USE OF GEO-INFORMATICS FOR COMBATING DESERTIFICATION IN STOD VALLEY (1F4C2), PADAM (ZANSKAR), DISTRICT KARGIL, J & K STATE

M.N. Koul[1], R.K. Ganjoo[2*], P.S.Dhinwa[3], S.K.Pathan[3] and Ajai[3]

1 Department of Geography, University of Jammu, Jammu 180 006, India
2 Department of Geology, University of Jammu, Jammu 180 006, India (ganjoork@rediffmail.com)
3 Space Application Centre, Ahmedabad 380 015, India

KEY WORDS :

ABSTRACT

The paper deals with the desertification status mapping of Stod valley of Zanskar region, District Kargil, Jammu & Kashmir State (India), located in the altitudinal belt of 3450m to 6200m asl. The valley, located in the rain shadow region of Tethys Himalaya, is studded by eight major glaciers and witnesses permafrost condition for nearly six months. The valley experiences semi-arid to arid type of cold climate designated as Bc. The temperature in the valley fluctuates between -48^{0}C to -20^{0}C in winters at different altitude levels. The permafrost conditions lead to solifluctuation and gelifluction process producing immature soils and triggering the natural geomorphic hazards, such as snow and rock avalanches, landslides, and fluvio-glacial erosion. The hazards have been largely responsible in the generation of mass movement and other catastrophic activities that result in high morpho-dynamic activity of weathering, breaking of ice, and damming and bursting of lakes causing the desertification of the region. Various thematic maps, such as maps of geomorphological features, soils, slope, drainage, and meteorology on the sacle of 1:50,000 on the basis of IRS data supplemented by field work. Besides, collateral data from Indian Meteorology Department, J & K State Revenue Department, J & K State Desert Development Authority and other state government agencies and NGOs have been consulted to authenticate the thematic maps. The field and satellite data compliment each other in understanding the degradation of land cover and its processes and further categorize the land degradation into slight, moderate and severe. Different layers of data are digitized and later synthesized for the entire valley (711.78 km^2). Three zones of high morpho-dynamic activities, namely glacial-peri-glacial (533.13km^2), barren (125.92km^2) and agriculture-grassland landscape (14.99 km^2) are identified. The limited and restricted agriculture, based on monoculture with a very low yield, compels the male population to migrate and make handsome earning from outside the region. A combat map, based on the data generated by filed work and study of IRS data, to mitigate and check the further spread of cold desert is under way.

---

* Corresponding author

INTRODUCTION

Cold deserts of India are situated in the rain shadow zones of Himalaya and Ladakh Plateau, above an altitude of 3500m asl. Himalaya acts as a barrier to prevent the monsoons from entering the region as a consequence the summer precipitation is sparse and mostly in the form of snow. The winter temperature dips as low as -30^{0}C (average) that leads to the operation of permafrost and peri-glacial conditions in the region.

The Ladakh Plateau, in general, and Zanskar region, in particular, are subjected to strong seasonal pattern of energy and moisture regime consisting of dry summers and wet winters. Radiation, temperature, humidity, precipitation and atmospheric pressure change rapidly with the gain in altitude. Ambient temperature, density of atmosphere, concentration of water vapor and carbon dioxide decreases with gain in the altitude. The Green House Effect of atmosphere drops the temperature sharply and ground surface heats and cools rapidly resulting in high diurnal temperature variations. The orientation of slope to or away from the sun determines the local heating character, a microclimatic variation within the region.

The intense climatic conditions are largely responsible for the degradation of landscape in Zanskar region. The growing population has further worsened the situation in the region.

OBJECTIVE

The major objective of undertaking the study at Stod valley, Padam, Zanskar is to prepare land-use policy map in the background of the deteriorated landscape due to intense climate conditions. Besides, propose measures to mitigate the natural hazards, such as slope failure, snow avalanche, etc. on a short and long term basis.

STUDY AREA

Stod valley (Padam) is the largest town of Zanskar region. The altitude of study area ranges from 3450m to 6270m and is studded with eight glaciers, namely Haptal, Yaranchu, Shimling, Mulung, Kanthang, Gompe, Chabber and Denya. The largest of all these Haptal glacier with an approximate area of 53.85 km^2. The Stod valley is griddled on three sides by lofty ridges, Pensi La pass and Durung Drung glacier in the northwest; Mulung, Haptal, Shimlings glaciers and Umasila Pass in the west, south and southwest; and Tanglangla Pass in the east and Stod river in the north. Umasila Pass along the Great Himalaya in the west connects Zanskar region with Padar valley of Kisthwar.

Stiod (Padam) valley contains some of the highest and steepest mountain slopes. The relative relief of main valley is rarel;y less than 2500m, even the tributaries have an elevation difference of 2000m in a horizontal distance of 2 to 4 kms. Valley walls are covered with rills, gullies and mud channels. Massive debris slope covered with scree gradually merge with fans, low terraces, valley fills and channel gravels in the floor of valley. The magnitude of relief, overall steepness of slopes and scale of debris accumulation causes the slope instability, mass movement and triggers catastrophic events that are accentuated by the arid environment of the region.

Stod (Padam) valley is represented by the rocks of Central Crystalline, Phe Formation and Purple Formation. Most of the south, southwest and west part of Stod is repressnted by Central Crystalline rocks consisting of crystalline schist, stratified migmatites, porphyritic granites, gneisees and feldspathic quartz-muscovite-biotite schist often granetiferous. The rocks are intricately folded into flexures, flexure slips, recumbent and disharmonic folds. The rocks of Phe Formation, exposed in north and northwest of Stod consist of phyllites, slate, quartzite, greywacke, grey-green micaceous sandy slates, brown ferruginous sandstones and limestone. In north and northwest parts of study area, overlying Phe Formation is thick sequence of conglomerates, quartzites and slates characterized by purple colouration and designated as Purple Formation.

METHODOLOGY

The area of study is covered by IRS 1C/D-LISS III satellite sheets covering pahs 76.15-77.0 and rows 33.15-33.45 for the months of May and October 2001. Topographic sheet nos. 52C/6, 52C/10, 52C/11,52C/14 and 52C/15 of Survey of India on the scale of 1:50,000 of the year 1965-66 were used to undertake the study of the area. The basic approach to study the area involves (i) traditional field work to study and generate data on geomorphology, geology, climate/weather of the region, (ii) preparation of base maps, such as drainage map, slope map, natural vegetation map, land-use map, etc., and (iii) assimilate the data generated to prepare hazard map and suggest necessary plans to combat the hazards and

DATA ANALYSIS

a) Climate Climate plays an important role in causing and controlling desertification of the region. The Stod (Padam) valley is under the influence of Western Disturbance (WD) and such receives heavy snowfall during winter season. The WD causes widespread changes in the weather, including distribution of moisture in the form of snow as well as effect the temperature and hygrometric conditions. Abrupt fall in temperature is peculiar phenomena of WD disturbance in the region. The variation in minimum diurnal temperature is very large and the temperature dips as low as -35^0C resulting in the freezing conditions. The analysis of weather data for past fifty years (1950-2000) shows no seasonality pattern as major part of the year (almost eight months) experiences cold weather. The summers are weak and last for four to five months only. The average daily temperature during summer season is 13^0C with highest reaching to 26^0C. The diurnal variation in summer temperature is 10^0C. The atmospheric temperature begins to decline from October and dips to its lowest in the months of January-February. The annual average precipitation is 573mm of which 90% is received in the form of snowfall between the months of November to March. The average snowfall received is 2 to 10 m. However, floor of Stod (Padam) valley receives less snowfall and frost action serves as primary weathering agent. The area of study has arid to semi-arid type of cold climate with 90% of precipitation concentrated in winter months , moisture regime of 30, moisture index –65 and thermal efficiency of 40%, designating the valley as E type of climate zone (Thornwaite) and H type of climate zone (Oliver and Hidore 2003).

b) Geomorphologial Processes Stod (Padam) valley has a great preponderance of height, deeply cut serrated ridges and sharp peaks rising well above the perpetual snowfields. Remnants of former (Pleistocene/Holocene) glaciers in the form of various types of moraines and striation marks, punctuate the valley floor suggesting the influence of cold climate conditions in the region since geological past. Less precipitation and extremely low temperature conditions of Stod (Padam) valley leads to the permafrost conditions in the region. As a consequence, large scree cones of various generations are developed in the study area. Large erratic spread over the floor of valley is a result of their plucking and transportation by the glaciers in the past and present. The abrasion of glaciated valley huge glaciers has resulted in the formation of coarse to fine material that has been transported and deposited along the valley walls by glacio-fluvial processes. The movement of glaciers in the geological past and even presently has resulted in the formation of lateral, ground, and terminal moraines.

Stod (Padam) valley has well developed drainage system. The antecedent drainage has distinctive characters and flows through various geological and structural set up. The rivers commence from an altitude of 4400m and traverse a distance of nearly 10kms to join Doda/Stod river, the trunk stream. The drainage system has developed trellis pattern in upland regions and dendritic in region below the altitude of 5500m. The rivers originating from High Himalaya are of 5^{th} order whereas other are of 4^{th} order. The bifurcation ratio ranges between 3.5 and 8.1 reflecting high rate of erosion in the valley.

A large floodplain , about 7km wide, is formed at the foot of Padam village where Lungnak and Doda river meet. Two levels of terrace surface are formed along the Doda river with an escarpment of 5m. The older terrace (T-1) stretches from Ating

village to Padam covering a length of almost 25km and width of 3km. The terrace surface is fertile and supports the agriculture activity. The younger terrace surface (T-2) is about 900m in width and stretches from Sani village to Padam, a distance of about 11km. This terrace surface is covered with boulders and sand and is thus not good for agricultural purposes.

The flowing/running water on the ground surface has resulted in four types of water erosion – (i) rill and gully erosion, (ii) mass movement along rivers, (iii) mass movement on open slopes, and (iv) other elements of erosion.

The active medium of rill and gully erosion is the rainwater. Less cover of vegetation/forest further accelerates the process of rill and gully formation. The river causes lateral erosion and causes mass movement along the river. The high gradient of river beds, shallow sediment in the river body, and less or negligible vegetation along the banks of river are some of the factors to accentuate the mass movement. The nature of rock material (schist, phyllite, sandstone) and steep slopes are responsible for the rapid movement of material in the form of debris flow causing mass movement on open slopes. The debris flow is stabilized and is reworked as landslide due to rainfall, though rare.

c) People Six villages inhabit the valley and are linearly located along Doda river. The data with regard to the size of village and agriculture land is retrieved from satellite imagery, topographic sheets and ground checks. The correlation between the number of households and village size is found to be between 0.8 and 0.9. The villages – Ating, Padam, Salapi, Sani, Pipting and Rugrug- cover an area of 1957.7 hectres. The area of village has increased to 28% since 1981. About 4200 people of the region are confined to 1.5% of the total area. The population of region has increased by 54.5% since 1981. The density of population of region is 2.6person/km^2. Study further reveals that 52% of population is male and 48% is female of which 20.7% fall in age group 0-15years, 18% in the age group of 15-30 years, 28% in the age group of 30-45 years, 19% in the age group of 45-60 years and 14% in the age group above 60 years. The total lietarcy arte is 18.78% with literacy rate as high as 75.5% in male and 24.5% in female.

d) Agriculture Agriculture is the mainstay of people. Out of the cultivable are of 1957.7 hectares, only 48.6% is cropped due to near availability of river water for irrigation. The agriculture activity is only four to five months of the year as for the rest of period the fields are covered under thick snow cover. In last two decades the agriculture practices have changed considerably and use of fertilizer and mechanization has increased the cropping from 860 hectares to 952.42 hectares, and increase by 10.7%. Wheat, barley, grim and peas are cultivated as food crop and fodder for animals. Almost 35% of cultivable land is devoted for wheat.

DISCUSSION AND CONCLUSION

The entire Stod (Padam) valley has been divided into four major physiographic divisions – basin floor, mountain rim, Zanskar uplands, and High Himalayan flank. These divisions are based on the characters of drainage pattern, nature of slope, and predominance of geomorphic agency. Each physiographic division comprises an appreciable are of the valley and posses characteristic features. Various geomorphic activities of each geomorphic agent, namely glacier and periglacial has been responsible in generating degradation of the landform by the activation of processes such as frost heaving, frost shattering, and glacier water erosion. The harsh weather conditions have been largely responsible for negligible vegetation growth in the valley that has further added to the desertification of the area. Having known the cause and factor responsible for the desertification, a combat plan to mitigate and check any further growth of desert is prepared accordingly.

REFERENCES

Oliver, J.E. and J.J. Hidore 2003 *Climatology: An Atmospheric Science.* Singapore: Pearson Education.

Thotnwaite, C.W. 1948 An approach toward a rational classification of Climate, *Geographical Review*, 38, 55-94.