Geo-environment in the Sustainable Development of Chinese Cities

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1 Introduction

Urban geo-environment generally covers two aspects\(^{[1]}\): one refers to natural geo-disasters such as landslides, surface collapse, etc.; the other refers to adverse effects and the consequences of human activities on the atmosphere, hydrology and land. As regards the former one, geo-scientists mainly work on mechanisms and measures of the natural geo-disasters and their reduction, and the latter deals with the geo-environmental protection and management. Nevertheless, they are not independent on each other but related internally. The breadth and depth of the influences resulted from human activities on the natural system of the earth primarily depend on how much and how fast earth materials are directly or indirectly moved in human activities. In developed countries, moved earth materials average 20 tons per person every year. If the annual total population of developed countries is roughly estimated as 1 billion, then the moved earth materials each year reaches about 20 billion tons in developed countries, which more or less equals to the amount of oceanic crust produced annually at mid-oceanic ridges in the world\(^{[2]}\). In that sense, human activities in the natural system have become one of the major forces driving the movement of earth materials (including crust), and one of the geological agents.

Such huge amount of earth materials being moved reflects the growth of human economy, development of technology, increase of population, and the urbanization process of human living places, i.e., the current change in human habitat: from rural towards urban. The census shows that 50% of the total 7-billion population of the world live in cities now, and these cities take up only 0.7% of the world's total land area. Around 85 cities in the world have a population of 2.5 million or over (classified...
as big cities), and 60 or so of them have a population of or over 5 million (classified as megacities). The average population growth rate of these megacities is 3 times as high as that of the whole world\[^3\]. Take our neighboring countries and regions as an example. The urban populations of Australia, Japan and Russia constitute approximately 86\%, 78\% and 73\% of their totals respectively. Singapore and Hong Kong rank the highest in urban population density, with around 4,500 persons and 5,600 persons per square kilometer respectively\[^4\].

Such big(mega)cities, so far as the environmental protection and management are concerned, often are considered as not only a pollution source but also the biggest victim of the geo-environment. Another characteristic of megacities is the vulnerability to disasters and environmental pollution, which will be aggravated with the expansion and the centralization of these cities. Therefore, in city planning, construction and sustainable development, the other aspect of geo-environment which has to be taken into consideration is the geo-disaster reduction, mitigation and prevention. Seeing that a big (mega) city usually supplies water, power and natural gas through a central control system and have several dense networks of transportation and communication. Once any kind of geo-disasters happens, the water, power and gas supply would be broken down partly or even totally and the networks of transportation and communication would collapse. Thus the organism of a city will be paralyzed. Subsequent disasters such as big fires, explosions and pestilence would usually be resulted. All these would, in turn, aggravate the original disaster’s threat and harm to the life and property of highly crowded city residents.

A Chinese big (mega) city generally functions as a political or economic center in a region, a province, the whole country or even Asia. Sudden weakening or disruption of its operating functions not only affects the city itself, but also neighboring regions, the province, whole country even Asia.

Investigation urban geo-environment mainly concerns the geology, geography, geophysics, land, climate, and hydrology as well as the relevant study on their management and protection. The corresponding study on geo-disaster hazards on their mechanism, reduction, and prevention is also included. So far as the geo-environment of big (mega) cities in China, special attention may be paid to the following aspects.

2 Urban geo-dynamical environment

The crustal movement and the seismic activity in and around a city are two main considerations of the urban geo-dynamical environment. China, lying on the Eurasian Plate, is collided and compressed with the Indian Plate in the southwest, with the Pacific Plate in the northeast and the Philippine Plate in the southeast. Hence China is located in the area with drastic and complex crustal movement in the world, and also in the one of the most active seismic regions in the world.

In addition, buildings in Chinese cities usually are not strong enough to survive in earthquakes, and Chinese population density in cities is very high as compared with foreign cities. So if a severe geo-disaster, like earthquake happens, heavy casualties and economic losses would be resulted, especially in the east part of China.

3 Urban hydro-environment

Supply of industrial and drinking water is one of the lifelines of a city. In China cities are generally lacking in water, and their water recycling rates are rather low. Such a large amount of groundwater is drawn in those cities which are short of surface water resources, so it results in the going down abruptly of the groundwater level, the thinning of the aquifer and the lowering of the water quality. Consequently, the subsequent hazards like ground subsidence, surface collapse, ground crack and surface deformation often occur. Usually, big (mega) cities built along rivers or coastal lines in China are exposed to the risk of water-logging, flooding and bank-bursting, at the time of abnormal weather. Therefore, urban hydro-environment is an important and keen problem for the geo-environment of Chi-
Urban environment of geology and geography

Urban environment of geology and geography is the basis of a Chinese city planning and construction. Related problems often being regarded in China are presented as follows.

1) Landslides and surface collapse. To meet all kinds of the city construction requirements: excavation, slope cutting and piling above and under the ground, despite precautionary measures having been taken, landslides still often happen in the cities, due to the permeation of rain or groundwater, especially in places where slopes cut or the slope protection construction are inappropriately made. As a frequent but often unpredictable hazard, landslides bring about heavy losses.

2) Ground subsidence and deformation, including ground cracking and cave-in. These phenomena have been found in hundreds of cities and towns in China. Although it is a gradual hazard, consequent deformation and cracking of work buildings, pipes and structures above or under the ground would seriously damage or even destroy their functions.

3) Foundation problems. Geological structure, soil texture, load-bearing capacity and stability are the most concerned ones in foundation engineering of a Chinese city construction.

Coastal cities in sea level rise environment

Many coastal cities in China face a special geo-environmental problem, i.e. the long-standing and hardly convertible trouble, sea level rise resulted from global warming. It causes an increase in the frequency of occurrence of harmful storm surge. For example, when a typhoon attacked Shanghai in 1949, the highest level of tide in the Huangpu River was 4.77 m, while in the late 1980’s, the corresponding level reached 5.22 m [5].

Relative sea level rise also leads to an rise of the lowest water level in coastal area. It can partly or even completely paralyze the existing drainage system designed for the present level of water flowing out. It also lowers the capability of the existing disaster prevention facilities (e.g. dikes), intensification of flooding and inundation of low-lying land.

Sea level rise results in the further erosion and retreat of the sea shore, beaches and bluffs. It is more apparent in sandy coasts. It also will cause submergence of some part of coastal zone and low-lying land to be submerged or turned into marshland. Sometimes sea level rise would possibly result in the sea level higher than or as high as the ground water level in coastal areas, which then accelerates the salty water’s intrusion into aquifers and surface water in the areas.

Urban meteorological environment

Average temperature, rainfall, atmospheric pressure and sunshine of a city are components of important geo-environment for city construction. The extreme values of these meteorological parameters in month, season, year and their duration usually form meteorological disasters. The cities along the southeastern coast area of China suffer the meteorological disasters such as typhoon and rainstorm with high probability every year. It is also the important conditions influencing the sustainable development of those cities.

Urban geo-environmental pollution

The weight of industrial and household wastes and rubbish produced in cities keeps increasing every year with the rate of 8,98%[6]. Large amounts of them, waste water, waste gas and solid wastes are often still active or toxic in physical chemistry and biology. Technology and methods of processing these wastes in Chinese cities up to now are still mainly to gather it together in an open-air place or bury it in a little depth. It will significantly affect, sometimes even destroy, the city’s ecological environment.
With the development of electronic information technology, big (mega) cities are playing an increasingly important role in the whole China. In them the China’s most part of finance and industries are gathered. They control and concentrate more and more information and nodes of communication, and supply arena of different kinds for important decision-makings. Therefore, geo-disasters to a big (mega) city in China may become a trigger of economic collapse for a province or even whole country. But contrary to the rapidly developing role of dominance of big (mega) cities, they grow more and more vulnerable to geo-disasters. It is because big (mega) cities’ functions keep stronger and stronger up in Chinese society that, once their functions should be weakened or disrupted upon any disaster, considerable chain effects would inevitably happen successively and rise serious damages on our country and our society.

Therefore, in order to decrease the vulnerability of a big(mega) city in China, in particular, for planning and sustainable development, the effects on the geo-environment, negative and positive, resulted from any important project for the city construction ought to be evaluated carefully; the capability of the project to mitigate and prevent against geo-disaster should be investigated; and possible political, economic, social and physical influences on surrounding areas during a geo-disaster should be studied and corresponding measures should be prepared accordingly, so that the big(mega) city’s vulnerability to geo-disasters can be reduced and its sustainable development and good ecological environment be kept on.

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