

## Chapter 7

# **Geo-environmental Management and Mitigation of Natural Hazards**

### **Environmental Protection in Areas where There Are Mining-Metallurgical and Chemical Industries**

According to the regional plan, Panzhihua and Dechang will be developed as steel bases; a non-ferrous smelter will be constructed in Miyi; a number of large-scale mines will be constructed or enlarged in Taihe, Baima, Lalachang, and Hongri, and, at the same time, many medium and small-scale mines as well as smelteries and corresponding raw materials' bases will be constructed. These engineering activities will bring about prosperity locally but they will cause environmental pollution also. More attention must be paid to environmental protection and feasible measures should be taken to prevent the deterioration of the environment and to ensure the continuous and steady development of industry.

In the area of mining-metallurgical and chemical facilities, the principal task of environmental protection is to maintain ecological balance and slope stability and to prevent the contamination of water and soil. Mining involves the destruction of the original ground formation and vegetation as well as the excavation and transportation of rock, soil, and ore for storage outside

the excavation zone. These activities will result in landslides, secondary debris flow, changes in the surface and ground runoff and in the water table, and seepage of polluted material into ground and surface water.

For the prevention of environmental destruction, protection measures must be taken.

- (1) Mining should not damage the local environment and the necessary reinforcement and support measures must be taken to maintain the stability of rock and soil masses.
- (2) To replace the plants destroyed during mining, excavation, and construction of roads, tree plantation should be carried out.
- (3) The waste from smelters should be dumped in suitable places and stabilisation measures should be taken to prevent the formation of secondary debris flow, erosion of farmlands, or contamination of water resources.
- (4) To solve the problem of change in natural runoff conditions as a result of mining and industrial building construction, artificial drainage must be constructed to prevent submergence, as well as to prevent a decrease in water quantity and in the quality of groundwater resources.
- (5) The waste water and materials from mines as well as smelteries must be dumped in suitable places to prevent soil and groundwater pollution.
- (6) Industrial facilities which produce a lot of waste or hazardous gas should be located far away from narrow basins or deep valleys, on terrains or sections with flat ground landform, to reduce the menace posed by smoke and fog concentration and to prevent air pollution.

### **Urban Environmental Protection**

At present, the urban population in this region is not too dense, but, after planned economic development takes place, the population will increase and the scale of light and processing industries will increase rapidly.

Bearing this in mind, measures for environmental protection should be taken into account in urban planning.

This region has a fragile natural environment and suffers frequently from natural disasters. Therefore, while selecting development sites in the city and in making town plans, more attention should be paid to avoid dangerous or hazardous zones such as active seismic zones, landslide zones, and debris flow zones. If construction is carried out in these zones, necessary protection measures must be taken such as anti-shock structures, slope reinforcement, and treatment of ditches and valleys. Both Xichang City and Mianning County are located in an active seismic zone, therefore, anti-seismic designs should be used in construction. Panzhihua City is near the active Yuzha seismic zone on a steep landform and, thus, not only the seismicity but also the possibility of collapses and landslides induced by earthquakes should be taken into consideration.

Urban environmental protection measures, besides concentrating on disaster prevention, should stress the prevention of water and soil contamination, the disposal of waste water from factories and residences, and the management of dumps to avoid pollution of water resources. The problem of water pollution in the cities and towns located in the river valleys and Xigeda basins of Dechang and Miya counties need to be solved. Since the amount of groundwater supply to these cities and towns is great, there should be protection zones around the concentration of water resources. Disposal sites for solid waste and garbage from cities and towns should also be included when making plans to select suitable sites, and engineering measures should be taken to purify the water and prevent land contamination. Soil contamination will not only result in the pollution of water resources, but it will also influence the use of land, directly affecting the production of vegetables, foodgrains, and livestock in the suburbs.

Another important aspect of urban environmental protection is the adjustment and control of surface runoff and drainage. The climate in this area can be divided into dry and damp seasons, and the rainy season is long. Rainstorms, which are frequent, may cause disasters and mountain floods. While planning, measures should be listed to prevent floods in low-lying locations, thereby reducing their influence on urban areas.

The excavation of land often results in deforestation because of rapid development of urban construction. It makes the land sandy and more

desert-like, therefore, plantation of forests and grasses should be carried out in a planned manner to maintain environmental and ecological balance.

### **The Geo-environment of the Anninghe River**

The Anninghe River is the biggest downstream tributary of the Yalongjiang River, flowing from north to south, passing through Mianning, Xichang, Dechang, and Miyi, across the whole region with a total length of 312km. The Anninghe River has a wide river valley with width varying from two to 10km. Along the river, the length of the gorges accounts for only 9.7 per cent of the total length. In the wide sections of the river, water flows slowly and shallows and sandbars exist. Food production and human commerce and habitation are carried out in the wide and open terraced zones of this region.

The climate along the Anninghe River has obvious spatial differences, both horizontally and vertically. The spring and autumn seasons, in the whole Anninghe River area, last for 10 months. The winter in the region is warm and the summer is not hot. In the area south of Miyi there is no winter season and the summer lasts for six months. Rainfall is plentiful, with an average annual precipitation of more than 1,000mm. The precipitation from May to October accounts for 90 per cent of the annual precipitation. The dry and damp seasons are obviously distinguishable.

Most years, the average annual amount of water resources in the whole drainage area totals  $7.52 \times 10^9 \text{ m}^3$ ; of which the surface runoff is  $6.94 \times 10^9 \text{ m}^3$  and the ground runoff is  $5.8 \times 10^9 \text{ m}^3$ . According to the data measured, most years the average discharge is 231 cubic metres per second, which means that the drainage area is full of water. In the drainage area of the Anninghe River, agriculture, forestry, and animal husbandry are more developed than in the nearby suburbs, with plentiful vegetation and a beautiful environment.

However, as a result of the development of mining-metallurgical, chemical, and processing industries, and the increase in the urban population during the past 20 years, the environmental situation of the drainage area of the Anninghe River is deteriorating. Programmes must be developed and measures taken to protect the environment, to improve the management of land, and to use it judiciously.

The environmental management and comprehensive resource exploitation of the Anninghe River include the management of water, soil, and forests, as well as the rational use of water and land resources, afforestation, and water and soil conservation. The principal measures are given below.

(1) *The Management of the Anninghe River*

Active debris flows occur in the Anninghe drainage area, especially along the Xichang and Dechang strip. Floods often occur because debris flows leave deposits on the river floor and silt up the river course. In the dry season, the water supply is inadequate, i.e., the needs of industries and agriculture as well as the daily needs of the urban population cannot be met due to a considerable reduction in flow capacity. Maintaining a stable water supply and developing agricultural irrigation systems are key steps in the afforestation of river valleys, sustainable land use, and environmental protection. Because of water shortages, the deteriorating environment, and the transformation of land into sand, desertification will certainly take place because the vegetation that has been destroyed cannot be recovered. Water management should have priority over soil management. Measures for the management of the Anninghe River should combine dredging and embankment methods. Dredging the 135km long wide valley from Xichang to Dechang is the first step, followed by the dredging of the narrow 130km long valley from Dechang to Miyi. After dredging, the water depth should increase to enlarge the drainage section during flood seasons, creating favourable conditions for increased land use and for carrying out tree plantation in the drainage area.

(2) *The Construction of Reservoirs for the Control of River Runoff*

The drainage area of the Anninghe River is rich in water resources but, at present, their exploitation is limited. In the whole drainage area, 40 small reservoirs have been built. Under normal conditions, the water supply is  $5.44 \times 10^8 \text{ m}^3$ , accounting for 7.2 per cent of the total water resources, of which 88.9 per cent is supplied by water diversion works, seven per cent by storage projects, and 4.1 per cent by rivers. Eighty-nine per cent of the area irrigated for agriculture depends on water diversion works. During the period from May to March - the time when water use increases - the shortage is very serious. Therefore,

an increase in the number of storage projects is one of the key measures in improving the environment of the drainage area. According to the programme, a reservoir will be constructed in Daqiao, Mianning County, and one or two more medium- or large-scale reservoirs will be built near the Sunshuihe and Jingchuanhe rivers. Both of these rivers are tributaries of the Anninghe River and its runoff can be adjusted by these measures, benefitting the overall management of the drainage area of the river.

### **(3) *Water and Soil Conservation and Tree Plantation***

Economic activities in the drainage area of the Anninghe River caused serious destruction to forests nearby; the Tongshan grass slope expanded; vegetation was destroyed; land destertified; and land in the river valley was transformed into sand. Under these conditions, the capability of land for reducing drought hazards decreased, drainage decreased, and environmental conditions deteriorated. This has had an adverse affect on economic and social development. Tree plantation in the Anninghe River area and the area of its tributaries must be carried out as rapidly as possible in order to recover the natural vegetation. The objective is to increase forest cover to up to 45 per cent of the whole area within this century, to strengthen the capacity for water and soil conservation, to reduce the damage caused by landslides, to maintain the ecological balance, and to change the ecological system for the better.

Because of the concentration of cities and towns, as well as industries and mines, and the presence of the Cheng-Kun Railway in the river valley of the Anninghe River, measures must be taken to prevent contamination of the river by waste.

### **Mitigation of Hazards in Mountainous Areas**

The main mountainous hazards are earthquakes, landslides, debris flows, and floods in river valleys. Disasters, such as rainstorms and hailstorms, often occur. During construction in mountainous areas, hazardous zones should be avoided or effective measures taken for mitigation (Figure 26).

This region is a very active seismic zone, located at the south-eastern end of the N-S seismic zone of China. The zones of high seismic activity include (1) the Mianning-Xichang section, in which the main earthquake-inducing structure is the Anninghe Fault; (2) the Xigeda-Yuzha section, in which the main earthquake-inducing structure is the Mopanshan-Luzhijiang Fault; and (3) the Yanyuan district, in which the main earthquake-inducing structure is the Jinhe-Qinghe Fault. In addition, there is a hazardous zone of medium to strong seismic activity near Huaping. In other places, there are mainly zones where medium to weak earthquakes of  $M < 5$  occur. Because this

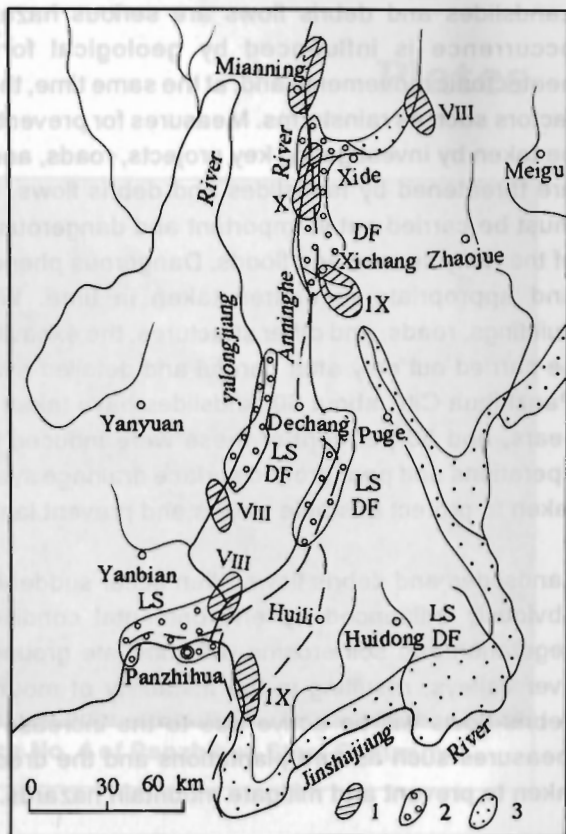


Fig. 26: Sketch of Natural Hazards

1. High intensity zone    2. Priority zone of management
3. Zone of mountain hazards; LS-landslide; DF-debris flow; VIII-X intensity

whole region is located in active earthquake zones and the faults, as well as earthquake-inducing structures are distributed extensively, while planning the construction of key projects, the hazardous zones where strong earthquakes occur ( $> VIII$ ) should be avoided as far as possible and relatively stable zones ( $< VII$ ) should be selected. Suitable anti-seismic measures must be taken concomitantly to make the engineering constructions safe and economical. In zones such as Xichang, Panzhihua, and Yuzha where the population density is high, earthquake-predicting stations should be established to guard lives and property by analysing the existing phenomena related to earthquakes and by giving forecasts.



Landslides and debris flows are serious hazards in this region. Their occurrence is influenced by geological formations, especially by neotectonic movements and, at the same time, they are linked with climatic factors such as rainstorms. Measures for prevention and mitigation should be taken by investigating key projects, roads, and residential zones which are threatened by landslides and debris flows. Necessary examinations must be carried out in important and dangerous zones before the arrival of the rainy season and floods. Dangerous phenomena must be identified and appropriate measures taken in time. While constructing urban buildings, roads, and other structures, the excavation of rock and soil must be carried out only after careful and detailed evaluation. For example, in Panzhihua City, about 60 landslides have taken place during the past 20 years, and 80 per cent of these were induced by excavation and filling operations and poor ground surface drainage systems. Measures must be taken to protect unstable slopes and prevent landslides.

Landslides and debris flows often occur suddenly, but their occurrence is obviously influenced by environmental conditions. The destruction of vegetation and soil erosion will stimulate ground erosion and erosion in river valleys, resulting in the instability of mountain slopes. In addition, debris flows will be active due to the increase of materials. Therefore, measures such as tree plantations and the dredging of runoff should be taken to prevent and mitigate mountain hazards.