

II. GENERAL CHARACTERISTICS OF THE STUDY AREA

Geo-ecological Conditions

Topography and Rivers

The topography on the northern and southern flanks of the Himalayas is fully asymmetrical, especially in the central Himalayas. In the south, the main ridges of the Great Himalayas rise abruptly to about 6000m above the Ganges plain, forming steep slopes with strong fluvial erosion in the gorges. Owing to uplifting of the mountain system and landform of "valley in valley" may be found here and there in the region. Settlements and farmlands are mainly located on the level shoulders, lying above the knick point in the transverse profiles.

By contrast, the topography of the northern flanks of the Himalayas is more gently undulating with a relative elevation of 1500-2000m. The plateau proper of south Xizang (Tibet) stretches to the northern flanks of the Himalayas with broad basins and valleys, where piedmont deposits are very extensive. Under the cold and semi-arid climate, a great many sand dunes and sand drifts lie along the river valleys.

The Hengduan mountains comprise a series of high mountain ridges sandwiched between deep river gorges. As a whole, the Hengduan Mountains slope from northwest to southeast and from north to south, with altitudes from 4500 to less than 3000m asl. The topography of the region is interlaced and separated by mountains, plateaux, valleys and basins in distinct relief.

The northern section of the Hengduan Mountains is a slightly dissected plateau with gentle slopes. In the middle section the plateau occurs with broad valleys, fluvial terraces, and flood lands may be seen in a number of broad valleys. The southern section of the region consists of basins, middle altitude mountains and plateaux, with an elevation varying from 3000 to 2000m asl. A number of basins with lower altitudes and gentle relief are suitable for crop growing and are an important area in this section.

Controlled by geological structure, the Himalayan ranges emerge in a series of drainage systems, cut through by very deep transverse gorges, such as the Indus, the Sutlej, the Pumqu (the upper reaches

of the Arun River), the Yarlung Zangbo, and other tributaries of the Ganges and Brahmaputra, including the Zayu River.

In the Hengduan Mountains occur the Nujiang River (upper reaches of the Salween River), the Lancang River (upper reaches of the Mekong River), the Jinsha River (upper reaches of the Changjiang River) and their numerous tributaries, such as the Yalong River, the Dadu River, and the Minjiang River. All of them cut deeply in parallel gorges with elevations of valley floors varying between 2000-4000m asl.

Climate

Influenced by the Asian monsoon, both the Himalayas and Hengduan Mountains are characterized by a monsoon climate with alternate wet and dry seasons. In winter, from November to April, the mountainous areas are under the control of the southern jet stream of westerlies. There is abundant sunshine and dry weather with rare precipitation, especially on the northern flanks of the Great Himalayas. The winter precipitation derived from the disturbed westerlies plays a significant role in the western Himalayas.

During the summer period, from May to October, the southern jet stream of westerlies withdraws northwards, and the southern moisture-laden monsoon from the Indian Ocean reaches up to the Himalayas and the Hengduan Mountains. The monsoon brings heavy rainfall on the southern flanks of the Himalayas and most areas of the Hengduan Mountains, while the south eastern monsoon prevails in the eastern and south eastern parts of the Hengduan Mountains.

The southern flanks of the east Himalayas, with an annual rainfall of 2000-4000mm, is the most humid section of the mountain system, decreasing westward, some 1000-2000mm is received on the southern flanks of the central Himalayas and about 500-1000mm by the west Himalayas. There is a rain shadow area with an annual precipitation of 200-300mm on the northern flanks of the central Himalayas and further westward it is less than 200mm; in the middle reaches of the Yarlung Zangbo River, the annual precipitation decreases from 600mm in the east to 200mm in the west.

On the peripheral region of the Hengduan Mountains, annual precipitation of 1200-1600mm has been recorded, but most of the area has a mean annual precipitation of about 500-900mm. The bottom of the gorge section of the Hengduan Mountains is climatically a centre of rare precipitation, forming a number of dry valleys with an annual precipitation of 300-500mm only.

Because the mean temperature of the coldest month is less than 18°C, the base-belt on the southern side of the central and east Himalayas may be considered as the northern fringe of the tropics. At comparable altitudes, the temperature regimes of the southern section of the Hengduan Mountains are similar to that of the southern flanks of the Himalayas, having a sub-tropical climate. Due to high elevation and unfavourable thermal conditions, the northern flanks of the Himalayas belong to the plateau temperate zone. Owing to various moisture regimes, temperature conditions in the northern and middle section of the Hengduan Mountain, and the plateau temperate zone as well, are not as favourable as the northern flanks of the Himalayas for crop growing.

According to differences in the thermal regime, the dry valleys of the Hengduan Mountains may be divided into 4 types: hot-dry valleys, warm-dry valleys, temperate-dry valleys and cool-dry valleys, correlated to increasing elevation of the valley bottom.

Altitudinal Belts

In the mountainous region the altitudinal belt forms the background for rational utilization of renewable natural resources and the development of horticulture. The altitudinal belt signifies various temperature-moisture regimes from the valley bottom up to the mountain ridges, suitable for plantations of tea, orchards, and for vegetable cultivation.

Based on the spectrum-structure the base-belt, dominant belt and the pattern of the altitudinal belt, two systems of the altitudinal belt may be identified: the monsoonal and the continental.

The monsoonal systems of the altitudinal belt prevail on the southern flanks of the Himalayas, the northern flanks of the east Himalayas and the Hengduan Mountains. It is characterized by dominant biochemical weathering, acid soil and mesophytic types of vegetation. The altitudinal differentiation is mainly dependent on the temperature. By contrast, the continental system is characterized by intense physical weathering, alkaline soil with coarse texture, meso-xerophytic and xerophytic types of vegetation.

In the southern flanks of the Himalayas, the altitudinal belt consists chiefly of montane forest belts with the base-belt of tropical evergreen and semi-evergreen rain forest, accompanied by lateritic red earth and latosols as well as yellow and yellow-brown soil. In contrast, the base belt of the altitudinal belt on the northern flanks of the Himalayas is montane shrubby steppe of the semi-arid type in the middle, while the base-belt of the montane desert-steppe and desert of the arid type is found in the west.

The montane evergreen broad-leaved forest and the montane coniferous forest of *Pinus yunnanensis* with red earth comprise the base-belt of the altitudinal belt in the southern section of the Hengduan Mountains, while the montane needle and broad-leaved mixed forest belt with brown earth is the base belt in the middle section of the region. At the bottom of the dry valleys, the shrub grassland with reddish laterite soil occurs in the hot and warm dry valleys, while thorny shrub with montane drab soil appears in the temperate and cool dry valleys.

The altitudinal belts of the study areas with different thermal and moisture regimes could meet the requirements of various horticultural crops such as fruit trees, tea, potatoes and vegetables, etc. The upper limit of the major crops of horticulture in the study areas are quite different.

Physico-Geographical Divisions

By integration of the thermal-moisture regimes and three-dimensional differentiation, 4 physico-geographical regions may be recognized in the study areas.

The tropical and sub-tropical montane monsoon region with humid climate

The region, including the southern flanks of the Himalayas and the Kangrigarbo Mountain as well as the southern section of the Hengduan Mountains, comprises Gyirong Nyalam, Yodong, Cona, Medog, Zayu counties in Xizang Autonomous Region, the Northwest Yunnan and West Sichuan.

In most of the valleys and hills with an elevation below 2500m asl. the mean temperature of the warmest month varies from 18-25°C, and that of the coldest month from 2-16°C. There is an absolute frost-free season below 1000-1200m asl. Mean annual precipitation varies from 800-3000mm in districts with altitudes below 2500-3000m asl.

Tropical and sub-tropical fruit trees and cash crops, such as bananas, oranges, grape vines, tea and sugar cane grow at lower altitudes, while the temperate fruit trees, such as apple, pear and peaches, can also be planted at higher elevations in the region. Warm-preferring vegetables such as tomatoes, peppers, etc grow very well.

The temperate plateau region with humid and sub-humid climate

The region, consisting chiefly of a series of high mountain ridges sandwiched between deep river gorges, comprises the middle and northern section of the Hengduan Mountains as well as the northern flanks of the East Himalayas and the Kangrigarbo Mountain.

The temperature obviously varies in accordance with altitudinal variations. The mean temperature

in the warmest month is 12 (10) to 18°C in the valleys and basins with an altitude of 2500-4000m asl and 6-10°C only in the high ridges or plateau surface with altitudes of 4000-4500m asl. Annual precipitation totals 400 to 1000mm, decreasing north westward from the periphery to the interior. At the bottom of dry valleys, the mean temperature in the warmest month reaches 18-20°C or more with an annual precipitation of 250-400mm.

The region abounds in forest resources. Native products include such medicinal commodities as the tuber of elevated gastrodia (*Gastrodia elata*), as well as mushroom. Tea may be planted at altitudes of less than 2500m asl in the peripheral area under humid climate. Temperate fruit trees such as apple, pear, peach and walnut grow well at altitudes of 2500-3500m asl.

The south Xizang with plateau temperate semi-arid climate

The South Xizang lies between the Gangdise-Nyalingtanglha ranges in the north and the Himalayas to the south. Its drainage is by means of the Yarlung Zangbo River and the Pumqu River systems.

Owing to the southerly latitude and a lower altitude of about 3500-4500m asl, the mean temperature in the warmest month ranges from 10-16°C, that of the coldest month, from 0-10°C. Average duration of a daily temperature of above 5°C varies from 100 to 220 days.

As a result of the climate barrier of the main Himalayan range, annual precipitation decreases from 500mm in the east to 200mm in the west with an aridity index from 1.5 to 3.0. In the valley along the middle reaches of the Yarlung Zangbo River, some 70 to 80 per cent of the precipitation occurs at night, resulting in abundant sunshine which is favourable for crop and vegetable growing.

The middle reaches of the Yarlung Zangbo River together with its larger tributaries, such as the Nyang Qu River and the Lhasa River, constitute one of the main farming areas with a number of towns and cities in Xizang. The farms are situated on terraces along the river and the lower part of alluvial-diluvial fans skirting the rims of the basins.

Temperate fruit trees such as apple and walnut can be grown in some plots at an altitude of less than 4000m asl. The region is suitable for potato cultivation and for vegetable farming.

The Ngari Region with plateau temperate arid climate

The Ngari Region, encircled by the West Himalayas, the Gangdise and the Karakoram Mountains, is composed of the upper reaches of the Indus River and the broad valley of the Banglong Lake, with altitudes varying between 3800-4500m asl.

The Ngari Region, with a mean temperature in the warmest month ranging from 10-14°C and that of the coldest month from -10 to -14°C, is rather warm in summer. Due to the climatic barrier of parallel ranges in the southwest, the annual precipitation is less than 50-150mm with an aridity index of 6.1 to 15.0. Strong winds occur frequently in spring and winter. Most of the region is used for grazing sheep and goats, with the exception of valleys at a lower altitude in the southern part, where small areas of farmland have been opened with irrigation and vegetable farming areas have expanded.

Socio-Economic Background

The study areas are mainly populated by people of Tibetan origin and have sparse population. The mean density of population is low, with distinct regional differentiations. The density of population is 1-3 persons/km² in the basins of the northern flanks of the Himalayas; 14 persons/km² along the valley in the middle reaches of the Yarlung Zangbo River in the south Xizang, increasing to 40-50 persons/km² in densely inhabited plain of the Lhasa, Gyangze and Zetang, less than 1 person/km² Ngari and 6-7 persons/km² in west Sichuan.

In 1986, only an estimated 21.4 per cent of the population in Xizang had completed primary school,

while about 1.7 percent of the population had an educational level of senior middle school. The extensive management of agriculture in the study areas is inefficient with a lower yield per unit area. Owing to poor techniques and dependence on the physical environment, only a small number of agricultural commodities are brought to market, the region being characterized by a self-supporting economy.

The Himalayan and Hengduan Mountain region were remote and inaccessible areas before the 1950s. Now, highways with a total length of about 30,000 km, connect every county town in the study areas. The mean density of highways is 18.1 km/1000 km² in Xizang and 33.1 km./1000 km² in the Hengduan Mountains. However, due to poor quality of some roads and an inadequate number of vehicles, transportation facilities should be further increased and improved.

Because of the unfavourable physical environment and the socio-economic background, the study area is an underdeveloped region, where farming and animal husbandry predominate. For example, the output value of industry accounts for 1/5 of the total output value in Xizang. Of the total output value of agriculture, animal husbandry and plant cultivation make up respectively 2/5, and the forestry, horticulture, sideline and other amount to 1/5.

In accordance with the dominant natural resources and their exploitation, animal husbandry is predominant, combined with plant cultivation and forestry. More attention should be paid to building up the infrastructure for energy resources and communication in order to develop processing industries (food, hides and wool), mining, and tourism.

Horticulture has developed on a large scale in the study area since the 1950s. For example, to establish and enlarge fruit tree and tea plantations in the south eastern part of Xizang, to expand vegetable farming in the suburbs of the major cities and towns of south Xizang may, to a certain extent, meet the demand created by population growth, raised living standards and economic development.

Horticultural Research

In 1951-1953 the Xizang working group, organized by the Central Commission for Culture and Education, carried out a study on horticulture in eastern and central Xizang.

A comprehensive scientific expedition to west Sichuan and north Yunnan, sponsored by CAS in 1959-1961, was engaged in studies on horticulture in these areas.

Experimental studies on horticulture, including the introduction and acclimatization of species and varieties of vegetables, potato and fruit cultivation measures, management techniques, as well as storage, etc., were conducted in Lhasa during the 1950s.

Three major experimental stations of agriculture (including horticulture) were established at Lhasa, Xigaze and Gyangze at the end of the 1950s and the beginning of the 1960s. A great deal of research into horticulture development has been made and abundant information and experimental results have been obtained since the 1960s.

Investigation of horticultural development in Xizang, including the conduct of surveys of varieties and species resources of fruit trees, tea, walnut; their bio-ecological characteristics, plantation management measures, diseases, pests, and their control etc, were carried out by the Integrated Scientific Expedition to the Qinghai-Xizang Plateau, CAS, in 1970s.

Studies on varieties of fruit trees and their potential development in the Hengduan Mountain Region specially in the dry valley, were made by the Chengdu Institute of Biology, CAS, in the 1970s and 1980s. The Xizang Institute of plateau biology in Lasha is carrying out research into horticulture, such as cultivation of medicinal plants and agronomical aspects of other crops.