CHAPTER I

ENVIRONMENTAL SETTING

Environmental Setting

1.1 Location and Extent

Pakistan occupies the eastern most basin of the three great rivers that traverse the steppe desert of the old world, the Egyptian (Nile), the Tigris-Euphrates and the Indus, which were the cradles of early civilizations. Hence in South Asia, the Indus has a distinctiveness that is lacking in other river basins of the region. Emerging as an independent nation in 1947, the country occupies an area of about 0.8 million square kilometres. The territory extends from 4°N to 37°N latitude and 61°E to 77° 45 E longitude. For management and administration it is divided into five provinces, Balochistan, Punjab, Sindh, Khyber Pakhtunkhwa and Gilgit Baltistan and two federally administered region, Federally Administered Tribal Area, and Federally Administered Capital Territory. Each province is further partitioned into divisions, districts, tehsils, cities and Mauzas (revenue villages).

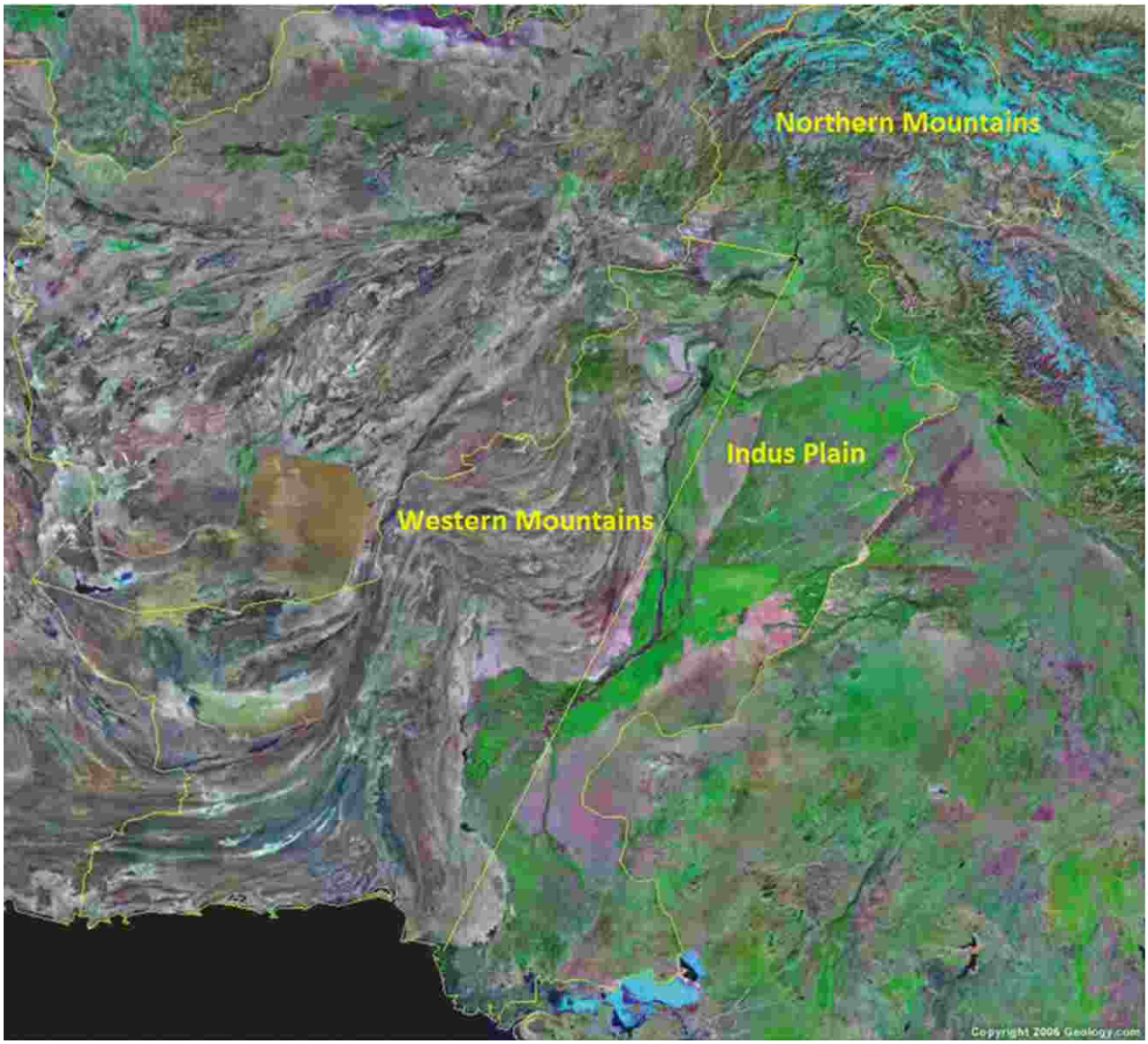
1.2 Physical Setting

1.2.1 Landform and Soils

Physiographically Pakistan can be divided into three major units: the northern mountains, the western highlands and the Indus plain. Two imaginary lines can be drawn on the satellite image (Fig. 1.1): one from a little north of Khyber Pass to Haripur and another from Haripur to a little west of Karachi. The northern mountains are roughly north of the first line, the western highland to the west of the second line, and the Indus plain to the east of the same line. In addition to these three, relatively small physiographic divisions comprise Potwar plateau and salt range in the Punjab occupying the north-western section of the Indus plain (Fig. 1.2).

The northern mountains are where three great mountain ranges of the world meet, the Karakoram, the Himalayas and the Hindukush. Virtually all elevations here are higher than 3,500 meters above sea level, more than half are above 4,500 meters with more than fifty peaks, which are above 6,700 meters. The area also abounds in glaciers, some of which are the largest in the world outside the polar region. These glaciers feed the Indus River and its tributaries, which form the lifeblood of Pakistan's irrigation system. The vast drainage area of the Indus corresponds roughly to the provinces of Punjab and Sind. The Indus plain in Punjab consists of fine alluvium deposited by the Indus and its five tributaries, Jhelum, Chenab, Ravi, Sutlej and Beas varying in thickness from about 150 to 300 meters. Southward in Sind, the plain differs in that it is lower in altitude and was formed by the deposit of only the Indus River and the alluvium here is of more recent character. The Indus plain is bounded, in the west by highlands, which are lower than the northern mountains and are also comparatively more arid. The aridity increases in these highlands as one moves from Khyber Pakhtunkhwa Province in the north to the Balochistan province in the south.

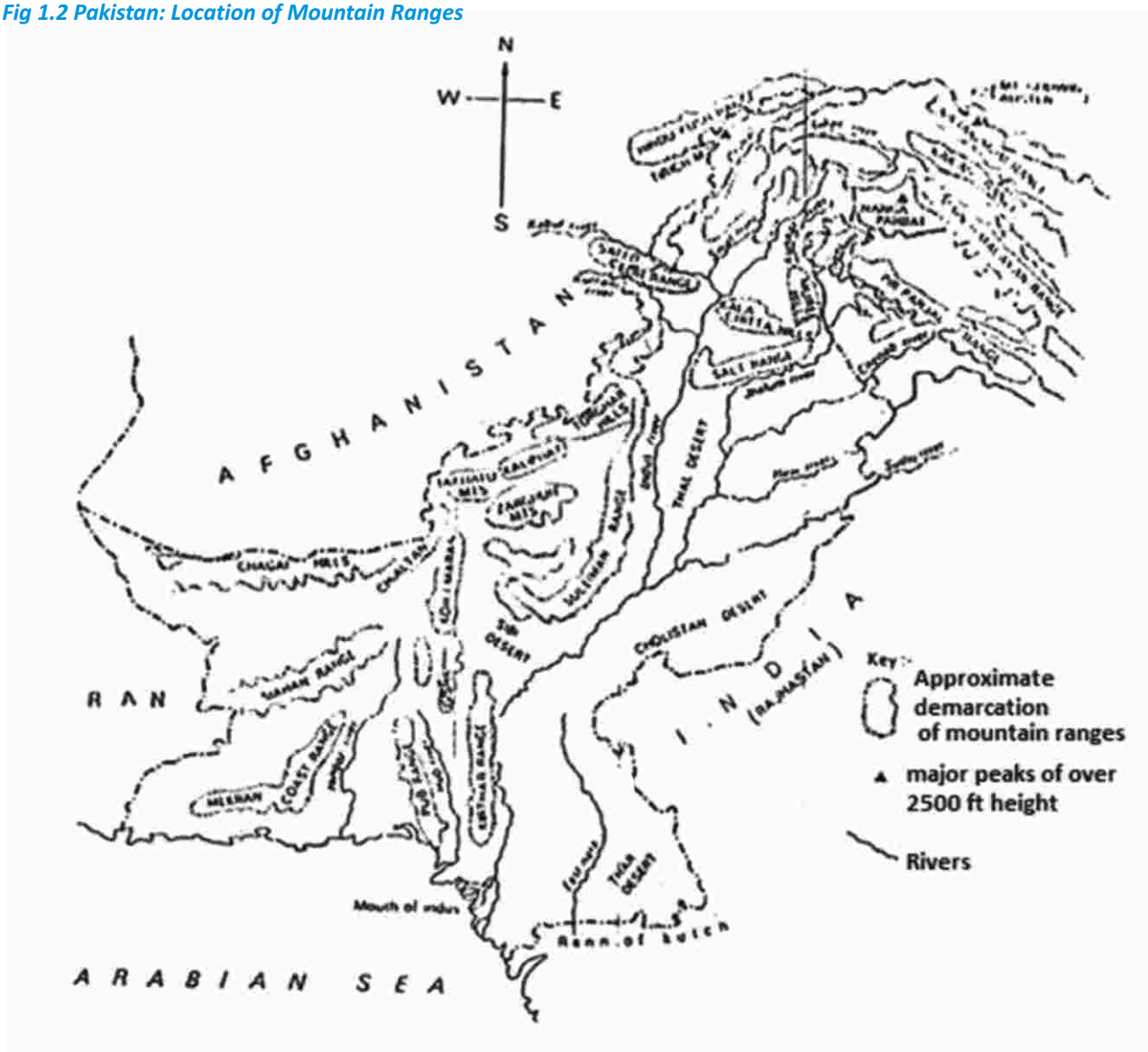
Fig. 1.1 Pakistan: Satellite Image



With a height of 3,374 meters, Takht e Suleman is the highest peak in the western mountains. Adjoining these mountains in the northeast are the Potwar plateau and the salt range. The plateau varies in elevation from 450 to 600 meters. It is deeply dissected by water and wind erosion leading to the development of bad land topography at places. At the base of the Potwar plateau is the east-west oriented salt range, a continuous chain of low flat-topped hills having rough topography and little or no soil (Fig. 1.2).

The soils of Pakistan vary significantly in kind and distribution. The Soil Survey of Pakistan covering 540,000 sq. km, established about 400 different soil series, some occupying extensive areas whereas others are of limited extent. The majority of soils range from medium to fine texture with 5 to 15 percent carbonate and a pH between 7.8 and 8.4 though pH values as low as 5 and as high as 10.5 have been recorded. The normal soils (not affected by salts) have a satisfactory permeability rate. Silty soils with weak structure and very low organic matter (less than 0.5 percent) in the top, result in crust formations which interfere with water infiltration, and consequently with seedling emergence (GOP, 1983).

Fig 1.2 Pakistan: Location of Mountain Ranges



Although the country's soil resources are vast, good quality soils that form prime agricultural land are limited. Improving a part of relatively poor quality soils could increase the extent of such soils a little, but this would be at formidable cost. Therefore Pakistan has to rely on the existing soil resources and protect prime agricultural soil from misuse that may result in its degradation or loss. Optimal use of this resource will not only ensure continued availability for the basic human needs for food, fibre and shelter, but also improve the overall environment.

1.2.2 Hydrology

Hydrologically, the country can be divided into three main basins, the Indus Basin, the closed basin of the Kharan desert and the Makran coastal basin. The Indus basin is the largest amongst these covering some 576,000 sq.km (GOP, 1978). Besides its five main tributaries in the Punjab, the Indus River is also drained by Kabul and its main tributaries Swat, Chitral and Panjkora as well as Kurrum and Gomal rivers of Khyber Pakhtunkhwa Province. The rivers of the closed basins of Kharan such as Mashkel and Zangi Nawar disappear

into playas such as Hamun-i-Mashkel and Hamun-i-Lora. The Makran Coast Rivers, with the two principal Hingol and Dasht, drain into the Arabian Sea west of the Indus River.

1.2.3 Climate

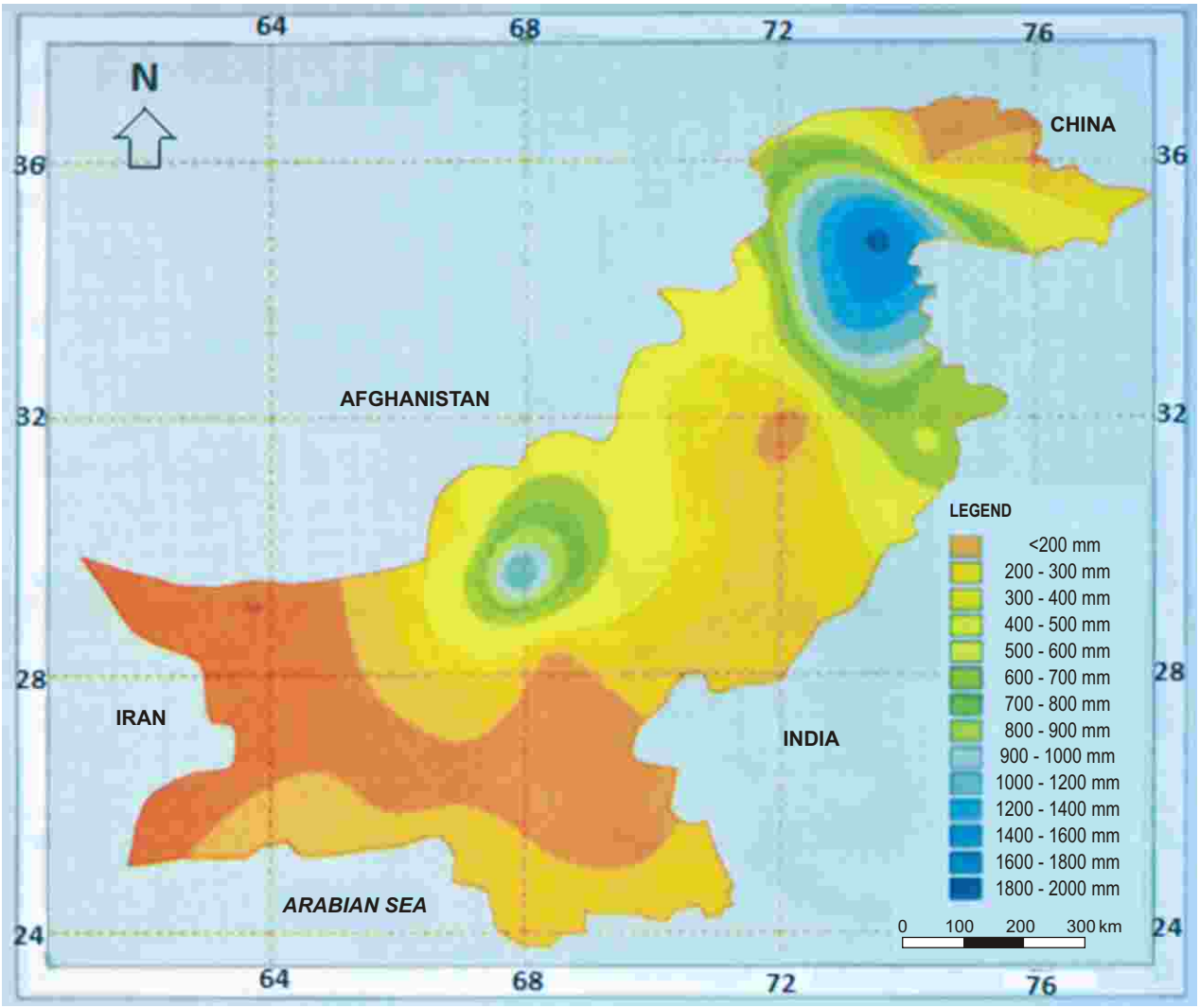
Pakistan is basically a dry country in the warm temperate zone. The country has four seasons: a) from December through February, cold and somewhat wet winters in north to mild dry winter in south, b) from March through May, a mild dry spring, c) from June through September, the summer rainy season or southwest monsoon period and d) October and November, the retreating monsoon period. The onset and duration of these seasons vary somewhat according to location. The climate of Pakistan has been classified by a number of sources including Ahmad (1951), Kureshy (1977) and Johnson (1979). Great climatic differences prevail from the northern mountains down to the seacoast in the extreme south, but the country's general climatic character is arid. Annual precipitation (except in the northern highlands) averages to less than 250 mm, decreasing from north to south (Fig 1.3). In all, more than three-fourth of the country has less than 300 mm annually while about 7 percent of the country, mostly mountain slopes, has more than 500 mm. About 20 percent of the total area has less than 125 mm total annual rainfall, with a high variability as a rule (Johnson, 1979).

1.2.4 Biotic Setting

Pakistan is endowed with a wide variety of ecosystems and habitats and many species of flora and fauna. The country is the meeting point of three of the six biological regions of the world. Species belonging to the Palearctic realm are present largely in the uplands; those belonging to the Indo-Malayan realm occur primarily in the Indus plain and the Himalayan foothills. The species with affinities to the Ethiopian region occur in the dry southwest (GOP, 2009). The major ecosystems in the country are the ocean, the swamps, the rivers, the lakes, the flood plains, the arid plains, the sand and pavement deserts, the tropical thorn, tropical dry deciduous, subtropical arid, subtropical dry and moist temperate and subalpine forests, grassy tundra and cold deserts. The choice for a habitat with in an ecosystem by an animal depends very much on its structure and biological characteristics. Depending upon the type of animal, a specific habitat is occupied. Many large mammals, particularly predators and most birds range over one or more major habitats whereas most small mammals and reptiles inhabit only a portion of a habitat, restricting to specific sites within that. For example, within the tropical thorn zone, several minor but special habitats can be recognized with different animals adjusted to and associated with it. Animals with different structural and biological characteristics have adapted to various sites. For example, some are tree dwellers, others rock and cliff dwellers, clay dwellers, sand dwellers, cave dwellers, marsh dwellers or water dwellers (Beg, 1975).

Historically, apart from Indus valley, man has occupied many other parts of Pakistan for several thousand years. Deforestation of vast areas followed by agriculture and grazing has changed the physiognomy of this land, which was thickly forested at one time. As a result odd physiognomic patterns have developed in various zones varying from savannah to scrub lands, grasslands, steppes and deserts. Thus much of the original tropical thorn forest is now not discernible, as most of it has been destroyed together with its fauna. Due to destruction of natural habitats, wildlife suffered a great setback. Many animals could not survive the changes brought by man and became extinct. Some managed to escape into the adjacent habitats. However, many did manage to survive. The present fauna of Pakistan has a representation of major natural zoological regions of the world. The trans-Indus and trans-Himalayan regions are Palearctic and have a good representation of European, North American and Asian fauna. The Indus plains of Sind and Makran are visibly influenced by Ethiopian fauna including African mammals.

Fig. 1.3 Pakistan: Distribution of Mean Annual Rainfall



The natural vegetation of Pakistan has been described and mapped by various scholars including Schweinfurth (1957), Champion (1936), Champion, Seth and Khattak (1965), Zehngraff (1967), Selod (1969) and Khan (1974). Most of them have considered the vegetation from a climatic point of view, whereas Champion, Seth and Khattak (1965) as well as Khan (1974) have also recorded edaphic types and even seral and degraded stages and therefore constitute the best references available. Stewart (1972) has estimated that there are roughly 6000 vascular plant species, 128 pteridophytes, 23 gymnosperms, 1140 monocots and 4492 dicots. Some of these plants are poisonous and can be fatal for livestock and humans. Chaghtai et al., (1984) have produced a list of these plants.

1.3 Human Habitat

The history of human habitation and village life in Pakistan goes back several thousand years. Some of the earliest relics of stone-age man in the subcontinent have been discovered in Soan Valley of Potwar plateau near Rawalpindi with a likely age of about 500,000 years. However, the process of land settlements and village formation is still unclear. It may have developed either spontaneously, as a result of permanent settlement of

the first tribes or as a deliberate act of colonization or invasion by newcomers. Recent archaeological evidence indicates that settled communities existed in the area 4000-5000 years ago (Kureshy 1961). When the Aryans entered India they found a mature and flourishing urban-agricultural civilization in Indus Valley (Fig. 1.4). The sudden end of this Indus civilization is attributed to one of the earliest known environmental degenerations (Box 1.1).

Comparable to the Indus Civilization (Wheeler, 1953) were other civilizations in Khyber Pakhtunkhwa province at Lewan Dheri and Rehman Dheri. However even before Indus Valley civilization, prehistoric settlements of Baluchistan appear to have met a similar fate of destruction. "The conditions of agricultural prosperity at that time in the now barren Baluchistan appear to be related to higher annual rainfall in those days. The numerous relics of elaborately built dams for the stopping and storage of flood water from the streams, suggest heavier rainfall" (Kureshy, 1961). The dams, locally known as gabar-bands, were a common feature of settlements in southern Baluchistan. The gabar-bands made of stone were about 300 yards (275 meters) long, up to 8 feet (2.4 meters) wide and 12 feet high (3.6 meters). Their stone facing was sometimes backed by earthen ramps. The existence of these gabar-bands reflects climatic conditions with a greater rainfall, as well as a large population, which provided the necessary labour for their construction (Stein 1931). Marshall (1951) suggests that the annual rainfall then might have been between 15 to 20 inches (380-500 mm).

It is believed that after the destruction of such civilizations, the reduction of resources could subsequently support the population only at a semi-nomadic level. Settlements analogous to present day villages were formed when the main races of the subcontinent transitioned again from nomadic to the sedentary agricultural stage. These settlements with their groups of land holdings have certain factors in common with the villages of other countries arising from similar elements in early tribal life. There are distinct varieties

Box 1.1 Environmental Degeneration and Destruction of Indus Civilization

From the excavated archaeological sites of Indus valley, it has been found that kiln burnt bricks were lavishly used by the Harapan culture (Indus Civilization) and evidently unlimited timber must have been available for use in the third Millennium B.C. Harrapan are therefore blamed to have cruelly used the forests. With no replantation by the community, the wholesale logging created deforestation and desertification in the Indus Valley. This deterioration of the environment had far reaching effects on the population. In other words, as the Harrapan paid no respect to the nature they had to face the consequences.

Forests serve a harmonious link between the human community and its physical environment. The first effect of wholesale logging was the destruction of the forest ecosystem. Animals depending on forests for food disappeared. Small plants, which depended on large trees for humus, vanished. Soil was exposed to erosion. Fast erosion caused silting of rivers resulting in frequent and devastative floods. Loss of top soil reduced the water retaining capacity of the region, depriving human community of fresh water supply. Transpiration, extremely important for optimum weather, ceased, causing arid conditions with unbearable temperatures. Gradually the entire climate, which was once usefully moderate to sustain luxurious forests and fertile soil, changed to greater extreme and turned the area to a mere dust heap. Consequently droughts, famines, floods and pestilence brought apocalyptic doom for the community. Ultimately, the civilization perished and bricked houses; roads and city walls were left to tell the woeful story of the extermination of the great Indus Civilization.

Fig 1.4 Pakistan: IndusValley and Post Indus Valley Settlements

from the coast of the Arabian Sea in the south to the mighty Karakoram Range in the north. The difference in environmental features and available resources has resulted in innumerable regional and local variations.

In all there were 43,198 rural localities in Pakistan in 1981, which increased to 50,613 by December 2012 (GOP, 2012). At the time of last population census held in 1998, they were 46,242 in number (GOP, 1998). Their population by locality size are given in table 1.1.

In addition to these there are about 415 towns and cities with sizes ranging from less than 5,000 to over 10 million. These settlements are located in varied environments and have their own pattern of resource use. On

Table 1.1: Pakistan: Population by Rural Localities Size

Size of Locality	Number (1981)	Number (1998)	Population (1998, in millions)
Under 200	6,360	5,709	0.55
200-499	8,425	6,888	2.37
500-999	9,323	8,625	6.31
1000-1999	9,946	10,383	14.97
2000-4999	7,682	10,946	33.96
5000-and above	1,462	3,691	31.16
Total (Inhabited)	43,198	46,242	89.32
(Uninhabited) 1969*	2,121		

*They are classified as Mauzas (revenue villages) but do not have any population within their area.
Source: Population Census Organization (1985) Handbook of Population Census Data and Population Census 1998

the one extreme there are the traditional agricultural societies in the mountains and on the other urban-industrial systems using capital-intensive technologies in metropolitan cities. Environmental impacts of human activities vary amongst these and a number of transient ones. One would have thought that traditional societies would be causing little or no harm to the environment. However, that is no longer true because of rapidly changing traditional societies due to population increase and cultural transformations as a result of outside influence. In fact, recent statistics on forest loss, erosion and sedimentation, overgrazing and desertification reveal that growing population and increased human activities in the fragile ecosystems of traditional societies is bringing irreversible changes in the environment.

Human interaction with environment is producing results of varying intensity. A comprehension of these processes however requires an understanding of the ecological regions of the country. The first attempt at identifying ecological regions in Pakistan was made by Selod (1969), who prepared a vegetation map of the country, which was used to zone the country into ten vegetation regions. Subsequently Rafiq (1971) identified 17 ecological crop zones on the basis of physiography, climate and soil. More recently, the Agricultural Research Council divided the country into ten agro-ecological zones using factors from both natural and human system.

This group of ten classified zones together with an eleventh urban or city system zone constitutes the terrestrial ecosystem of Pakistan. The wetlands of the country including lakes, rivers, marshes and seas constitute its aquatic ecosystem, while the blanket of air enveloping the two ecosystems (Terrestrial and Aquatic) is the third Atmospheric ecosystem. The environmental transformations, which are occurring within these ecosystems due to varied human activities and the story of their endurance in the face of adversity is the theme of the following chapters of this report.

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