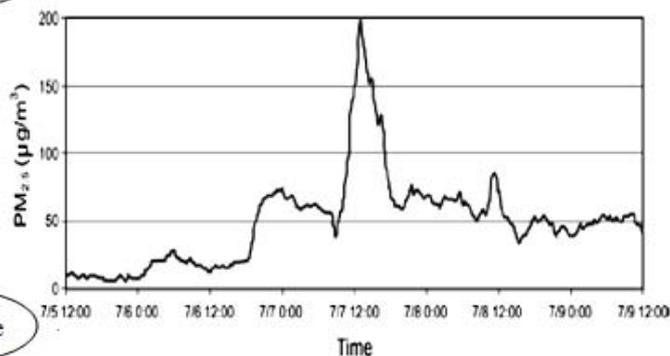


Fig.7-9 Outdoor PM_{2.5} concentrations in

before, during, and after July 7, 2002

Discussion

Atmospheric Brown Clouds

A recent international study, the Indian Ocean Experiment (INDOEX), documented the vast extent of the so-called Asian haze, a 3km thick brownish layer of pollutants hovering over most of tropical Indian Ocean, South, Southeast and East Asia. The haze particles consist of sulfates, nitrates, organics, black carbon and fly ash amongst several other pollutants, which can be transported far beyond their source region, particularly during the dry season. Potential direct and indirect consequences of the haze together with involve regional and global climate change, impacts on ecosystem, the water cycle, agriculture and human health.

2. Health effect

2.1 An international perspective

2.1.1 Health effect of ozone

1) Health effect of ozone in stratospheric

The chlorofluorocarbon in the greenhouse gases has tremendous destructiveness to the ozonosphere. The increase of the ultraviolet radiation, especially UV-B, due to the depletion of ozonosphere, can cause the skin cancer, accelerate aging and enhance the morbidity of the skin cancer, cataract and snow blindness. The statistics results of 1971-1972 and 1977-1978 in the United States showed that, along with the increasing of the sun radiation index, the morbidity of skin cancer in white people obviously increased.

2) Health effect of ground-level ozone

Climate warming will speed up the rate of photochemical reaction between chemical pollutants, resulting in an increase of photochemical oxidants. Ozone is the main component of photochemical smog. Exposure to elevated concentrations of ozone is associated with increased hospital admissions for pneumonia, chronic obstructive pulmonary disease, asthma, allergic rhinitis, and other respiratory diseases, and with premature mortality. Although a considerable amount is known about the health effects of ozone in Europe and North America, few studies have been conducted in other regions.

2.1.2 Allergy

Recent increases in CO₂ have already stimulated plant growth, and projected future increases will continue to do so. However, CO₂ does not discriminate between desirable (e.g., wheat, rice, and forest trees) and undesirable (e.g., ragweed, poison ivy) plant species with respect to human systems. More than 100 different plant species are associated with contact dermatitis, an immune-mediated skin inflammation. Global warming has been shown to increase pollen production of western ragweed by 84%, and is making the pollen season last longer and attracting insects. One of the most common plant-induced health effects is related to aerobiology. Plant-based respiratory allergies are experienced by approximately 30 million people within the United States. Symptoms include sneezing, inflammation of nasal and conjunctival membranes, and wheezing. Complicating factors, including nasal polyps or secondary infections of the ears, nose, and throat, may also occur. Severe complications include asthma, cardiac distress, chronic obstructive pulmonary disease, and anaphylaxis. The influence of climate change on symptoms of respiratory allergy is still unpredictable. Two opposite effects could be relevant. On the one hand, global warming could increase the length and severity of the pollen season and, as a consequence, of pollen allergy. Moreover, the overall effects on health-related air pollutants seem favourable to an increase in urban air pollution episodes. On the other hand, increases in the earth's temperature could reduce the effects of cold air on asthma and rhinitis, also making patients less susceptible to upper respiratory infections.

More subtle interactions regarding plants may be related to indirect effects of CO₂ on fungal decomposition. The fungus is also an important source of allergens. For example, increasing CO₂ concentration resulted in a 4-fold increase in airborne fungal propagules, mostly spores. The link between spore formation, potential changes in allergenicity of the spores, and the mechanism associated with spore release in the context of elevated CO₂ has not been entirely elucidated.

2.1.3 Effects on air-borne diseases

Microorganisms in the atmosphere include the bacteria, epiphyte, virus and phage. Climate warming is propitious to the prevalence of heat related diseases. The reproduction rate and spread velocity of pathogens may be both accelerated with global warming. Meteorological factors, which can influence the content of microorganisms, include temperature, relative humidity and wind speed. The content of atmospheric microorganisms increases with the increased temperature and accelerated wind speed, and decreases with the increase of relative humidity. Moreover, a study in China found some association between atmospheric microorganism content and air monitoring indexes, there was significant positive correlation between the atmospheric microorganism content and PM₁₀ concentration. As the carrier of atmospheric microbial, PM₁₀ has become one of important factors to air-borne diseases.

2.1.4 Other effects

Climate change will cause weather factors, such as pressure, flow to change, at the same time, global warming will further aggravate the urban heat island effect, and impact the distribution, proliferation of atmospheric pollutants, such as SO₂, NO_x, PM, then increase the health effects of air pollutants.

Most studies on health impacts of climate change are about weather conditions, and are rarely about climate change in the strict sense. Meanwhile, the effective quantitative models are so scarce used to evaluate the relationship between climate change, air quality and occurrence and development of disease.

2.2 A national perspective

In China, the health effects of climate change are carried out only in recent years, focusing mainly on the temperature (extreme heat), as well as infectious diseases of health effects. The data about air quality is less, which focused on health impact of the change of weather conditions.

2.3 Uncertainty of health effect

2.3.1 Future air quality will be determined by energy and transportation choices, economic development, and population growth;

2.3.2 The degree to which human intervention and planning can minimize changes in vegetation and aeroallergen exposure remains unexplored;

2.3.3 The rate and magnitude of climate change in the future will depend on how rapidly and successfully global mitigation and adaptation strategies are deployed;

2.3.4 New technologies addressing climate change and air pollution as well as new medical treatments for asthma and/or allergic disease could alter current predictions and trends.

3. Adaptation measures

As a developing country of responsibility, China attaches great importance to the issue of climate change. The National Coordination Committee on Climate Change was established, and a series of policies and measures to address climate change has been taken in the overall context of national sustainable development strategy, making positive contributions to the mitigation of and adaptation to climate change.

3.1 Expedite the constitution and amendment of laws and regulations

The Chinese government has taken great attention on the control and prevention of air pollution and have established a series of regulations and strategies especially:

- ✧ Law of the Peoples Republic of China on the Prevention and Control of Atmospheric Pollution
- ✧ Ambient Air Quality Standard
- ✧ Energy Conservation Law of the Peoples Republic of China
- ✧ Renewable Energy Law of People's Republic of China
- ✧ The China's National Assessment Report on Climate Change
- ✧ China National Plan for Coping with Climate Change
- ✧ National Environment and Health Action Plan (2007-2015)

3.2 Developing air pollution monitoring

Developing air quality surveillance in city, continuously and systematically collecting the data of climate change and its affecting factors for a long time, strengthening meteorological hazards forecast, establishing prediction, monitoring network, extending preventive epidemic areas, e.g. strengthening forest fire forecast, to reduce the health effect of climate change.

From 2005, air pollution and human health monitoring system has been establishes. It is conveyed by institute for environmental health and related produce safety, China CDC. The pilot cities are Shanghai, Nanjing, Taiyuan, Qingdao, Harbin, Zhang

Jiagang, Wuhan and Shenzhen city. Through long-term data collection on meteorological, air and disease, develop the surveillance on exposure risk factors and symptoms or Physical sign. Further, forecasting the health impact events by air pollution, reducing the health impacts by air pollution and improve the capability on early warning, protection and control to the air pollution-related disease, the air pollution and human health monitoring system will continuously play a major role in health hazards monitoring.

3.3 Ozone warning system

China meteorological administration has built air monitoring network of Yangtze River in Chongming, Jinshan, Pudong region of Shanghai, Lin'an in Zhejiang province and Taizhou in Jiangsu. At the same time, Shanghai Meteorological Center of the Urban Environment Bureau and national center of atmospheric research in United States (NCAR) has set up atmospheric chemistry lab and air monitoring network. They set monitoring pilots in the five regions of the cities and urban O₃ early warning system will be build in 2010 to provide warning information to control the main pollutants such as automobile exhaust.

3.4 Improving energy efficiency, optimizing energy mix

Beginning from the late 1980s, the government of China paid more and more attention to the change of the economic growth pattern and the restructuring of economy, and integrated the reduction of energy and other resources consumption, the promotion of clean production, and the prevention and control of industrial pollution into its national industrial policies. Under national policy guidance and with financial support, the share of high grade and clean energy was improved by strengthening the development and utilization of hydropower, nuclear energy, oil, gas and coal-bed methane, and supporting the development and utilization of new and renewable energy including biomass, solar, geothermal and wind power in rural areas, remote areas and other suitable areas. Share of coal in China's primary energy mix decreased from 76.2% in 1990 to 68.9% in 2005, whereas the shares of oil, gas and hydro increased from 16.6%, 2.1% and 5.1% in 1990 to 21.0%, 2.9% and 7.2% in 2005, respectively.

3.5 Strengthening education, training and propagation of the impacts of climate change on ecosystems and human health

Add the contents about climate change in the teaching, and through various media, strengthen the publicity, education and training on the globe climate change, encouraging public participation to enhance the public awareness of protecting the global environment and climate, guide people to establish a life style and consumption mode that helpful for reducing greenhouse gases emissions and to learn

about the direct and indirect effects of climate change on air pollution human health, to promote social and economic development.

4. Gaps in knowledge

The government and scientific community attach great importance to global warming and its potential impact in the past 20 years. Since the United Nations Conference on Environment and Development, held in 1992, international action coping with global warming and its impact has been at full blast. The countries have launched their own global climate change research and assessment activities. In Germany and Japan, the greenhouse effect and climate change is priority research area priority.

Due to limitations on knowledge and analysis methods, there exist large uncertainties in the present assessment of climate change impacts carried out by various countries. The ecosystems that have received relatively little disturbance from human beings can be used as the reference pointer to assess the observed impacts of climate change.

However, systems like agriculture, water resources and human health are influenced not only by climate change but also by other factors; therefore it is rather difficult to single out the impacts of climate change. Studies indicate that climate change has caused some impacts on China, such as sea level rise in the coastal areas, glacial retreat in northwest area, and the earlier arrival of spring phenophase. It will also bring about significant impacts on China's natural ecosystems and social economic system in the future. Meanwhile, as a developing country at a low development stage, with a huge population, a coal-dominant energy mix and relatively low capacity to tackle climate change, China will surely face more severe challenges when coping with climate change along with the acceleration of urbanization, industrialization and the increase of residential energy consumption. Existing impact assessment efforts in China have mainly concentrated on agriculture, water sources, ecosystems, and coastal environments. Not many studies have looked at the Potential impacts of climate change on human health and air quality. There are many researches of health effect about single meteorological factors, but combined effects about many weather factors have less study. We will strengthen combined effects about meteorology factors. The similar research in China is still limited. Most of the researches in this field refer to climate change (temperature and humidity) and air-born diseases. In present the researches mainly focus on monitoring and predicting distribution of air pollution because of climate change; lacking of epidemiological studies about health effects, which limited in a small number of large, medium cities, lacking of individual exposure data of different groups about air pollutants on; lacking of combined effects of climate change and air pollution on health, we need to strengthen research in this area.

【Case study】

Air pollution and diseases surveillance sites

1. Objective

- 1). Establish dynamic monitoring system of climate change, air pollution and health.
- 2). Explore evaluation mode of climate change, air pollution and health, further improve the early warning system of public health.

2. Monitor city

Selecting Taiyuan, Shanghai, Nanjing, Qingdao, Haerbing, Wuhan, Shenzheng, Zhangjiagang as air pollution and diseases surveillance sites(Fig. 7-10), make full use of resource, collect, survey, report the information of air contamination, weather, residenter health condition.



Fig.7-10. The distribution of monitoring city

3. Monitoring

3.1. Atmospheric data collecting and monitoring

Collecting the daily atmospheric monitoring data at Surveillance Sites in cities and in all functional zone. Index: SO₂, NO₂, PM₁₀, CO. Supplement surveillance in community.

3.2. Meteorological monitoring

Collecting temperature, humidity, air pressure, wind speed, sunlight hour, plotting wind rose data at Surveillance Sites in cities.

3.3. Symptom monitoring

Carrying out pupil respiratory system disease symptom monitoring, COPD and coronary heart disease of middle-aged symptom monitoring in some community.

3.4. Death monitoring

Collecting the daily causes of death from all causes data at surveillance sites in cities and in all functional zone.

4. Anticipating outcome

4.1. Establish dynamic monitoring system of climate change, air pollution and health;

4.2. Evaluation mode for the health effects of climate change, air pollution.

【Exercises】

Experience and insufficiency that health sections have acquired in protecting air quality to response to climate change; and the priority of next work.

【Recommended Readings】

Climate Change 2007:Synthesis Report;

http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_cn.pdf;

Climate Change Impacts and Adaptation: A Canadian Perspective ;

The Ministry of Environment Protection of China;

<http://www.zhb.gov.cn/plan/index.htm>;

The work of environmental and health in 2005;

http://www.mep.gov.cn/tech/hjjk/200607/t20060726_91372.htm.

MODULE 8

Extreme Weather Events and Public Health Emergency Response

Extreme Weather Events and Public Health Emergency Response

【Learning Objective】

- To learn the current status, tendency, as well as the health effects of climate change in China.
- To study the policies and measurements the government made to deal with extreme weather events.

【Text】

Climate change follows certain laws of nature. Extreme weather events are rare weather events which exceed the normal changing range and relate to the probability distribution of weather-related events. At present, the international research on the extreme value of climate change often use a percentile value (e.g. 1% of the maximum or minimum observations) as the threshold of extreme value. The probability more than this threshold value is considered to be extreme and the event can be regarded as extreme events. Some scientists use the marginal value of different climatic distribution pattern to determine the extreme climate value or use certain threshold value of climatic factors causing human or biological effects as the extreme climate value. (e.g. days of high temperature or frost). Actually, heat waves, draughts, floods, hurricanes and so on can be treated as extreme weather events. Climate is closely linked with human health. Climate conditions, climate disasters and climate changes directly affect human health. Despite the extreme weather events is a small probability event, it's harm is quite shocked. With the global warming, the occurrence of climate extreme events will be more and more frequent. the impacts of climate disasters on health and lives will be greater.

1. The changing tendency of extreme weather events world wide.

In recent years, global climate extreme events and the serious disaster bring about by it showing an increasing trend. The simulation scenes obtained by using large-scale computer show that climate warming will lead to an increase of extreme weather and climate events. Now, the world is in a period when extreme weather and climate events occurred frequently. It's of high possibility to have heat waves days in almost all continents. Extreme precipitation value and frequency in many areas is likely to rise. Furthermore, the frequency of strong typhoon increased even though the total number of typhoon didn't show an increasing trend. According to statistics analysis, the number of world's serious meteorological disasters is 5 times more than that in the 1950's. In 1980's, there are about 120 natural disasters each year all over the world, and it has increased to 500 annual now. Asia suffered from natural disasters most

frequently among all the 7 continents. Between 1900~2000, the number of extreme weather events account for 43% of the total events all over the world. The global average population affected by natural disaster each year is 174,000,000 between 1985~1994. It has increased 68% to 254,000,000 after 20 years (1995~2004). According to the latest statistic data, the economic losses caused by global climate change and related extreme weather events has increased by 10 times the average in the past 40 years. According to the United Nations Statistics, more than 200,000 people die from the frequent attack of extreme weather events in the 1990's and the economic losses is as high as hundred billions. Global climate change is affecting almost every corner and every body in the world at an unprecedented rate.

Studies show that the area affected by extreme high temperature has become wider with global warming. High-temperature and heat waves used to be the typical meteorological disasters in India, Pakistan and other tropical and sub-tropical region, but in recent years, with the situation becoming more and more serious in those areas, Europe, the United States, Japan, China and other middle-and high-latitude regions where used to be cool are becoming increasingly hot. Great Lakes in United States, France, Britain, Spain and North China have gradually become a regional high temperature center and hot days, hot nights and heat waves occurred more frequently (IPCC, 2007a). According to Japanese scientists Statistics, annual global average temperature increased 0.7°C in recent 100 years. while the average temperature in big cities has increased by 2 ~ 3 °C, and the temperature in Tokyo increased as far as 7 °C during the period. It will be called "Hot Night" when temperature is above 25°C in Japan. 50 years ago, there were less than 5 "Hot Night" in Tokyo each year, while increased to 14.9 between 1961~1970, then 23.8 between 1981~1990. The annual average number of "Hot Night" in Osaka was 38 in 10 years between 1991~2000.

Extreme precipitation events were much more significantly changed in response to climate change. Other studies show that, in the past several decades, the frequency of extreme precipitation events has increased by an average of 2% -4% in the northern hemisphere and the high latitude areas. Severe droughts and floods did not show obvious long-term changing trend in worldwide between 1900~1995, but in the latest two or three decades, drought disaster in Saharan, East Asia and South Africa exacerbated, while floods disaster in United States and Europe increased at the same time. It is estimated that, the number of affected population by global meteorological and hydrological disasters annually was 211,000,000, 7 times the number of the people affected by war or conflict. Catastrophic extreme rainfall occurred from time to time throughout history. In April 1927, the flood occurred in Mississippi River, the United States, caused 67 thousand square kilometers of land flooded, more than 2,000 people died, beyond 600,000 people homeless. In 1937, the rainstorm and flood happened in Calcutta, India, lead to 300,000 deaths. Between 1943~1944, the rainstorm and flood occurred in Bangladesh result in more than 1,000,000 deaths. Vietnam storm flood in 1971 killed 100,000 people.....

Global warming does not mean the weather always warming. There still will have a cold winter, but the frequency will gradually slowdown. The northern hemisphere still

has to facing the serious problems of cold waves. In recent years, frequent storms and cold wave events happened in Northern Europe and North America brought about serious damage to the socio-economic and public health.

Research based on the past 35 years 'survey data shows that the number of tropical cyclones categorised above 4 (equivalent to strong typhoons) increased significantly. It increased about 57% after the mid of 1980's (2005, Peter Webster) . From 2004, the tropical storm significantly became rampant. Four hurricanes that struck Florida, United States, were unprecedented. Ten hurricanes landed in Japan, which 4 more than the highest history record. In 2005, the number of summer hurricanes of North Atlantic broke the history record again, in which include the "Katrina" and "Rita" Hurricane with strong power of destruction (2005, Kevin Trenberth) .

2. The changing tendency of extreme weather events in China.

In the context of global warming, extreme weather events, as well as possible climate change-related natural disasters occurred more and more frequent worldwide. In China, Their frequency and intensity also had significant changes. Serious floods, mainly appeared as high temperature, flood, drought, torrential rains, hurricanes, storms and so on, caused great destroys to the society, economic and public health.

2.1 The frequency and intensity of high temperature and heat waves are increasing

Since mid-1990's, daily maximum temperature greater than or equal to 35°C days increased significantly in China. Extreme high temperature occurred from time to time everywhere. High temperature as 38°C、40°C or above also occurred frequently. North, northwest, east areas in China and most areas in the south of Yangtze River become vulnerable areas of extreme heat disaster, extreme high temperature events happen more and more frequent. Three heat wave peaks happened in the last 100 years were 1940s, 1960s and after 1999. Since 1999, serious and extensive high temperature days (daily maximum temperature greater than or equal to 35°C) will last for more than 10 days every year in North China, East of North-west China and the south of Yangtze River. In the summer of 2003, By the impact of sub-tropical high pressure, Jiangnan and South China occurred rare high temperatures than usual. Extreme high temperatures days sustained for more than 40 days in South China. The general daily maximum temperature were between 35°C —38°C with some area reached 38°C —40°C or even as high as 40°C—43°C. The scope, duration, temperature were seldom appeared in previous same period. In 2004, Guangdong province suffered a hot wave from June as the



result of typhoon "Dandelion" and subtropical high pressure. On July 1, the daily maximum temperature in Guangzhou reached 39.7°C, which is above the highest record of 38.7 °C previously.

2.2 Extreme rainfall events are increasing

The changing trend of total precipitation in the whole country was not obvious, however, rainy days significantly reduced. The unchanged or increased total precipitation and the reduced frequency of rainfall means that the trend of the rainfall process may be strengthened and the tendency of drought and floods may be increased (Panmao Zhai et al., 1999). The main characteristic is that the strength and frequency of regional extreme rainfall increased (Zhongwei Yan, et al. 2000), and it would lead to the increasing of drought and flood (Fig 8-1). The precipitation in south and southwest China increased significantly, which increased 20~60mm every 10 years. The amount of yearly rainfall and extreme rainfall increased in the south of Yangtze River, and the extreme precipitation amount and precipitation intensity had been enhanced. Since 1990, the proportion of extreme rainfall tends to increase (CNCCP, 2007). There are frequent floods in some areas, particularly since 1990, the Yangtze River, Pearl River, Songhua River, the Huaihe River, Taihu Lake, both for the Yellow River floods occurred repeatedly. In June 2007, the State Council issued the "China National Climate Change Program", in which Chinese scientists predicted that the annual average precipitation will show an increasing trend in the next 50 years. The national annual precipitation will increase 2%—3% to 2020, and 2%—3% to 2050, in which, most are in southeast coast of China.

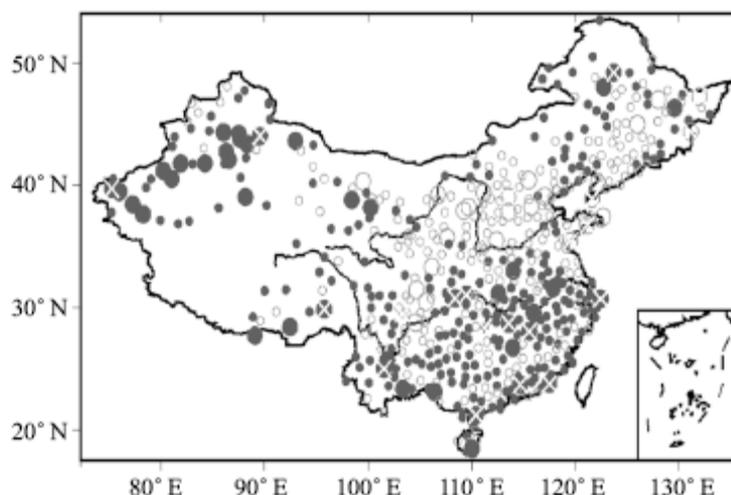


Fig.8-1 Change of days with extreme strong rainfall over China in the last 50 years

⊗ >7.5%/10a, ● (7.5%—2.5%)/10a, • <2.5%/10a, ⊗ <-7.5%/10a, ○ (-7.5%—2.5%)/10a,
 ◊ >-2.5%/10a, areas marked with pork if the changes are significant. (From Yihui Ding et al., 2006)

As another form of extreme precipitation, the decrease in annual precipitation was significant in most of northern China, eastern part of the northwest, and northeastern China, averaging 20~40 mm/10a. The decrease in northern China was the most



Fig8-2 The draught in north China in 2009

severity, where the drought situation became more and more serious over the past 20 years. The climate in North of China District was changed from wetness to drought between the middle of 1960s and the middle later of 1970s. The drought in North of China District was strengthened since the later of 1970s. The great drought in North of China District continually occurred since the later of 1990s. In 1997 and 1999~2002, Some regions have continually suffered drought for

five or six year, then have caused shortage of water resources, deterioration of the environment and great loss of agricultural production. In late 1990's and early 2000's, the scope suffered from drought and losses caused by it are the worst in the past half century.

During the late 90's and early 21 years, extensive drought, losses are the worst in half a century. From 1 November, 2008, the precipitation decreased 50-80% than previous year in winter wheat area in north China. 155,000,000 Mu field affected by drought disaster. 42,900 people and 20,700 livestock were lack of water because of draught. Chinese State Flood Control and Drought Relief Headquarters announced the grade I Drought Emergency Response for the first time, which is the first class Emergency Response System in China.

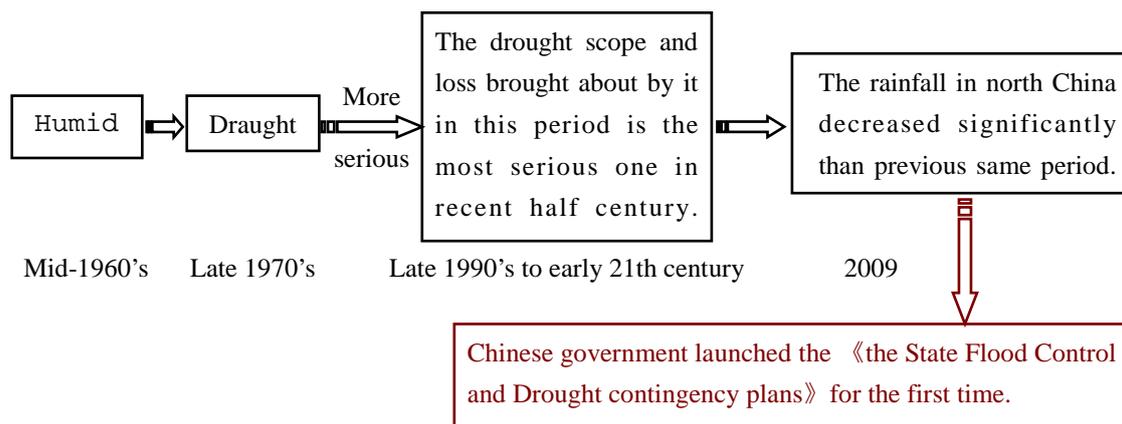


Fig8-3 The changing tendency of draught recent years in North China

2.3 Low temperature and snow disasters have great influence

In the context of global warming, the temperature of China, especially the northern

region, was significantly increased. The number of lower temperature days and frost days reduced gradually, and so did the cold wave. The number of frost days in northern China declined significantly in recent 50 years. The changing variability of north, east part of northwest and south-west part of northeast were larger, especially for the frost days showing frequency in the middle and northern part of North China and the east part of northwest China. Generally speaking, the variability of eastern part is greater than the western region. Since 1970's, the showing frequency of low temperature days in Northeast China reduced rapidly, almost no serious large-scale low-temperature days appeared after the 1980's.



Fig8-4. Ice and snow disaster in south China in 2008

Despite the global trend of winter temperature increasing, extreme low temperature events may still occur somewhere at sometime. Accompanied by increased precipitation in winter in some areas, an, the frequency of snow disaster increased. Tibetan Plateau was the area where the frequency of snow disaster was highest. The winter rainfall in Qinghai-Tibet Plateau was significantly increasing since the late of 1980s and the frequency of snow disaster increased in winter and spring. In January 2008, China has witnessed a Severe Weather event with Cold Air, Freezing Rain and Snow over South China. For It's lasting so long, the intensity was so large and the influenced areas were so broad, it made severe social problems and the direct losing in economic were reached 151.65 billions.

2.4 Destructive typhoons occurred frequently

Global warming can cause ground and sea surface temperature increasing, which are the strengthening factor in the self-generating and demise process of typhoon, thus easily lead to increased tropical cyclone intensity. The global frequency of strong typhoons is only about 20% before 30 years, but at the end of 1990's, the frequency has increased to 35%. In recent 50 years, the strength of typhoon landing in China increased year after year. In 2006, "sanmai", which is the strongest typhoon in the last 50 years, landed China. According to incomplete statistics, from 1982 to 2006, the highest death caused by typhoon was in 1990, and the annual average was up to 497.6. In 2006, the death toll could get 1552 and it was the second place for the past 24 years because of super typhoon and mobile complicated path of the typhoon. In recent 20 years, more than 2,000 persons died from typhoon each year in Zhejiang, Fujian, Guangdong province and so on, which is the most serious area suffered from typhoons.

3. Climate extremes and public health

During the development of human society, people have a long-term fight against natural disasters. Natural disasters caused by extreme weather events can bring about direct or indirect effect to public health. The extreme weather events can also damage the social infrastructure thus obstruct the normal social order, production and living condition.

3.1 Heat waves and health effect

Global climate warming is likely to be accompanied by an increase in the frequency and intensity of heat waves, as well as hot days in summer. Extreme summer heat's impact on human health may be exacerbated by increases in city air pollution and humidity. The most direct health effect of global warming is thermal effects. Also high temperature can make germs, bacteria, parasites and allergen more active as well as damage people's spirit, immunity and resistance. The direct impacts of heat waves on human health are the increasing of morbidity and mortality. Besides the direct effects such as heat stroke and death, heat waves can result in cardiovascular, cerebrovascular and respiratory diseases. In big cities the number of the death has increased by several thousands due to heat waves, especially among the vulnerable groups or in the vulnerable area, according to the studies in China, Africa and USA (Bojkov RD et al.,2005). Since the beginning of summer 2003, heat wave affected the whole world. Everywhere occurred record-breaking temperatures as high as 38-42.6 °C. The heat wave affected India, Pakistan, Europe and China. There were more than 1,000 people lost their lives in India alone, among which many were older people.

In the recent several decades China have consecutive suffered from broiling summers in 1988, 1990,1994,1998,1999,2002 and 2004. Some reports indicated that heat waves could bring thousands of excessive deaths every year. For example, in 1988, 1488 deaths were ascribed to heat waves in NanJing and Wuhan [2]. And in 1998 Shanghai suffered from the most severe heat waves in the recent several decades, the deaths during heat wave were 2 to 3 times of those during not heat waves, especially, the mortality of the elderly aged 65 and over increased even more. Heat waves do great harm to infants, too. Infants will be more vulnerable if they were suffering from certain diseases such as diarrhea, respiratory infections and mental defect during the heat wave period

Furthermore, high temperature direct affects the people's mood and psychology, high temperature easily results in fatigue, worry and irritation, and increases various accidents, even increases the rate of crime. For example, the homicide incidents increased by 138.5% than usual in New York during the heat wave period in July 1996. During the heat wave in July 2003, the data of Beijing's first aid show that rising traffic accidents had relationship with high temperature. Meteorological factors affect the people's response time and speed, and affect work efficiency and cause the

accidents.

3.2 Cold waves and health effect

Tremendous short-term fluctuations of weather can cause serious health effects. Extreme low temperature can also lead to fatal diseases, increase the mortality of heart and respiratory disease. When the cold waves come and temperature decreases sharply in winter, body has not established the protective mechanism adapting to the cold stress and apt to be infected by bacteria, virus and other pathogenic microorganism. The incidence of respiratory diseases such as influenza, pertussis, measles, epidemic meningitis and scarlet fever will go up rapidly. Moreover, cold waves are also extremely harmful to some chronic diseases like cardiovascular diseases, nephrosis, cancer, asthma, tracheitis and emphysema. It could cause the recurrence of disease, the aggravation of symptom and even jeopardize the life of patients. Unfortunately, the epidemiological researches about the impact of cold waves on health in China have not been found.

3.3 Natural disasters which are related to extreme climate and the health

Since 1960, the world population doubled while the cost of the disaster rose 30 times, from 3 billion in 1960 to 100 billion in 1995. In 1990, nearly 600,000 people died from natural disasters related to climate, in which 95% were lived in poor countries.

Flood is a natural phenomenon bring about by rapid increase of water level caused by rainstorms, rapid melting of ice or snow, storm surges etc. for natural or human reasons. Flood was the disaster which caused the largest number of deaths throughout the history. In middle ages, extreme flood events of Nordic river caused by storm brought about billions of deaths. In Dec 1999, about 30,000 lives were killed by the flood of Caracas. In Austria, flood occurred more frequently in the later 50 years of the 20th century. In October 1999, 10,000 people died from the hurricane occurred in Orissa, and about 10 to 15 million people were affected. In August 2005, the hurricane “Katelila”, which was more than five-category and equivalent to 17 typhoons more, resulted in more than a thousand deaths, 400 missing and more than \$100,000,000,000 of loss in the United States. In 2006 the Super Typhoon “Saomai” landed in China, which was the strongest typhoon since 1949 and the center of wind reached 17 category, resulted in hundreds of deaths,. In November 2007, strong tropical storm “Sid” swept through southern and southwestern regions of Bangladesh also caused significant losses of lives and properties. Up to November 23rd, the disaster has caused more than 4000 people dead or missing, more than 8,000,000 people were affected and economic losses were as high as 2,300,000,000 dollars. By now, the most serious area was Yellow River basin in China. With vast territory and dynamic climate change, precipitation in Yellow River area decrease from southeast to northwest with frequent floods and droughts. There occurred several serious disasters, which affected several provinces and continued for several years throughout history. In 1332, 7,000,000 people drowned and more than 10,000,000 people died

from the following famine and diseases. In 1887, flood destroyed the dam which was 22 meters tall and 1,000,000 people drowned. The recent flood was occurred in 1930, millions of people drowned and may be 11,000,000 people died of famine. These serious natural disasters have threatened people's lives and the development of the economic.

Floods, storm and other extreme weather event not only cause the deaths but also are very easily to deteriorate clean water. The confluence of drinking water and sewage may pollute the well and surface water at the same time and led to the risk of water-borne disease. Especially in the densely populated low-lying areas, the prevalence of such diseases will be a greater risk. Meanwhile some micro-organisms may be rushed into the valley and accumulated in coastal. In 1997-1998, El Nino led to serious floods in Peru, Ecuador, Argentina and Uganda. Since the average daily rainfall in these areas was as high as 75-125 mm along with the surrounding atmosphere and ocean temperature changes, the incidence of water-borne diseases highly increased. Referred to the weather-related diseases, some studies have shown that the incidence will increase by 8% per°C increase in the temperature of atmosphere surrounding. In South Pacific region, there is positive correlation between an average temperature and the incidence of diarrhea. Another example is of Latin America and the Caribbean with different climatic zones. It is even more vulnerable in the face of natural disasters and climate change. In 1970-1999, 70 percent of the region's natural disasters was related to their special terrain and climate change. Flooding is the most serious and major disasters. In addition to the topography, population density could increase the vulnerability to climate change. In this region, about 60% of the population lives in coastal areas, 70% of the big cities locate in coastal areas. During 1970-1999, 30 natural disasters occurred including typhoons, floods, droughts and tsunami, which have increased water-borne diseases chance by various potential forms.

The most serious and widest natural disaster is drought. Drought happened in the sub-continent of India in 1769, 1790, 1866, 1876-1977 killed millions of people. In China, the drought is also a major problem. In 1878, 10,000,000-30,000,000 people died of famine which was caused by drought. In 2000, there is severe drought in most regions in China, resulting in more than 4,000 million hectares of crops affected, with total destruction of 8,000,000 hectares, and led to more than 300 county-level cities and towns were forced to limit time-limited water supply. More than 2600 million people in total were affected. In some plains of eastern China, there is excessive extraction of ground water in shallow grave. Groundwater level has dropped to the current ten meters from 3-4 meters years several decades ago. It is said that there is water shortage in 60% of the cities, including 110 cities which are serious water shortage. It has to be noticed that the impact of drought on the economic and social is growing. Although drought may lead long-term sick, it has little effect on the population growth.

Because of the poor living condition and the change of drinking water supply, environment and food supply after the natural disaster, many diseases may be

occurred and spread. In all, floods, drought and other extreme weather events, have also affect human health in stages adopted in many ways. It can be divided into short-term, medium-term and long-term effects. Short-term effect is the main casualties. Medium-term effect is the spread of infectious diseases and the increase of the incidence. Long-term effect includes the spirit of depression due to economic hardship and loss of life or property caused by floods, the increased malnutrition in crowd due to no harvest of grain production caused by drought, and also a variety of diseases caused by the lack of water. Because of global warming, extreme weather events may occur more frequently and the risk due to natural disaster may also be increased.

4. Adaptation measures—public health emergency plans in climate disasters

When struggling with the natural disaster, people learned lessons from it, formed some useful experiences and even found some law of nature spontaneously. Since the 20th century, governments have paid high attention to natural disaster caused by extreme weather events. Related work started very lately in China and didn't study deeply. After 2003, government sped up the pace of public health emergencies work. The release of "Regulation of Emergency Public Health Situations" and "Overall Emergency Preplan for National Sudden Public Incidents" accelerated comprehensive initiation of public health emergencies work. It also brought the extreme weather events and public health emergencies related work into national planning.

4.1 Perfect the legal construction and develop public health emergencies by law

In order to meet the needs of public health emergencies, State Council issued the "Regulation of Emergency Public Health Situations" in 2003 and NPC Standing Committee revised the "Prevention and Cure Law for Infectious Disease of People's Republic of China" in 2004. These two laws show the responsibility of all levels of government and related departments have to take. "Regulation of Emergency Public Health Situations" also makes some rules of emergency response system and the establishment of emergency preparedness. The laws mentioned above laid a legal basis for the public health emergencies work related to extreme weather events.

In order to reinforce the construction of health emergency laws and regulations, Ministry of Health set up monitoring and early warning mechanisms, emergency response mechanisms, published information mechanisms, incident reporting mechanisms, emergency management mechanisms, emergency steering mechanisms, and emergency assessment mechanisms, worked out " National Health Emergency Management Practice in Health Department(Pilot)" and " Management of Emergency Medical Relief Work in Disaster", consummated the management of public health

emergencies caused by extreme weather events, perfected the operation norm and technical scheme of emergency investigation on the basis of carry out the "Prevention and Cure Law for Infectious Disease of People's Republic of China" and "Public Health Emergency Ordinance". Through these, they can carry out public health emergencies caused by extreme weather events quickly and effectively.

Health administration at all levels and medical and health units obey the rules such as "Prevention and Cure Law for Infectious Disease of People's Republic of China", "Food Sanitation Law," "Regulation of Emergency Public Health Situations" and "health regulations in public places" strictly, strengthen the management of public health emergencies and the fulfillment of the measures, focus on the prevention and control of infectious disease and food poisoning of the area affected by extreme weather events, monitor and manage drinking water, food hygiene and environmental health, carry out the propagation of disease prevention and patriotic health campaign, prevent the occurrence and spread of infectious disease, food poisoning and other public health emergencies of the area affected by extreme weather events. In recent years, there were a lot of flood, snowstorm and drought and other extreme weather events in China, but epidemic disease didn't occur with the effort of health administration at all levels and health professionals.

4.2 Perfect the accountability and system construction of public health emergencies

4.2.1 Enhance system construction of public health and improve emergency response capacity to extreme weather events

In 2005, Ministry of Health issued "some regulations about system construction of disease control and prevention" and "some regulations about system construction of sanitation monitor", finance at all levels increased investment, strengthened the construction of CDC at all levels and initially established public health emergency mechanism. Ministry of health and development and reform commission established "plan for the construction of Medical treatment system of public health emergencies" which made systemic arrangements for the construction of emergency medical rescue centers, professional institutions for treatment of poisoning, professional institutions for the treatment of nuclear and radiation damage and infectious disease hospital, and construction projects have been basically finished.

4.2.2 Promote the organization construction of emergency management and carrying out the responsibility system for public health emergency

State Department takes the organization construction of emergency management as an

important aim. In 2004, Ministry of Health set up emergency office to manage daily work of public health emergency. Provincial Departments of Health of the whole country have set up emergency office in provincial health administrative departments with the sanction of the provincial establishment department. Some provincial and municipal CDCs have also set up emergency office. Health administrative departments of all levels founded steering group of health emergency to ask for information, integrate resources and carry out medical rescue and disease prevention work efficiently.

4.3 Strengthen the system construction of public health emergencies

Ministry of Health has build up national Decision-making and commanding system of public health emergency in 2006 in order to suit the new situation. This new system is connecting with the provincial emergency commanding and decision-making system which is under construction, making full use of all kinds of manpower, information and technology, collecting the information about disaster, hurt, epidemic and public health emergency, doing statistical analysis on time and deploying efficiently so as to realize commanding integration, information networking, implementation programmed and decision intelligence.

In order to prevent and cope with all kinds of extreme climate event, Ministry of Health organized 31 related departments to build up emergency coordination mechanism which can be used to intensify informative communication and measure linkage among departments. They hold regular conference and take training as needed. Ministry of Health set up collaboration mechanism of public health security caused by weather with National Weather Service, production and reserves system of emergency goods with State Development and Reform Commission, adequate financial resources system of public health emergencies with Ministry of Finance, and interconnection mechanism of disaster and epidemic information with Ministry of Civil Affairs, Ministry of Water Resources and seismological bureau. Departments of health at various levels also set up communication and coordination system with government relevant departments.

4.4 Perfect the construction of emergency response planning system

Ministry of Health summarized the experience of public health emergencies since 1949 and issued emergency response plannings of extreme weather events such as “Flood and disease prevention plan”, “Drought and disease prevention plan”, “High Temperature and Heat Stroke Events Hygiene Emergency Plans”. Since 2005, State Department has carried out national prearranged plannings and special purposes about extreme weather events such as “Overall Emergency Preplan for National Sudden Public Incidents”, “National Flood Control and Drought Contingency Plans”, “National emergency medical rescue Plan of public health emergencies” and “National relief plan of extreme weather events emergencies”and

4.5 Carry out disease monitor in the area where was affected by extreme weather events, prevent and control acute epidemic and poisoning event

In January 2004, China formally started management information system of epidemic and public health emergencies which was based on case report. The system improved the timeliness, sensitivity and accuracy of the report and realized dynamic statistics and analyses. The government also organized relevant experts to predict and analyze possible epidemic situation of the area where was affected by extreme weather events, carried out emergency preparedness and predicted acute epidemic situations and poisoning events. Department of Health examines the area affected by extreme weather events regularly (morning inspection and afternoon inspection), makes sure the condition of drinking water, environment and food, find the sign of the breakout of epidemic and food poisoning, deals with environmental cleaning and disinfection seriously so as to improve the environmental condition, prevent public health emergencies and make sure there will be no epidemic after the disaster.

4.6 Reinforce the construction of health emergency response capacity and implement the health emergency measures

4.6.1 Strengthen the built of hygiene team and improve the ability of dealing with emergencies.

The government has set up national advisory panel of public health emergency in order to provide decision-making, technical guidance and emergency treatment. On the basis of cultivate professionals engaged in emergency management at provincial level, every area carried out step training to improve the capability of related workers. Chinese Field Epidemiology Training Program carried out by CCDC also brought up emergency treatment talents for every area.

4.6.2 Carry out the emergency reserves work to highly ensure the ability of dealing with health emergency.

In order to make sure physical supply of emergency medicine and prepare the emergencies sufficiently, Ministry of Health set down the catalog of emergency medicine and materials and developed medicine reserves system after consulted with the National Development and Reform Commission. Ministry of Health and the Ministry of Finance determined standard grant and approval procedure of epidemic prevention and restoration and reconstruction of health institutions. Every area also

explored reserve pattern and calling mechanism to provide powerful security for disease control and public health emergencies.

4.7 Carry out health promotion work actively and launch patriotic sanitation campaigns among all citizens.

Departments of health regard health education seriously all the time. In order to prevent disease and improve the quality of life, they often spread disease control and prevention knowledge through TV, banner advertisements, brochure and propaganda in field. The public health emergency contents have been included into health education program so that the departments of health could propaganda emergency knowledge pointedly.

Department of health sends a health education team which is composed of medical staffs to spread emergency knowledge during disaster occurs. They tell residents sanitary condition, popularize the knowledge of drinking water, food and environment and give suggestions of secondary disaster. At the same time, they ask the residents to get into the good habit so as to reduce the occurrence of epidemic diseases.

4.8 Strengthen technology research and international cooperation , enhance the ability of early warning system of extreme weather events

In order to cut down the loss of life and assets which is destroyed by natural disaster and lessen or avoid climate calamity attack population health , each rank of environmental protection bureau , weather bureau and health department give forecast to every coming serious weather and climate calamity ,such as rainstorm 、 flood、 hurricane、 snowstorm、 heat wave、 heavy mist、 freezing cold . They provide the most elaborate information about the extremely weather for mass so that warning people adopt protection actions in time.

4.8.1 Heat and cold early warning system

Many cities all over the world release the high temperature or heat wave alarm. In America, The National Meteorological Bureau releases the high temperature alarm according to the Apparent Temperature, which takes both the temperature and relative humidity into consideration. When day time Apparent Temperature exceed 40.5°C for 3 days continuously or exceed 46.5 at any time, the National Meteorological Bureau will release the high temperature alarm. In China, according to the change of temperature, the government release three-level early warning signals include yellow signal, orange signal and red signal. Their implications are as follows(Table 8-1):

Table 8-1. Heat and cold early warning system in China

	Early warning signal	Implication
Heat warning	Yellow signal	The maximum temperatures will approach or reach 35°C or have reached above 35°C within 24 hours.
	Orange signal	The maximum temperatures will increase above 37°C within 24 hours.
	Red signal	The maximum temperatures will increase above 39°C within 24 hours.
Cold warning	Yellow signal	The local temperature decrease rapidly by 10°C within 24 hours, or the daily average temperature maintain below 12°C.
	Orange signal	The local lowest temperature will decrease below 5°C.
	Red signal	The local lowest temperature will decrease below 0°C.

The system forewarns the different weather only from the perspective of air temperature and didn't take other meteorological factors and their influences on human health into account. The guiding significances for protecting human health to adapt to climate change is very limited. First, it supposes that the health effect is only due to the two weather factors, temperature and relative humidity, while ignoring other important weather factors' health effect. Second, it doesn't take the negative health effect of a serious of continuous hot days into consideration. And also doesn't consider that the health effect of heat waves take place in early summer is even more serious than that take place in late summer. Third, the high temperature days determined by maximum temperature or heat index are lack of the verification of morbidity and mortality data. Finally, it is impossible to estimate the morbidity and mortality only by releasing the heat alarm. In fact, the health effect of heat wave is due to many meteorological factors synthetically rather than only one meteorological factor' function. So, an appropriate method to evaluate the association between weather and healthy is to classify a certain place's daily weather condition, and then firm a high dangerous air mass or the "offensive" air mass, there are direct relations between the heat wave days determined by "offensive" air mass and human's mortality.

Faced with more frequently climate calamity and international cooperation, China is building and perfecting its early warning system. Supported by WMO/ WHO in 1999, Shanghai meteorological bureau and Health department cooperated with Delaware University of America to develop a health monitoring and early-warning systems of heat wave in Shanghai. The whole frame of system is shown as figure 5. The system classifies the daily weather condition and forms a weather calendar by using the method of SSC (the Spatial Synoptic Classification) weather classifying method, which is developed by the Delaware University of America, and develops a forecasting function to determine the type of air mass and mortality with the help of death data. Establish the regression equation of excess death number due to heat wave with the weather and death data in 1989-1998 of Shanghai and test it with the data of 1998. The correlation coefficient between the forecast value of excess death number and the actual value is 0.64 (being test at 0.001 level). Examine the predictability of the system with the data of 1999. Compared with the actual death number 271, the predicted number 346 of excess death due to heat wave shows that the system is satisfying on heat wave monitoring and early-warning ability.

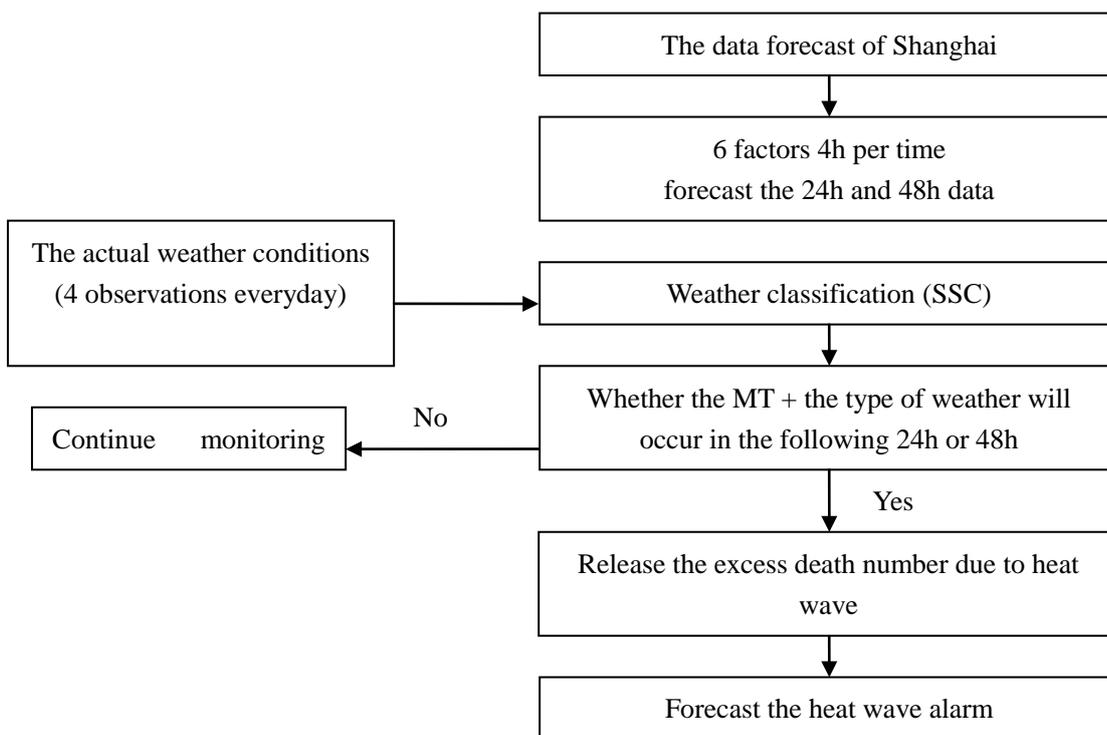


Fig8-5 The framework of heat waves monitoring & early-warning system in Shanghai

Once the early warning of heat waves was released, the public could receive timely alarm by media such as broadcasting stations, television stations and newspapers and other media; the public health department and media should enhance the publicity and education of the knowledge related to the heat waves especially for the risk population who are apt to affect by heat waves on how to defend against heat waves and protect people's health; the hospital and community service sections should make sufficient preparations; the departments of power supply and water supply should



ensure the supply of electricity and water during the alarm period of heat waves; the residents should prevent sunstroke by turning on the air-conditionings, staying under the cool environments, arrange their activities in the coolest time of one day. slowing down the pace of work, reducing or canceling violent activities, and so on.

In 2007, National Climate Center of China meteorological Administration organized Shanghai region climate center, Wuhan region climate center, Shanxi climate center and Chongqing climate center to join the program of “Heat wave early-warning monitoring system”. So far, National heat wave monitoring, forecasting and effective assessment system has been established. Two regional-level (Shanghai and Wuhan) and two provincial (municipality)-level (Shaanxi province and Chongqing municipality) heat wave supervision, forecasting and assessment system have been put into practice. Further, all the corresponding network service programme has been carried out to gone with it

4.8.2 Early warning system of extreme weather events (NEHAP,2007)

In the background of global warming, the character of atmospheric circulation, the extremely climate events also changed accordingly. Coping with the extreme weather events should be pushed at the important position for addressing the climate change. In National environment and healthy action plan (2007-2015), the health impacts of climate change have been taken to be one of the important assignments. It is particularly emphasized to research on high temperature and heat wave, rainstorm and flood, windstorm, sandstorm, drought, haze, and so on. To focus on those effects on the incidence rate of disease that sensitively to the climate change in all the country. And to explore and establish the early warning system, preparedness plan to response to the emergency and the corresponding methods or technology. Evaluate the validity of the series of countermeasures.

In 2007, the important project that supported by national scientific and technique development planning “crucial skills of monitoring, detecting and forecasting to the primary extremely weather events and the significant meteorological disasters in China” was established. It was lead by the China Meteorological Administration and several departments engaged such as Chinese Ministry of Education, Chinese Academy of Sciences, Chinese Ministry of Water Resources and Chinese Ministry of Land and Resources. The purpose of this project is to develop and expand the analysis method and crucial skill of monitoring, detecting and forecasting to the extremely weather events and significant meteorological disasters caused by these events in China, to analyze the effect to community economy in China by these climate events and disasters, to set up a professional system up to the international advanced level to defend and reduce disasters in China, it is a system of monitoring, detecting, forecasting, impact assessment, early warning and risk management to the extremely weather and climate events.

It was pointed out in “Response to Climate Change: China’s Policies and Actions”promulgated by the State Council in October 2008 that now the capacity

building of monitoring and early warning to extreme weather events was improved, and the emergency disposal mechanism to the related meteorological disasters and the derivative and secondary disasters was basically established. The defense to the extreme weather events like violent typhoon and regional rainstorm and flood has rapidly improved, the unified observation system to climate and climate changing was basically established.

From 1980s, some countries, international organization and international cooperative projects established ecological, environmental observation and research nets of national, regional or even global scale. China joined in the “Global Outbreak Alert and Response Network” of international hygiene organization. This network integrated the human and technical resources of 112 organizations in the world together (include 13 state-level laboratories in China) to identify, recognize and respond the outbreak of international infectious diseases. In view of the system have a set of automated continuation response procedures, so that once the alarm, the emergency system will be activated right away and to make the system response within 24hrs.

5. The weakness of early warning system of extreme weather events in China at present and the future working priority

5.1 The weakness of early warning system of extreme weather events in China at present

At present, our State Department and local government establish the bill of urgent prevention referring to natural disasters, accident calamity, public health events, and society security events. Because the urgent events bill system has been set up, the urgent department’s ability of dealing with and ensuring urgent has enhanced. Our ability of coping with extremely weather also strengthened. Especially in 2008, the freeze snow frost speak volumes for our strength, ability and level. However, there are “six inadequate” in our working of dealing with extremely weather events : ① information lack sensitivity②reaction lack speed; ③disposition lack adequate; ④system not perfect; ⑤ team not complete; ⑥foundation not solid. The “six inadequate” reflects our weaknesses in management and system building of dealing with extremely weather events and they manifest in some aspects as follow:

5.2 Complete the construction of legal and regulation system

Though referring law, regulation and urgent prevention bill have established and every department also set up their special prearranged planning which provided legal assurance, there are still problems such as departments’ regulations can not link up, standards disunion, function not specific, circulation complicated, administration cost

high but efficiency low, lack quick reaction ability and so on. And there are empty of corresponding regulations for the workers who take part in urgent events work about their assurance, commend, premium, subsidy, pension. perfect the mechanism of decision-making, commanding and management in dealing with urgent events

5.3 It is not complete in department's decision-making and commanding system

When dealing with urgent public health events which are generated by extremely weather, and there are lack of standard management, efficient linkage, information interaction and share between the departments and the local administration. For the monitoring of urgent public health events which caused by extremely weather, epidemiology investigation, events alarm, happen and develop information, it can not in time and efficiently collecting, reporting, gathering, analyzing and evaluating risk, so that it can not put forward scientific decision suggestion. At present, some department and local administration have not set up urgent management institution yet. Many manage by temporary institution, and its function is not specific, the authorized of its workers and outlay can not be assured under the province level, so the daily urgent events can not cope with well and also can not efficiently realize classification charge and local manage.

5.4 Monitoring and reporting system is not sound

Risk factors and available urgent resource's background is not clear, monitoring system is not perfect, there has monitoring blind area and blank spot, information reporting and monitoring prevention system also is not sound, urgent inspect technology supporting system is not complete, celerity inspect method and ability is low, all of which result in monitoring and reporting system's reaction slowly.

5.5 Strengthen the assurance and ability developing

It has not been built up emergency outlay administrate mechanism, and it is common that all are less regular management; the emergency equipment is simple, short of technology training and practice base, basic establishment weak and the measure dropped behind.

5.6 Emergency material reserve system is not complete

At present, it has not been built up complete emergency material reserve database and synthetic management system yet, and short of scientific evaluation and decision making system about emergency material reserving and utilizing, so that it still not built up sanitation emergency material reserve center which need scientific

programming and reasonable distribution.

5.7 Our early warning and forecast of extreme weather is inadequate, and referring research start relatively late

Coping with the extreme weather events should be pushed at the important position for addressing the climate change. In 2007, the important project (2007-2015) that supported by national scientific and technique development planning “crucial skills of monitoring, detecting and forecasting to the primary extremely weather events and the significant meteorological disasters in China” was established, and in “Response to Climate Change: China’s Policies and Actions” promulgated by the State Council in October 2008 all put the extreme weather events synthesis examine, monitoring, detecting, forecasting and risk management as the important position. But it is obvious that our referring research start relatively late, short of the natural disaster’s monitoring and forecasting system which is caused by extreme weather. And the extreme weather and climate’s forming mechanism and its predict and forecast need further analysis and study. Because the weakness of the software and hardware of public health emergency disposal system, the emergency disposal ability is low.

6. Future working priority

As global warming and other kind of extreme weather events happen so frequently, how to deal with extreme weather emergency disposal prepare, emergency disposal treatment and system resume so to ensure people’s health and life security is our new task to face with. Next, we need carry out such works as follows:

6.1 Need further legal management, perfect regulation criterion, and develop health corresponding work according law

Regulation and criterion are the fundamental assurance to enhance emergency disposal management level, and also the necessity request for emergency disposal legal construction. Take charge of people and thing with regulation and criterion is the premises of emergency disposal management become scientific and standard. So we need comply with “The Law of the People’s Republic of China on Emergency Responses” and “Regulation of Emergency Public Health Situations” to enhance every area’s emergency disposal management regulation and criterion building and realize emergency disposal management become standard and legal.

6.2 Perfect joint defense and control mechanism and emergency disposal regulation

At the same time, further strengthen the health department interaction at all levels about disaster prevention information communication network construction, and gradually form the whole interaction network of prevention and control of horizontal linkage mechanism, timely and effectively response to emergency public health issue which caused by extreme weather events.

6.3 Further improve various types of extreme weather events and health emergency response network, focusing on strengthening primary health emergency disposal mechanism and capacity-building

As“*The Law of the People's Republic of China on Emergency Responses*”is carried out and in accordance with emergency health needs of actual work, to increase the leadership of the State Council on strengthening the coordination of health emergency management agencies to implement the spirit of building instructions, and actively develop the National Health Emergency Management Agency ‘s research and promoting the health departments and health institutions Emergency Management Agency’s technical supporting, carry out the implementation of responsibility and accountability system. In the "Eleventh Five-Year" period, gradually establish and improve the central, provincial, city (prefecture) and county emergency workers four levels health management system. Focus on strengthening basic health emergency response mechanism and capacity-building. Combination of urban and rural health service system, put the urban community health service centers and township hospitals as priority, focusing on strengthen the health systems of China's basic health emergency management, and give full play to the basic health system in the health emergency management and disaster prevention. Increase basic health emergency disposal capacity-building inputs, to guide primary care combined with local health agencies to develop various types of extreme weather events and emergency health disposal bill, and enhance the region's ability to prevent disaster. Guide and supervise primary health care of local health agencies about various extreme weather events which may lead to the sudden public health problems to develop operational control measures and conduct regular emergency health awareness, and further promote social change in a variety of non-public sanitation, unsafe behavior, and strive to improve self-help among people to save themselves and develop the ability of disease prevention and control.

6.4 Investigate the establishment of health emergency response capacity about extreme weather events and performance evaluation mechanism

Careful analysis of different types of extreme weather events, as well as the same type incident in different regions' performance characteristics ,and different circumstances extreme weather events may lead to different kinds of public health issues, understanding the requirement of the affected areas' public health services (such as the needed treatment in disaster on the elder in the heart, the brain vascular disease, etc.), speed up the establishment of extreme weather events, health emergency response capacity and performance evaluation mechanisms, to develop an objective and scientific work to deal with extreme weather events evaluation, the establishment of a standardized assessment and evaluation system method to extreme weather events, bringing the evaluation of the health emergency response capacity into the government and health performance appraisal system to evaluate regular or irregular, so that we can ensure the level of emergency response capability toward extreme weather events continuous improve.

6.5 To study and organize the implementation of the rapid restoration of extreme weather events regional medical and health security system

Study from the lessons and experience of domestic and foreign health emergency disposal of extreme weather events, combined with the construction of township hospitals in our rural areas and the overall norms and urban community health service institution-building requirements, speeding up the research in line with the national conditions of our medical and health security system's restoration and reconstruction mode, the Government of the affected areas to restore the development of medical and health institutions to provide technical reference to the reconstruction of planning for extreme weather events affected areas to restore the health sector capacity to provide medical and health protection work of the guidance. Development and Reform Commission actively consultations, financial and other sectors, joint to develop and organize the implementation of the rapid restoration of extreme weather events affected areas' medical and health security system, concrete measures to carry out , to ensure the masses of the affected areas form sustainable and combined with its demand's medical and health services.

6.6 Further strengthen scientific and technological support system

According with the "national scientific and technological development and long-term planning framework," using technology to improve forecasting capability of early warning extreme weather events and the public health emergencies capacity, give technology support to the basis theory of health emergency management, application and key technologies about extreme weather events through the National Science and

Technology Plan, Science Foundation, and the expenses department. Through the establishment of shared database and index system about extreme weather and climate events caused by major meteorological disasters, in-depth study the incidence of law of extreme weather and climate over the past century, and the background of global warming, the causes of frequency and intensity changes and formation mechanism of extreme weather/climate events,; further improve the event of extreme weather and climate monitoring network system, enhance its technological predictability breakthroughs, initially establish integrated monitoring, forecasting, business impact assessment system of extreme weather events and related disasters; Improve the simulation capabilities of existing numerical model to extreme weather/climate events, develop new climate numerical models, forecast the next hundred years' extreme weather events development trends in our country at the background of climate warming; the ultimate establish a with the fundament of meteorological data, combined with hydrology, geology, agriculture, marine, transportation and electric power industries information build the dynamic monitoring, quantitative impact assessment, early warning systems. Provide timely and accurate scientific and technological support and assurance for all levels' industry and government to build disaster risk management system, decision-making, disaster risk assessment and scientific management.

At the same time, the national disease prevention and control institutions, medical institutions, research institutes should strengthen disaster forecasting and early warning of emergency health discipline, make great efforts to train disaster forecasting and early warning of emergency health science and technology talent. Adhere to independent innovation and the introduction of a combination of digestion and absorption, forming extreme weather events forecasting and early warning response mechanism of the health emergency, scientific and technological innovation and health emergency management technical support system. Organize and support strategy and technology-related research in health emergency of extreme weather events, closely tracking the development of international research developments and trends, combined with our disaster forecasting and early warning of health emergency management to develop command and decision-building projects, gasping the key technology research in dealing with extreme weather events on public health impact, improving the disposal capacity of early warning of extreme weather events and forecasting capability of the health emergency events.

【Case study】

How to deal with the flood disasters for public health department?

➤ Flood hazards

- Directly cause drowning or death, wound due to collapse of building. Famine and diseases caused by flood also can cause death.

- Flood disasters can change the bio-environment, destroy human's living environment, lead to outbreak and prevalence of infectious diseases by changing their source and transmission.
 - ✓ Impact on the source of infectious diseases. Flood may drown the source of some infectious diseases. Then the S rodents and other animal host may spread, transfer or expand, thus causing the prevalence of certain infectious diseases.
 - ✓ Impact on the route of transmission. Flood also lead to prevalence of infectious diseases by changing bio-environment, expanding the breeding place of insect hosts, and increasing the density of insect hosts.
 - Flood disasters may cause great immigration, which is a potential influence factor of disease prevalence.
 - Bad environment after flood disaster can easily cause illness or death, especially for the weak, old, young and people with chronic diseases.
 - Post-disaster psychological depression, malnutrition caused by shortage of food and so on, may decrease the body immunity against disease, thus causing a serious of infectious and non-communicable diseases
- Contingency plans taken by public health department after flood disaster. (For more detail please consult "National Flood Control and Drought contingency plans")
- Strengthen the information reporting system. Mainly include the initial report, stage report and summary report, will be reported according to their different reporting requirements and time limits.
 - Public health status and needs assessment. Investigate and assess the status and needs of food, drinking water, toilet, medicine, vaccines, health education, etc, in disaster area.
 - Disease surveillance in disaster area. Monitor the disaster-related infectious diseases and non-infectious diseases in the disaster and related areas during and long period after natural disasters.
 - Prevention and control work of the infectious diseases and frequently occurring diseases in the disaster areas.
 - Response and protection work of drinking water hygiene in disaster areas.
 - Response and protection work of food hygiene in disaster areas.
 - Response and protection work of environment hygiene in disaster areas.
 - Toxic hazards guarding work in disaster areas.
 - Disinfection, pest and rodent control work in disaster areas.
 - Health education work about flood disasters in disaster areas.

【Exercises】

1. What's the main type of extreme weather events in your hometown in recent years? What's the main effect it bring about to local social, economic and public health?
2. From 1 November, 2008, the precipitation decreased 50-80% than previous year in winter wheat area in north China. 155,000,000 Mu field affected by drought disaster. 42,900 people and 20,700 livestock were lack of water because of draught. Chinese State Flood Control and Drought Relief Headquarters announced the grade I Drought Emergency Response for the first time, Please talk about the bad effect it brought about and how to carry out the public health emergency work combining with your personal experience?

【Recommended readings】

High Temperature and Heat Stroke Events Hygiene Emergency Plans

<http://www.moh.gov.cn/publicfiles/business/htmlfiles/zwgkzt/pwsyj/200804/31434.htm>

National Flood Control and Drought Contingency Plans

http://www.gov.cn/yjgl/2006-01/11/content_155475.htm

The Law of the People's Republic of China on Emergency Responses

http://www.gov.cn/flfg/2007-08/30/content_732593.htm

Regulation of Emergency Public Health Situations

http://www.gov.cn/zwgk/2005-05/20/content_145.htm

Overall Emergency Preplan for National Sudden Public Incidents

http://www.gov.cn/yjgl/2005-08/07/content_21048.htm

Prevention and Cure Law for Infectious Disease of People's Republic of China

http://www.gov.cn/ziliao/flfg/2005-08/05/content_20946.htm

National Health Emergency Management Practice in Health Department(Pilot)

<http://www.ncws.gov.cn/law/ShowArticle.asp?ArticleID=749>

Management of Emergency Medical Relief Work in Disaster

<http://www.bjchy.gov.cn/affair/zfyj/law/12858.htm>

Response to Climate Change: Chinas Policies and Actions

http://www.gov.cn/zwgk/2008-10/29/content_1134378.htm

MODULE 9

Effects of Climate Change on Food Safety

Effects of Climate Change on Food Safety

【Learning Objectives】

To provide an introduction of climate change in China.

- ✧ To provide knowledge on effects of climate change on food safety.
- ✧ Challenges and adaptations in China.

【Text】

1. Facts of climate change

In recent decades, global warming has influenced many countries in different ways. The Fourth Assessment Report proposed by Intergovernmental Panel on Climate Change (IPCC) made it clear that greenhouse gases caused by human activities had increased average temperature and sea level by $0.13^{\circ}\text{C}/10\text{a}$ (1956-2005) and 3.1mm per year (1993-2003) respectively (IPCC, 2007) .

With global warming, heat resources also increase in most districts of China. From 1980 to 1998, annual average temperature of China increased at a rate of $0.52^{\circ}\text{C}/10\text{a}$, which is significantly higher than global rate in the same period. The warming trend was more significant in western, eastern and northern China than in the south. The most significant temperature increase occurred in winter, and 20 consecutive warm winters were observed nationwide from 1986 to 2005.

2. Effects of climate change on food safety

Many researches have shown an adverse relationship between climate change and human health. The detection and attribution of health effects to climate warming has become a key research challenge. The direct effects as well as longer-term effects are mainly caused by extremes of temperature and rainfall such as heat waves, floods, and drought. According to indirect effects, concerns about effects of climate change on food safety increase during these years

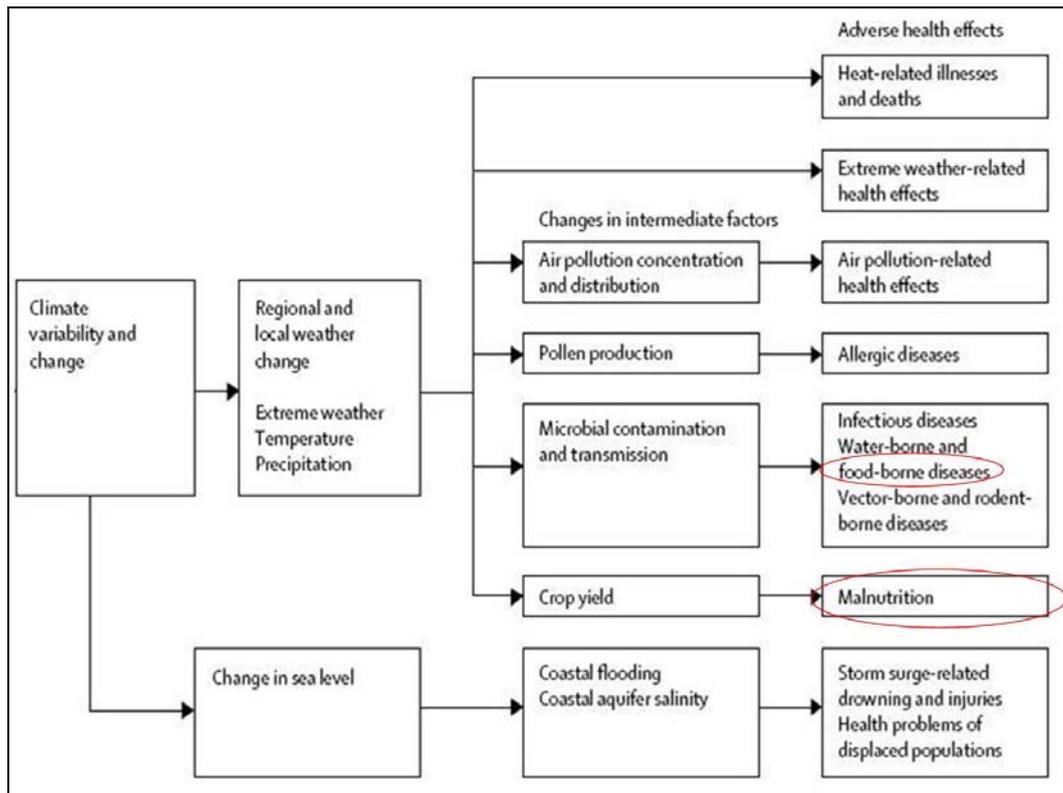


Figure 9-1: Potential health effects of climate variability and change.

from A Haines, RS Kovats, etc.

In recent years, with the progress of globalization, attention on food safety caused by climate change has increased. Food safety refers to the change of food supply and quality, such as agricultural production decrease, foods shortage and so on. On the other hand, as a result of climate warming, food-borne diseases have occurred frequently.

2.1 Food supply and quality

2.1.1 Food supply

Foods mainly come from agriculture. Climate change will be benefit or harmful to agriculture, but basically the adverse effects are more prominent. The adverse effects vary depend on several factors, such as crop species, regional difference and environmental conditions, etc. With climate warming, water deficit and shortened growth period of crops become more common in agriculture, which will reduce the crop yield. Warming may also change the current farming system, such as the layout of crops planting. There are several mechanisms by which climate can affect food supply:

With the oceans warming and expanding, the sea level will rise, threatening coasts and small islands with flooding. Some low-lying lands adjacent to coast might be

submerged and the fresh water resources may be polluted.

Frequent disasters, such as drought ,typhoon, tsunami, etc. The direct economic losses of agriculture caused by meteorological disasters every year are more than 1,000 billion yuan in China, accounting for about 3%~6% of the gross national products.



Fig 9-2 Drought in North of China, end of 2008

The diseases of plants and pests will also spread: Climate warming will greatly affect crop pests. Some ecological features of crop pests, such as growth, reproduction and distribution, have close relation with weather. Recently, the incidence of disaster caused by crop pests increased and as a result the output of crops reduced.

2.1.2 Food quality

1) Water used in agriculture change

Global warming affects the distribution of rainfall, which in turn affects the amount of water used in agriculture. With climate warming, increased evaporation would reduce the river flows, which would greatly decrease the water quality. Reduced river flow would exacerbate the water pollution, especially in dry-season. The rise of water temperature would also accelerate the deposition of pollutants and the decomposition of waste in river.

2) Nutrition in food change

About 63% of the warming effects caused by greenhouse gases have been correlated with carbon dioxide. Carbon dioxide regulates the photosynthesis of crops and will

have different effects on crops.

Increase: sugar, citric acid and viscosity in fruits

Decrease: nitrogen and protein

Some experiments have shown that when the concentrations of carbon dioxide reach 565 ppm, the wheat protein will decrease by 3% -5%. When the concentrations of carbon dioxide doubled, the contents of amino acids and crude protein in soybean will decrease by 2.3% and 0.83% respectively, whereas the contents of crude fat, saturated fatty acids and unsaturated fatty acid in kernel increase by 1.22%, 0.34% and 2.02% respectively.

2.2 Food contamination and food-borne diseases

Food contamination: Climate change also raises the issue of food safety and may have impact on food contamination from following aspects: foods with pathogens itself (eg. pork with trichinosis), foods contaminated by pathogens in the producing process (eg. polluted ice cream or vegetable salad); foods contaminated in the process of storage, transport and sale (many pathogens of infectious diseases such as dysentery, hepatitis A can contaminate foods by the patients, pathogenic carriers or mosquito).

Higher temperatures favor the growth of bacteria in food. Infections with *Salmonella* spp. rise by 5–10% for each one-degree increase in weekly temperature, at ambient temperatures above 5°C. Hot weather can also favor refrigeration failure and the emergence of flies and other pests.

Food-borne diseases: It is also possible that climate change could affect the incidence of ciguatera poisoning. This is due to the consumption by humans of fish containing toxin derived from planktonic dinoflagellates. Toxin is found in over 400 species of tropical reef fish and causes rapid onset of gastrointestinal symptoms within 24 h and neurological symptoms up to 3 days after ingestion. Paralytic shellfish poisoning and diarrhetic shellfish poisoning cause neurological and gastrointestinal symptoms change respectively. They are both temperature-dependent and highly seasonal.

3. Impacts on nutrition and food safety: A National Perspective

In other countries, researches about the effects of climate change on food safety are mainly as follows:

3.1 Diversity on outputs of crops in different countries and regions

The impacts of climate change would not be the same in different countries and regions. With climate change, food productivity is projected to decrease in the Mediterranean area, southeastern Europe and central Asia, where food safety is at risk. Crop yields could decrease up to 30% in central Asia by the middle of the 21st

century and threaten food safety. This may lead to a worsening of malnutrition, especially in the rural poor, whose family income is closely linked to food production.

An estimation of the world's three major crops (wheat, corn and rice) in Future (2020, 2050 and 2080) indicate that the crop yields will be reduced in some developing countries, while increase in developed countries of northern hemisphere. For example, with a larger population, the grain imports in Asian increases from 2,000 million tons in 1961 to 8,000 million tons in 1998. In the future, the supply and demand of food in Asian will face greater pressure.

3.2 Concern the increasing population with malnutrition

Climate change will further increase the number of malnutrition in developing countries. It is estimated that there are about 790 million people with malnutrition in developing countries. In remote regions, trades are not so prosperous and people are more vulnerable to crops reduction and foods shortage. Malnutrition children physically and mentally stunted, declines the work capacity of adults, and increases the possibility of infection. Recent studies have shown that malnutrition is a most important single factor resulting in diseases. In 1990, there are nearly 6,000,000 people died of malnutrition in the world, which is nearly doubled that of people died of smoking.

In the countries of the regions, where malnutrition, low levels of education, poor basic infrastructure and low-income are in common, the groups (including young children, the elderly and physically unhealthy person) will suffer great difficulties to adapt to climate change and have the highest healthy risks. The groups are usually living in small islands, mountain areas, and regions with water scarcity, large cities and coastal areas in developing countries (particularly large-scale cities in the Asia Delta). The groups also include the poor and those who have no health services.

Most studies show that global warming leads to the rise of food prices, and increase the number of population threatened by hunger. More researches are needed to confirm these results.

3.3 The vulnerability to climate change in different regions

With different intrinsic characteristics, natural resources and legal systems, different societies and nature systems have different sensitivity, adaptability and vulnerability to climate change.

The effects of climate change on health are likely to impact most heavily on low income countries where capacity to adapt is weakest, but also on the most vulnerable groups in developed countries. Because of unstable economy, low level of financial and natural resources, and lack of regulation and technical ability, most developing regions such as Africa, Latin America and Asia, etc. show lower adaptability and high vulnerability to climate change. Even in the regions with higher adaptability such as

North America, Australia and New Zealand, there are still vulnerable communities, such as indigenous communities, where the ecosystem adaptability is very limited. Southern Europe and the Arctic are more vulnerable than the other parts of the continent.

3.4 Impacts of climate on foods

Nutrition and food-safety control are big challenges that will grow with climate change. The Second WHO European Action Plan on Food and Nutrition Policy set goals and targets to reduce the health burden associated with food and nutrition, which should also result in action relevant to climate change. This includes strengthening surveillance and monitoring systems to detect changes and analyze trends in food borne and nutrition-related diseases, and educating consumers on healthy diets and food-safety practices.

Global warming may increase the incidence of food-borne diseases. Studies had shown that from 1982 to 1991, the incidence of food-borne disease in British is closely related to the average temperature, and this relation exist only when the average temperature is higher than 7.5 °C. As a result, it can be forecasted that by 2050, food-borne diseases will increase by 5% to 20% in British.

4. Situation in China and its challenges on food safety

4.1 Situation in China

Food supply: Taking no account of water impact, climate change will reduce the outputs of early-rice, late-rice and single-harvest rice. The reduction rate of single-harvest rice descended from north to south: about 17% in the middle and northern part of North China, 10%-15% in the middle and northwestern parts of China, and 6%-10% in the South China. The yield of early-rice is less affected in the central area of South China (reduced less than 2%) than in its surrounding areas, especially in the western area of South China (usually reduced 2 %-5%, and 6% in some regions). The yield reduction of late-rice is more obvious in the northwestern area of South China (10%-15%) than in the southeastern area (7%-10%). (Fig.9-3)

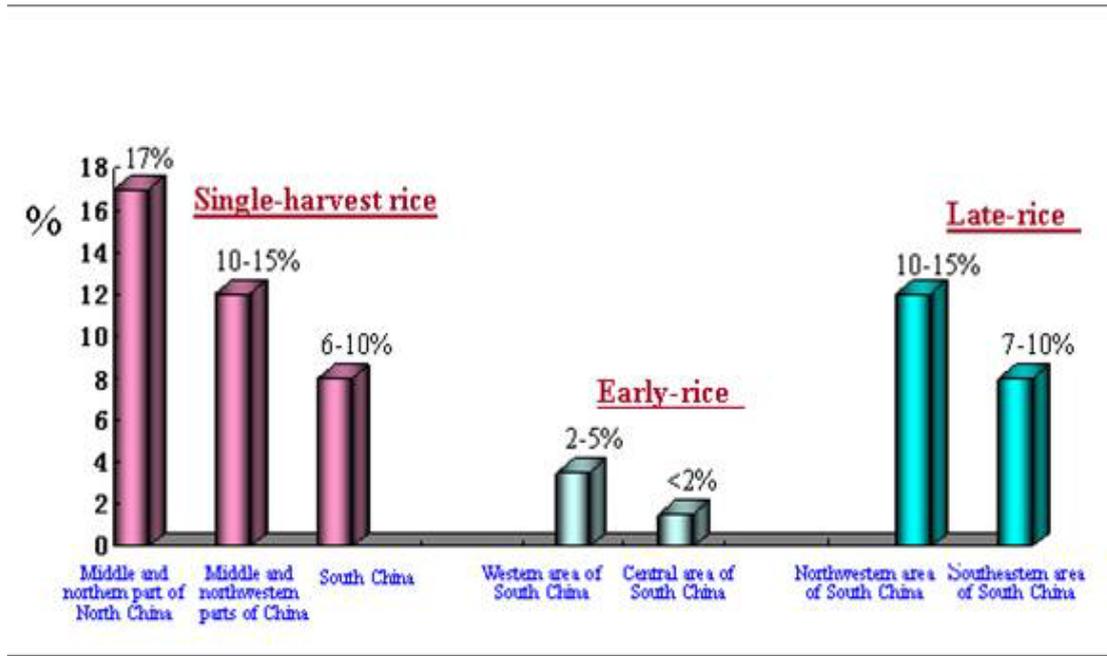


Fig. 9-3 Reduction rate of rice output in China

Water resource: In the past 50 years, the variations of annual and regional precipitation were obvious. Precipitation was high in the 1950's, then significantly reduced in 1960's, decreased to the lowest in 1970's, and a slight increase in 1990's compared with 1980's, but it still not reached the amount of the 1950's and 1960's. Precipitation has obvious regional and seasonal features. Precipitation is mainly reduced in summer, and North China is the droughtiest area, and followed by the middle and south of China, then the east and southwest of China (Figure 9-4).



Figure9-4: a part of the Yellow River in north China

Crop pests: With climate warming in China, some ecological features of crop pests, such as growth generation, reproduction and distribution have also changed. As a result, the crop diseases caused by pests occur earlier and end later which will cause the output of crops reduced.

4.2 Adaptability

As a large country, China has different climatic conditions and geographical features. The regional agricultural productivities are also influenced by climate change in varying degrees.

North-East of China: The frozen and other disasters affecting crops reduce with climate warming, which the growing periods of crops extend and cultivation systems are also changed correspondingly.

North, North-West and South-West of China: The adaptabilities of crops on temperature increasing are poor and inhibitory effects of climate warming on yields have been shown.

East and Central South of China: The responses to temperature change on crops are not so obvious, which means that agriculture in these regions are not sensitive to climate warming and has a good adaptability.

From above it concludes that:

There is a great potential to adapt climate warming for agriculture in high-latitude areas of China. In the mid-latitude areas, the adaptability is not so good, but through scientific and technological progress the negative impacts caused by climate warming will still be reduced. But in the low-latitude areas, because of high temperature background, if temperature still increases in the future the agriculture in the areas will face severe challenges and the rapid reduction of cultivated land will also be a threat to food safety in the regions.

4.3 Challenges in China

In China, most researches are focused on the relation of climate warming and agricultural production. The effects on agriculture caused by greenhouse are deeply investigated. These studies will play an important role not only in accurately evaluating the effects of climate change on China's agricultural production, but also in establishing strategies to mitigate or avoid adverse effects of climate change.

Little researches are on hunger and malnutrition caused by global warming and should be strengthened. In future, the instability of agricultural will increase and will also exist for a long time. Furthermore, nutrition deficiency and food shortage would pose a challenge to the health of people. For example, in recent years, due to global warming and natural disasters, more bacteria pathogens are discovered and reported. Food poisoning caused by these pathogens has also been increased. This kind of poisoning shows no significant seasonal differences, and is a great threat to human health.

5. Adaptive measures of China

5.1 Country level: enhance adaptability for sustainable development

The best strategy against global warming is to enhance the adaptability to climate, and strengthen the abilities of sustainable development, not only meeting people's basic needs, but also allowing people to choose methods and technology for development.

Undoubtedly, climate warming has diverse influences on ecological environment and growth system of agriculture. In turn, with increased investment to agriculture, the concentrations of greenhouse gases in atmosphere will increase further, which will accelerate the warming process. Therefore, when making national development strategies and long-term planning for agriculture, greenhouse effects resulted in climate and environmental change should be taken into account.

5.2 Weaken the sensibility of agriculture on climate change

Protect and reasonable utilize land, mines, water, forest, grassland and climate resources. Improve the ability to comprehensive utilization of resources. Strengthen protection and management of eco-environment. Speed up the construction of key environmental protection and pollution control projects. Reduce the emission of pollutants. Plant trees and grass for wetlands protection. Establish disaster prevention and environmental protection safety system.

5.3 Strengthen scientific researches on climate change

There are many uncertainties on estimating the future climate changes. These uncertainties are related to the diversity of man-made discharge programs, the uncertainty of climate models, the unpredictable feature of natural climate changes, and the complexity of interaction and feedback of different factors in weather system.

Further research is needed to improve understanding on the changes of climate system, reduce the uncertainty in current researches. Furthermore, it is also essential to further understand the interaction and feedback process of the circles in global climate system, explore the circulation process and mechanism of the greenhouse gases and aerosols, detect and forecast the climate change.

According to the Strategic of Meteorological Development, a series of important researches are undertaking in China, such as China Climate Observation System, Atmospheric Composition Observation System and Climate Simulation Model System. These plans will facilitate us to observe global climate change and its impacts of human activities. By analysis and simulation of climate models, we will enhance the prediction accuracy of climate change.

Additionally, the assessment system for sensitivity, adaptation and vulnerability in

response to climate change should be improved and quantified. Emphasis may be placed on the frequency and intensity of climate changes in extreme weather events.

5.4 Enhance the public health system and researches related to climate change

Public health safety should be placed in the most important position in the climate change measures, especially giving priority protection to vulnerable groups.

Although science and technology has been fully developed, food contamination and food borne illness are still occurred. The status of food-borne disease warning us that public health is facing new challenges. Therefore, it is necessary to compose relevant laws and regulations, apply advanced technology to control food safety, improve food hygiene awareness and sense of responsibility, take comprehensive and effective measures to reduce risk factors in food to prevent food-borne diseases.

Different adaptation strategies, especially in the assessment of population nutrition and food safety caused by climate change, should be taken at local and national levels in order to minimize the impact of climate change on people's health.

More researches are required to explore the relationship between weather, extreme events, food safety, and nutrition among people. Improving the existing public health infrastructure and enhancing climate monitoring capabilities could mitigate or avoid possible health effects caused by climate change.

【Case study】

Drought happened in China

Eg. Drought happened in China, the end of 2008—early of 2009.

XinHua news: **Droughts put north China on red alert (Feb. 2009)**

<http://www.52scp.com/gdzx/view/id-10296>

According to the Office of State Flood Control and Drought Relief Headquarters on Sunday the droughts in northern China have affected about 9.67 million hectares of crops and have left 3.7 million people and 1.85 million livestock with poor access to drinking water.



Figure 9-5 Droughts in China

Through kinds of photos, news and information, learn the impacts of climate warming and adaptive measures especially in food safety.

【Exercises】

- In certain areas: according to its characters in climate change

Propose the possible factors of climate change which could influence food safety and nutrition in local areas. (10min)

What should we do in local CDC?

How to obtain the data;

- What kind of people should we pay close attention to? (10min)

Old people and children, physically weak, etc.

How to investigate?

Crisis reply and early warning?

Where should we report to?

【Recommended readings】

1. http://news.xinhuanet.com/politics/2007-06/04/content_6196300.htm
2. http://news.xinhuanet.com/world/2009-02/09/content_10786989.htm
3. http://www.nxnet.net/pinglun/bjtt/200902/t20090213_445323.htm

MODULE 10

Review and Assessment

Review and Assessment

【Learning Objective】

1. All contents of this training will be reviewed in this module;
2. Training effect will be assessed.

【Training procedure】

The trainer will make a brief summary of information learned from module 1 to module 9.

【Exercises】

1. The trainees can make comments on the training workshop or put some questions. Then officials from Ministry of Health, experts from World Health Organization or the trainers will answer the questions.
2. All the persons who attend the meeting discuss the future work of environmental health, focusing on climate change and health impacts.
3. The gaps between the status of China and the international experience will be analyzed. It is also needed to seek for further help from international organizations, such as WHO.

【Assessment】

1. Articles feedback

The trainees are required to finish an article focused on climate change and health impacts. And the article should base on the work experience and it also should provide some actual advices on the scientific study or management. Main content of the article have been listed as follows, one or more aspects can be chosen to write. The title of the article can be determined by the trainees. The number of words in the article should not be less than 2,000. It is required to feed backed to MOH and IEHS of China CDC.

- 1) According to thermal stress on public health, what should be done by the health sector in your province?
- 2) What achievements have been got by the health sectors in response to climate change impacts on air quality? Please point out the disadvantageous of the current work and what should be focused on in next step.
- 3) Combined with local status, please give some talk on the impact of climate

change on freshwater resources (including water quantity and quality), and the resulting problems of drinking water safety, as well as the corresponding measures have been taken and recommendations.

4) Please clarify the effects of climate change on the prevalence of vector-borne diseases.

5) Please work out the main factors which are endangering to food safety and also give some suggestions on the counter measures, combined with the local climate type and environmental pollution status.

6) Do you think the occurrence trend of extreme weather events in your hometown have changed or not? Whether such changes are related to global climate change or not?

7) What's the disadvantageous of the environment and health management based on your daily routine work, please also make the suggestions.

2. Questionnaires for trainees

In order to evaluate the effect of this training and result in better training sessions in the future, two questionnaires have been designed to find out what the trainees know about climate change and health impacts before and after the workshop (see next page).

Training Module Evaluation Form

(Before the training)

In order to know the knowledge you have got about the climate change and further to develop the training module evaluation , please choose the right number or put down your answer on blank line for each questions. Thanks for your kindly help.

1. Name: _____
2. Gender: _____ 1= male 2=female
3. Age: _____
4. Institution: _____
5. Education degree: _____
1=Doctor Degree 2=Master Degree 3=Bachelor Degree
4= college graduate 5=High school or even bellow
6. Position/Title: _____
7. Working Field/Direction _____
8. Do you know the current changing trends of global climate? _____
0=not know 1= have some knowledge 2=very clearly
9. What's your opinion about the importance of the global climate change? _____
0=not important 1=somewhat important 2=important
3=very important 4=don't know the answer
10. Do you think that global climate change can make effects on human health?

0=no effect 1= some effect 2= relative large effect
3= significant effect 4=don't know the answer
11. From which sources do you acquire the knowledge about the climate change? _____
1=professional course or conference 2 =Internet 3=TV 4=Broadcasting
5=books or magazines 6= communication among the colleagues
7=others _____
12. Do you have engaged in related training?

0= no 1=yes

If “yes”, please answer the following questions:

12.a Training areas and content: _____

12.b Training Form: _____ (such as lecture, training workshop and audio-video materials,etc.)

12.c Training Hours/Days: _____hours (or _____day)

13. Do you have engaged in related work on climate change? _____

0= no 1=yes

13a、 If “yes”, please give a brief explain about the work content and the funding sources.

14、 Are there some works about climate change have been done in your institute? _____

0= no 1=yes

14a、 If “yes”, please give a brief explain about the work content and the funding sources.

15、 Do you know the objectives about this training? _____

0=no 1= somewhat 2= very clearly

16、 What themes would you like to learn from this training?

Training Module Evaluation Form

(After the training)

In order to know the training effects, please choose the right number or put down your answer on blank line for each questions. And please also hand in the questionnaire to the committee affairs set before you leave. Thank you for kindly help.

1. Name: _____
2. Gender: _____ 1= male 2=female
3. Age: _____
4. Institution: _____
5. Education degree: _____
1=Doctor Degree 2=Master Degree 3=Bachelor Degree
4= college graduate 5=High school or even bellow
6. Position/Title: _____
7. Working Field/Direction _____
8. According to your opinion, weather this training courses is necessary or not? ____
0=not necessary 1=necessary in some degree 2=Necessary
9. Through this training, do you have acquired new knowledge about climate change and health. _____
0=no 1=yes
10. Focused on all the contents in the training modules, please write the right number according to your opinions on the extent of knowledge acquired through the training.
0=have fully understand all the contents before the training;
1=partly understand the contents, and get some improvements through the training;
2=completely not understand the content before the training, and get clearly improvements through the training.
- A The causes, status and trends of global climate change. _____
- B The characteristic of the climate change in change. _____

- C The climate change impacts on vector-born disease. _____
- D The relationships between the climate change and the prevalence or mortality of the chronic disease. _____
- E The relationship between the climate change and air pollution _____
- F The impacts of climate change on food safety _____
- G The impact of climate change on water sources and the safety of drinking water. _____
- H The relationship between climate change and extreme weather or nature disaster. _____
- I The public health emergency measures in coping with the extreme weather events or nature disease. _____
- J International management system about environment and health. _____
- K National management system about environment and health. _____
- L The monitoring and forecasting system about environment, climate change and health. _____

11. Do you interested in all the contents mentioned above? Please select the most interested items. (Please write directly the sequence number A~L, and you can fill in multiple choice items)

12. On what themes presented in the training modules would you like to get more information in the future?

13、What themes **not included** in this training courses would be interesting for you in the future?

14、 If you have some more suggestions or requests on the training form, we will happy to see your comments here.

15、 What should be focus on about the training contents in the provincial level or below the provincial level training which will be held in the near future? Please give your suggestions.

16、 Your comments about this training.
