PK ISSN 0030 - 9788

PAKISTAN GEOGRAPHICAL REVIEW

Volume 56 . . Number 1 & 2

2001

EDITORIAL BOARD

PAKISTAN GEOGRAPHICAL REVIEW

EDITOR

Farhat Gulzar

ASSOCIATE EDITORS

Tasneem Kausar **Abdul Ghaffar**

MANAGING EDITOR

Safdar Ali Shirazi

ADVISORY BOARD

1. Maryam K. Elahi
2. Qazi Shakil Ahmed
3. Fazle Karim Khan
4. M.H. Bukhari
5. Masaud A. Mian
6. Muhammad Said
7. Israr-ud-Din
8. Agha Abdul Hameed
9. A. Hameed Rathor
10. Azhar Hameed
11. S.M. Khalid
12. Chaudhry M. Nawaz
13. Amir Khan
14. Muhammad Khan Malik
15. M. Rafique Dhanani
16. Gul Muhammad
17. Birjies Talat
18. Arif Mahmood

CORRESPONDING EDITORS

1. Chauncy D. Harris, University of Chicago, U.S.A.
2. Oskar H.K. Spate, Australian National University, Australia
3. Graham Chapman, Cambridge University, Cambridge, U.K.
4. BLC Johnson, Australian National University, Australia.

PAKISTAN GEGRAPHICAL REVIEW

Volume 56
Number 1& 2 2001

Pakistan Geographical Review

Volume 56 Number 1 & 2 2001

CONTENTS

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 1-16

EFFECTIVENESS OF FLOOD HAZARD REDUCTION POLICIES: A CASE STUDY OF SHPAG KALEY, PESHAWAR VALE

Amir Nawaz Khan
Department of Geography, Urban and Regional Planning,
University of Peshawar, Peshawar
and
Atta-ur-Rehman
Department of Geography, Govt. Post Graduate College, Noshera

ABSTRACT

This study attempts to evaluate the National Flood Hazard Reduction Policies (FHRP) in the flood plain of Kabul river and make it effective. For this purpose Shpag Kaley area, 32 Km north of Peshawar was selected. Shpag Kaley is an Island, bounded on all sides by the braided channels of Kabul river. It has an area of about 4905 acres. There are in all ten villages, but for a sample survey, three villages: Khanpur, Wazir Kaley and Piari Payan were selected. These villages have been studied in their environmental background. In the study area, flood is one of the serious and recurrent hazards of this area. Whenever, water overflow the natural levees, it destroyed standing crops, canal network, farm buildings and dwellings. As a consequence, the economy of the villages badly hit by the recurrent floods.

This paper consists of seven sections. Section one deals with the introduction of the paper. Section two assesses the concept and definition of flood hazard. Research methodology discussed in section three. Section four deals with the existing flood hazard reduction Policies of the Government. Section five evaluates the flood hazard reduction policies in the study area. Section six discusses summary and conclusion, while policy recommendations are given in the final section.

INTRODUCTION

This study is aimed at making the National Flood Hazard Reduction Policies (NFHRP) effective in the flood plain of Kabul river. Flood is one of the serious and recurrent extreme natural event of this area. From time to time Kabul river has overflowed the natural levees and in effect causing disasters to the people of the area including loss of life and destruction of

property. Shpag Kaley area is located 32 Km north of Peshawar. It Is an island, bounded on all sides by distributaries of Kabul river. Its total area Is *4905* acres (Map No.1).

Geomorphologlcally, it is a flood plain made by river Kabul. The soli Is very fertile and suitable for all types of agriculture. In the study area, there are In all ten villages, namely Khanpur, Wazlr Kaley, Plarl Payan, Plarl Bala, Khwajl, Dang Lakhtl, Juganl, Shaghall Bala and Shaghall Payan. But for a sample survey, Khanpur, Plarl Payan and Wazlr Kaley were selected at random. The settlement pattern Is dispersed and compact. Out of these ten villages seven are located right on the bank of river, which Is a very good Indicator, that 70% villages are prone to flood hazard. Therefore, this study was carried out to find out the weaknesses in the Government flood hazard reduction policies and make it effective, to ensure safety of human lives, standing crops and other public and private property.

CONCEPT AND DEFINITION OF FLOOD HAZARD

The concept of natural hazard has been variously defined by many researchers (Burton and Kate's, 1961; Burton, et ai, 1978; White, 1974). Despite differences in their point of view, most of the researchers agree that natural hazards are dangers brought about by a degree of exposure to geophysical or extreme natural events, for which the Individual or society is not prepared with In the normal pattern of life. Hence, natural hazard is a condition of natural environment and has a strong relationship with man. The extreme natural events like floods, wind, earth quake and landslides are hazardous only when they prove detrimental to man and his activities. Therefore, without man there is no concept of natural hazard. A flood becomes a natural hazard, when it affects man and his activities.

Historically, rivers and other large bodies of water have played a great role in the development of civilization. Flood plains with fertile alluvial soil, has always encouraged settled agriculture and enjoyed a long history of settlements. From time to time rivers have overflowed their banks causing disasters involving loss of .life and destruction of property bringing in their wake hardships, suffering, disease and famine (Ward, 1978; Burton, et al. 1978). Different scholars have variously define~ flood.

- "It is the overflow of water" (Ward, 1978).
- "It is high flow of water which inundate the natural channel, which is provided by natural flow of river" (Foster, 1948).
- "Any high stream flow, which over-topped, the natural or artificial bank of river" (Hassan, 1995).
- A flood may be defined as a discharge which exceeds the channels capacity of a river and then proceeds to inundate the adjacent flood plain (Smith, 1979).

- "Flood may be any relatively high water discharge above a selected flood level" (Paul, 1984).
- "Flood is a body of water, which rises to overflow the land, which Is not normally submerged" (White, 1945; Burton, et ai, 1978; Alexander, 1993).

Since man is unable to control the basic atmospheric processes, which produce most floods. He has attempted to adjust to the hazard by means of floods alleviation projects concerned with the land base phase of the hydrological cycle through the application of high technology and the massive investment of capital.. The flood threat to capital and human life has decreased appreciably in most developed countries with in recent decades (Smith, 79).

For example, Geraghty, et al (1973), estimated that the annual deaths resulting from flooding in USA averaged more than 185 during the period 1831-1940, where as (White, 1974) has indicated that fatalities were reduced to less than 83 per year between 1925-71. This improvement has been largely achieved as a result of better floods warning measures, which have permitted the temporary evacuation of hazard area. On the other hand, it is becoming increasing evident that the flood risk has been in no way eliminated. Indeed, it appears that the advanced countries are actually becoming more vulnerable to loss of property and the social disruption associated with floods judged against socio-economic criteria. Present flood alleviation strategies have failed in their objectives of reducing flood losses, and flooding now a source of growing environmentally-based stress in many countries (Smith, 79).

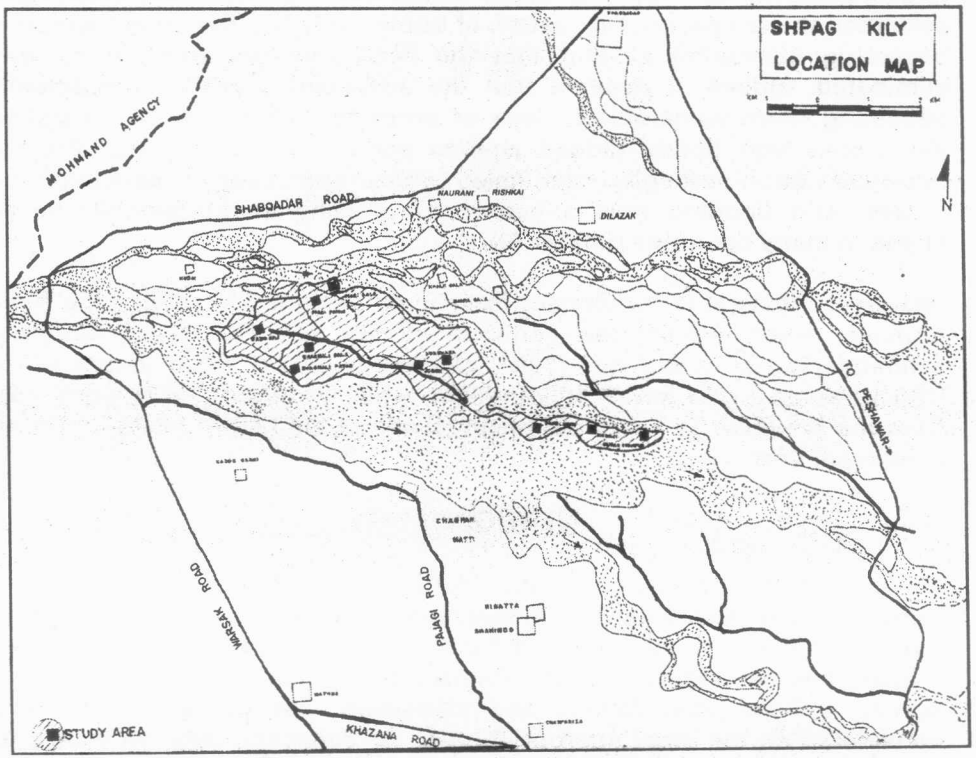
Despite considerable investment in scheme designed to reduce the flood problem, mean annual loss continue to rise. For example, in an early estimates Burton and Kates (1964) placed the annual flood losses in the USA between $ 350 and $ 1000 million, while Goddard (1971) using date from the previous 35 years put mean losses at the higher figure of $ 1000 million per year.

METHODOLOGY

To achieve the objectives of the study, three villages out of ten were selected by random means. The three selected villages are Khanpur, Piari Payan and Wazir Kaley. For the detail study, data were obtained from both primary and secondary sources. Primary source based on Questionnaires survey, general observations and interviews. The primary source was considered as the most appropriate tool for collecting data necessary for the study. Ideally, the entire popUlation of the area should have been surveyed. However, given the time and resources available, it was considerp"↵ i,ecessary to conduct a sample household survey. During field

work two types of questionnaires were used: one for the village as a whole and the other for individual household.

Questionnaires for the whole village were filled from the farmers, community leaders and elderly people. More than two questionnaires were filled from each of the three selected villages. As far as individual questionnaires are concerned, it has 120 questions and was filled from 30% households. The sample of the respondents selected for interview is fairly diversified and heterogeneous in its composition. The questionnaires were designed to collect Information regarding existing flood hazard reduction policies and damages caused to socio-economlc and physical environment. During the field survey data about the mitigation and damages incurred during the last twenty years were collected. To collect data necessary for the study, an interviewing schedule was prepared for the officials of the implementing agencies. As far as secondary data is concerned, it was obtained from the flood dealing line agencies. Consequently, it was possible to find out the socio-economic damages as well as the extent of flood level.



FinaHy, the collected data were analysed and presented in the form of maps, tables and descriptions. Analysis of data was carried out through computer accessories like Excel and MS 97. Than the collected data and

information were interpreted in the light of flood hazard reduction policies and existing socio-economic and physical environment of the study area.

EXISTING FLOOD HAZARD REDUCTION MEASURES

On the bases of field observation and people's perception in the study area following flood hazard reduction policies were found:

- Modifying flood hazard by engineering protective measure.
  - Retaining walls! Marginal embankment..
  - Guided Spurs/dykes.
  - Earth Embankment..
  - Water Reservoir and Dams.
- Flood warning system/measure.
- Flood emergency relief measure.
- Emergency evacuation.
- Emergency rehabilitation.

EVALUATION OF FLOOD HAZARD REDUCTION POLICIES

Effectiveness of structural measures

Since the creation of Pakistan, Government is consistently involved in flood management of Kabul river. Despite of Warsak dam, Government has also constructed stone spurs, earth embankment and retaining walls or marginal embankment on both sides of river Kabul (GoNWFP, 98). The effectiveness of structural measures has to be judged by the beneficiaries (Khan, 93 a & b). Therefore, public were asked to give their point of view about the existing marginal embankment and guided head spur/dykes. In Khanpur 60%, in Piari Payan 10%, and in Wazir Kaley half of the total respondents were satisfied from the existing protective measures. Because they provides, to some extent, protection from the flood hazards. This category of respondents either living in those places, where structural measures have been carried out or living away from the flood effects. In Plarl Payan 40%, while in Khanpur and Wazir Kaley an equal proportion (30%) of the respondents were not fully satisfied from the protective measures. They were of the view that it was not adequately protecting the area. Most of the respondents in this category are those, whose fields were prone and vulnerable to flood hazard. A considerable high percentage of the respondents in Piari Payan *(50%)* were not at all satisfied with the protective embankment. Because they are vulnerable to flood hazard and a protective measures have not been extended to this village (Table-No.1).

In Shpag Kaley flood plain of river Kabul, Government has constructed about 3 Km long protective embankments for the reduction of flood effects (GoNWFP, 98). But such embankments are not solving the problem effectively. There is still an urgent need of about 6 Km marginal

embankment or guided head spurs at appropriate location to keep water within the channel..

Table-1 : Effectiveness of protective measures (%)

S.No.	Village name	Satisfied	Less satisfied	Not Satisfied
1.	Khanpur	60	30	10
2.	Piari Payan	10	40	50
3.	Wazir Kaley	50	30	20

Source: Field Survey 1997.

Flood warning system

The objective of the flood warning is to give timely warning to the people concerned and to the organization responsible for flood fighting and evacuating people from flooded area (UNO, 76). Therefore, flood warning is considered as the most appropriate non-structural measure to reduce the flood effects. In response to the existing flood warning system, general public were asked to give their observations about the performance of flood warning agencies. In village Khanpur 80% of the total respondents replied that we were warned ahead of the flood occurrence, while a high percentage in Piari Payan (80%) and in Wazir Kaley (90%) said that we were not informed of pre-flood occurrence, because these villages are located away from local police station (Table No.2). This is the situation inspite of the fact that an elab6rate w~r:{ling system has been clearly mentioned in the NWFP disaster plan (GoNWFP, 77).

The respondents were mainly informed by the two agencies: police and general public. in Khanpur 75% respondents were informed by police and 25% by common people, while in Piari Payan an equal proportion of respondents were informed by both police *(50%)* and general public *(50%).* As far as Wazir Kaley is concerned, common people informed the residents. Nahqi is the police station of Shpag Kaley located on the east of the study area. The analysis revealed that as the distance increases from the police station the effectiveness of flood warning also decreases and vice versa. In Shpag Kaley flood plain of river Kabul, mostly people were informed verbally (Khanpur 100%, Piari Payan 80% and Wazir Kaley 100%). The media can also play a vital role in the dissemination of flood hazard warning.

Table-2: Flood Warning

Village Name	Warned pre-flood occurrence(%)		If yes than who Informed (%)		How Informed (%)		Believed on it (%)	
	Yes	No	Police	Common People	By load speaker	Verbally	Yes	No
Khanpur	80	20	75	25	0	100	~00	0
Piari Payan	20	80	50	50	20	80	100	0
Wazir Kaley	10	90	0	100	0	100	100	0

Source: Field Survey, /997.

When respondents were asked, non-of them denied the occurrence of flood. 100% believed in flood occurrence.

When they were further asked as *"what was their individual response during flood warning".* In Khanpur *50%,* Piari Payan 30% and in Wazir Kaley most of the respondents (60%) replied that "Panic". While a considerably high proportion of the respondents said that we had started evacuation (Table No.3).

Table-3: Spontaneous response during flood warning

S. No.	Name of Village	Individual response (%)		
		Panic	Did not believed	Started evacuation
1.	Khanpur	50	0	50
2.	Piari Payan	30	0	70
3.	Wazir Kaley	60	0	40

Source: Field Survey, 1997.

Flood time and performance of line agencies

In Shpag Kaley flood plain of river Kabul, flood is a recurrent natural event. Whenever, flood occurs in any part of Pakistan, officials of the Government agencies or non-Govt. organizations visit it. But the role of community participation is of keen importance. Because they are the fastest and nearest of all the relief agencies (Samee, 96). Their job is to reduce flood losses through structural and non-structural measures.

The role of Government officials have been evaluated by beneficiaries. In response to the question, *"Has the flooded area visited by any agency".* In Khanpur 19%, Piari Payan 35% and in Wazir Kaley majority (70%) of the respondents said that the affected area visited by officers of the Irrigation Departments (Table No.4). In Khanpur 70% of the total respondents replied that the flooded area was also visited by the army. While in Piari Payan only 25% respondents said that the damaged area watched by the army. In Khanpur 11%, Piari Payan 20% and in Wazir Kaley 30% of the respondents answered "No", because they were of the view that the flood devastated area has not visited by any officials. They replied that only local people efficiently worked for the reduction of flood effects.

Table-4: Role of Govt during flood time

S.No	Name of Village	Affected Area Visited by (%)			Not visited
		Irrigation department	Flood relief agency	Army	
1.	Khanpur	19	0	70	11
2.	Piari Payan	35	20	25	20
3.	Wazir Kaley	70	0	0	30

Source: Field Survey, 1997.

Flood proneness and public mitigation measures

Shpag Kaley flood plain, is a community of ten villages. Out of ten, seven villages are located right on the bank of river Kabul. Therefore, they are considered as flood prone settlements. All residents of the three sample villages said that we were prone to flood hazard. They expressed that whenever flood occurs they prefer some activity for protection. In Khanpur 10% and Piari Payan 60% of the respondents said that they wish to construct protective embankment to reduce the adverse effect of flood hazard. In Khanpur 20%, Piari Payan 10% and in Wazir Kaley 10% respondents replied that they make sidewall from the stones available in the riverbed (Table No.5). An equal proportion (10%) of the respondents in Piari Payan and Wazir Kaley replied that during flood time they look after their property. A considerable proportion of respondents (Khanpur 40%, Piari Payan 10% and in Wazir Kaley 80%) said that they prefer wood and bushes for reducing flood damages. Only in Khanpur 30% respondents make traditional embankment locally called as *"Gargich".*

Table-5: Flood Proneness and General Public preparedness, 1997

Name of Village	Flood Proneness		Prefer an activity for protection		Name of Activity (%)					
	Yes (%)	No (%)	Yes (%)	No (%)	Embankment	Stones	Watching	Bushes twood	Traditional Embankment	Plantation
Khanpur	100	0	100	0	10	20	0	40	30	0
Piari Payan	100	0	100	0	60	10	10	10	0	10
Wazir Kaley	100	0	100	0	0	10	10	80	0	0

Source: ***Field Survey, 1997.***

Emergency Evacuation

In a disaster situation people are required to be shifted from the places under threat of flood to safer places (UNO,76). Evacuation is an organized withdrawal or removal as of persons or things from a place or area as a protection measure (Ahmad, 95). The evacuation process contains some formal or informal organizations as well as people or property are moved from one place to another and the movement is temporary till the crisis is over.

In Shpag Kaley flood plain of river Kabul, data regarding emergency evacuation were collected from the general public. During field survey, a number of questions were asked, to find out the effectiveness of emergency evacuation. In response to a question *"How were you evacuated during flood time?"* In Khanpur 62.5% of the total respondents said by 'army', 20% replied 'local people' and only 17.5% told that we were

evacuated by themselves (Table No.6). In Piari Payan 37.5% said by "army", 20% replied by "local people" and a considerable proportion told by "himself". As far as Wazir Kaley is concerned, only 10% of the total household said by "army", 30% said by local people and a high proportion (60%) replied personally. This high percentage share clearly indicates that there has been a close relationship with the flood hazard evacuation and remoteness. The table shows that as the remoteness increases the emergency evacuation by army decreases. Therefore, Khanpur has higher army evacuation than Piari Payan and Wazir Kaley.

Table-6: **E**mergency **E**vacuation

Name of Village	Evacuated by (%)			Which agency helped (%)		Satisfied from evacuation (%)	
	Army	Local People	Your own	Govt.	Local people	Yes	No
Khanpur	62.5	20	17.5	71.4	28.6	90	10
Piari Payan	37.5	31.2	31.25	63.6	36.3	35	65
Wazir Kaley	10	30	60	10	90	30	70

Source: Field Survey, 1997.

In the study area local people were asked *'which agency helped you in evacuation?'* The responses were recorded, processed and tabulated. In Khanpur 71.4% answered "Govt." 28.6% said "local people". In Piari Payan 63.6% replied "Govt." 36.3% replied "local people". In Wazir Kaley as many as 90% sample household replied "local people" and only 10% said "Govt." (Table No.6).

To further confirm the strong evaluation of the emergency evacuation in the area, respondents were asked a direct question *"were you satisfied with emergency evacuation?".* The responses were different at different villages. In Khanpur ,90% respondents replied "yes" and only 10% said "No". In Piari Payan, 35% replied, "yes", whereas 65% said "No". (Table No.6). As far as Wazir Kaley is concerned, a considerable proportion (70%) of the sample population answered "No", and only 30% replied "yes". The analysis confirms that satisfaction decreases with the increasing distance from the main road and police station. Khanpur is loc.atednear to the Nahqi Police Station and the Charsadda road as compared to' the ~ther villages. Therefore, it has comparatively high emergency evacuation.

Emergency Rehabilitation

The rehabilitation phase is also called the transition phase. It initially includes people returning to work and the permanent repair of physical infrastructure and other actions necessary to help the community return to normal as quickly as possible (Cunny, 83). Hence, the rehabilitation phase

can be evaluated through pUblic responses. In the field a number of questions related to rehabilitation were asked from the sample households. Their answers were recorded, tabulated and analysed.

In Shpag Kaley flood plain of river Kabul, a question pertaining to rehabilitation was asked that *"which agency helped you in rehabilitation?',* In Khanpur 30% of the total household replied "Govt.", but the majority (70%) said "local people" (Table No.7). In Piari Payan 10% of the sample population answered "Govt." and a high proportion (90%) said "general public". In Wazir Kaley majority of the respondents (92%)'answered "local people" and only 8% told "Government".

When the affected population of the area was asked, *"what Sort of help was provided during floods?",* In Khanpur 10% household replied "cash (aid)", 60% said "food (ration)" and 30% answered that "no help" was extended at all (Table No.7). While in Piari Payan, majority (92%) of the respondents answered in negative an~ only 8% said "food". 10% of sample households in Wazir Kaley told "food", and rest of the respondents denied any assistance.

Table-7: Rehabilitation

Name of Village	Agency helped in Rehabilitation ("10)		Type of help during flood ("10)			After Flood ("10)	
	Govt.	Local people	Cash	Food	No help	Cash	No help
Khanpur	30	70	10	60	30	11.11	88.88
Piari Payan	10	90	0	8	92	0	100
Wazir Kaley	8	92	0	10	90	0	100

Source: Field Survey, 1997.

In response to the question, *"what sort of help was provided after flood? ",* it was found that in Khanpur only 11.11% of the respondents answered "cash", and rest replied in negative (Table No.7). In Piari Payan and Wazir Kaley, cent percent of the households denied any help, being extended to them.

Effectiveness of institutional arrangement for flood hazard reduction:

The reality on the ground is that the administration is involved in protecting lands belonging to local influential. It was also accused of mismanagement of funds allocated for the relief and mitigation effort on a massive scale (Samee, 96). The mismanagement is due to the fact that flood preparedness plans are not revised periodically, the community perspective is absent from planning documents, and there is lack of co-ordination between various players. Government responses are reactive and not anticipatory. The community is not mobilised to aid the relief, mitigation and

preparedness efforts. There is undue political interference in decisions relating to flow of relief and management of infrastructure. The media coverage is restricted, incomplete and often contrary to the reality.

SUMMARY AND CONCLUSION

It can be concluded that the engineering protective measures are very limited, because they are expensive and the standard of economic is low in the area. By applying local protective measures flood losses cannot be easily reduced through stones, watching, bushes, wood or other related measures. it needs a concrete engineering protective measures e.g. Marginal embankment, guided head spurs, flood dykes etc. Consequently, it can be interpreted that the role of Government in emergency relief, evacuation, rehabilitation measures is very limited. Only in Khanpur the response is up to the mark, while in Piari Payan and Wazir Kaley, rehabilitation stage is totally neglected.

It has been observed that the failure of the flood hazard reduction Policies is mainly due to structural deficiencies and lack of implementation capabilities. Field examination revealed that the compensation policies has not been able to help the low income household, because of unrealistic requirements for the entitlement of compensation (Khan, 96). Field study shows that lack of legislative measures encouraged the community to build and rebuild their houses close to the river banks. The Irrigation Department constructed protective embankment without proper planning rather they were made in discontinuous way, with a number of gaps. Field study has confirmed that though spending on flood control measures has proliferated; yet flood damages continue to escalate. The adjustment is totally based on the structural approach with engineering work. It is mainly undertaken after the occurrence of flood hazard. It was found that FHRF is carried out by a number of line departments, including forest, public health engineering, revenue, Federal Flood Commission, emergency relief cell, ~ealth department, livestock department, irrigation department, WAPDA, and Flood Forecasting and Warning Bureau, Lahore. They have overlapping power, lacking any horizontal co-ordination in the distribution of roles and responsibilities. A review of the reports and interviews with the concerned officials has confirmed that these departments lack suff icient capital resources and technical expertise to deal with the flood hazard.

POLICY RECOMMENDATIONS

In order to reduce the adverse effects of flood hazards, it will be necessary to bring about some radical changes in the policy. Following are some suggested policy recommendations:

Modify flood hazard by engineering protective measures

The most popular approach to reduction of flood hazards both in the developed and the developing countries has been to alter the timing and distribution of water associated with floods (Khan, 96). The most widely used techniques to modify hazards are protective measures. Protective measures are aimed at preventing floods from reaching infra-structure and agriculture land. The level of safety has a direct relationship with the level and construction of embankment. In the study area two types of embankments were found (i) Constructed by the Irrigation Department and (ii) traditional constructed called *Gargich.* The Government has already constructed about 3 Km embankment, for the reduction of flood hazard effects, but these are not solving the problems effectively and still their is an urgent need of about 6 Km embankment for the protection of Shpag Kaley flood plain of river Kabul.

Proper compensation policy

This is the simplest and most common form of adjustment to a hazard. Historically, when disaster occur, there has been much more emphasis on the compensatory policies (Burton, 78). The relief and rehabilitation assistance is given to victims in the aftermath of the disaster, in the form of property damage, relief, food and medical assistance etc. Flood relief not actually means to reduce the losses of flood hazards such as it left the burden from the shoulders of individuals who are exposed to flood. The importance of pUblic flood relief also- can not be denied. It has been considered as necessary, helpful, and beneficial for the people in the hazard-hit community. Consequently, it is strongly recommended that FHRP should try to avoid policy in its traditional form, where every affected household can claim compensa~ion. However, if this policy really does seem necessary in some hardship cases, then arrangements must be made to make sure that compensation reaches to the needy and vulnerable households.

National Flood Forecasting and warning System

In the field of flood forecasting system, the National Flood Forecasting & Warning, Bureau (NFFWB) has achieved quite an efficient flood forecasting system (GOP, 84): But the forecasting accuracy can be further enhanced If the follov I mg recommendations are considered:

♦ Provision of geostationary satellite facility

At present NFFWB and Pakistan Meteorological Department (PMD) are utilizing the satellite Picture of National Oceanic Atmospheric Administration (NOAA) polar orbiting satellite with less Arial coverage and

these are received only 4-6 times in 24 hours. Therefore, Ground Satellite imagery recovering stations for Geostationery satellite with vast Arial coverage and more frequent data collection is the need of the hour.

♦ Provision of independent telecommunication system

Pakistan Meteorological Department does not possess an Independent telecommunication system. PMD presently manages the tele printer network of PTC, which give low priority to the maintenance of this network resulting adversely the forecast capability of the NFFWB because the Weather report loose much of its value unless received with in the permissible time limits. The weak telephone line, linking the quantitative precipitation measurement RADAR~Sialkot with NFFWB, Lahore, is also maintained J:jyPTC. This link is subject to frequent disruption causing non-receipt of the most vital rainfall data from the catchment of the rivers. Unluckily the frequency of su.ch disruption are higher in cases where events are very significant and need to correctly forecast in time. Ultimately, it is recommended that more scientific system of flood forecasting and flood warning should be developed. This can be achieved by installing' control stations at important nodal points with appropriate communication means.

Process of relief Plan

The relief and emergency plan should cater the following necessities:

- Provision of food, shelter and other essential material assistance to the affectees.
- Staging areas for temporary shelters, rescue equipment, clothes, blankets, medicines etc. should be designated and at least partially stocked in advance.
- Testing and treatment of drinking water sources against contamination.
- Health care including vaccination to safeguard against spread of epid~mics, through line agencies, volunteer doctors and hired medical staff, if necessary.
- Restoration and recovery of what has been left or partially damaged.
- Restoring communication links including repair of bridges on essential link roads.
- Refurbishing irrigation channels before the next sowing season.
- Provision of seeds and fertilisers for the next crop to the most needy on easy terms and conditions.
- Provision of services for the clearing of cultivable land e.g. tractor and bulldozer services.

Estabilising Ecosystem

Interference',with the ecosys.tem,i.e. rapid deforestation was identified as a major reason for the severity and frequency of floods. Therefore, due appreciation should be given to the ecological aspect such as afforestation, reforestation and measures to curb unchecked deforestation and degradation of range land and watersheds. Also the physiographic, geologic and hydraulic features of the area should be taken on priority basis.

Land use planning and regulatory Policy

The available data from different source together with field observation revealed that there is lack of land use planning and regulatory' policy for reducing flood losses. So, this process ultimately led the community into hazard-hit zone, which is frequently inundated during the summer session. Therefore it is recommended that Government should produce land-use regulation and control to reduce the flood effects.

Public education and information system

Proper training and education of the public appears to be one of the principal means of reducing the adverse effects of flood hazards by making known to the public the consequences of the building in the wrong location. Before people can help the FHRP in connection with land use and regulatory measures; they need some kind of information and education. People must be made aware of the problem of hazards and their appropriate solutions. Such information should be communicated to the people through an organised public information programme. Necessary information can be disseminated by a number of means, such as conferences pUblic meetings, door to door companies, pUblic notices, displays of natural hazard maps, and integration of hazard' education in school curricula and adult education programme.

REFERENCES

Ahmed, N. and Qureshi, LA. (1995) Disaster Management in Punjab: A study of flood management in district Jehlum. Pakistan Academy for Rural Development, Peshawar. Alaxander, I. (1993) Natural Disaster. UCL Press Ltd. P. 631.

Alia, et al. (1996) Causes, Effects and Remedial Measures of flood, Swat valley. An unpublished report submitted to the Department of Geography, University of Peshawar.

Burtcm, etal. . (1964) The perception of Natural Hazards in resource management. Natural resources journal 3; PP. 412-41.

Burton, et al. (1978) The Environment as Hazard. New York. Oxford University Press, London. P.240.

Burton, I. and Kate, R.W. (1964) The flood plain and the sea shore-A comparative analysis of hazard zone occupance. Geographical review 54, PP. 336-85.

Cunny, F.C. (1983) Disasters and Development. Oxford University Press, London. P.278.

Foster, E.E. (1948) Rainfall and run-off. The Macmillan Co. New York. P. 487.

G.O. NWFP (1998) Flood Management of Kabul and Swat rlver./lood and Drainage Division, Peshawar.

G.O. NWFP. (1977) NWFP Disaster Plan. Office of the Relief Commissioner, NWFP.

Geraghty, et al. (1973) Water Atlas of the United States. New York: Water International Centre.

Goddard, J.E. (1971) Flood plain management must be ecologic~lly and economically sound. Civil engineering special issue environment for man and Nature, American society of Civil Engineering, PP. 81-85.

Goodman, B. (1991) natural wonders and disasters. Little brown an~ company, London, p.96.

GOP (1994) Flood Forecasting System in Pakistan and its Limitation. An unpublished report of National Flood Forecasting Bureau and Pakistan Meteorological Department Lahore, Pakistan.

GOP (1997) Second flood Protection sector Project, Umbrella PC-1. Ministry of Water and Power, Federal Flood Commission, Islamabad.

Hassan, H. and Shah, B. (1995) causes and effects of floods in river Jehlum, Muzafarabad, An unpublished report submitted to the Department of Geography, University of Peshawar.

Hewitt, D. and Halvey, J.D. (1970) Effects of forest clear felling on the storm hydrograph. Water resources Research series No.6.

Kates, R.W. and white, G.F. (1961) Flood hazard evaluation. Department of Geography, University of Chicago. Research Paper No. 70.

Khan, A. N. (1993 a) An evaluation of natural hazard reduction policies in developing countries with special reference to Pakistan. Pakistan journal of Geography Vol. III, PP-81-97.

Khan, A.N. (1993 b) Towards an appraisal of Hazard response theory. Journal of Rural Development and Administration. Vol. 25(4). PP .42-63.

Khan, A.N. (1996) Planning for Reduction of Flood Hazard. Proceeding of Pakistan Geographical Association, Bahawalpur Conference, PP.182-203.

Khan, et al. (1995) Towards an appraisal of Landslide Hazard Reduction Programme (LRP) in Murree, Pakistan. Pakistan Journal of Geography, Vo1.3,PP. 14-30.

Paul, B.K. (1984) Perception and Agricultural Adjustment to floods, Jamuna flood plain, Bangladesh. Journal of Human Ecology, vol. 12. No.1.

Said, M. (1992) Natural Hazards of the Hunza valley. Proceedings of the National Seminar on Progress of Geography in Pakistan, pp. 75-83.

Samee, M. (1996) Coalition building for flood disaster preparedness. A report of the workshop organised by Catholic Relief Services and OXFAM-Pakistan.

Smith, K. (1992) Environmental hazards: Assessing and reducing disasters. Routledge, London. P. 325.

Smitt, K. and Tobin, G. (1979) Human adjustment to the flood hazard. Lomgman Group ltd. London. P. 130.

UNO (1976) Guidelines for flood loss prevention and management in Developing countries. Natural Resources/water series NO.5.

Ward, R. (1978) Floods: A geological perspective. The Macmillan Press Ltd. P.244.

White, G.F. (1945) Human adjustment to floods: A geographical approach to flood problem in the United States. Department of Geography, University of Chicago. Research Paper No. 29.

White, G.F. (1974) Natural hazards. Local, National, Global. New York: .Oxford University press.

PK ISSN 0030-9788
Pakistan ,Geographical Review
Volume 56 Number 1 & 2 2001 pp. 17-28

THE PHENOLOGY AND BIOLOGICAL SPECTRUM OF DESERT PLANTS-A THREE YEAR STUDY IN THE SELECTED HABITATS OF CHOLISTAN DESERT, PAKISTAN

Asad Ali Khan
Department of Geography
and
Muhammad Shafiq Chaudhry
Cholistan Institute of Desert Studies. Islamia University. Bahawalpur.

ABSTRACT

The phenological and biological spectrum of annual and perennial species in the selected habitats of Cholistan desert was examined. The study that lasted for three years revealed that onset and duration of growth and flowering are correlated with the timing and abundance of precipitation. Whereas variation in total rain does not affect the onset of flowering in phanerophytes and hemicryptophytes while therophytes affected. Late rain delayed the onset of all phenological phases in all the life forms. Peak growth occurs during January to March and flowing from July to November depending upon the availability of moisture. Flowering in phanerophytes and chamaephytes occurred from 3 to 4 weeks after rain while in therophytes from 2 to 6 weeks after rain. It was concluded that three-year phenological studies are not enough to encompass all the plants growing in Cholistan desert.. At least 10-15 years should be devoted to include full range of plant phenological patterns in Cholistan.

INTRODUCTION

Cholistan desert is one of our major deserts that occupy 2.69 million hectares of land comprising nearly 67 percent of the total area of Bahawalpur r'ivision. Bahawalpur City itself is located at the northern fringe of the Cholistan and forms a transition between green agricultural land and desert. The said desert is located between 2r 42' and 29° 45' N latitudes and 69° 52' and 7J0 52' 30" N longitudes. Geologically Cholistan is divided into two distinct zones namely i) Greater Cholistan (70% of the total Cholistan area) on the South and ii) Lesser Cholistan (30% of the total Cholistan area) on the North of the old Hakra riverbed (Akram, 1993).

The climate of the area Is arlC,(sub - tropical continental, characterized by low sporadic rainfall, high temperature, low relative humidity, high rate of evaporation and high summer winds (Sukhera, et al., 1993). Although the rainfall Is uncertain and Irregular, varying from 125 to 250mm per annum (Muhammad Shaflq and Naslm, 1995), yet whenever there are good rains Chollstan turns Into a green rich grazing ground (Rao, et al., 1989).

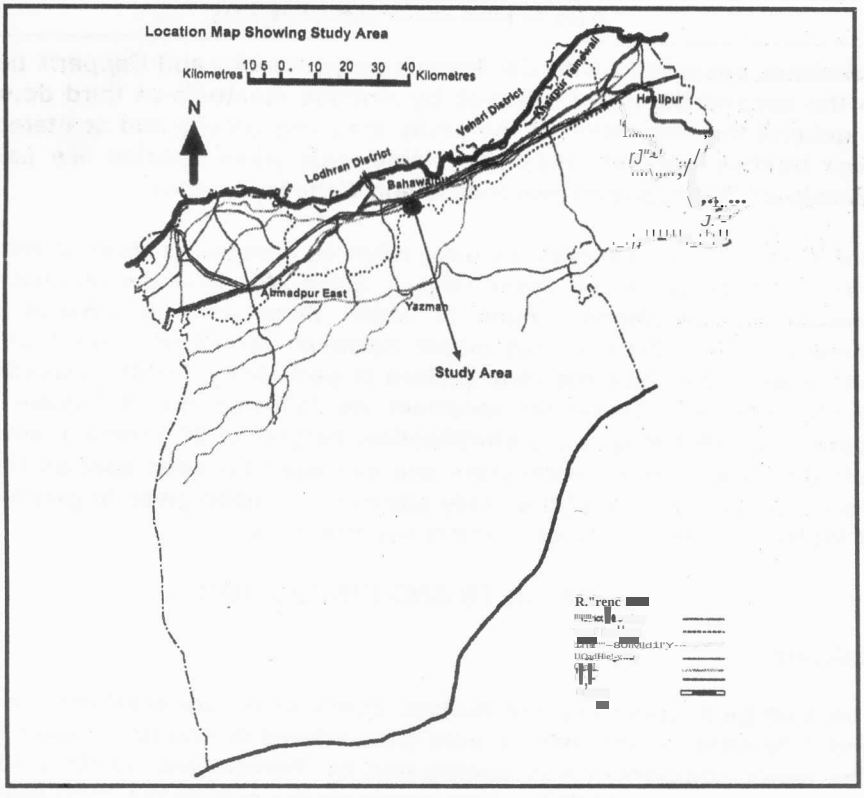
The vegetation of the said, area is of xeric type and true outcome of the habitats. Environmental conditions and exiting biotic influences. Variations in the environmental conditions may induce various responses in plants. These responses are expressed as variations in morphology, physiology and they may be represented by changes in adaptive value and stress induced partial and complete degradation (Pieter, et ai., 1989).

All these phenological changes in the plant species are resultant of inherent genetic characteristics of each ,species according to the prevailing environmental situations. The definite appearance of the community in different parts of the year is called aspect. Most communities have a definite aspect in different seasons of the year. The chief aspects in Cholistan desert are winter, summer, autumn or pre - monsoon, monsoon, and post - monsoon or spring. The vegetation of Cholistan shows very distinctive physiognomy during these aspects or seasons (Muhammad Shafiq and Nasim, 1995).

Life form is a physiognomic classification based on growth forms and habitat. Etherington (1975) named 10 growth forms, the physiognomy of which was believed to be essential for the study of plant communities. Similarly, Willems (1982) proposed 30 plant communities on the bases of physiognomy and floristic composition. By using the techniques of multivariate classification in a semi arid ecosystem 18 life forms has been defined by Zavalahurtado, et al., (199~).

Biological spectrum is an important tool used to compare plants and climate of the various parts of the world. This is done by comparing biological spectra with the normal spectrum of Raunkiaer (1934) and classifying the climate on the bases of life forms. Thus the spectra of life forms give a direct impression of the climatic peculiarities of a particular physio-geographic region.

We find virtually no spectral or phenological study belonging to Cholistan desert vegetation in the literature. This paper represents three years biological spectral and phenological studies in the selected habitats of Cholistan desert. Such studies are crucial to assess the vegetational pattern and type of prevailing ecosystem. More over physiognomic studies provide the solid base to determine analytical characteristics of a community and helps to the plant scientists for the selection of most suitable new species when they are to be introduced in the new habitats.



MATERIAL AND METHODS

The study sites were located 10Km away on the Southeastern side of Bahawalpur City which is the part of lesser Cholistan. Topographically the sites had got dunes, shifting sands, humps. sand sheets, clayey and sand valleys and few calcium carbonate nodules covered patches. In short the said area depicts all the characteristics of lesser Cholistan desert. Human activity in the study area had been enormous over a period of 3 years because of prevailed semi drought conditions. Livestock grazing and unchecked extraction of woody stems for fuel purpose had damaged the endemic vegetation to a great extent. Realizing the situation we selected three permanent 100 X 100 Sq. m. plots on the least disturbed locations. We also seek the help of local inhabitants not to disturb the study plots. The situation is much better now and the vegetation cover is about 50% enhanced at the study sites.

The study plots were marked about half kilometer apart from each other. Out of three, two plots were dominated by *CymQopogon jwarancusa* associated with *Arisfida mutabilis* and *Cenchrus ciliairis* species as the second and third dominants. The third plot was dominated by *Lasiurus*

scindicus, associated with *Calligonum polygonoides* and *Capparis decidua* as the second dominant followed by *Aristida mutabilis* as third dominant. In general the vegetation in the study area was patchy and scattered. The large bushes were strongly associated with grass species like *Lasiurus scindicus, Cymbopogon jwarancusa* and *Cenchrus ciliaris.*

The phenological observations were taken by wandering about in the study area for three years (i.e. from 1998 - 2000). We omit the months in the construction of phenerograms in which there were no change In the phenology from the previous month however described in the text where felt necessary to give the clear picture of periodicity. For the classification of life form and biological spectrum we followed the Raunkiaer (1934) system. In order to give the stratification, heights of 20 sample plants were actually measured in centimeters and averaged for each species found in the study area. A map of the study site has also been given to give the idea of location for the study sites and ready reference.

RESULTS AND DISCUSSION

Results

The biological spectrum and floristic composition are presented in Figs 1 and 2. Nineteen plant species were encountered durlng the present survey. The major component was contributed by *therophytes* (42.10%), followed by *Phanerophytes* (26.31%). *Hemicryptophytes* gained the third place with 21.05% contribution while the minimum 5.26% were of *Chamaephytes* and *Megaphanerophyte.*

With regard to the floristic composition 47.36% were shrubs and 31.57% grasses. 15.78% were herbaceous plants however, only the tree specie *Phoenix dactylifera* was found to be growing in the study area (5.26%).

Phenological observations in the forms of phenograms of all the life forms are given in the Table-1. It had been found that the climatic variations, especially the temperature and moisture availability were the major factors effecting the calendar of events in the life history of the plant species. Phenological observations for the individual plant species encountered during the present study are given below.

Cenchrus Ciliaris

D~rjng November this plant was in the state of dormancy, however few plants were observed having little green vegetative biomass. The state of dormancy continued to the middle of December then there was a mix'.ure of plants, i.e. some plants were in the state of dormancy while many plants began to germinate and were showing considerable amount of green v"!getative portion. At the beginning of January most plants were green and

flowering was initiated. The maturing of seeds was observed during March and June and after shedding seeds most of the plants were with little or no green biomass in October.

Tnble I • Phenogcams nf .egelalion atlhe sludy sites ill Choli.t.n de.ert (Three ye.rs sludy from 1998 - 2000)

~:	Plant species	Nll"emh:;-	Tl:~~::m'"h..;	J..."",r:'t.	r.:hnlar:"...	M#,,'h	Juno:	Scpt.-rt.	O•1ober
I	Ccnc}InIS cili:.lril' ~il\n.	O	10	O	O	~O	~y	O	O
2	Smloo,l fnll1cosa (LioUl.)Forsskal	O,-.P	O	O	O	O	O	O	O
3	.Tribulus longipclah:s viv.	U	O	O	I()	O	O	O	O
~	AriSiida. mUlabilis Trin. & Rupr.	O	O	0	10	O	10	O	O
S	Cymhopngon jW3l:mcusa (Jones) Schult.	O	O	O	O	O	\0	O	10
6	Cappuris decidua (Forsskal) Edgew.	10	Q	O	O	D	Q	Q	O
7	Halo~lon salicomicum (Moq.) Bunse	D	Q	Q	a	0	O	O	O
S	AelVa pereica (Bum", f.) Mellill.	O	Q	-0	D	D	a	O	O
9	Lepladenio pyrotechnica (Forsskal) Decoe.	10	10	Q	O	10	O	10	O
III	Dlpccl")'glum gtaucum Decoc:	10	O	O	O	O	O	J	D
tl	Crotulilria burhi::l Ham. c:< 8th.	lD	ro	?5	rD	10	10	O	O
12	Lasiurus scilwiiolS Honr.u'd	Q	10	U	10	10	O	(J	U
13	CORvoh·,lIus miaoph)'Uus Siel>.Ex. Spreng	0'	,O	ll-	O	10	O	ex	a
I~	CalliJlOl1um polysonoid •• UM	O	O	O	a	O	O	Q	Q
IS	SaccJwum bcnplenle Rett.	O	O	O	O	O	0'	lU	O
16	Ca\olzopls proccra (Aiton) Aiton f.	O	10	O	U	D	G	U	C
17	PhoenL~ dactylifera L.	O	O	0	O	10	U	0	C
18	Euphorbia proslr.Jla Ai\.	O	O	O	a	O	O	U	L
19	Ochlhochloa comp •.••• (Forsskal) Hitu	O	O	O	O	O	O	10	0

7X 2
6V 3
5 4

Legends

1 - germinating
2 - Vegetative.
3 - Flowering.
4 - Fruit formation.
5 - Seed maturation.
6 - Death/Dormant
7 - Green.
g - Less green.

Suaeda Fruticosa

In November few plants were observed with green vegetative biomass and flowers. The vegetative portion was less green and many plants were entering into the state of dormancy. Almost similar situation prevailed during December. However, January and February were the months of dormancy for this plant.. In March there was germination of old parenting buds and new plants begin to emerge from the seeds with lush green biomass. Few plants were observed with flowers. In June most plants of this specie were at the stage of seed dissemination while few plants were with only green vegetative biomass.

Tribulus Longipetalus

During November this plant was in the state of dormancy, however few plants were observed vegetative, less green biomass. December and January were of complete dormancy for this plant.. In the early days of February there was emergence of new plants however the seeds and full-grown green plants were observed during March. Flowing was started in September while maturing and shedding of seeds occurred during the October.

Aristida Mutabilis

In November three states of the life cycle for this plant could be observed Le., some plants were with little and less green biomass, some plants had passed their seed dissemination stage and still others were entering into dormant stage or became dead. From December to March most of the plants were pale and dry. In June germination was started and large patches of green biomass could be seen. This plant remained vegetative during June and flowering occurred during September. In October mature seeds were observed in the flowers.

Cymbopogon Jwarancusa

This specie was green, vegetative and flowering during November. In December most of the plants had matured seeds and shedding of seeds was achieved up to the middle of December. January was dormant for this plant.. During February the plant began to determinate and some plants were with large amount of green biomass. From March onward up to June the plant remained vegetative and green. In September the plants were vegetative, less green to green and flower buds began to appear on some plants. In October most plants were blossoming and reproductive cycle was completed up to December.

Capparis Decidua

This plant specie belongs to evergreen type of species i.e., when riot in the reproductive stage, it remains vegetative and green. November, December and then September and October were recorded as the most important months of the year for this plant (i.e. reproductive cycle was completed during these months). Thus this plant is biannual.

Haloxylon Salicornicum

During November the plants of this specie were less green to green with mature *fruits* and seeds. During December the position almost remained the same however, during January the phenology changed and along with fresh germinating shoots very few plants were left with flowers. In the rest of the months of the year the plants remained vegetative and less green to green.

Avera Percica

Few plants of this specie were found to be growing in the study area. The plants were in the state of dormant or dead during November. In December the plants began to become green and up to the end of this month some plants were seen with flowers and even with fruits. During January extreme cold hampered the *fruit* formation but in February and March all states of life cycle could be observed in this species i.e. right from stage of germination to seed maturation. During the months of June, September and October this plant was seen either dead or with sonic less-green vegetative biomass and empty dry fruits.

Phoenix Dactylifera

Very few trees of *Phoenix dactylifera* were found to be growing in the study area. Flowering was observed only in February. Otherwise the plant remained vegetative. Vegetative germination of offspring's was observed almost through out the study months except in November and December. When the plant leaves were relatively less green dry compound leaves were also observed in the lower ring.

Euphorbia Prostrata

It is a herbaceous species found through out the year wherever there is little water and sandy loam. During November this plant was vegetative, germinating or flowering. Mature seeds were found during December and January however, flowers continued to develop. From February to March the process of seed maturation and dissemination of seeds were completed. In June it was found dead and dry. In September to October this

plant was again less green to green and vegetative.

Ochthochloa Compresso

This plant was found vegetative and green during November and December. In January the flowering initiated and seed maturation was verified during March. Flowering and fruit formation continued to occur up to October. However, green biomass was reduced in many plants, otherwise vegetative and green plants were found to the end of February.

Crotalaria Burhia

Crotelaria burhia is usually found on the interdunal sandy *flats* in Cholistan desert. It is perennial and completes its reproductive cycle from March to October. Depending upon the availability of moisture flowering and resprouting started during the early days of March.

Fig - 1 Biological spectrum for the flora found at the study sites

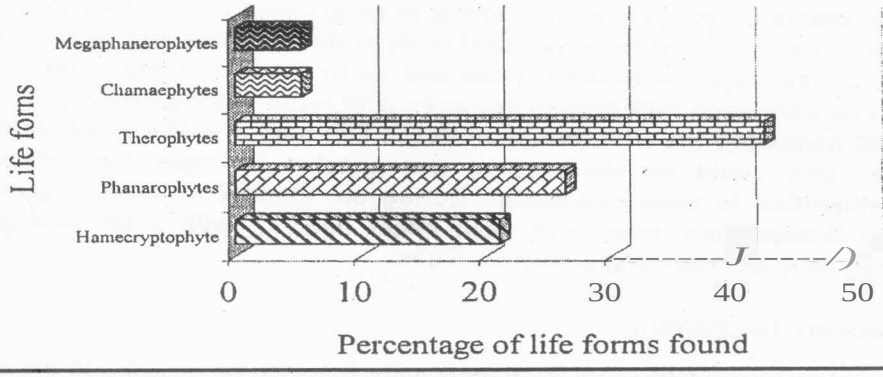
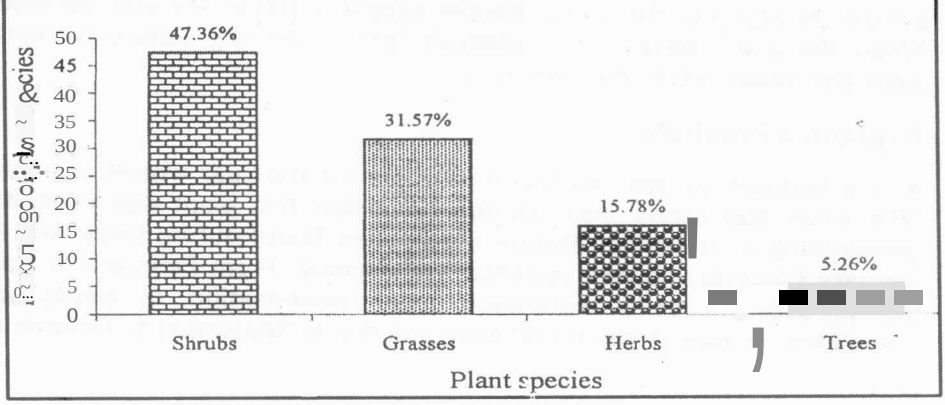


Fig - 2 Proportion of various plant species found in the study area



Pollination in usually completed up to May and maturation of seeds is achieved in June. Dissemination of seeds may prolonged up to October. The plant remained pale and vegetates during the other months of the year.

Lasiurus Sciendicus

It is an important fodder plant and contributes a major portion of vegetation of Cholistan desert. It's flowering starts during November and reproductive phase is completed to the end of December. It is a perennial grass and remains vegetative during most of the month of the year i.e. from March to November and remains dormant during January and February.

Convolvulus Microphyllus

It is a biannual herb, that becomes green and flower during the month of September and then in December. Seed shedding and germination starts during the same months. The months from March to June are the peak reproductive season and plant completes its reproductive cycle during the same period. In September and October this plant shows re germination of last year shoots however germination of new plants from seeds were also observed.

Laptadenia Pyrotechnica

From November to January the plants were green, vegetative and flowing. (Please see the phenograms of this plant). During February and March there were stages of fruit formation and seed maturation but during June some plants were again observed with fresh flowers. Which were converted to mature fruits in September. October was vegetative and dormant for this plant.

Dipterygium Glaucum

The flowering and seed maturation were achieved during the month of October and November while germination starts during December. In January reproductive cycle was completed and plant remain either vegetative with less green to green biomass or dormant during the rest of the year.

STRATIFICATION

The vertical dispositions of plant parts are given in Fig. 1. The stratification and profile structure are described according to the height of various plant species during the present survey.

The lower most stories of vegetation strata was formed by either prostrate

plants or by the species that w..erewith green biomass up to the height of 15cm from the ground level (i. e. Euphorbia prostrata Tribulus longipetalus and convolvulus microphyllus). The plants that attained the height up to 40cm formed the second story of the vegetation. Species li~e *Cenchrus ciliaris, Aerva percica, Suaeda fruticosa* and *Cymbopogon jWlll'ancusa* were included at the third story. The later species may got up to the height of 90 cm.

The fourth story of the strata was occupied by those plants which had the height up to 150 cm. while the fifth story was categorized by the th~e plants which attained the height up to 250cm such as *Leptadenia pyrotechnica* and *Calligonum polygc)noides.*

Capparis decidua and *Saccharum bengalense* usually grow up to the height of 400 to 500 cm and were included in the sixth story. *Phoenix dactylifere* was the only tree species found at the study site and formed the top most story of the vegetation (Fig-3).

DISCUSSION

Each plant stand has its own characteristic out look by virtue of dominating life form. Biological spectrum manifests the size, structure and stratification of the vegetation types. Raumkiaer (1934) recognized the importance of life forms in plants and classified them according to their ability to survive unfavorable season. In our case species like *Suaeda fruticosa, Capparis decidua, and Haloxylon salicornicum* were *phameophytes* having aerial parenting buds. These were susceptible to drastic climatic changes and cuttings of vegetative portions particularly at the ground level. *Therophytes* that comprised the largest portion bt vegetation (42.10%)are characteristic of arid regions and complete their life cycle within the growing season. Their life cycle is mostly confined to the rainy season and must pass through a number of phases in the life cycle from seed of one generation to that of next during this period. These plants provide good intermittent fodder during the early vegetative growth. Shrubs like *Crotalaria burhia. Dipterygium glaucum* and the herbs like *Convolvulus microphyllus* and *Euphorbia prostratea* are included in this class.

All the perennial species especially the grasses such as *Cymbopogon jwarancusa, Cenchrus ciliaris* were *hemicryptophytes.* They have the parenting parts (buds) in or just below the soil surface (Vogi 1974),this is why they can with stand the high grazing pressure (Muhammad Shafiq and Javeed, 1999). The *hemicryptophytes* has the same life cycle phases, as that of *therophytes* main difference is that *hemicryptophytes* do not over-winter in the seed phase but remain vegetative and dormant while *therophytes* do not.

Our study shows that the on set and duration of growth and flowering are correlated with the timing and abundance of precipitation. Where as varieties in total rain does not affect the on set of flowering in *phanerophytes* but *therophytes* are affected. Late rains usually delays the onset of all phenological phases in all life forms. Peak growth occurs from January to March and flowering from August to December depending on rain. *Phanerophytes* are least affected in their growth *phenophases with* less rain. Flowing in *phanerophytes* occur from 3 to 4 weeks *after* rain while in *therophytes* from 2 to 6 weeks after rain similar results had also been reported by Ghazanfar(1997).

Infact in the arid regions like that of Cholistan desert annual alteration between a cool moist winter and a hot dry summer has had a profound effect on the annual growth cycles of plant species and majority of species show corresponding alternation of active and dormant phases which were synchronized with the seasonal climatic changes. Under such conditions there is problem of surviving during a period of water stress. Plant Species are in active growth phase during the rainy period and enter a phase of dormancy/dead during the summer.

The transition from vegetative to the reproductive phase involves profound changes in the structure and physiology of the plant. In the vegetative phase they grow by the activity of the apical meristems of shoot and the root, new tissues are being added to the existing tissue so that the pattern of growth is accretionary. Moreover, there meristems are potentially capable of unlimited growth, provided conditions remain favorable, the shoot and the root are said to show an indeterminate pattern of growth. However, transttion from the vegetative to t~e reproductive phase involves a radical change in the organization and behaviour of one or more shoot apical meristems from a structure which is actively producing leaf and stem-primordia to one which produces flower primordia and at the same time thus terminating the capacity for unlimited growth.

In a plant community where a number of species with different life forms are associated together, they mitigate the competition and climatic adversities though adjustment in height and spread of the above ground and underground plant parts. In the present study we recognize seven different strata depending upon the height of the plants. In deserts the main limits to plant growth are scarcity of water and mineral nutrients. Therefore, the adaptation of plants is more on the bases of nutrient availability rather than to light. The plants with different rooting pattern and depth many associate with each other since their roots are distributed in the soil in such a way that they do not come in competition for nutrients. Thus stratification in sandy deserts is governed by the heterogeneity in soil physicochemical characteristics along with climatic regimes.

CONCLUSION

It is concluded that the sequence of flowering for the majority of species is more or less constant despite differences in the timing and amount of rain. Soil structure, chemistry and topography playa key role in the distribution of plant species arid stratification. Ongoing drought has immense detrimental effects on the vegetation cover and phenological cycles of individual plant specie. An assessment of climatic variability for the area suggests that at least 10 years of study would be required to encompass the full range of plant phenological patterns in the·Cholistan desert.

BIBLIOGRAPHY

Akram. M. 1993. Rehabilitation of Cholistan desert lands for sustainable production, Proceedings of the sixth all Pakistan geographical conference, 26 - 29 December 1993, Department of Geography, Islamia University, Bahawalpur. pp. 55 - 61.

Etherington, J. R. 1975. Environment and Plant Ecology. John Wiley, New York.

Ghazanfar, S. A. 1997. The phenology of desert plants - A 3-year study in Graval desert Wadi in Northern Oman. Journal of Arid Environments 35(3): 407- 417.

Muhammad Shafiq Chaudhry and Faiz-ul-Hassan Nasim. (1995). Combating Desertification in Cholistan Desert. S & T in the Islamic World, Vol. 13 No.2, April-June.

Muhammad Shafiq Chaudhry and Javeed Iqbal (1999). Chemical Investigations of some fodder Plants from Cholistan Desert, Pakistan. Acta Sci, 9(1): 153-164.

Pieter, J. C., K. Dean and Jacquebline Schuit. 1989. Root functioning under stress conditions: An introduction. B. C. Loughman, et al., (Ed), In structural and functional aspects, of transport in roots, PP. 209 - 213.

Rao, A., M. Arshad and M. Shafiq. 1989. "Perennial grass germplasm of Cholistan desert and its Phytosociology". Published by CHIDS, Islamia University, Bahawalpur,

Raunkier, C. 1934. The life forms of plants and statistical plant geography. Charendon Press, Oxford.

Sukhara, M. B., M. A. Khan and S. M. Nasir. 1993. Wind statistics of Cholistan, with special reference to energy, Sci. Int. (Lahore), 5(4): 319 - 320.

Vogl, R. L. 1974. Effect of fire on grasslands. pp. 139 - 194. In T.T. Kozlowski and C. E. Ahlren. Fire and Ecosystems. Academic Press, New York.

Willems, J. H. 1982. Phytosociological and geographical survey of Mesobromion communities in Western Europe. Vegetato, 48: 227- 240.

Zavalahurtado, J. A., P. L. Valverde, A. Diazdolis, F. Vite and E. Portilla. 1996. Vegetation - Environment relationship based on a life - forms classification in a semiarid region of tropical Mexico, Revista de Biologia Tropical. 44(2A): 581 - 590.

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 29-39

RAPID POPULATION GROWTH: A CAUSE OF INCREASING POVERTY IN PAKISTAN

Muhammad Hafeez
Department of Sociology, University of the Punjab
Quaid-e-Azam Campus, Lahore. 54590

ABSTRACT

Poverty in Pakistan is a complex phenomenon as it involves social, cultural, economic and resource constraint factors. Access to markets, low productivity and low literacy levels are also linked with poverty. Another important factor of poverty in Pakistan is said to be the high rate of population growth. The relationship between poverty and the rate of population growth is complex. Simple economic arguments would suggest that high population growth aggravates poverty. For example, population growth holds down returns to labour relative to capital and other factors of production. As a result, it depresses wages and worsens income distribution. Rapid population growth swells the traditional and informal labour force and delays the time which modern sector capital expansion exhausts the supply subsistence-level workers. These pieces of theory are deficient and the link between poverty and population growth is not a clear one. Nevertheless, while acknowledging the complexity, it is likely that most social scientists would accept that there is connection between population growth and poverty.

Poverty and inequality in Pakistan are reported to have increased in recent years. The increase in poverty is generally linked with a slowing of economic growth in the country's economy. According to Pakistan Economic Survey, the value of Ginni Coefficient increased from 0.346 in 1986-87 to 0.400 in 1996-97 showing a significant hike in inequality and poverty. The Survey showed that the major increase in poverty occurred during 1987-88 to 1990-91, a short period of about three years. This line of argumentation attributed poverty to skewed distribution of resources and to a 'slowdown in economic growth. Although these explanations are plausible but economic determinism and resource distribution issues explicate part of the story.

BACKGROUND

Poverty and Inequality In Pakistan are reported to have Increased In re years (MHDC 1997). Due to the growing visibility of poverty anc projection In the country, recent polley attention towards Its allevlatlol1 been noted and welcomed (Gazdar 1999). The Increase In poverty Is II with a slowing of growth In the country. Various summary measure! used to show Income inequalities. The Gini coefficient is the most pO statistical indicator of Inequality (Government of Pakistan 1994). The coefficient varies from zero (complete equality) to one (com Inequality), so that the more unequal the income distribution, the highe Ginl coefficient. . It is an aggregate measure of inequality. Table 1 st Gini coefficients of the household income distribution in Pakistan 1986-87 to 1996-97. The data clearly show that Inequality has been gro since the mid-1980s, the Gini coefficient increasing from 0.346 in 1986- 0.400 ten years later. The major increase in poverty occurred between' 88 and 1990-91.

Table-1: Household Income Distribution in Pakistan

Year	Household Gini Co-efficient
1970-71	0.330
1971-72	0.345
1979	0.373
1984-85	0.369
1985-86	0.355
1986-87	0.346
1987-88	0.348
1990-91	0.407
1992-93	0.410
1993-94	0.400
1996-97	0.400

Source: Government of Pakistan 2000

According to the 1997 Human Development Report for South Asic disparity between economic growth and social development is grea Pakistan than in most other countries (MHDC 1997). For example, rei capita income (in terms of purchasing price parity dollars) in Pakisl about 75 percent greater than in India, but Pakistan lags behind Ind most social indicators, including literacy and mortality (MHDC 1997). 2 shows a summary of key indicators for nations in the region an developing countries overall. Similarly, with the exception 9f countries like Sri Lanka and the Maldives, Pakistan's GNP and GDI capita are the highest in the region, but it has the worst under-five

BACKGROUND

Poverty and inequality in Pakistan are reported to have increased in recent years (MHDC 1997). Due to the growing visibility of poverty and its projection in the country, recent polley attention towards its alleviation has been noted and welcomed (Gazdar 1999). The increase in poverty is linked with a slowing of growth in the country. Various summary measures are used to show income inequalities. The Gini coefficient is the most popular statistical Indicator of Inequality (Government of Pakistan 1994). The Glnl coefficient varies from zero (complete equality) to one (complete inequality), so that the more unequal the income distribution, the higher the Glnl coefficient.. It Is an aggregate measure of Inequality. Table 1 shows Glnl coefficients of the household Income distribution in Pakistan from 1986-87 to 1996-97. The data clearly show that Inequality has been growing since the mid-1980s, the Ginl coefficient increasing from 0.346 In 1986-87 to 0.400 ten years later. The major increase in poverty occurred between 1987-88 and 1990-91.

Table-1: Household Income Distribution in Pakistan

Year	Household Gini Co-efficient
1970-71	0.330
1971-72	0.345
1979	0.373
1984-85	0.369
1985-86	0.355
1986-87	0.346
1987-88	0.348
1990-91	0.407
1992-93	0.410
1993-94	0.400
1996-97	0.400

Source: Government of Pakistan 2000

According to the 1997 Human Development Report for South Asia, the disparity between economic growth and social development is greater in Pakistan than in most other countries (MHDC 1997). For example, real per capita income (in terms of purchasing price parity dollars) in Pakistan Is about 75 percent greater than in India, but Pakistan lags behind India on most social indicators, including literacy and mortality (MHDC 1997). Table 2 shows a summary of key indicators for nations in the region and the developing countries overall. Similarly, with the exception 9f small countries like Sri Lanka and the Maldives, Pakistan's GNP and GDP per capita are the highest in the region, but it has the worst under-five

-2: Comparative Socio-Economic Profile of Pakistan in South Asia

	India	Pakistan	Bangladesh	Nepal	Sri Lanka	South Asia (Wtd Avg)	Developing Countries
lation illions) 1998	987	153[a]	128	24	19	1313[b]	4799
al population th rate 1995-00(%)	1.8	2.7	2.2	2.5	1.2	2.0	1.8
per capita (US$)	130	130	80	90	230	126	880
	370	500	360	220	800	393	1250
GDP PC-PPP $[c]	617	820	621	584	1389	648	790
	1422	2209	1382	1145	3408	1531	3068
me poverty (head lt Index)	25	34	48	NA	22	28	NA
expectancy at birth	62	63	58	57	72	62	62
ı	62	64	58	57	74	62	64
ale ulatlon with access lealth services (%)	85	55	45	NA	93	78	80
i ulation per doctor)	2694	3500	8424	30062	7172	3875	NA
J	2459	1923	12884	13634	6843	3684	5767
nt mortality/l000 births 1997	71	95	81	75	17	75	65
ths aged 1-4 per 0 surviving at exact 1 1997(.q,)	40	45	31	30	2	38	33.2
,pie with disabilities ⅞ of total population 2	0.2	4.9	0.8	3.0	0.4	0.83	2.6
erate adults as % of ll adult population 15	48	62	62	72	10	51	29
:>lic expenditure on Jcation as % of GNP)5	3.5	2.7	2.3	2.9	3.1	3.5	3.6
blic expenditure on 31th as % of GDP ~7	0.7	0.8	1.2	1.2	1.4	0.8	2.0

ree: MHDC 1999

!s:

ulation figures for 1990, 1995, and 2000 are taken from UN: Age and Sex Distribution of ulation: The 1994 revision.

dium variant). The population growth rate has been calculated by using the formula {[(new le/old value)lll1nj-l)*100.

According to the 1998 Census of Pakistan, the total population of the country is 131 ion with an annual growth rate of 2.6percent.

The South Asian figures include Bhutan and the Maldives.

The real GDP per capita in Purchasing Price Parity dollars.

Data not available

Table-2: Comparative Socio-Economic Profile of Pakistan in South Asia

	India	Pakistan	Bangladesh	Nepal	Sri Lanka	South Asia (Wtd Avg)	Developing Countries
Population (in millions) 1998	987	153[a]	128	24	19	1313[b]	4799
Annual population growth rate 1995-00(%)	1.8	2.7	2.2	2.5	1.2	2.0	1.8
GNP per capita (US$)							
1973	130	130	80	90	230	126	880
1996	370	500	360	220	800	393	1250
Real GDP PC.PPP $C							
1960	617	820	621	584	1389	648	790
1995	1422	2209	1382	1145	3408	1531	3068
Income poverty (head count Index)							
1993	25	34	48	NA	22	28	NA
Life expectancy at birth 1997							
Male	62	63	58	57	72	62	62
Female	62	64	58	57	74	62	64
Population with access to health services (%) 1995	85	55	45	NA	93	78	80
Population per doctor							
1980	2694	3500	8424	30062	7172	3875	NA
1993	2459	1923	12884	13634	6843	3684	5767
Infant mortallty/1000 live births 1997	71	95	81	75	17	75	65
Deaths aged 1-4 per 1000 surviving at exact age 1 1997 (.q,)	40	45	31	30	2	38	33.2
People with disabilities as % of total population 1992	0.2	4.9	0.8	3.0	0.4	0.83	2.6
Illiterate adults as % of total adult population 1995	48	62	62	72	10	51	29
Public expenditure on education as % of GNP 1995	3.5	2.7	2.3	2.9	3.1	3.5	3.6
Public expenditure on health as % of GDP 1997	0.7	0.8	1.2	1.2	1.4	0.8	2.0

Source: MHDC 1999

Notes:

Population figures for 1990, 1995, and 2000 are taken from UN: Age and Sex Distribution of population: The 1994 revision.

(Medium variant). The population growth rate has been calculated by using the formula {[(new value/old value)^1/nj-1}*100.

a According to the 1998 Census of Pakistan, the total population of the country is 131 million with an annual growth rate of 2.6percent.

b The South Asian figures include Bhutan and the Maldives.

c The real GDP per capita in Purchasing Price Parity dollars.

NA Data not available

mortality, 136 deaths per thousand live births. Reported under-five mortality from the 1996-97 Pakistan Fertility and Family Planning Survey (PFFPS)(Hakim et al. 1998) is below the MHDC figure, but still higher than in other regional countries, as is mortality among children aged 1-4 years. In Pakistan, 41 children aged 1-4 years die per thousand live births, which is the highest rate in South Asia. Pakistan's proportion of illiterate adults is equalled by Bangladesh and surpassed only by Nepal. In short, Pakistan is a classic example of economic growth without commensurate social development. In other words, there is a disproportionate share of poverty in Pakistan than that in its neighbouring countries.

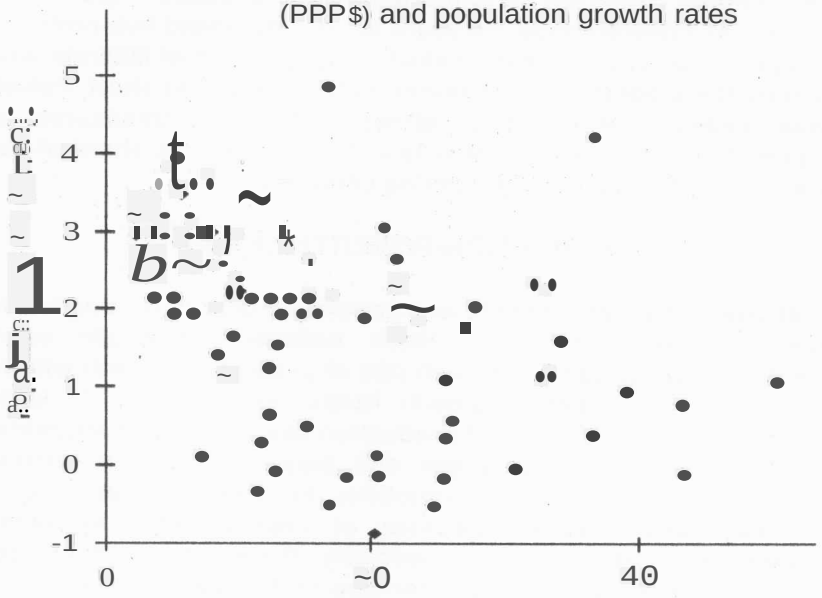
POPULATION-POVERTY NEXUS

The relationship between poverty and population growth is complex, not an obvious one, as it is many times believed. Simplistic economic argumentation will suggest that high rate of population growth will worsen poverty as rapid population growth keeps down returns to labour in comparison to various factors of production like capital and infrastructure. Such relationships depress wages and aggravate income distribution. However, the relationship is too simplistic. For example, rapid population growth may have resulted because of improvements in sanitation, vaccination, and national health; secondly, the economy of the country may grow at a rapid pace without attending to the need of equity in income distribution; or political disorder, chaos, or rampant corruption in a country may significantly contribute to poverty while population growth may actually be slow. These perplexities show that the relationship between poverty and population growth is complex and inconclusive.

Nevertheless, while conceding complex nexus between poverty and fertility, the most population researchers seem to acknowledge a connection between population growth and poverty (McNicoll 1995). Lowering fertility is most likely to help alleviate poverty, at least partly and in the short term, in most poor countries including Pakistan. The reverse relationship of reduction in poverty will result in lowering fertility is also widely accepted. In other words, population growth and poverty alleviation appears to be mutually reinforcing, if not linked in a clear causal direction.

A usual and common sense empirical evidence shown usually by scatter plots of countries on axes representing population growth rates versus per capita GNP is not persuasive (Weeks 1992, McNicoll 1995). Figure 1 below is a typical example of such a relationship. The association is complex and confusing but certainly show that high population growth countries are nearly all poor. In addition to fertility, mortality and migration rates also confuse this picture and multivariate analyses are not very helpful to clarify the association between poverty and population growth (McNicoll 1999).

Figure-1: Scatter plot showing relative NP per capita (PPP$) and population growth rates



Source: McNIcoll1999

However, a hazy and Inconclusive cross-sectional evidence of the linkage should not be thrown away due to the complexity of the relationship, rather, efforts should be continued to untangle the nexus between poverty and population growth. As McNicoll puts it •• complexity does not imply inconsequence" (McNicoll 1999).

There are three possible ways through which poverty can be explained in relation to environment and social settings. Firstly, a direct relationship with population growth and economy is widely reported. Secondly, rapid population growth has negative effect on the environment, resulting into increasing poverty. Thirdly, population growth can have a significant Influence on social instability and disorganization having a great potential of worsening poverty (McNicoll 1999).

The focus of this paper is the third link that suggests that demographic forces can undermine the social order leading to state failure and consequential negative impact on distribution of economic resources. Political disorder and consequent erosion of social capital can disrupt economic activity. In Pakistan, social disorder persisted for a long enough time leaving a harmful effect on institutional and material base of production and distribution. The civil strife and resulting degeneration of state capacity has resulted into drastic economic deterioration In the

country. Such a scenario has caused widespread poverty in Pakistan. The inverse argument that poverty causes civil unrest may also be forwarded but this line of thinking is less likely to get support. However, it may also be noted that social conflict does not always lead to impoverishment. For example, the social conflict may be transitory and does not affect economic relations negatively. In Pakistan's case, however, the social disruption had persisted for a long time leaving a severe damage to national economy and Institutional structure. It Is evident from the fact that Pakistan's economy grew by almost double the rate In the 1980s than In the 1990s (see Table 3) and has contributed towards Increase in poverty.

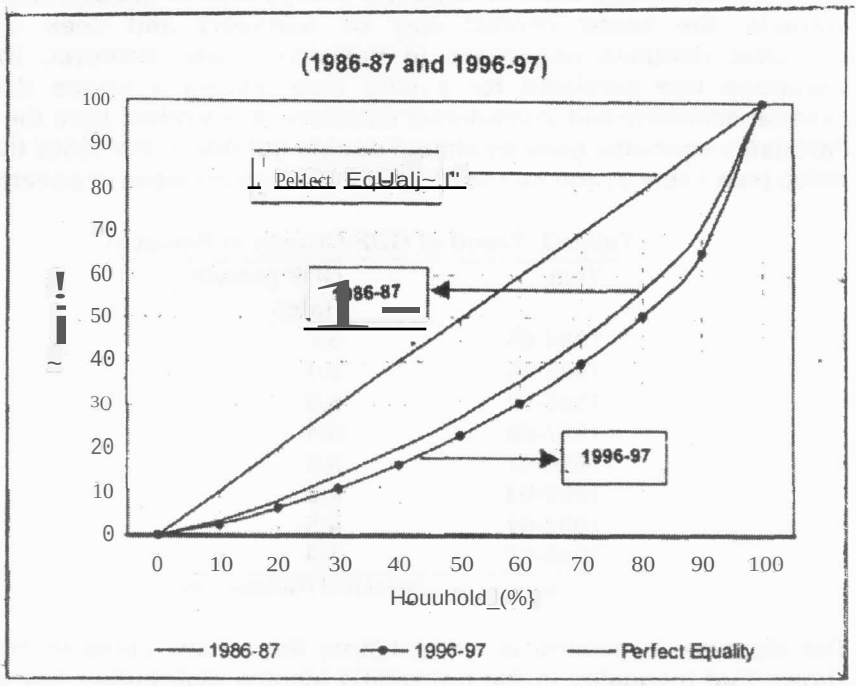
Table-3: Trend of GDP Growth In Pakistan

Year	GDP growth Rates
1984-85	8.7
1985-86	6.4
1986-87	5.8
1987-88	6.4
1990-91	5.6
1992-93	2.3
1993-94	4.5
1996-97	1.9

Source: Government of Pakistan 2000

The increase in poverty is evident from the Lorenz curve in Figure 2. It shows that inequality in the household income distribution has increased over the last few years and this is mainly due to resource distribution problems located in social disorder, institutional degradation and widespread corruption. It is also evident from the Lorenz curve that inequality has increased significantly since 1986-87.

Figure-2: Lorenz Curve showing changing household income inequality between 1986-87and 1996-97



Source: Government of Pakistan 2000

The above discussion indicates that rapid population growth has contributed to poverty in many situations. It may be through changes in distribution of economic resources or through indirect means involving changes in social and environment conditions. However, no solid conclusions can be made on the basis of the above said linkages and arguments. Since the outcome of increased poverty depends upon the specific settings within which social disorganization has contributed towards inequality, therefore situational factors may attract close analysis.

At micro level, demographic behaviours of individuals and families is not likely to appreciably explain the population-poverty nexus because the macro-economic forces are outside the control of individuals and families. In other words, economic opportunities are dependent upon macro-economic conditions that being the domain of individuals and families are shaped by the material and social environment. It implies that individuals and families themselves are not responsible for their demographic behaviour.

DYNAMICS OF FAMILY ON FERTILITY AND POVERTY

The dynamics of intra-family transmission of poverty suggest that parents expect several benefits from having many children. These benefits include income, care of younger siblings (possibly at some cost to their own future economic prospects), dowry, developing kinship networks through marriage, and the provision of support and protection to parents in old age. In this context, Caldwell (1978) has found that the net flow of wealth is from children to parents. The empirical evidence, however, does not support this relationship (Lee 1997). Similarly, there are counter-arguments to show that there are no substantial net benefits of wealth to parents from children (Kaplan 1994). In Pakistani set up, the Caldwellian theory seems to apply and average Pakistanis like to have as many children as possible because they expect that anyone or more of their children may attain high socio-economic status and render subsequent benefits to their families and parents.

It may be noted however, when development proceeds, the economic disadvantage of higher number of children becomes evident because the parents start recognizing the need to invest in their children's education and training. They begin believing in quality of children rather than the quantity. Here again, the evidence is weak because the impact of family size on education is not conclusive (Kelly 1994:57).

It may also be noted that in some cases, ill-health of families may be an outcome of large family sizes due to early childbearing, closely spaced pregnancies, or through unwanted births. Among poor families, these ill-effects pose a more serious problem due to low education, lack of access to health care, and predominating negative attitudes towards birth control. Low birth weight of children and stunting are some of the poor health outcomes of poverty among low class families, and result in perpetuating poverty from one generation to another. Low human capital may be continued within a family or social group through poor parenting practices, economic insecurity, and culture of poverty. As fertility rises, the chances of children raised in poor and disadvantaged circumstances increase significantly.

In Pakistan, parental resources like agriculture land, pastures, water ponds, etc. are distributed among their children. If the number of children is large, such inherited resources do not sustain new and large families in the making. With overuse, the productivity of these resources declines leaving an immediate impact especially on the poor. It suggests that the connection between population growth and poverty is quite evident. Ever increasing reservoir of informal child labour is the logical result. Starting from very early ages, rural children start participating in activities like carrying water, gathering fuel, caring of the live stock, and help in other farming opertions. In urban areas on the other hand, for petty amounts, the parents are forced to send their children to work contributing to ever

growing pool of child labour. This results in degradation of human capital and results in a vicious cycle of poverty that can be linked to population growth. Secondly, population growth leaves a damaging impact on the environment and maims its capacity to sustain the growing population.

Tradition and culture provide a way of life to people. They keep doing things or behaving in certain ways without even any disregard for those behaviours as they are ingrained in tt:'eir minds for generations. The intermingled customs can create a social milieu that perpetuates high fertility and poverty. Dasgupta (1993) points out that if a large family size is a norm, the people of that society will not like to break that norm unilaterally. In such a situation, customary normative structures are difficult to break as societies can get stuck to their structures for which society may have a collective rationale in the past but not now. Such social and cultural structures provide social equilibrium that is usually rigid and people are hesitant to go against it. In a similar context, Caldwell (1997:803) said: "economists will have to learn to be more sociologically sophisticated, taking into account the fact that most families are constrained to make choices similar to those of other families in the society". People of a given society are part of a coherent belief system that is usually resistant to change. And people keep following those norms without giving much thought to their costs and benefits.

CONCLUSIONS

It is by no means certain that population growth is holding back economic development in Pakistan, but the suspicion is certainly there. The government of Pakistan has the same attitude towards population and development. Accordingly, the government is attempting to provide reproductive services to ao::;many people as possible. The fertility is reported to have declined during the recent years but even with a rapid decline in birth rate, Pakistan's population is not likely to stop growing into the near distant future. The economy of Pakistan may continue to face pressures from growing population in the country.

In this paper, an attempt has been made to show the mechanisms through which population growth can influence poverty-related outcomes. An effort was made to make a distinction between the direct impact of popUlation growth on poverty and the influences through social order and governance. In general, the emphasis has been on social instability and the distribution of economic resources. It is the social order and stability with which Pakistani policy has to deal with. The best way to deal with population and poverty issues is to work on institution building and attaining social stability. The stability and persistence in policy implementation shall be the key to the success of governmental interventions. Custom made policies according to the needs of particular circumstances in view of the local administrative capacities can transform

local perceptions about government programs and can assure success to policy interventions.

REFERENCES

Arif, GM (2001). Profile of poverty in Pakistan. Islamabad: Pakistan Institute of Development Economics

Caldwell, J. (1978). A theory of fertility: from high plateau to destabilization. Population Development Review 4: 553-577.

Caldwell, J. (1997). The global fertility transition: the need for a unifying theory. Population and Development Review 23(4): 803-812.

Dasgupta, P. (1993). *An inquiry into well-being and destitution.* Oxford: Clarendon Press.

Gazdar, H. (1999). Poverty in Pakistan: a review. In S. R. Khan (Ed.), *50 years of Pakistan's economy* (pp. 241-326). Karachi: Oxford University.

Government of Pakistan (1994). National Report on Population of Pakistan for International Conference on Population and Development, Cairo. Islamabad: Ministry of Population Welfare.

Government of Pakistan (2000). *Economic Survey 1999-2000.* Islamabad: Finance Division, Economic Adviser's Wing.

Hakim, A. et at (1998). Pakistan fertility and family planning survey (PFFPS) 1996-97. Islamabad: National Institute of Population Studies.

Kaplan, H. (1994). Evolutionary and wealth flows theories of fertility: empirical tests and new models. Population Development Review 20: 753-791.

Kelly, A. C. (1994). Population growth and education. In A. A. Dennis et al. (Ed.), *Population and economic development: A report to the Government of the Commonwealth of Australia,* Canberra.

Lee, R. D. (1997). A cross cultural perspective on intergenerational transfers and the economic life cycle. In A. Mason (Ed.), *Intergenerational economic relations and demographic change,* New York: Oxford University Press.

McNicoll, G. (1995). On population growth and revisionism. Population and Development Review 21(2): 307-340.

McNlcoll, G. (1999). Population and poverty: the policy Issue. Canberra: The Australian National University.

MHDC (1997). *Human development in South Asia* 1997. Karachi: The Mahbub ul Haq Human Development Centre.

MHDC (1999). Human development in South Asia 1999. Islamabad: The Mahbub ul Huq Human Development Centre.

Qureshi, M. L., Ed. (1959). Population growth and economic development with special reference to Pakistan. Karachi: The Institute of Development Economics.

UNFPA (2001). Rapid growth: a cause of poverty in Pakistan. PopUlation Headliners.

Weeks, J. R. (1992). *PopUlation:* an *introduction* to *concepts* & *issues.* California: Wordsworth Publishing Company.

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 41-55

ROLE OF GIS AND REMOTE SENSING AS TOOLS FOR FLOOD HAZARD MANAGEMENT IN PAKISTAN: A CASE STUDY OF SUB-DIVISION JHELUM

FALAK NAWAZ
Department of Geography, Urban and Regional Planning,
University of Peshawar, Peshawar

ABSTRACT

This study focuses on *the application of modern techniques like Geographical Information System (GIS) and Remote Sensing (RS) for the management of flood hazard. Whenever any area in Pakistan becomes flooded, the main and first solving problem for the civil authorities is* to *find out the area and number of flood affectees, which have been affected. The flood of 1992, 1995 and* 1997 *are such* an *example that civil authorities always feel hesitation to'show the exact areas and affectees affected by the flooding. The collection of such information in the field take* a *long time and the affectees complain the civil authorities for the delay of relief. There is also one possibility that the data collected in hurry may not be* so *authentic or reliable,* as *it is always seen from the post flood relief activities in Pakistan, that affectees normally do not satisfied with the relief disbursement. Now with the introduction of GIS and RS techniques, these problems can be solved very accurately and quickly.*

For this reason an *attempt has been made* to *apply GIS and RS* as *techniques* on *Sub-Division Jhelum* on *regional scale* as a *case study. The reason for the selection of this area was, first the area was severely affected by the flood of* 1992, 1995 *and 1997 and second the availability of Landsat image* on *30*30 meter resolution taken during* 1998, *which has been used* as a *basic tool. Side by side field observations and data has been collected* to *verify the extent of flooding during* 1992, 1995 *and 1997 flooding. The resultant maps and tables show the area, which was affected and extent of the flooding, which leads for the creation of* a *computerized flood hazard mapping with* a *GIS database* as an *attached attribute tables.*

INTRODUCTION

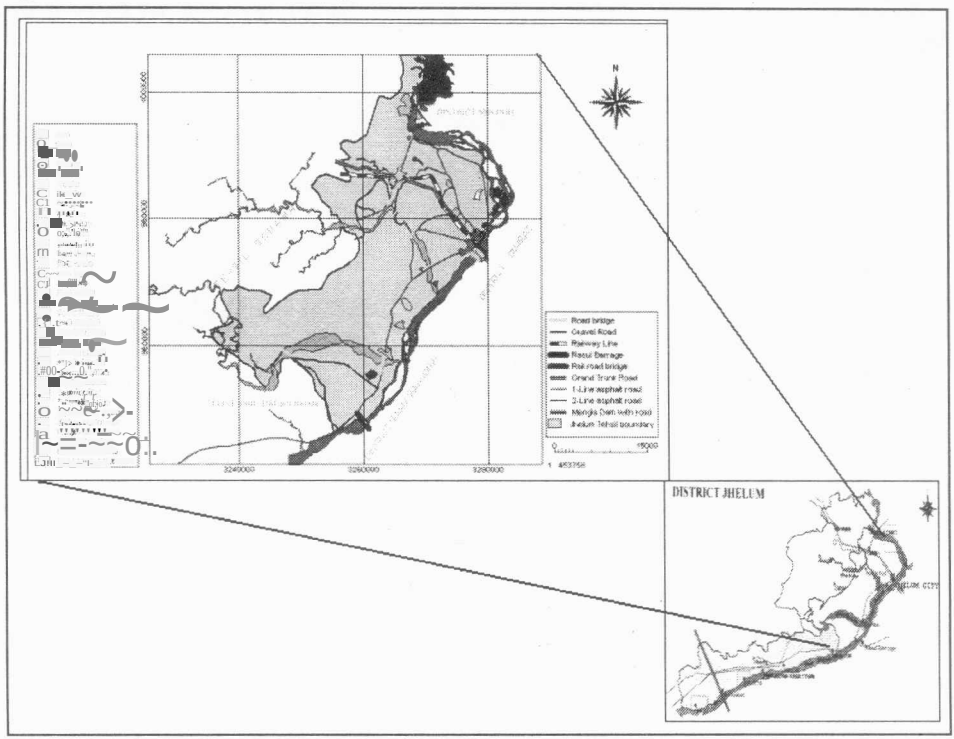
The study area is a sub-division of District Jhelum and it is situated in the Northeast of district.. It is one of a severely flood affected area during the monsoon season. River Jhelum is the main contributor to flooding in this area. Two other important rivers, River Bunha and Kahan are also flowing in the area. River Jhelum is flowing on the eastern side of the sub-division, thus forming a natural boundary between sub-division Jhelum to Gujrat and Mandi Bahauddin districts. On the west Sohawa sub-division, on north is Mangla reservoir and Mirpur city of Azad Kashmir are situated while Pind Dadan Khan sub-division of the same district is situated in south of the study area (Fig.1). Geographically the study area is stretches roughly from 32°. 36' to 33°. 10' north latitudes and from 73°. 10' to 73°. 50' east of Greenwich longitudes. District head quarter Jhelum town and Mangla cantonment is situated on the flood plains of river Jhelum. Besides, many other populated villages are also situated on the flood plains. The flood prone area is situated in the form of a narrow strip along the course of river Jhelum, which stretches almost in north-east to south-west direction. The straight length of the flood plain areas along the river Jhelum is more than 100 kilometers. The maximum width is about 11 kilometers.

The physiographic setting exposes this area more to flood hazard. Just after the releasing of flood waters from Mangla dam, it take a curve shape towards east side, the flood waters instead of following the river coarse comes out from the natural channel and flow straight by hitting first to the Jhelum city, which is situated along this river at a distance of 20 km from the Mangla dam (Fig.2). The area between Mangla dam & Jhelum city is very fertile agricultural land. It is the main crop producing area in the whole district. But often all standing crops are washed away or flood waters spread a thick sheet of sediments on it. Especially the river Bunha brings a lot of sediments with it during flooding. Due to this sedimentation, the width of the river Bunha at the confluence of river Jhelum reach up to almost two Kilometers, but it hardly contains water except during monsoon season.

The area affects more severely when the Rasul barrage, which is constructed on the river Jhelum for irrigation purposes, stops the flood waters. The whole flood plain area become like a huge reservoir during flooding, normally affecting the village Bhambar, which is situated at the confluence of river Bunha and Jhelum. The whole of the area including Jhelum city were severely affected during 1992, 1995 and 1997 floods. The flood of 1992 has been found more severe than the previous floods in the history of river Jhelum. District Jhelum was the most severely affected district during that flood, which caused a damage of about 6.5 million-rupees, and taking 92 lives. A total of 235 villages were affected, and

standing crops on 45,387 acres of land and 6,997 cattle were lost (Disaster relief cell Lahore, 1998).

Fig. 1: Location of the Study Area



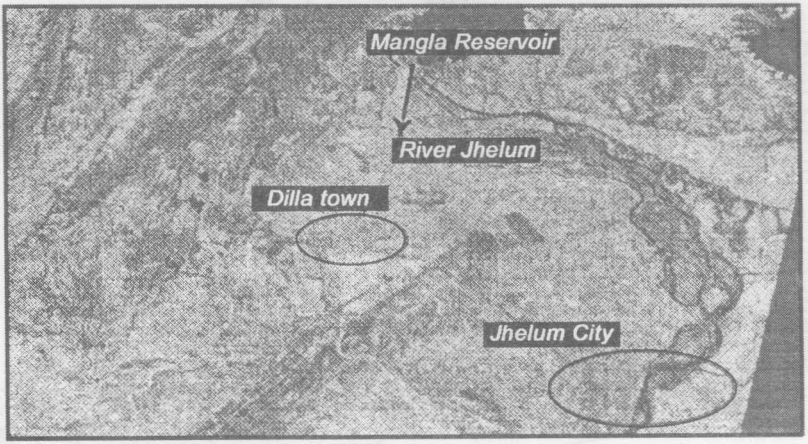
Source: District Census Report of District Jhelum, 1998

PHYSIOGRAPHY AND CLIMATE

The famous salt range enters into the study area at its south-west corner. The highest peak in the range is called Chell and is 1131 meters above mean sea level. This range on the west and river Jhelum on the east side acts as a natural boundary for Jhelum sub-division. Near the town of Jalalpur Sharif, this range changes abruptly to the north-west and follows a short course to the bank of the river Bunha. From river Bunha, another range runs parallel to river Jhelum towards the north-east. It is an upland range between Potwar Plateau, for behind in Sohawa sub-division and river Jhelum. This range is called as Tilla Range. Jogi Tilla is the important peak, which is 986 meters above mean sea level. A broad alluvial plain spreads out between river Jhelum and the hills, which is called as Reverine region in local term, it starts from Mangla Cantonment (just near Mangla Dam) to Bhambar village, which continues further in Pind Dadan Khan sub-division. The average width of the flood plain is about 11 kilometers but is subject to

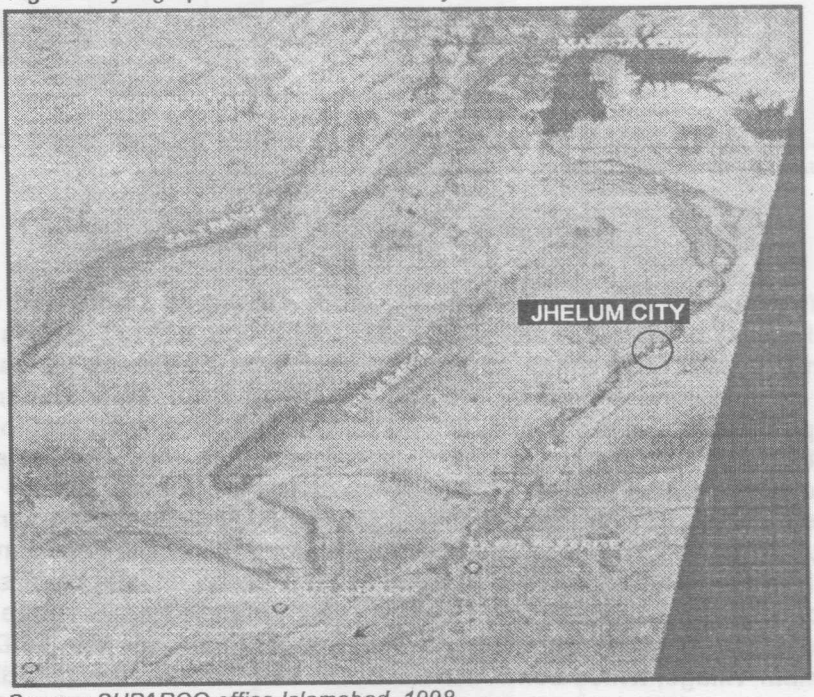
great variation, for example, near Jalalpur Sharif town the plain extends almost in few meters toward river. This tract consist of fertile loam which gradually grows sandy as it approaches the river and stony as it approaches towards the mountains. The hill torrents generally bring down fertilizing floods, but sometimes sweep away fertile ground, or bury it in a layer of unproductive sand (Fig.3).

Fig. 2: Physiographic setting between Mangla reservoir and Jhelum City



Source: SUPARCO Islamabad, 1998.

Fig. 3: Physiographic features of the study area.



Source: SUPARCO office Islamabad, 1998.

The climate of area is continental sub-tropical. . It is almost sub humid in the north-eastern part and gradually changes to semi-arid in the south-western part of the sub-division. The main general features are high temperature in summer, cold nights in winter and torrential and erratic monsoon rains in late summer. May and June are the hottest months usually ranging from about 44 to 46Co. July and August are also the hottest months but normally monsoons raining during these months keep the weather pleasant up to some extent. December and January are the coldest months. Temperature ranges between 1 to 4Co at night.. The rains are received in two rainy seasons. About two third of the total rain is received during monsoon season from July to September. The monsoon rains are usually accompanied by thunderstorms and occur as heavy downpours. The remaining rain received in the form of gentle showers of long duration during winter. Table.1 show the month wise mean temperature and precipitation during 1961-1990.

Table-1: Month Wise Mean Climatic Data of District Jhelum During 1961-1990

MONTH	TEMPERATURE(CO)		PRECIPITATION(mm)
	MAXIMUM	MINIMUM	
January	24	1.8	118.4
February	26.9	3.5	117.4
March	32.5	7.4	261
April	39.4	12.4	144.1
May	43.7	16.8	89.1
June	45.7	21.1	148.9
July	42.2	21.8	502.5
AuglUst	38.8	21.9	545.9
September	38.2	18.8	252.3
October	36.3	12.4	61.5
November	31.5	5.4	40.1
December	25.9	2.4	186.3

Source: District Census Report of Jhelum, 1998.

DRAINAGE PATTERN

River Jhelum is the main river flowing in the study area and is the main contributor to frequent flooding. It is an eastern tributary of the Indus River system. Its catchment area above Mangla dam is 20,708 Square kilometers (including the main river Jhelum and its tributaries) and flow from north-east to south-west direction after entering into district Jhelum territory. It rises from the spring of Verinag in the north-west side of Pir Panjal Mountains range. It flows through Dal and Wular lakes in Occupied Kashmir. From point of origination up to Mangla Dam, it covers a distance of 563 kilometers. During its course, the river falls approximately at an average rate of 4.67 meter/kilometer.

When river Jhelum enters from Mangla dam into District Jhelum. Two important river EJi4nhaand Kahan join it. On the map these rivers look like a large river, but in fact for a few days in the year it contain very little water.

These remain full of overflowing after heavy rains but at other times they are merely look like wastes of land. The Kahan is nearly 64 kilometers long. It drains the centre and west Jhelum, and is formed by many branches, which originates from the Nilli hills and joins one another near Domeli village. After a course nearly due east, it flows in between the Tilla range under the walls of famous Rohtas Fort and eventually falls into river Jhelum just below the Jhelum Cantonment (Gazetteer of Jhelum, 1995).

River Bunha rises in the government forest reserved area" *Sur/a"* in district Chackwal on the north side of the mountains. From there it turns east, and near Duhman is joined by the Kulian, the Kutian and the Saruli nullahs. The united torrents flow through the Ghorigala pass. Afterwards, spread out into a broad waste of sand, which is year after year extending its beds. Its bed at the Ghorigala is only a few p~ces in width, but near the confluence of River Jhelum it is not far short than two kilometers wide. It falls into the River Jhelum between Darapur and Bhambar village. Gurawala, Sanghoi, Mackrach and Jabba kas are other unimportant torrents, which join River Jhelum in the study area (Nazir, 1978).

RESEARCH METHODOLOGY

The methodology was adopted in the study according to the objectives of the study, available data and techniques.

OBJECTIVES OF THE STUDY

Following were the main objectives of the study,

- To develop hazard mapping at a regional scale for Jhelum sub-division by applying Remote Sensing and Geographical Information System techniques.
- To demarcate on the map, the areas that are at risk.
- To delineate the flood boundary of 1992, 1995, 1997 and to find out the affected villages and area.
- To show the return period of different magnitude of flooding for the area.

AVAILABLE DATA

Following were the data available on regional scale,

- Landsat image (FCC of 30*30 m resolution) of the study area.
- Topographic sheets (43 G/11, 12, 13, 15, 16, K/4, H/9, 16 and U1) on scale 1:50,000.
- Potwar circle map prepared by Population Census Organization on Regional scale.

RESOURCES USED DURING THE STUDY

- ILWIS software for Image processing and analysis.
- Computer set with printer.
- Digitizer for the digitization of map derived from topographic maps.
- Screen dlgitization on Land Sat image.
- EXCEL software for tables & diagrams
- Micro Soft Word

CAUSES OF FLOODING

In the study area, flash floods, prolonged/excessively heavy rainfall, Ice melts In the mountainous catchment areas are the common causes of flooding. Floods are normally restricted to three months but early and late floods have also been experienced In the month of June and October. The main source of rainfall is monsoon, which continues for three months I.e. July, August and September. During these three months, the excessively heavy rainfall occurs in the catchment areas of all the rivers, which give birth to severe flooding downstream. The monsoon depression originates from the Bay of Bengal, which enters Pakistan after crossing India, reached up to Indian and Pakistan's Kashmir. The monsoon rainfall accompanied with the melting of snow in the summer months further deteriorates the situation.

CREATION OF MAPS IN GIS ENVIRONMENT AND PROCEDURE FOLLOWED

Fig.4 shows the methodology to adopt for the creation of these maps. The creations of these maps were based on the collection of data during field survey. During a questionnaire survey carried out during 1998-99, the researcher asked questions about the area flooded during these flooding. Moreover the data has also been confirmed by the Revenue office. Three kinds of maps helped the researcher to draw the flood boundary. One was the availability of a Potwar circle boundary map, topographic sheets and Landsat image of the study area. Before drawing the required maps, all of the above mentioned maps were georeferenced to each other. The following steps have been taken.

VISUAL INTERPRETATION OF LANDSAT IMAGE

Landsat image was used for the interpretation and drawing of boundaries of flooding. The resolution for this image was 30*30 meters, which was quite helpful to demarcate the flood boundary.

STUDY OF TOPOGRAPHIC SHEETS

.To further enhance the study, the topographic sheets (43 G/11, 12, 13, 15, 16, K/4, H/9, 16 and L/1) on scale 1:50,000 were used. The topographic study helps the researcher to identify the name, location and height of

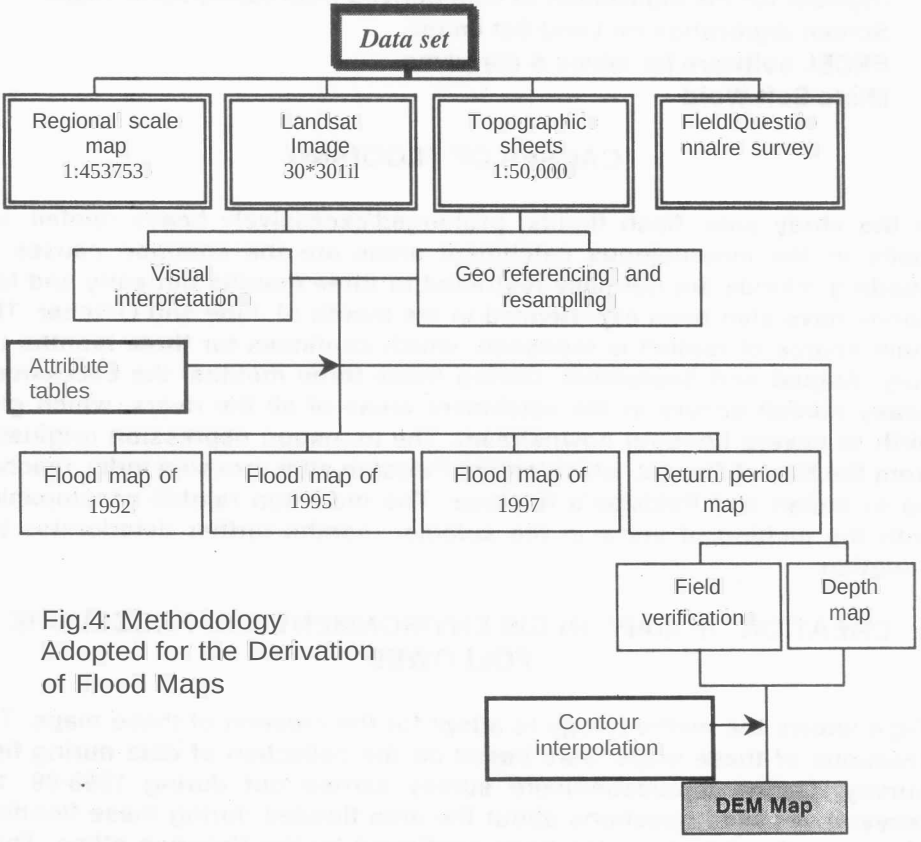


Fig.4: Methodology Adopted for the Derivation of Flood Maps

different settlements and rivers in the study area. Different sites were also compared with the sites, which were visible n Landsat image.

STUDY OF REGIONAL SCALE MAP

Sub-division map prepared by the population Census of Pakistan was used for the demarcation of Potwar circle boundaries. As there was no village-wise map available, therefore the researcher used Potwar circle map. Location of important villages were pointed out on the topographic sheets and then placed at the exact place with special

care in the Potwar circle map. This regional scale map was geo referenced with the Landsat Image and was used as a base map for the delineation of flood boundary.

FIELD VERIFICATION FOR THE FLOOD BOUNDARY

After taking data about flooded villages from Revenue office Jhelum, field verifications were carried out during the field survey. For this purpose confirmation were derived by asking questions in the some of the selected villages and field observation help me to delineate the flood extent.

FINAL MAP PRODUCTION

As a result of the available data and maps, the researcher delineated the flood boundary by using screen digitizing over the Landsat Image on computer. An attribute table was created separately and data was put in the said table. This Jable contains information on flood extent to different areas. Domain of 1992 flood was given to the table and it was linked with the attribute maps of 1992, 1995 and 1997. The created map was then polygonized, and the above mentioned attribute table was attached to the map, which are shown here in Fig. 5, 6 and 7. These maps show the extent of flood boundary, potwar circle inundated and villages affected during these floods. During 1992 flood, a total of 588.89 km^2 areas has been affected while during 1995 and 1997, the area affected as' 519 and 649.71 km^2 respectively (Table. 2).

FLOOD DEM MAP

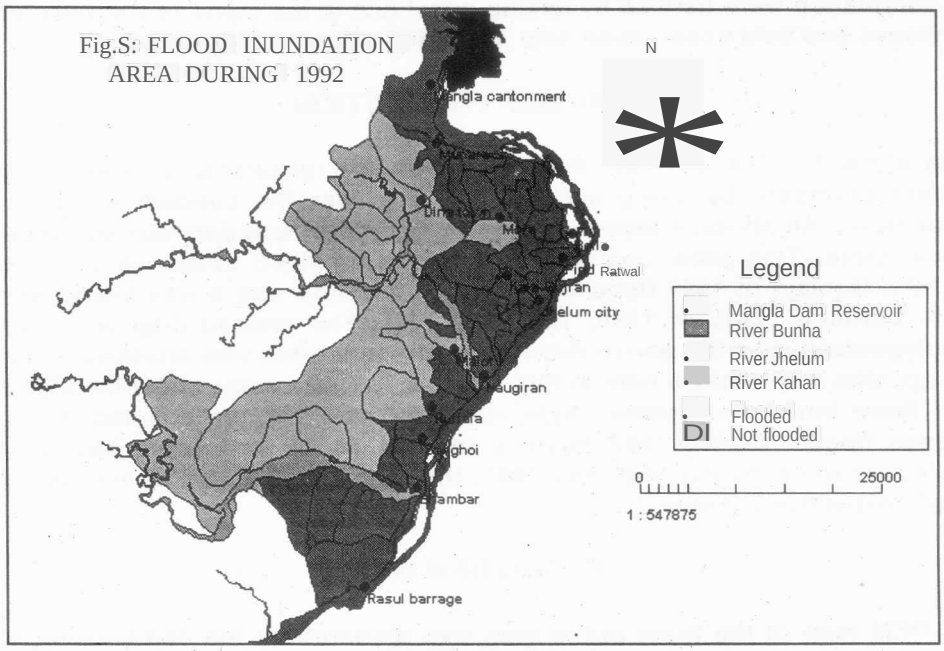
A OEM map of the flood prone area was prepared by the combination of depth of the flood water along rivers in the study area. The depth of the floodwater was the result of continuous observations during the field survey and also verified by the local people. A map indicating the depth of the water of the rivers has been drawn as contours. With the help of contour interpolation, the rasterized OEM map of the study area has been derived. To show only the study area the map has been masked with the study area map and the final map was obtained. Fig.8 shows that the depth of the water is very high along river Jhelum as normally all houses is submerged under the water during flooding.

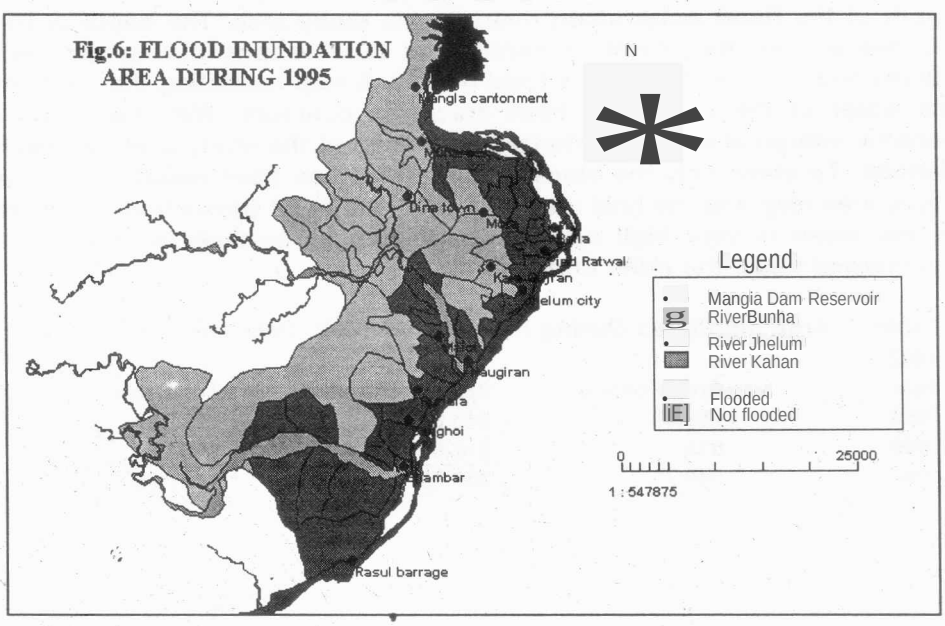
Table-2: Area Inundated During Flood}ng of 1992, 1995 and 1997 (Area in KM2)

Year	Area flooded	Area not flooded	Total area
1992	588.89	548.89	1137.69
1995	519	618.69	1137.69
1997	649.71	487.98	1137.69

FLOOD RETURN PERIOD MAP

The return period of the flood depends upon the magnitude of a specific flooding. For this study, flood with a magnitude of 150,000cosecs has been chosen as standard as such data has collected from the. Revenue office and also data has been collected in the field. During.questionnaire survey, one question was about the return period of the





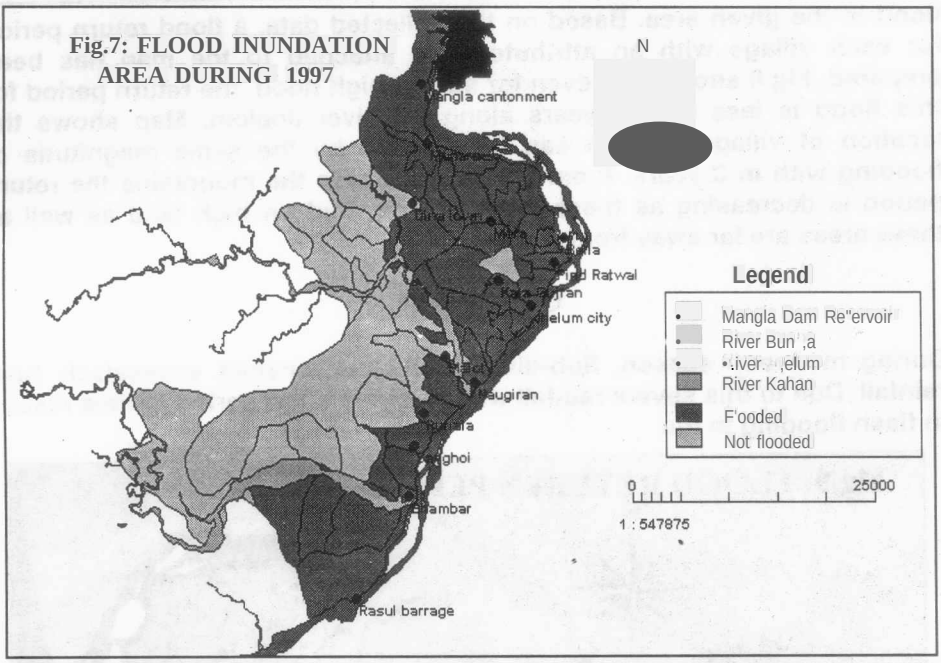


Fig.7: FLOOD INUNDATION AREA DURING 1997
N
Mangla cantonment
Leqend
Mangla Dam Re"ervoir
River Bun ,a
River Kahan
F'ooded
Not flooded
0
25000
1 : 547875
Rasul barrage

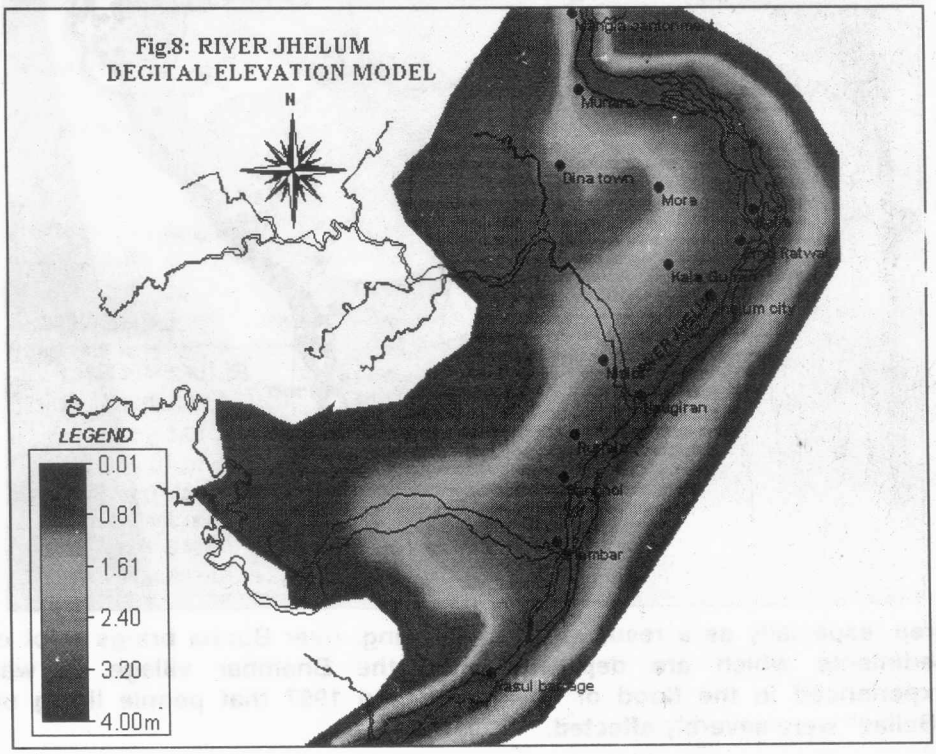


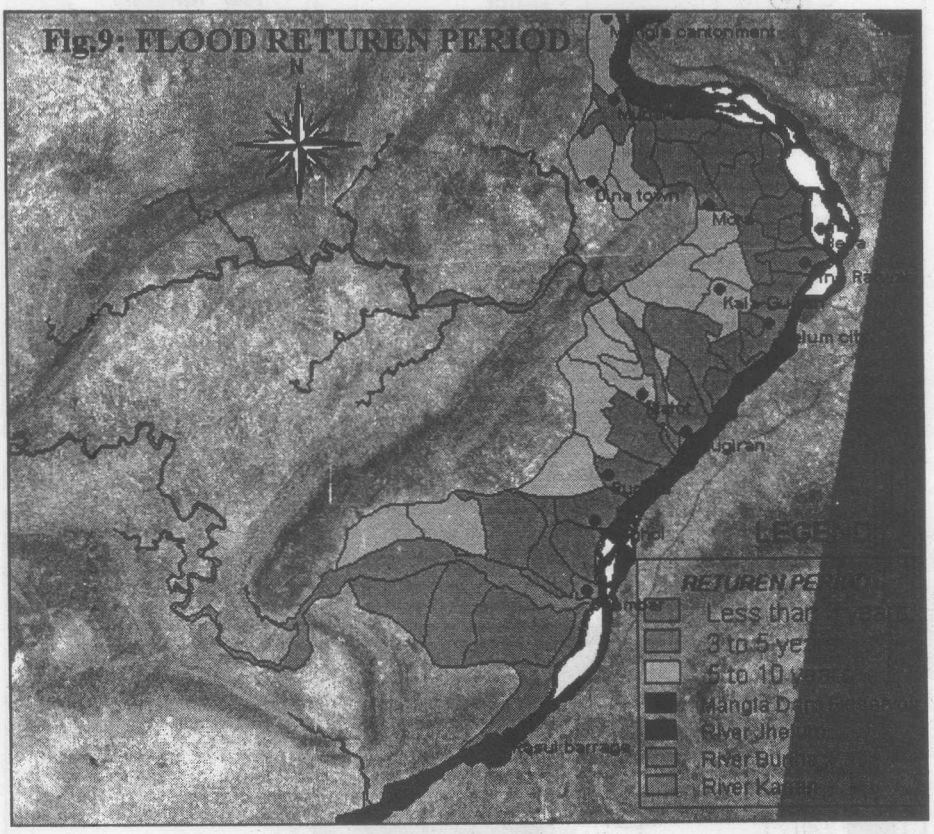
Fig.8: RIVER JHELUM DEGITAL ELEVATION MODEL
N
Dina town
Mora
LEGEND
0.01
0.81
1.61
2.40
3.20
4.00m

flood in the given area. Based on the collected data, a flood return period for each village with an attribute table attached to the map has been prepared. Fig.9 shows that even for such ~ high flood, the return period for this flood is less than 3 years along the river Jhelum. Map shows the location of villages, which can be affected by the same magnitude of flooding with in 3 years. From the river towards the mountains the return period Is decreasing as these areas are situated on high land as well as these areas are far away from the river.

CONCLUSION

During monsoon season, Sub-division Jhelum receives excessively high rainfall. Due to this severe rainfall with In a very short period of time results In flash flooding In the

Fig.9: FLOOD RETUREN PERIOD



area, especially as a result of flash flooding, river Bunha brings a lot of sediments which are deposited near the Bhambar village. It was experienced in the flood of 1992, 1995 and 1997 that people living on "Bellas" were severely affected.

After originating from the reservoir, the river Jhelum take curve shape, due to which the flood water comes out from the channel, flows straight and forms a huge lake and when the water reaches up to Rasul barrage again the water is trapped by the barrage, while at this place the river Bunha and river Jhelum both accumulate water and are further stoppage by the barrage. As a result many nearby villages are affected very severely.
The return period of the flooding shows that all of the area near the river Jhelum can be flooded with in every three years of time, but still the popUlation is growing In these areas.

The infrastructure between Jhelum city and Rasul barrage is very poor. All bridges and roads are completely washed away during the flood of 1992. After passing so many years still the road is closed for traffic and bridges still are broken, as a result of which people adopt alternate routes. There is no bridge over river Bunha and during flooding the road remains closed for several days and thus the remaining areas remain cut off with the district head quarter.

RECOMMENDATIONS FOR FLOOD HAZARD MANAGEMENT

Following are some of the recommendations for flood hazard management in the stUdy area.

HAZARD ASSESSMENT AND RISK MAPPING

Recent development in Remote Sensing, Aerial Photography and GIS techniques have allowed the natural hazard event to be observed and mentioned in advance and in much greater detail than even before. Due to this teChnique, a natural hazard mapping can be prepared now to delineate flood prone areas on the map. In most of the countries, the concerned authorities are preparing risk map by applying Geographical Information System (GIS) and Remote Sensing (RS) as a tool. Such kind of maps would enable the authorities for quick assessment of potential impact of a natural hazard and initiation of appropriate measures for reducing the impact.

NEED OF A COMPUTERIZED GIS DATA BASE

There' is intense need for a completely computerized GIS database for Jhelum district.. Such a data will help the planners and decision-makers to take positive and in time steps durina pre-disaster situation. It will also help the planners and decision-makers during post-disaster activities for the assessment of damages and losses occurred due to flooding.

TRAINED PERSONNEL

There is a need of trained staff to operate GIS database and up-date this data from time to time. Training is advised at these levels;
Planners, decision makers, civil administraiion officers.
FieldlTechnical staff of Iinl;!department

The contents of this training program may include basic and advance technical knowlEldge about Geographical Information System and Remote Sensing, side by side knowledge about physical environment, socio-economic set up, institutional system and information management about the area may also be needed. Besides, seminars and refresher courses for planners and administrators should be organized. Foreign training should be given to planners and decision-makers. In this way, they will be able to know more about the natural hazard prevention and preparedness system there, which will serve as bases to review their own system.

ACQUISITION OF IMAGES DATA FROM SUPARCO

Acquisition of images especially during any particular flood event from SUPARCO is very much important. It will help the planners and decision-makers to find out the area and villages, which have been affected by flooding. If it is possible then aerial photographs of the flood peak time will further help them to stream line their strategies to mitigate and rehabilitate the flood affectees more efficiently and more quickly.

REFERENCES

Arcuri Claudia., (1995). "Flood hazard assessment and zonation of the Medinas river catchment (Tucman, Argentina)", MS thesis submitted in AGS division, ITC Enschede, The Netherlands.

Asaduzzman A.T.M., (1994). "A geomorphic approach to flood hazard mapping in Bangladesh using GIS & RS", MS thesis submitted in AGS division, ITC Enschede, The Netherlands

Blaschke Thomas and Vogel Michael., (1993). "The long way from Geographical Information System to Ecological Information System: A case study in the alluvial flood plain of the Salazch (Bavaria)., Published in conference proceedin~s on GIS for environmental studies by KRAKOW, Poland on 25-27 Novem er 1993., pp.29-42.

Chaudhry. B.S., Arya. V.S., Babu. T.P., Ruhal. D.S., (1999). " Satellite application for monitoring flood hazard in Haryana, India: A case study" In: Nieuwenhuis G.J.A., Vaughan. R.A., and Molenaar. M (eds) Operational remote sensing for sustainable development., A.A.Balkema publishers, Rotterdam The Netherlands., pp.281-284.

Coppock Terry, J., (1995).-"G1S& natural hazards: An overview from a GIS perspective"., In: A Carrara and F.Guzzetti.(eds) Geographical Information System in assessing natural hazards. Kluwer academics publishers, The Netherlands., pp.21-34.

G.O.P, (1998) "District Census Report of District Jhelum", Population Census Organization Islamabad, Pakistan.

G.O.P, (1995) "Gazetteer of District Jhelum" Archives Department Islamabad, Pakistan.

Joerin, F., Consuegra, D., and Vitalini, F., (1995). "Flood delineation and impact assessment in agricultural land using GIS technology"., In: A Carrara and F. Guzzetti. (eds) Geographical Information System in assessing natural hazards., Kluwer academics publishers, The Netherlands., pp.177-198.

Lanza, L., and Siccardi, F., (1995) "The role of GIS as a tool for the assessment of flood hazard at the regional scale" In: Geographical Information System in assessing natural hazards.,(eds) A Carrara and F.Guzzetti., Kluwer academics publishers, The Netherlands., pp.199-217.

Maatius B.H.P., Timmermans W.J., and Meijerink A.M.J., (1999). "New real time assessment of the June 1996 flash flood in Central Yemen"., In: Schultz. G.A. and Engman E.T. (eds) Remote sensing in hydrology and water management., Springer publishers, Rotterdam The Netherlands., pp.295-300.

_____.,(1997). "Mapping and monitoring floods with Radar sat images"., report prepared for water resources planning organization (WARPO) Ministry of water resources Government of Bangladesh., pp.1-7.

Meijerink A.M.J., et.al,. (1993). "Introduction to the use of GIS for practical hydrology", publication No.23., published with the support of ITC, Enschede The Netherlands, UNESCO and Ministry of education and environment, The Netherlands., pp.205-212.

Nazir, Ahmed. (1978) "Water resources of Pakistan and their utilisation" Gulberg press Lahore Pakistan; pp.3.1-3.17.

Shafiee Mardiana., Ahmed Azman and Kadir Osman., (2000). "Capability of radar sat data in monspon flood monitoring"., In: proceedings of the 21st Asian conference on Remote Sensing., December 4-8-2000 at Taipei, Taiwan., pp. 222-227.

Singh R.B., (1994). "Space technology for disaster monitoring and mitigation in India"., serial No.6., International center for disaster mitigation engineering India.

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 57-64

STATE OF ERITREA: AT A GLANCE

Shamim Roshan Ara
Editor, Urdu Encyclopedia of Islam, University of the Punjab,
Allama Iqbal Campus, Lahore.

ABSTRACT

Eritrea is an *African Muslim country, situated in the eastern part of Africa newly emerged out from Ethiopia. Its area is 93.679-sq. km* (36.171 *sq. miles). According to the population estimates of 2000 the total population is* 3.8 *million. Arabic and Tigrinya are the official languages.*

From 1890 to 1941 *it was the colony of Italy. It fell to British forces in the Second World War and became the British protectorate. Eritrea began* an *armed struggle for independence under the leadership of the Eritrea peoples liberation front (PLF).* On *24th May* 1991 *they captured Asmara the capital of Eritrea. At* a *referendum held* on 23-25 *April* 1993, 99.8% *majority was in favor of independence. Thus* on *24th May* 1993 *was proclaimed the Independence Day. Issaias Afewerki was first elected president.*

As it is a *newly emerged out Muslim country in Africa it is important* as *far* as *its economic conditions, poli~ical situation and historical background is concerned. Therefore* a *need has been felt to produce material about its historical, geographical, political and economic conditions.*

INTRODUCTION

Eritrea is an African Muslim country, which is situated, in the eastern part of Africa. It's bounded in the northeast by the Red sea, southeast by Djibouti, South by Ethiopia and West by Sudan. Its are~ is 93.679-sq. km (36.171 sq. miles).

Arabic and Tigrinya are the official languages.48% of the population speaks Tigrinya and 31% Tigre. There are 7 other indigenous languages. Arabic is spoken on the coast and along the Sudanese boarder. English is used in English Schools.

There are 10 provinces. AKEL GUZAR, ASMARA, BARKA, DENKEL, GASH-SETIR, HAMASIEN, SAHEL, SEMHAR, SENHIT and SERAVE.

HISTORY

The word Eritrea is derived from Greek word Marie Erytrian. Islam was spread in Eritrea in the end of first century of Hijra. Eritrea was an important trade center in ancient time. Lelantine war was fou~ht in 8th century B.C and Eritrea was against the Chalcis. In the middle of 5h century B.C it became the Athens colony but in 411 B.C it became rebel. From the earliest of 4th B.C it became under the Athens and Macedonian for long and the Rome took over it in 146 BC.

The site of the kingdom of Aksum was flourished to 4th - 6th century AD. This region was linked to the beginnings of the Ethiopian Kingdom. Aksum (Axum) was the Ethiopian state until its decline in the 8th century. Later this area fell to the ottoman, Turks and after ward to the Egyptians.

In 1557 the Turkians conquered the port of Massawa and in 1864 the Sovereignty of Eritrea was transferred from Turks to Egyptians. Eritrea as political entity first emerged to Italian occupations of the Red Sea port of Massawa and other coastal enclaves in the 1880's. The British had great interest in this region but they were not opposed to Italian expansion. In 1889 Italy signed the treaty Ucciali with the emperor of Ethiopia Menelik and in 1890 it was given a new name Ethiopia. Through treaty the Italian govt. had controlled over the colony, and the borders agreed upon there in are now the borders of modern day Eritrea. After Second World War the British took control over it. They ruled there from 1941 to 1952. In 1952 a compromise agreement was accepted in the UN. Under this agreement a federation was formed between Eritrea and Ethiopia. After the formation of federation the Ethiopian Emperor Haille Selassie reduced the Eritrea's status to that of Ethiopian province by1962. There was no provision for proper federal institutions.

The Eritrean liberation movement founded in 1958. It was succeeded by Eritrean liberation front (ELF), which began an armed struggle in September 1961. In the mid of 1960 organizational and ideological difference arises in the ELF. The reforms of the increasing number of educated Guerrilla fighters particularly those from the Christian high lands and the Muslim eastern low land towns. On the basis of these differences reformist group was separated from the ELF. This group formed a new party popular liberation forces renamed the Eritrean people's liberation front EPLF in 1977. They did the military confrontation with the Ethiopian Govt. A major difference, which split the two groups, was the civil war of 1970 to 1974. After clashes between ELF and EPLF the ELF associated with Ahmed Nasser, the leader of the ELF revolutionary council (ELF-RC).

In 1974 a revolution came in Ethiopia therefore in 1977 Mengistu Hail Mariam took the powers of the state. Thousand of recruits joined the EPLF. They captured the cities such as Keren and Decam Lare in 1977. The armed Struggle eventually transformed into full-scale conventional war fear. The Ethiopian forces got some victories over the EPLF. After defeat in high lands, the EPLF took strong hold in the north of Eritrea. During Ethiopia's red star offensive in 1982 which aimed to destroy the Eritrea resistant. After it EPLF launched counter attack through out the late 1980's and slowly drove back the Ethiopian forces on all sides. By 1989 the EPLF gained controlled of the north and the west of the country. A US sponsored peace talk was held between Septembers to November 1989. It was failed .The EPLF conquered the Massawa port on the Red Sea and it provided rout to the Ethiopian forces. In May 1991 the EPLF forces entered in Asmara, Ethiopian troops were fled and EPLF immediately established an interim administration.

After the liberation of Asmara by the EPLF and Adis Ababa by Ethiopian people revolutionary democratic front (EPRDF), a conference was held in London, UK in August 1991. The assistant secretary of states of Africa chaired it. The representatives of EPLF and EPRDF attended it. In this conference the USA and Ethiopian delegation both accepted the EPLF administration as the legitimate provincial Govt. of Eritrea. The EPLF was also agreed to hold a referendum on independence in 1993. The problems, which was faced by the new Govt., to re habitat and develop Eritrea's war-torn economy, infrastructure and the 80% population, which depend on agriculture. An other problem of the Govt. was how to reintegrate 750,000 refugees of whom 500,000 lived in Sudan.

A referendum on independence was held between 23rd and 24th April 1993 under the supervision of UN. 24th May 1993 was proclaimed Independence Day and on 28th May the state of Eritrea became the 182nd member of the UN. In following month Eritrea became the member of organization of African unity (OAU).

After independence a four years transitional period was declared for establishing a constitution and pluralist political system. In transitional Govt. there were three institutions.

The conservative council: It is the executive authority, which formed from the ministers, provisional governors and head of Govt. commissioners.
The National Assembly: It is the legislative authority formed from the EPLF, thirty members from the provincial assemblies and thirty individuals selected by the central committee.
Judiciary:

The National assembly's first act was the election of the head of the state. Issaias Afewerki the secretary general of EPLF was elected as the president of Eritrea. He got 99% votes. President Afewerki appointed a new state council in June 1993. It was comprised on fourteen members of EPLF and ten regional governors. Afewerki was elected chairman of an eighteen member executive committee. Seventy-five members of PFDJ central committee was also elected and seventy-five members were elected for PFDJ regional committee.

In early March 1995 the National assembly adopted a series of resolution including an amendment in the structure of the executive administration. A resolution was adopted for the creation of a 50 member's constitutional commission. International conference to draft constitution was held in July 1994.The constitution of Eritrea was enforced on 23rd May 1997..1n1995 Presidential and legislative elections were held in May 1997. President Afewerki was re-elected. In 1999

CLIMATE

The temperature gradient is steep. Average annual temperatures rang from 17!!C 63l!f) in the high lands to 30 C (86 F) in Massawa.The Danakil depression in the south east, which is more than 130 meters below sea level in places, experiences some of the highest temperatures recorded, frequently exceeding 50 C (122F). While the temperatures in Massawa In the coldest and hottest months are as

January 78 'F (25.6 'C)
July 94 'F (34.4 'C)

The rainfall is less than 500 mm per year in low land areas increasing to 1000 mm in the high lands. Annual average rainfall is 8" (193 mm).

POPULATION

The population of Eritrea was 2.7 million according to the Ethiopian census of 1984, but the war for independence has resulted In large-scale population movements. Some 500,000 refugees are thought to be in neighboring Sudan and a large number of Eritrea's still live in Ethiopia.

Table-1: PQDulationof Eritrea in Different Years

YEAR	POPULATION
1984	2,748,304
1989	3,239,400
1990	3,329,600
1991	3,435,500
1995,	3,531,000
2000	4,082,000

The birthrates and death rates have been decreased from 1980 to 1995 as shown in table below.

Table-2: Annual Average Births and Deaths

YEARS	BIRTH RATE PER 1000	DEATH RATE PER 1000
1980-85	45.2	20.3
1985-90	44.6	17.0
1990-95	43.0	15.2

Source: UN world population prospects: The 1994 Revision.

AGRICULTURE

In 1995 approximately 79% of the economically active population were engage In agriculture. Several systems of land ownership exist: In 1994 the PFDJ proclaimed the sole right of the state to own land. The production of different crops Is given In table 3.

Table-3: Production of Principal Crops

CROPS	1993 (000) METRIC TONS	1994 (000) METRIC TONS
WHEAT	3	3
BARLEY	4	4
MAIZE	6	5
MILLET	8	8
SORGHUM	51	50
POTATOES	39	39
OTHER ROOTS & TUBERST	70	70
PULSES	13	13
GROUNDNUTS	1	1
SESAME SEED	5	5
LINSEED	3	3
VEGETABLES	25	25
FRUITS &BERRIES	4	4

Source: FAO Production Year book

MINERALS

Eritrea's mineral resources are believed to be of significant importance. There is a possibility of large reserves of petroleum and Gas beneath the Red Sea. There are deposits of gold, silver, sulpher, Zinc, Copper, Nickel, Crome and Potash. Marble, Sand, Lime stone and SUicate are extracted. Oil exploration is taking place in the Red Sea.

INDUSTRY

Eritrea's industrial base traditionally centered on the production of Glass, Cement, Footwear and canned goods, but most industrial enterprises were badly damaged during the war.1n 1994 industrial production including Mining Manufacturing, construction and Utilities accounted for an estimated 18.1% of GDP. although some of the 42 public sectors factories-producing textiles, footwear beverages and other light industrial goods were operating in 1991.By 1995 production had increased considerably, mostly as a result of substantial aid from the government, which provided raw materials and new machinery. The Government has calculated that the cost of industrial recovery would be $20 million, for the private sector and $ 66 million for the state sector.

The manufacturing sector provided an estimated 12.3% of GDP in 1994.in June of the same year there were 43 public enterprises in the industrial sector, with the total of 10,4640 employees. Imported petroleum is processed at the ASSAB refinery, whose entire out put of petroleum products is delivered to Ethiopia under a quota arrangement.

Light industry was well developed in the colonial p~riod. During the war of independence much of Eritrea's industry was destroyed and dismantled and
Removed to Ethiopia. There are foods, Textiles; Leather wears, building material, Glass wear and Oil products industries in Eritrea

FISHERIES

Fisheries are a potential growth area for the Eruitrean economy and have been given serious consideration. Fishing of Sardines, Anchovies, Tuna, Shark and Mackerel is practiced in the Red Sea. However, the activity is on a very small scale with the total catch of 7,900 tonnes in 1996. It is estimated that sustainable yields are as much as 70,000tonnes per year.

EDUCATION

In Eritrea education is not compulsory. It is free in Govt. schools and at the University of Asmara. There is no age distinction in any education level. But usually nursery education begins at the age of four, elementary (grade-6) from 6 to 10, Junior secondary education (grade 7-8) is from 10 to 13 years and secondary (grade 9-12 from 13-17)years of age.

In 1994 there were 85 pre- primary schools, with 171 teachers and 3,788 students781 primary schools, 381 teachers, 75,751 students secondary school, 588 teachers, 16,616students.

In 1993 there were 2 teacher-training colleges, 2 post-secondary vocational schools and 1 agricultural institute.

In 1995 adult literacy was 78.5%(89.6% for males and 68.1% for females.

RELIGION

Eritrea is almost equally divided between Muslims and Christians. Half the population is Sunni Muslims along the coast and the North. And half optic Christians (In the North).

HEALTH

In 1993 there were 10 small regional hospitals, 32 health centers, 65 medical posts. There are 68 doctors, 488 nurses, 33 mid wives and 850 medical personnel.

Its resources are meager; population is small and poorly educated. Communication is difficult and energy is short.

ECONOMY

In 1996 its revenue was US $ 226 million and expenditure US$ 453 million. Real GDP growth grew by almost 8% a year betwe~n 1994 and 1996.

A new currency the NAKFA has replaced the Ethiopian currency BIRR. A 9% in inflation was recorded in 1997.

The central Bank is the National Bank of Eritrea. All Banks arid financial institutions are run by the state. There is a commercial bank of Eritrea, which has twelve branches. Agricultural and industrial banks, a housing and commercial bank and insurance corporation is also present.

COMMUNICATION

In 1996 there were 4,010 km of roads of which 875 km are paved new line of 117 km in length was re opened in Jan 1997 between Asmara and Masawa.
In Eritrea there are international airports at Asmara and Assab. Massawa is the main port and Assab is used mainly for imports to Ethiopia.
In 1992 international telephone links were restored. There are the facilities of Radio and TV Daily government newspaper is published in Arabic and Tagrania.

REFERENCE

African South of the Saliara 1996, pp 370-378
Dr. David Munuro; Chamber world Gazetteer, p192.
Encyclopedia American, 10: 545
Shaping a people destiny thee story of Eritrean and the United Nation, New York 1953;
The Encyclopaedia of Islam, 2: 709-710.
The New Encyclopaedia Britannica (Mlcropeadla), 3:945.
The States Man Year- Book 2000, P589-992.
The world Almanac and book "f facts, 1995, P765.
World Muslim Gazetteer, P 527-529

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 65-72

USEFULNESS OF SPOT IMAGE IN THE MAPPING OF LANDUSE/LANDCOVER RESOURCES IN CHIKUN AND KADUNASOUTHLOCALGOVERNMENTAREASOF KADUNA STATE, NIGERIA

Olumlde Aklnwumi Oluwole
Department of Geography, Nigerian Defence Academy
Kaduna-Nlgeria

ABSTRACT

This paper demonstrates the usefulness of Spot image in the mapping of landusellandcover resources in Chikun and Kaduna South Local Government Areas of Kaduna State, Nigeria. Effective administration requires purposive and coordinated landuse planning, hence, Local Government Administration can be improved upon by using spatial data sets acquired through remote sensing technique. Our research effort is directed at *mapping landuse/landcover resources in Chikun and Kaduna South Local Government Areas from the Spot image. This is because mapping techniques are fast becoming integral parts of overall strategies for the provision of information necessary for managing environmental resources. The Spot image of Kaduna (KADUNA SPOT ULC* 319956, 1157573. *LRC* 329956, 1147573) *was manually interpreted. A landuse/landcover classification scheme was designed for use and the resultant map was analysed for the effective management of Local Government's landuse/landcover resources.*

INTRODUCTION

Maps have been, and indeed will always be, essential in resource management. Mapping techniques are fast becoming integral parts of overall strategies for the provision of information necessary for managing environmental resources (Foster Smith, 1997. Uluocha, 1999). According to Rilwani and Ufuah (1999), Local Government Administration can be improved upon by using spatial data sets acquired through remote sensing. Rilwani and Ufuah (1999) discussed the fact that effective administration requires purposive and coordinated landuse planning. Dale and McLaughlin (1990)advocated that, the resources and attributes of land need to be carefully managed if they are to be properly used and if waste is to be avoided. Management of land can be viewed both from an

environmental and from institutional perspective. The focus of this paper is on environmental perspective and according to Dale and McLaughlin (1990), the environment may be thought of as including all the physical, biological, and chemical factors that compose people's surroundings and that may be distinguished in terms of continuing, renewable and non-renewable resources.

In view of the recent sectoral disturbances in parts of Kaduna State, conventional methods of data acquisition may not be suitable, at least for now, because of the fear and suspicion on the part of the inhabitants of the area. A challenge recognised by Kressler and Steinnocher (1999) therefore, is to gather the necessary data at acceptable costs at regular interval and to develop suitable techniques for extracting appropriate information. In this assertion lies the attractiveness of remote sensing techniques which according to Lo (1986)' is a group of techniques of collecting information about an object and its surroundings from a distance without physically contacting them. This paper, therefore, focused on the use of Spot image in mapping for management of landusellandcover resources in Chikun and KadLina South Local Government Areas (LGA^S)of Kaduna State.

THE STUDY AREA

The study area is carved out of Chikun and Kaduna South Local Government Areas of Kaduna State. In the briefs on Local Government Areas in Kaduna state by Kaduna State ministry of Commerce, Industry and Tourism, Chikun Local Government is situated South of Birnin Gwari, Igabi and Kaduna South Local Government Areas, North of Kachia Local Government and West of Kauru Local Government Area. The main economic activities of the inhabitants include farming, trading and animal husbandry. Investment opportunities in Chikun Local Government are very promising in terms of conducive climate and nearest to Kaduna and Abuja. Quite a number of industries and infrastructure facilities such as Ideal Flour Mills and IBBI can be seen in form of spill over from Kaduna town. There are quite a number of both primary and secondary schools spread all over this Local Government.

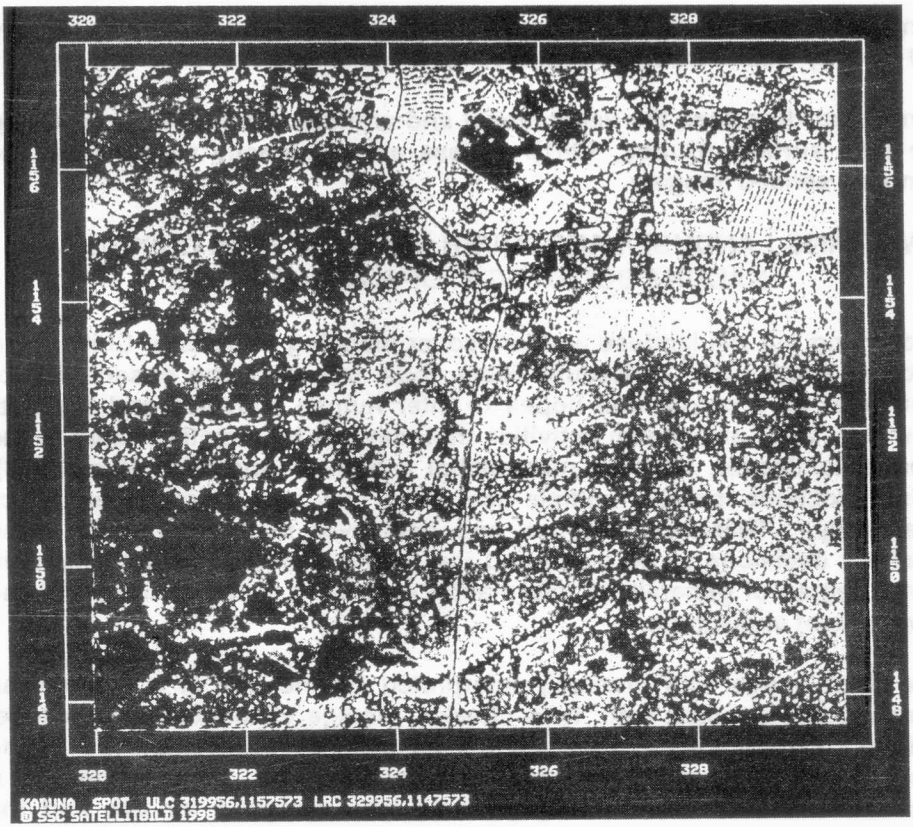
Kaduna South Local Government Area occupies the Southern part of the State capital and it is made of Tudun Wada and Makera Districts. Nearly all the industrial areas where industries are highly concentrated are found in this particular Local Government. Such industries include Defence Industries Corporation (DIC), Peugeot Automobile Company Limited (PAN), Kaduna Refinery and Petrol-Chemical Company, United Nigeria Textile (UNTL), Nigerian Brewery Limited, Nigerian Bottling Company Ltd, NOCACO Ltd, Arewa Pharmaceuticals Ltd and Dino Agricultural and Dairies Ltd to mention but a few. This Local Government has about forty

(40) primary schools and fifteen (15) Government Secondary Schools. Higher institutions already established include Kaduna Polytechnic (with three (3) of its campuses at Tudun Wada, Barnawa and Television Village), National Eye Centre and National Institute for Water Resources.

DATA AND DATA SOURCES

The data selected for the study consisted of Spot image of part of Kaduna with identification: KADUNA SPOT ULC 319956, 1157573. LRC 329956, 1147573. produced by SSC SATELLITBILD-1998(Appendix 1).

The Spot image was obtained from the Chief Cartographer, Department of Geography, Nigerian Defence Academy, Kaduna. The scale of the Spot image was determined through 'ground-Checks' and was found to be 1:50000



Kaduna Spot ULC 319956 1157573 LRC 329956 1147573 SSC Satellitbild 1998

JUSTIFICATION OF THE STUDY

Lo (1986) recognised the fact that landuse and landcover data are most essenti,al to planners who have to make decisions concerning land res0ltl/le management. These data are usually presented In map form and the use of remotely sensed Imagery Is particularly appropriate for the production of such maps.

OPERATIONAL DEFINITIONS

Land Is a raw material of a site, which Is defined In terms of a number of natural characteristics, namely, climate, geology, soli, topography, hydrology and biology (Aldrich, 1981).

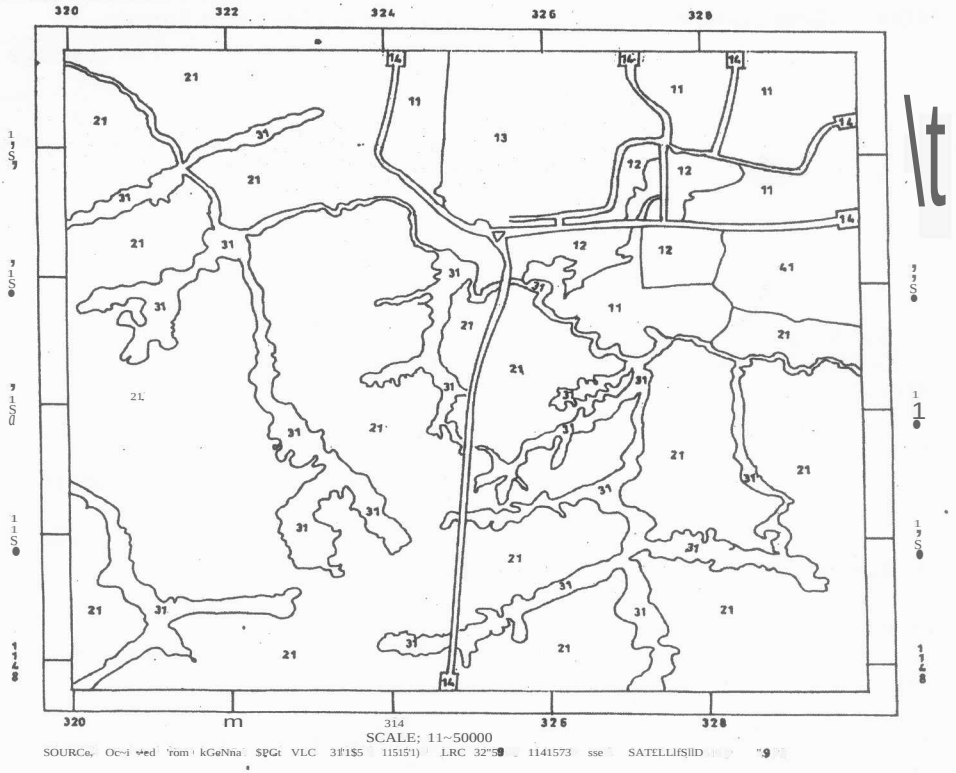
Landuse Is man's activities on and In relation to the land, which are usually not directly visible from the imagery.

Landcover describes the vegetathmal and artificial constructions covering the land surface (Burley, 1961). These are all directly visible from the. remotely sensed imagery.

MAPPING LANDUSEILANDCOVER RESOURCES IN CHIKUN AND KADUt;,lA SOUTH LGA^S OF KADUNA STATE

In carrying out the liinduse and landcover mapping of parts of Chikun and Kaduna South LGA^S of Kaduna State, thus, based on the observation of landcover as a proxy, one hopes to infer human activities and landuse. However, there are human activities that may not be directly related to the type of landcover, such as recreational activities (Anderson et al. 1976). Other problems include multiple use which may occur simultaneously or alternately. Therefore, landuse and lafldcover mapping require some arbitrary decisions to be made and the resultant maps inevitably contain some degree of generalized informatiop according to their scales and the purposes of application.

The Spot image was manually interpreted by the use of a zoom desk stereoscope, coupled with 'field checks'. Image elements such as tone, pattern, texture, shape, size and site/association were employed in the visual analysis and manual interpretation of the image. A landusellandcover classification scheme was designed for use and the resultant map is as shown in figure 1 A transparent graph sheet of 1cm by 1 c"1 rgridwas super imposed over the entire classified regions of the Spot image. The grid information was used to create essential geometrical control over measurements, which were made taking into cognisance the scale of the map which is 1:50000 ..



SOURCe, Oc~i ved 'rom kGeNna SPGt VLC 31'1$5 11515'1) LRC 32"5 1141573 sse SATELLIfSIID "9

LEGEND

·(1)BUiCT:up·CANb----------	,-r1-Re$ideri"tiT 12 Commerciaand sarvlces 13 Indusirlal 14 Transportation
(2) AGRICULTURAL LAND	21 Cropland and paslure
(3) WATER	31 Stream
(4) BARREN LAND	41 Mixad barranland

Fig.1: level II landuse/landcover map of the study area.

RESULTS

The entire area of the spot image was calculated and found to be 75.69km^2. Also, the area of coverage of each of the classified terrain was adequately determined. The quantified results of image analyses were transformed into tables. Table 1 showed the number of grid squares and hence area coverage of each of the classified terrain while table 2 showed total lengths of the linear features basically roads and streams in the area.

Table-1: Grid Squares and Area Coverage of the Classified Terrain

		Number of Grid SQuares	Area coverage Ckm^2)
(1) Built-up land	11 Residential	24	6.0
	12 Commercial and services	8	2.0
	13 Industrial	18	4.5
(2) Agricultural land	21 Cropland and pasture	245.76	61,44
(4) Barren land	41 Mixed barren land	7	1.75

Source: Derived from Kaduna spot ULC 319956, 1157573. *LRC* 329956, 1147573. *SSC SATELLITBILD 1998.*

Table-2: Length of Linear Features

			TOTAL LENGTH	
			CM	KM
(1) Built-up land	14 Transportation (Tarred Road)	45	22.5	
(3) Water	31 Stream	86	43.0	

Source: Derived from Kaduna Spot Ulc 319956,1157573. *Lrc* 329956, 1147573 *Ssc Satellítbild* 1998.

The built-up land in the study area with the sUbsequent level 11 classification reveals (11) Residential (12) Commercial and services (13) Industrial and (14) Transportation. The residential with total land area of 6.0km^2 comprises settlements of Ungwa-Romi, Ungwa-Television and Trikania. Here, the local government will intensify effort at tenement rate collection as well as provision of local health inspectors for the enforcement of necessary hygiene to mention but a few. The commercial and services with land area of 2.0km^2 cover areas such as Command Boarding Secondary School and Television garage. The Television garage is a pivot for revenue generation. Here, local government motor/vehicle tax receipts can be issued by officials of the local government on a daily bases to transporters. The industrial land area of 4.5km^2 in the region might not be of special interest to the local government.. This is because the industrial taxation as well as provision of utilities required in the industrial zone are the responsibilities of both the Federal and State Governments. The transportation routes with a total length of 22.5km will help to ascertain where exactly the Local Government input in road mending will be required.

The larger proportion of the study area is made up of agricultural land with an area of 61.44km^2. The agricultural land is used for crop and pasture. The Local Government may have to provide the farmers in this area with

access roads, machineries such as tractors and harvesters, fertiliser at reduced costs and also veterinary assistance to livestock farmers.

The total length of all the streams in the area is 43km. The Local Government Authority should enact measures that will prevent dumping of refuse in this natural physical resource so as to prevent flooding of the environment and danger to lives and properties.

In the North-Eastern corner of the map, with an area of 1.75km^2 is the mixed barren land. The notable feature here is the cemetery. The Local Government Authority should ensure that burial of corpses takes place only in this designated zone for sanitary reasons.

CONCLUSION

In Nigeria we operate "three-tier" of government-Federal, State and Local. It is at the Local Government level that the yearnings and aspirations of the populace could be judiciously met. It is at this stage that a vital data for effective management of Local Government resources is necessary.

This study showed that the Spot image could be a good data for effective management of environmental resources. The Local Government will need to possess such data and learn how to extract the necessary information from it when need arises for effective management of landuse/landcover resources in their domain.

REFERENCES

Aldrich, F.T. (1981) Landuse data and their acquisition: In Lounsbury, J.L., Sommers, L.M. and Fernald, E.A (eds) Landuse: A Spatial Approach. Kendall Hunt Publishing Company: Dubuque, Iowa, USA and Toronto, Ontario, Canada. Pp79-95.

Anderson, J.R., Hardy, E.E, Roach, J.T. and Witmer, R.E. (1976) Alanduse and Landcover classification system for use with Remote Sensor Data. Geological Survey Professional Paper 964, US Government Printing Office: Washington, DC.

Burley, T.M. (1961) Landuse or land utilization? Professional Geographer Pp18-20.

Dale, P.F. and McLaughlin, J.D. (1990) Land Information Management, An introduction with special reference to cadastral problems in Third World countries. Clarendon Press. Oxford.

Foster-Smith, J. (1997) The Role of Mapping in Marine Natu Conservation Management, in Evans, S.M., Vanderpuye, C.J. and Armah, A.K. (eds) The Coastal Zone of West Africa: Problems and Management, Penshaw Press, Sunderland, U.K.

Kaduna State Ministry of Commerce, Industry and Tourism (___) Briefs on Local Government Areas in Kaduna State. Guide to commercial/Industrial investment opportunities in Kaduna State. Paragon Printers, Kaduna.

Kressler; F.P. and Steinnocher K.T. (1999) "Detecting landcover changes from NOAA-AVHRRdata by using Spectral mixture analysis" JAG, Vol 1, Issue 1, Pp.21.

Lo, C.P. (1986) Applied Remote Sensing, Longman Inc; New York.

Rilwani, M.L. and Ufuah, M.E. (1999) Mapping the Landuse-Landcover Resources of Edo North-East for effective Local Government Administration, in Balogun, O.Y. and Soneye, A.S.O. (eds). Cartography in the Service of Government. Special Publication of the Nigerian Cartographic Association. Pp61-63.

SSC SATELLITBILD (1998). Kaduna Spot ULC 319956, 1157573, LRC 329956,1447573.

Uluocha, N.O. (1999) Mapping for integrated management of tourism resources in Lagos State, in Balogun, O.Y. and Soneye, A.S.O. (eds). Cartography in the Service of Government Special Publication of The Nigerian Cartographic Association. Pp 71.

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 73-89

TEMPERATURE AND RAINFALL FLUCTUATION
A CASE STUDY OF UDIGRAM, SWAT VALLEY, NORTHWEST PAKISTAN

Saifullah Khan
and
Mahmood-ul-Hassan
Department of Geography, Urban and Regional Planning,
University of Peshawar, Peshawar.

ABSTRACT

A study of temperature and rainfall fluctuation of Udigram, Swat, reveals decrease in annual rainfall during the past 15 years. As a result climate has become sub-humid in 2000, as compared to the humid in 1980. The valley receives both summer and winter rainfall, but the annual share of winter rain is higher than summer season. January is the coldest month when the temperature falls to freezing point, and June is the hottest month when the temperature exceeds 30 degree Celsius. There are four rainy seasons i.e. winter, pre-monsoon, monsoon, and the post monsoon. The temperature of the valley increlses at the rate of 1°C per year since 1998. The summer rain showed little decrease, whereas the winter rainfall declined at the rate of 5cm per year during the past six years since 1995. If the rainfall of the valley decrease at this rate, then the climate of the area will be semi-arid by 2020. This climatic fluctuation may be the result of the changes in the air pressure, wind speed and direction, and deforestation on global level, and the Gulf-Afghan crises. However, due to rapid increase in temperature and decrease in pressure, it is estimated that this reduction in winter rains of the area will be recovered upto 2005.

INTRODUCTION

Udigram, a historical place of evergreen land of Swat Valley, Northwest Pakistan, is located at 72°-18' east longitude and 34°-47'north latitude, at an altitude of 961m above the sea level.. The Population of the village was 4402, in 1981, and increased to 12497, in 1998. The village is bounded by Balogram in the north, Raja Gira mountains in the east, Gogdara in the south and the Swat river in the west.. The tributaries of Swat and Murghazar rivers cover the whole drainage of the *tract* (Map-1).

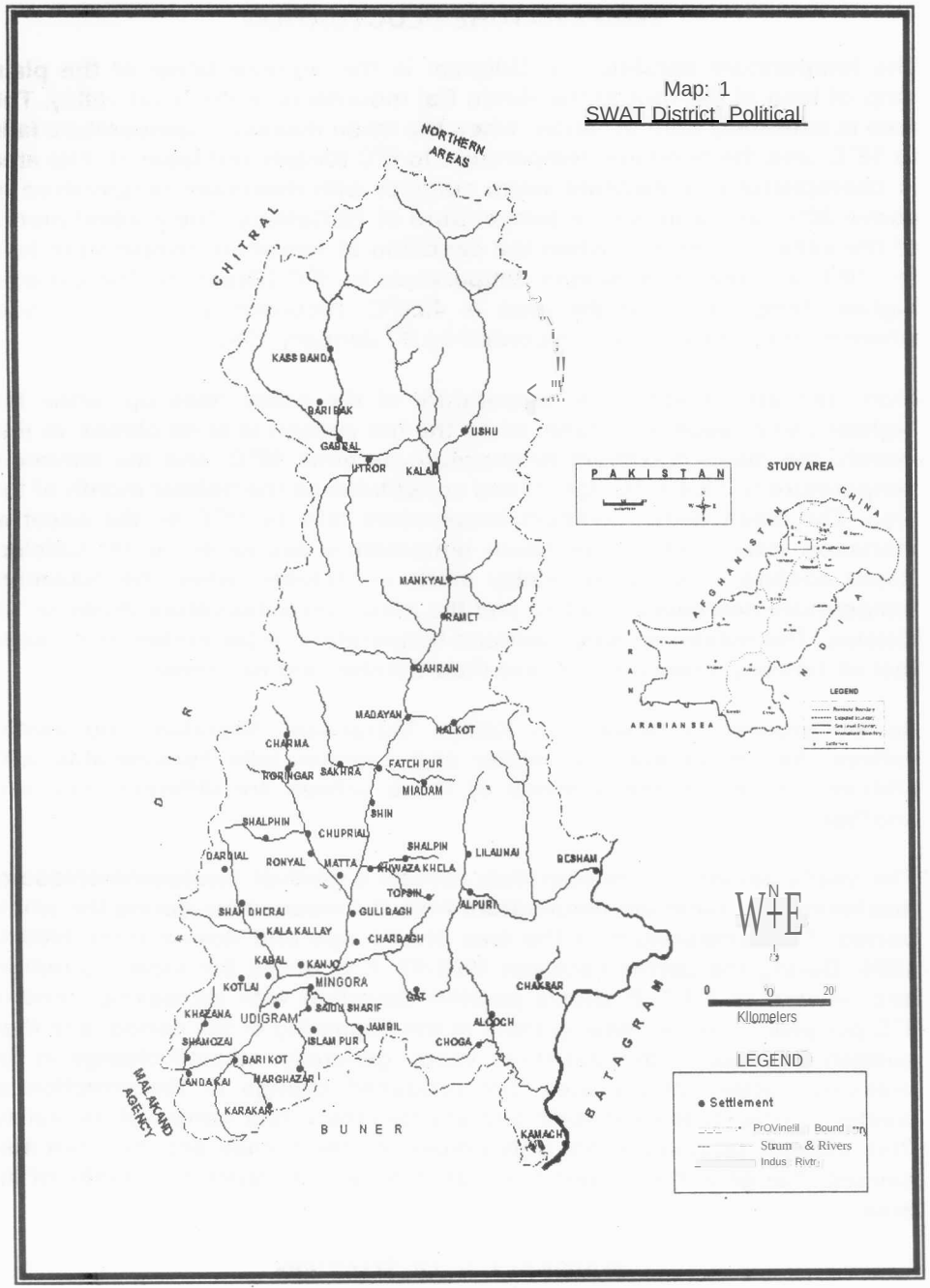
The present paper deals with the rainfall and temperature variation of the Udigram valley during the past fifteen years, and its possible causes in the background of the global climatic changes.

A number of workers have studied the fluctuation of temperature and rainfall on regional level in the past, including Kazi (1951), Kazi and Khan (1959), Shamshad (1966), Nasrullah (1968), Khan (1990), and Khan (1993) etc. The present study is aimed at Udigram only, where the reduction of rainfall has caused a number of environmental problems.

METHODS AND DATA

The work is based on the daily as well as monthly weather data, covering a time duration of fifteen years i.e. 1986-2000, published by Water Management Department, Agriculture University Peshawar, and Agriculture Research Station, Takhta Band, Mingora, Swat. The variables studied, are temperature and rainfall.

The monthly and annual averages have been calculated for the study. For each parameter, deviation from the mean and regression has been calculated, which provides a trend of annual as well as monthly fluctuation of rainfall and temperature. The year has been divided into two main seasons i.e. summer and winter. Months of the year having positive deviation from the mean condition of maximum and minimum temperature have been considered as summer months, otherwise winter. The two main seasons are further sub-divided into four sub-seasons i.e. winter rainfall (Mid-November to Mid-April), pre-monsoon season (Mid-April to June), monsoon season (July to Mid-September), and the post-monsoon season (Mid-September to Mid-November). The time duration of each season has been decided on the basis of positive and negative deviation from the mean condition. April, September, and November show increase, therefore, the total rainfall of these months have been divided by two, and each half of the value is added to the both seasons.


Map: 1
SWAT District Political
NORTHERN AREAS
CHITRAL
KASS BANDA
DARI BAK
GABRAL
UTROR
KALAM
USHU
MANKYAL
BAHRAIN
MADAYAN
BALKOT
CHARMA
KORINGAR
SAKHRA
FATCH PUR
MIADAM
SHIN
BHALPHIN
CHUPRIAL
DARGAI
RONYAL
MATTA
KHWAZA KHELA
LILAUNAI
BESHAM
TOPSIN
SHAMDHERAI
GULI BAGH
ALPURI
KALA KALLAY
CHARBAGH
KABAL
KANJO
MINGORA
KOTLAI
GAT
CHAKDAR
KHAZANA
UDIGRAM
SAIDU SHARIF
JAMBIL
ALOCH
SHAMOZAI
ISLAM PUR
CHOGA
BARI KOT
LANDAKAI
MARGHAZAR
KARAKAR
BUNER
MALAKAND AGENCY
DIR
BATAGRAM
KAMACH
PAKISTAN
STUDY AREA
AFGHANISTAN
CHINA
INDIA
ARABIAN SEA
LEGEND
W N E S
0 10 20
Kilometers
LEGEND
Settlement
Provincial Boundary
Streams & Rivers
Indus River

TEMPERATURE FLUCTUATION

The temperature condition of Udigram is the representative of the plain strip of land at the foot of the Hindu Raj mountains in the Swat valley. The area is extremely cold in winter, when the mean maximum temperature falls to 18°C, and the minimum temperature to 6°C (Graph and table-1). The area is characterized by pleasant warm summer with maximum temperature of above 30°C, and a minimum temperature of 18°Celsius. The coldest month of the valley is January, when the deviation of maximum tempe,rature falls to -10°C and that of minimum temperature to _9°C(Graph-2). The extreme highest temperature of the area is 43.6°C, recorded on 1st June 1988, whereas, the lowest is _3°C,recorded on 3rd January 1987.

From January to April, the temperature of the valley rises up, while the highest value reaches in June, when the hot season is at its climax. In this month, the mean maximum temperature exceeds 32°C, and the minimum temperature to 18.4°C (Graph-1) and constitutes as the hottest month of the area. The mean daily maximum temperature falls to 30°C on the onset of monsoon lows, and the minimum temperature decreases to 18° Celsius. Rapid cooling of air in the valley starts in October, when the maximum temperature decreases to 24°C, and the minimum temperature drops to 10° Celsius. The maximum and minimum temperature in December, is close to that of January, however, it is less than October and November.

As we proceed northward to Kalam, Murghazar, Miandam and Jambil valleys, the temperature in winter and summer falls considerably with altitude. Therefore, the climates of these valleys are different from one another.

The yearly variation of temperature reveals a gradual increase/decrease of maximum and minimum temperature from the mean value during the whole period. The temperature of the area shows ups and downs from 1986 to 1994. During the period between 1994-97, it is below the mean condition, and onward to 2000, it shows positive deviation with increasing trend of 1°C per year. This decreasing trend in the beginning of the period, and then sudden increase in the last three years, generally, caused change in the pressure pattern of the area that produced change in the direction of westerly currents toward north and effected the winter rainfall of the valley. This climatic fluctuation not only influenced the human activities but also caused change in the evapotranspiration as well as relative humidity of the area.

RAINFALL FLUCTUATION

Udigram has sub-humid climate with annual rainfall of 98.9cm (39.6inches) as has been shown in table-3. The area is highly moist in March, when the rainfall increases upto 17cm, followed by July with rainfall above

13centimeters. The driest month of the year is November, when the rains drops to less than 4cm, followed by May, with rainfall above Scentimeters. The area receives both summer and winter rains, but the contribution of winter rains is higher as compared to summer (Graph-1).

The recent fluctuation of rainfall, plotted on graph-3 and 4, shows a gradual decrease in rainfall during the past fifteen years. The precipitation during 1986-90 shows a decreasing trend. The area recorded 17.6cm rainfall In 1986 that dropped to -S.4cm, In 1990. In the period between 1991-9S,the rainfall reveals a rapid Increase from 9.3cm to 15.1em, with negative deviation anomalies In 1993 and 1994 and then falls to -27cm, In 2000. As shown In graph-4 that the rainfall of the valley in the last five years (1995-2000) decreased at the rate of 5cm per year. This rapid reduction in rainfall not only Influenced the crop growth and yield, but it also affects the human activities of the area. Inspite of this, from 1931 to 1970, the average rainfall of the valley was above 40inches (100cm), and the area had a humid climate. But the reduction of rainfall in the past fifteen years *(5cm/year)* put the area in sub-humid climate. If the rainfall decreases at this rate continuously, then the climate of the valley will change from sub-humid to semi-arid upto 2020 i.e. during the next 20 years.

Swat valley receives both summer and winter rains, and the annual rainfall is the average of these two seasons. The deviation of rainfall from the mean condition of the seasons, plotted on graph-S, shows that from 1986 to 1990, the summer rains increased from 11 to 18cm, and the winter rains from 12 to 18centimeters. From 1991-95, the summer rain reveals positive deviation of 14 to 20cm, and the winter rainfall from 0.6 to zero centimeters, with little increase of 7 to 9cm, in 1991 to 1992. In 1995 to 2000, the summer rains decreased from 20 to Scm, while the winter rains dropped from zero to -26centimeters. In the last five years, the summer rains of the area decreased at the rate of 3cm/year, whereas, the fall in winter rain is 5.3cm/year. The decrease in the winter rains of the valley is higher than summer, and due to this rapid decrease, the area is continuously going towards aridity.

Based on annual march of rainfall, these two seasons are further divided into four sub-seasons i.e. winter, pre-monsoon, monsoon, and the post-monsoon seasons. The general description of each season is as follow.

WINTER RAINFALL

The winter rainfall is associated with the passage of western disturbances, which move eastwards from Iran and Afghanistan from Mid-November to Mid-April. An active western disturbance can induce fairly heavy rain. In some of the heaviest falls in winter, amount as high as 10.2cm has been recorded on 2nd February 1980. The total rainfall of the area recorded in

winter is 46centimeters. The rains, in this season start with its lowest amount in December (5.1cm), and increase upto 17.4cm in March.

The rainfall v~riation plotted on graph-6, shows that the total rainfall of the area was 56.5cm in 1986, and dropped rapidly to 32.5cm in 1989. In 1990, the winter rains increased to 70.2cm, and then decreased continuously to 25.2cm in 2000. In winter, the rainfall shows a high decrease, which may be the result of change in atmospheric circulation, temperature, and air pressure. However, the rapid increase in temperature in the last five years will cause high rains due to low pressure in the area, which may recover the deficiency in rains of winter quota upto 2005.

PRE-MONSOON RAINFALL

The season generally lasts from Mid-April to June, when the temperature of the valley reaches to its extreme. These rains are mostly the result of the ascending air currents, due to local heating, and therefore, they are also designated by the name, "local thunderstorms". The total rainfall of the season is 15.8cm, with high rainfall of 10.2cm in April, and lowest is 5.6cm in May.

The rainfall recorded in the pre-monsoon season is 30.6cm in 1986, and decreased to 2.5cm in 1990. Again there is an Increase in the next 10 years and by the year 2000, it has increased to 14.4centimeters. The variation of rainfall, generally, shows very minor decrease, but the rate of decreases is less as compared to 1986. This minor fluctuation in the area leads to increase in temperature particularly in May and June, and the mountain slopes, help to activate the warm moist air parcels to condensation level and bring rains.

MONSOON RAINFALL

The monsoon precipitation is associated with the convergence of the Arabian sea and Bay of Bengal currents in upper troposphere when a tropical depression is developed over central part of the Indo-Pakistan sub-continent.. The monsoon winds reach to the area in the first week of July and are well-established upto mid of that month. The major share of summer rains from these winds is 24.4cm, which is one-half of the winter rains. July, with 13.7cm rainfall, is the leading month of the season, while it decreases to 6.3cm in September, when the monsoon currents reverse from land to Arabian sea (Graph-6).

The fluctuation of monsoon rainfall for Swat valley shows that in 1986, the area recorded a total rainfall of 25.9cm, and reduced to 18.8cm in 1990. In 1991, it increased to 35.8cm and 38.9cm till1995. Onward, the rainfall shows gradual decrease to 23.3cm in 2000, with 3cm falls per year.

POST- MONSOON RAINFALL

In September, when the summer convergence zone shifts southwards, there is a marked decrease in rainfall of the area. Rainfall decreases further, after the withdrawal of the monsoon, and November is usually the driest month of the 'year. The post-monsoon season remains from Mid-September to Mid-November. During this season, the total rainfall of the area drops to 7.6cm, with 3.1cm in October and 0.5cm in November.

The area recorded 4.5cm rainfall in 1986, which decreased to 2cm in 1990, and then increased to 7cm in 1995, and 9cm in 2000. The fluctuation in the past 15 years show a marked increase in rainfall, but it is many times less than the decrease in winter rains and does not fill the reduction of winter quota (Graph-6).

CAUSES OF TEMPERATURE AND RAINFALL FLUCTUATION

The following are the possible causes of climatic change in the Swat valley.

- The recent climatic fluctuation seems to be the result of change in the atmospheric pressure on global scale, particularly, between equator, tropics, and polar region. According to Khan (1960), "The annual pressure was rising in the South Asian low pressure belt and the Equatorial trough and falling in the Siberian high pressure, since the beginning of the period 1881 to 1915. After this period the trend changed to one of increase in the Siberian high pressure and decrease in the South Asian low pressure and the Equatorial trough. This trend continued upto 1941-50, after which it showed signs of reversal to the previous trend." This change in the pressur~ gradient on global scale may be responsible for the present fluctuation of rainfall in the area.

- Another main cause of low winter rain in Swat valley may be the change of speed and direction of westerly currents. Khan (1960) is of the opinion that, "The rainfall condition has been improving over the southwest monsoon regime during the period of 1931-50 and has shown deterioration over the northeast monsoon regime. The rainfall had been persistently decreasing over Middle East and increasing over the Soviet Republics of Central Asia. The trend seems to be most probably connected with a northerly shift of the track of western disturbances. The deterioration of rainfall in the arid and semi-arid zone of West-Pakistan and Baharat may also be due to a reduction in the winter quota of the annual precipitation." This northerly shift in the wind direction of westerly currents may have increased the share of winter rain in Central Asia and decreased it continuously in Indo-Pakistan sub-continent

- Deforestation is another main human activity, and most of the natural vegetation of the valley has been cut for lumbering or farming, without immediate replanting of new trees. The mountains and soil are barren and completely exposed to rain and wind erosion. Such exposed terrain, generally, reflects high amount of incoming radiation back to space and causes change in the atmospheric temperature of the area.

- The Middle East, Indo-Pakistan, and Afghanistan are the war zones from the past 30 years. These crises created serious problems due to the use of highly explosive devices and burning of 011 wells In Kuwait and Iraq, which produced a huge amount of un-burned methane and ethane gases, particularly during Gulf war, that caused ozone depletion. Consequently the rate of ultraviolet radiation increased on the earth surface and this may be one of the cause of the temperature fluctuation in the Indo-Pakistan sub-continent..

RECOMMENDATIONS

The suggestions for the improving of winter rains in Indo-Pakistan sub-continent are as follow:

- The global climatic change is mainly the result of various human activities like, exhaust gases from industries, wars, deforestation, chloroflorocarbons, and the use of fossil fuels. Therefore, it is needed to initiate programs to create awareness among the people about the effects of these atmospheric pollutants on the physical environment of the area.

- Legislation is needed to prevent sever cutting of forests and also to ensure the immediate replanting of trees, cut for lumbering or farming and also to provide alternate sources of energy e.g. bio-gas, and natural gas for the domestic use. However, the plantation of eucalyptus is not recommended, as it evaporates more than S0liters of the groundwater into atmosphere per day and is more dangerous to watertable.

- Contourwise ploughing of the hill slopes should be carried out at right angle to the hill slopes. This impedes the downward flow of the rainwater and checks soil creep so that gullying does not develop. Much of water is also retained by the furrows and absorbed by the plants that are grown in a contourwise pattern, improving the crop. Therefore, for the proper surface run-off and control of soil erosion; the awareness of people about the contourwise ploughing in the catchement area should be created.

- For exter:::ive afforestation, it is necessary to provide facilities to the inhabitants of the area and to encourage the community reforestation.

- Further study is needed to find out the causes of modification in temperature, pressure, wind speed and direction, and rainfall on global
- scale so that by proper planning, the problems arising due to the shortage of water may be met with.

CONCLUSION

The area is cold in winters, and warm in summers. January is the coldest month, when the minimum temperature drops to below freezing, whereas, June is the hottest month, whe,nthe maximum temperature exceeds 30°C. The variation of temperature shows marked increase of 1°C per year in temperature, particularly from 1998to 2000.

The area receives both summer and winter rains. The summer rains are the result of pre-monsoon and monsoon season, while the winter rains are the sum of the post-monsoon and western depressions. The annual total rainfall of the area is 98.9cm (39.6inches) currently and the climate has changed from humid (>40inches) to sub-humid. The highest rainfall of the area is received in March (17.4cm),which decreases to 3.3cm in November. The total winter rainfall of the valley is 82.9cm, whereas, that of summer as 57.5centimeters. Thus the major share of rainfall in the area is from winter season. The rainfall of the valley recorded in pre-monsoon season is 15.8cm, while from monsoon it is 24.4cm, and from post monsoon it is 7.6cemimeters. The pre-monsoon period shows very little fluctuation, while the other three rainy seasons lead to rapid decrease in rainfall from 1986to 2000. The deviation of rainfall from the mean condition falls to negative deviation from 1986to 1990,then it increased from 1990to 1995,and again fell to negative deviation upto 2000 at the rate of 5cm per year. The winter rains' decreased continuously for the last five years up to -26cm, while the summer rains decreased from 1995to 1999,and then increased to 4.6cm in 2000. in general, the winter rains of the area continuously decreased as compared to summer rainfall. However, the rapid increase in temperature is a hopeful sign for the recovery of winter rains upto 2005. This variation of rainfall generally triggers to change in air pressure, wind- speed and direction, increase in temperature, and deforestation on global scale.

ACKNOWLEDGEMENT

The authors are indebted to Dr. Roshan Ali, soil scientist, Agriculture Research Centre, Mingora Swat, for providing the weather data, to Mr. Abdul Wahab Khan, associate professor Govt. college Matta, Swat, and to Mr. Mukhtar Bacha, School Mapping Consultant, British Council, Peshawar, for provJdinq computer facilities.

BIBLIOGRAPHY

Amin M.M. Metorological Observations., *Weather and Climatic Elements.,* NWFP Agriculture University Peshawar., 1992-2000.

Anwar M.M. 1993., A Geography of Pakistan., Publication of Book-World Islamabad and Lahore., p. 10-30.

Arnon I. 1972, Crop production in dry regions; A Publication of National Book Foundation of Pakistan; and Great Britain by Cox & Wyman Ltd., P.1-40.

Bao Z. & Mikami T. *Summer Rainfall Anomalies in the Yangtze, Valley.... from* 1951 to 1991., Vol. 71., No.1., 1998., p.59-71.

Blair T.A. 1942., Climatology., *(General and Regional).,* Publication of Prentice-Hail, INC. New York., p. 1-200.

Critchfield H.J. 1987., General Climatology., (4th eddltlon)., Prentice' Hall of India New Delhl-110001., p. 40-250.

GOP, OCR of Swat., Pakistan Census Organlza\ion Statistics Division, Islamabad., June 1983., p.98.

GOP, OCR of Swat., Pakistan Census Organization Statistics Division, Islamabad., November 1998., p.202.

Karlen W. *Climate Variation and the Enhanced Green House Effect., Ambio., A Journal of the Human Environment.,* Vol. XXVII., No.4., June 1998., P. 270-274.

Kazi S.A. & Khan M.L. *Variability of Rainfall and its Bearing on Agriculture in the Arid and Semi-Arid zone of West-Pakistan.,* Pakistan Geographical Review., Vol. 16., No.1., January 1961., p. 25-35.

Kazi S.A. & Khan M.1. *Variations of Moisture types and their Bearing on Soil erosion in West-Pakistan.,* Pakistan Geographical Review., Vol. XIV., No.1., 1959., p.1-19.

Kazi S.A. 1951., *Climatic Regions of West Pakistan.,* Pakistan Geographical Review., Vol. VI., No.1.

Kazi S.A. etal, 1961., Variability of Rainfall & its Bearing on Agriculture., PGR, Vol. 16., No.1.

Kendrew W.G. 1941., Climates of the Continents., Publication of Oxford University Press London., pp. 208.

Khan F.K. 1991(1) 93(11)A Geography of Pakistan *(Environment, People Economy).,* Oxford University Press Karachi, Pakistan.

Khan J.A. May 1993., *The Climate of Pakistan.,* Rahber Publishers Karachi.

Khan M.L. *Recent Climatic Fluctuation Over South Asia and the Indian Ocean.,* Pakistan Geographical Review., Vol. 15., No.2., June 1960., p.18-37.

Khan S. *Impact of Ozone.,* The Daily Frontier Post Peshawar., August 13th, 2000., p-3.

Morishima W. & Mikami T. *Interannual Variations in Asian Summer Rainfall and their Association with Tropical Convective Activities and Global SST Anomalies.,* Geographical Review of Japan, Vol. 71., No. 2., 1998., p.85-99.

Nasrullah .K. January 1968., *Climate of West Pakistan According to Thornthwaite System of Classification of Climates.,* Pakistan Geographical Review., Vol. 23., No.1., p. 12-25.

Salim M. *The Facts of Forestry in Swat Valley.,* Urdu Medium., Udyana Today, A Magazine of Environmental Protection Society Swat., Issue. 4., Vol. 7., Oct.-Dec. 2000., p. 14~18.

Suzuki H. *World Precipitation Present and Hypsithermal.,* Bulletin of the Department of Geography University of Tokyo., No.7., March, 1975., p. 1-15.

UDIGRAM

Table-1: Mean Monthly Maximum Temperature (°C) 1986-2000

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1986	14.2	14.5	17.4	22.3	27.5	35.0	34.4	31.4	29.1	25.7	18.5	12.9	23.6
1987	13.7	16.0	18.5	23.3	26.2	33.7	35.0	31.8	31.5	23.8	22.5	18.0	24.5
1988	14.7	15.5	13.9	23.9	33.9	34.9	30.6	29.1	31.5	26.2	19.2	16.0	24.1
1989	14.5	14.3	19.1	22.5	32.6	35.7	33.0	29.2	31.0	19.8	19.7	15.1	23.9
1990	14.3	13.9	17.9	21.3	32.4	32.0	34.2	30.5	30:0	26.9	21.1	20.5	24.6
1991	12.7	14.0	19.8	22.0	28.7	31.0	32.6	31.2	28.9	26.8	11~5	16.5	23.0
1992	12.8	15.2	17.7	23.4	28.3	33.5	31.7	35.2	22.0	17.4	28.6	26.0	24.3
1993	13.4	18.7	16.0	26.0	31.1	32.7	28.8	30.2	29.3	26.1	21.5	18.5	24.4
1994	12.9	11.9	19.6	21.9	28.8	34.7	30.1	29.9	28.5	23.4	20.9	14.4	23.1
1995	13.5	14.6	16.3	21.3	29.5	35.9	31.7	29.8	29.2	23.9	21.9	14.4	23.5
1996	14.0	16.0	16.8	24.2	26.8	31.5	31.8	30.5	30.2	24.5	20.8	16.5	23.6
1997	14.2	14.8	17.3	21.6	26.8	30.9	32.0	30.5	29.7	19.4	18.9	13.7	22.5
1998	13.2	12.8	16.6	24.1	29.7	32.9	32.1	31.5	28.8	27.6	23.1	19.6	24.3
1999	11.8	14.1	18.2	26.8	32.9	34.0	32.3	30.9	30.1	26.9	19.7	19.0	24.7
2000	14.0	13.4	17.5	28.0	33.8	33.8	32.0	31.4	29.4	28.3	22.0	17.8	25.1
Average	13.6	14.6	17.5	23.5	29.9	33.5	32.2	30.9	29.3	24.4	20.7	17.3	23.9

Source: Pakistan Agriculture Research Station Mingora Swat

Table-2: Mean Monthly Minimum Temperature (°C) 1986-2000

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1986	3.7	4.1	5.3	11.3	19.3	16.2	20.6	19.3	16.6	12.6	7.3	4.0	11.7
1987	2.9	5.0	8.2	11.2	13.7	18.2	19.4	20.4	17.6	12.5	6.0	2.5	11.5
1988	3.8	4.7	6.2	12.7	15.0	20.4	22.7	19.3	17.6	10.6	5.4	3.6	11.8
1989	4.3	5.6	9.2	9.5	14.1	17.6	19.2	19.2	20.1	8.4	5.0	4.2	11.4
1990	2.5	4.3	6.0	9.6	15.8	18.1	22.1	21.6	18.0	11.9	4.1	2.3	11.4
1991	1.8	3.7	7.4	9.5	13.9	17.1	19.0	20.1	15.7	11.5	4.2	4.5	10.7
1992	3.1	n	7.0	11.4	14.2	18.5	20.8	20.1	16.0	9.0	6.1	3.7	11.1
1993	1.2	4.7	5.2	11.8	16.2	18.9	20.3	18.4	16.3	8.5	5.3	2.6	10.8
1994	1.0	0.9	7.5	7.6	15.2	18.9	22.2	21.2	14.3	7.9	4.9	0.6	10.2
1995	1.7	1.9	4.6	7.6	15.9	19.0	21.2	20.6	14.3	10.0	2.8	0.4	10.0
1996	-1.3	2.0	7.0	10.4	13.7	17.5	19.8	19.8	16.4	9.7	2.7	-1.4	9.7
1997	0.0	1.1	6.2	10.3	12.6	18.1	22.6	20.5	17.2	11.9	4.9	0.7	10.5
1998	-0.1	2.3	4.5	10.7	15.6	18.2	21.9	20.7	17.0	11.3	3.9	-0.9	10.4
1999	0.9	5.0	7.3	12.2	16.3	18.6	21.3	20.1	18.5	10.7	6.8	0.7	11.5
2000	1.2	1.6	6.3	10.9	16.7	20.2	21.0	19.8	16.0	10.5	5.9	2.0	11.0
Average	1.8	3.3	6.5	10.4	15.2	18.4	20.9	20.1	16.8	10.5	5.0	2.0	10.9

Source: Pakistan Agriculture Research Station Mingora Swat

UDIGRAM

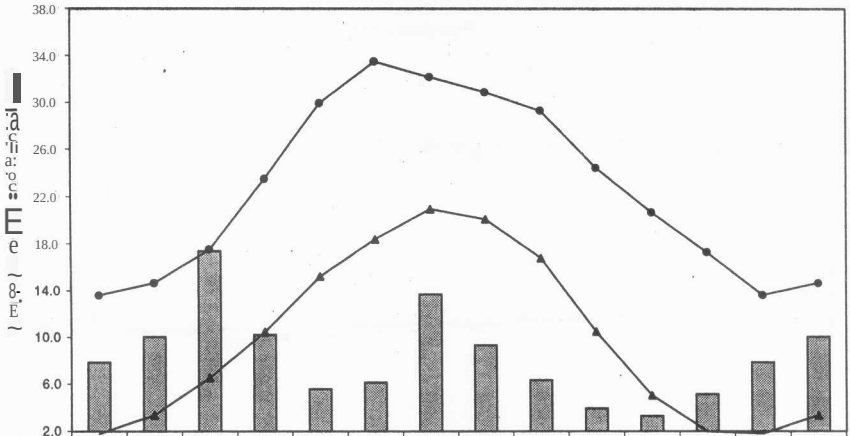
Table-3: Mean Monthly Rainfall (cm) 1986-2000

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1986	4.5	3.8	35.2	18.1	1.6	19.5	14.4	9.5	4.0	0.2	4.6	1.2	116.5
1987	4.1	11.2	15.0	5.0	4.5	Nil	9.0	Nil	Nil	Nil	16.3	8.0	73.1
1988	7.5	9.0	25.0	2.5	1.5	7.5	21.0	16.5	10.5	2.0	Nil	12.4	115.4
1989	9.1	2.8	12.2	2.4	10.4	3.8	Nil	7.5	3.0	0.5	Nil	7.2	58.8
1990	7.7	19.6	26.2	4.0	Nil	0.5	3.5	14.0	2.5	Nil	1.6	13.9	93.5
1991	4.3	13.2	17.9	19.3	10.3	1.0	27.2	3.2	10.7	Nil	0.6	0.6	108.2
1992	24.5	7.0	15.8	Nil	8.6	3.9	15.7	8.7	11.2	9.4	2.1	3.7	110.7
1993	4.1	4.4	31.5	16.4	2.7	5.4	14.0	5.4	5.2	3.2	4.6	0.2	97.1
1994	4.6	5.8	7.7	12.4	4.9	2.2	10.8	7.5	4.3	8.8	0.3	11.8	80.9
1995	1.1	11.8	14.6	17.7	2.0	17.0	29.0	9.1	1.6	4.0	3.5	2.6	113.9
1996	8.2	22.0	15.3	6.7	8.5	6.0	7.8	6.8	4.1	6.8	0.4	1.5	94.1
1997	3.2	2.1	11.3	19.5	8.1	7.7	6.5	12.3	2.5	4.8	2.3	1.5	81.8
1998	7.2	23.8	11.3	12.1	6.9	1.1	10.5	12.1	8.0	3.3	0.3	Nil	96.5
1999	18.7	8.6	14.2	6.5	1.4	3.0	14.9	7.3	10.0	1.0	5.4	Nil	91.0
2000	8.8	5.7	7.6	0.6	7.0	7.2	7.5	10.3	11.0	3.1	0.9	2.4	71.9
Average	7.8	10.0	17.4	10.2	5.6	6.1	13.7	9.3	6.3	3.9	3.3	5.1	98.9

Source: Pakistan Agriculture Research Station Mingora Swat

Udlgrlm

Grlph·1: Meln Monthly Mlxlmum. Minimum Templrlturelnd Rllnflll (1986·2000)

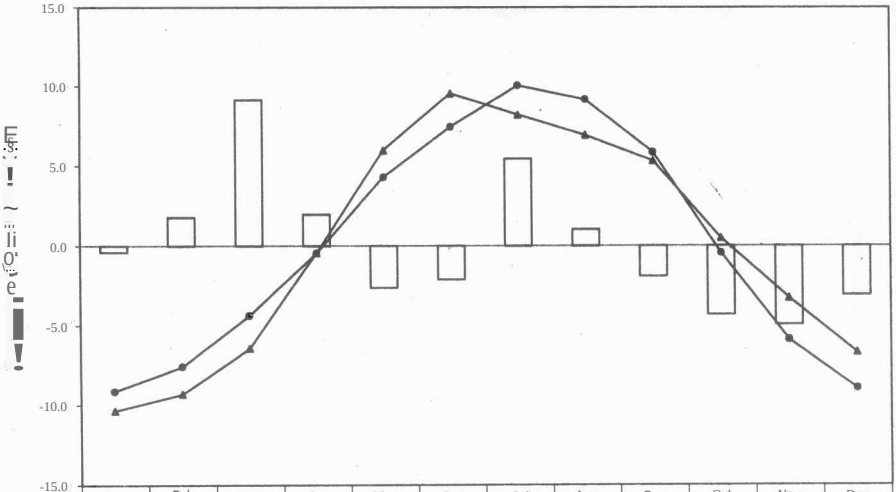


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Rainfall	7.8	10.0	17.4	10.2	5.6	6.1	13.7	9.3	6.3	3.9	3.3	5.1	7.8	10.0
Maxi.T.	13.6	14.6	17.5	23.5	29.9	33.5	32.2	30.9	29.3	24.4	20.7	17.3	13.6	14.6
Mini.T.	1.8	3.3	6.5	10.4	15.2	18.4	20.9	20.1	16.8	10.5	5.0	2.0	1.8	3.3

Months

Udigram

Graph-2: Deviation of Mean monthly Maximum, Minimum Temperature and Rainfall

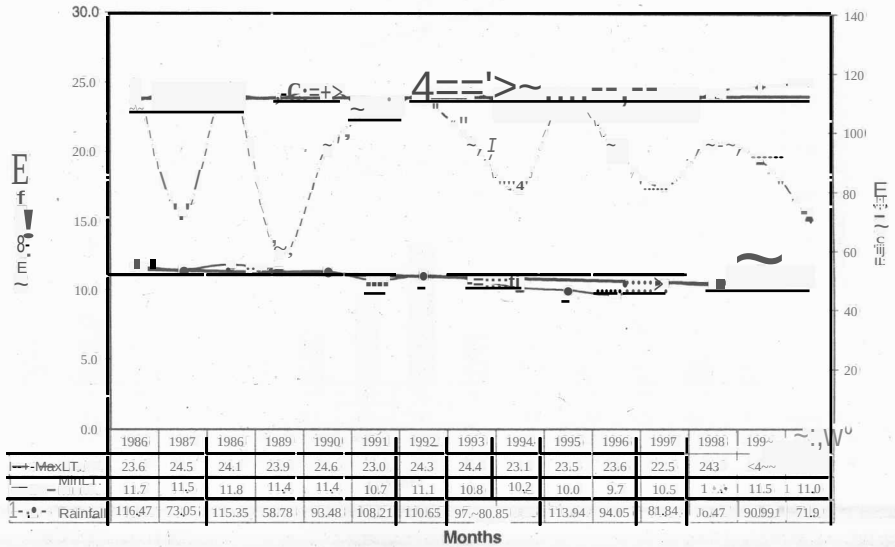


	Jan	Fqb	Mar	Apr	May	Jun	Jul	Aug	Sap	Ocl	Nov	Doc
c:JRainfan	-0.4	1.8	9.1	2.0	-2.6	-2.1	5.5	1.1	-1.9	-4.3	-4.9	-3.1
MaxLT.	-10.4	-9.3	-6.4	-0.4	6.0	9.5	8.2	6.9	5.3	0.5	-3.3	-6.7
Mlnl.T.	-9.1	-7.6	-4.4	-0.5	4.3	7.5	10.0	9.2	5.9	-0.4	-5.9	-8.9

Months

Udigram

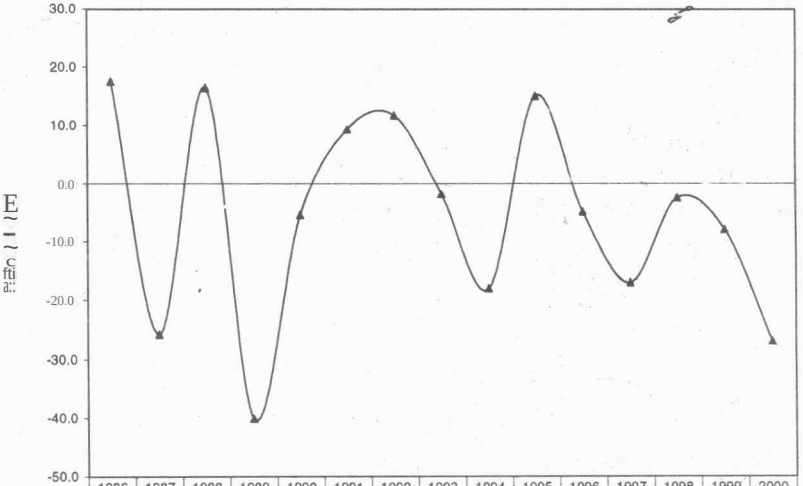
Graph-3: Mean Monthly Maximum, Minimum Temperature (0C) and Rainfall (em)



	1986	1987	1986	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	199~
MexLT	23.6	24.5	24.1	23.9	24.6	23.0	24.3	24.4	23.1	23.5	23.6	22.5	243	<4~~
MinLT	11.7	11.5	11.8	11.4	11.4	10.7	11.1	10.8	10.2	10.0	9.7	10.5	1	11.5	11.0
Rainfall	116.47	73.05	115.35	58.78	93.48	108.21	110.65	97.~80.85		113.94	94.05	81.84	Jo.47	90.991	71.9

Udigram

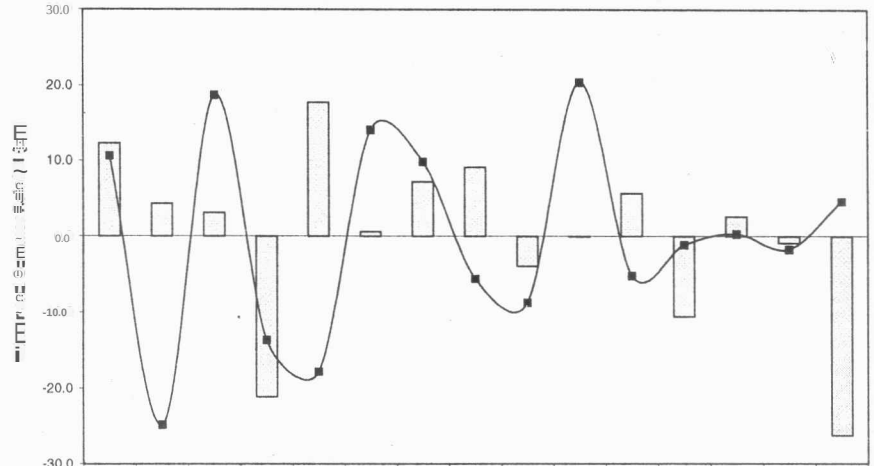
Graph -4: Deviation of Mean Monthly Rainfall (1986-2000)



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Rainfall	17.6	-25.8	16.5	-40.1	-5.4	9.3	11.8	-1.8	-18.0	15.1	-4.8	-17.0	-2.4	-7.9	-27.0

Udigram

Graph -5: Deviation of Mean monthly Summer and Winter Rainfall (em)

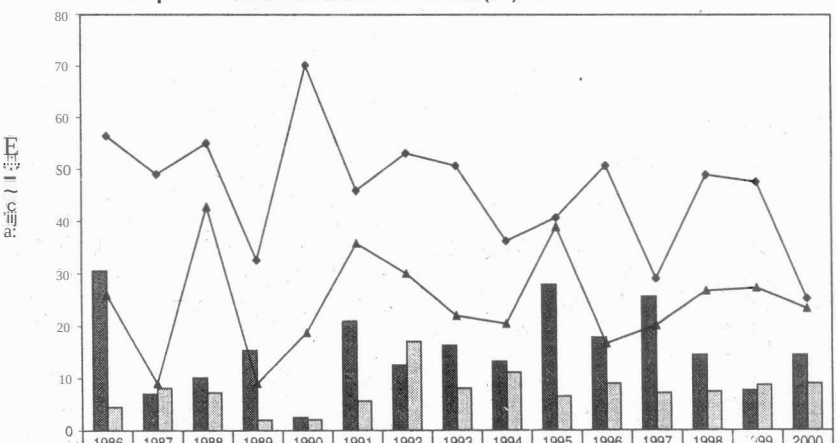


	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Winter	12.3	4.3	3.1	-21.1	17.7	0.6	7.2	9.2	-3.9	0.0	5.7	-10.6	2.6	-0.8	-26.2
Summer	10.6	-24.8	18.7	-13.6	-17.8	14.1	9.9	-5.6	-8.7	20.4	-5.2	-1.1	0.3	-1.7	4.6

Year

Udigram

Graph -6: Seasonal Variation of Rainfall (em)



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Pre-Monsoon	30.56	7	10.15	15.4	2.5	20.97	12.54	16.31	13.2	27.87	17.83	25.55	14,48	7.65	14.44
c=JPost-Monsoon	4.5	8.15	7.25	1,98	2.05	5.65	17.08	8.1	11,1	6.55	9.02!	7.15	7.41	8.72	9.05
Winter	56.45	48.95	55	32.5	70.15	45.89	53.06	SO.66	36i2	40.68	SO.65	28.99	48.86	47,49	25.17
Monsoon	25.9	9.0	428	9.0	18.8	35.8	30.0	22.0	20,4	38.9	16.6	20.1	26.6	27.2	23.3

Year

PK ISSN 0030-9788
Pakistan Geographical Review
Volume 56 Number 1 & 2 2001 pp. 91-96

INDUS: THE MIGHTY RIVER

Ali Iqtadar Mirza
Department of Geography, Government College, Lahore.

Abstract

The Indus River System conceal great ruptures and factures of the earth crust thousands of feet in depth. It was originally occupied by sea. During the past few million years, the depression has got filled up with alluvium washed down from the mountains. The area which now constitutes was originally a sea bed. The depth of the bed rocks within the plains of the Indus has not been exactly mapped. At places it has been considered to be as deep as 15,000 to 20,000 feet.

THE SOURCE

The Tibet plateau which is located in western and south western part of China, is the highest plateau in the world. It is also known as the "Roof of the world". It forms the top of China's topographical staircase. It covers an area of 2.3 million square kilometers at an elevation of 4,000-5,000 meters. Geographers call the Tibet plateau, which is composed of a series of imposing mountains a "Mountain-Locked Land". Massive mountain ranges loom on all sides-the Himalayas to the south, the Kunlun and Qilian range to the north, the Hengduan Mountains to the east and the Karakorum mountains to the West. Many of their melt-water the stupendous snow mountains on the Tibet plateau supply head streams to many of the major rivers in east, southeast and south Asia. These rivers includes the Huange-He (Yellow), the Changiang (China), the Mekong to Southeast Asia, the Brahmaputra to South Asia, the Indus to South Asia (Pakistan). The Plateau is studded with lakes, notably Qinghai Lake in Qinghai province, Namco Lake in Tibet, which is 4,718 meters above sea level (the highest salt lake in the world). The Ngangla Ringco Lake, which is situated in Tibet Plateau to the north of Kailas range. The lake 'Ngangla Ringco' is the source of the river Indus (The Time Atlas of the world 1986). It lies at nearly 17,00 feet in western Tibet, on the northern slopes of the Kailas range, approximately 31° 25' N, 83° 30' E roughly the Latitude' of Shanghai). The river Indus flows for 3180 Km (1975 Miles) takes its origin from the Tibet Plateau "Ngangla Ringco' lake to its mouth near south of Karachi. According to the WAPDA reports, 1984, from the source to the control line, the length of the Indus is about 700Km and from the control line to the mouth of the Indus its length is about 2480Km. From its source, the river runs through broad stony

valleys across the high plateau of western Tibet, bedding southwest & west, north and west again. Here the valley is about 10,000 feet below the surrounded mountains. In the Tibet plateau, the east to west slope is gentle. In the early stage of the river Indus, it has clear summer track and water become gray and thicken with ice-melt.. In winter the river freezes and its track during winter is covered with snow. The Indus crosses the mighty Himalaya through a deeply cut gorge. The Indus enters the Kashmir region near its confluence with Gartany River at a height of about 4,245m above the sea.

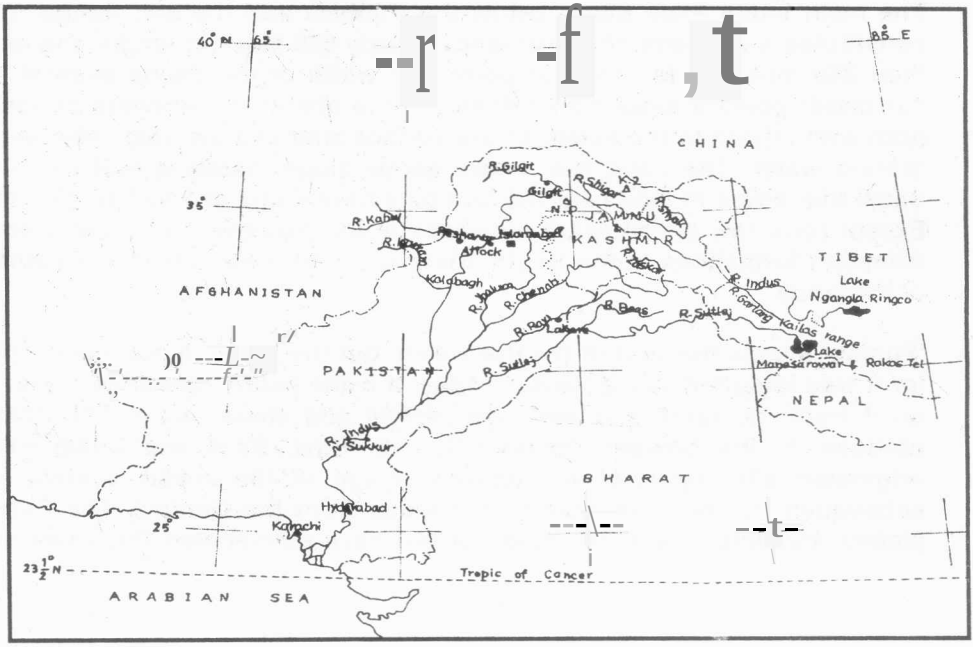
THE UPPER COURSE

The name of the Tibeten Indus is Shiquan He. Tashigang is the junction of the river Indus and the river Gartang, out of Tibet and down through i..adakh (Bharat) and then Baltistan (In Pakistan). Out of Tashigang, the river nearly ninety yards across, but its maximum dept is few feet near the border of ladakh the mountains beings to close in on it and its floor falls away; the river begin to drop sharply. The first battle between rivers the mountains starts here. Working of base of the cliffs, digging into the rocks. South of the lake Pangong it takes a shape turn and cuts through the ladakh range. The valley of the Indus near the border of ladakh becomes narrow. Here the Indus is rapid, torrential, and unnavigable. In this stage, the Indus is in a very youthful on immature age of development, and is continuously are work in cutting down the inequalities in its course and degrading or lowering its channel, the Indus cuts again a little above the Shyok confluence. Flowing almost straight in a north westerly direct at Bunji (1,415 meters). In this stretch of about 725Km the fall in the river bed or the slope of the river valley is about 4 meters per kilometer. In 350 miles it drops nearly 12,000 feet.. The valley is quite narrow in Ladakh through alluvial flats are found in the extreme east of its Kashmir course. In Baltistan the catchments of the Indus widnes.

The chief right bank tributaries of the Indus are the Skyok, the Shigar and the Gilgit.. While the important ~eft bank tributaries are the Astar, the Shigar (South), the Zaskar, and the tianle. The Shyok originates from the Depsang plain (above 5,000m) and meets the Indus about 40Km above Skardu. The Shyok is dangerous river. Abov~ its junction its junction with the Shyok, the Indus narrow to one of the most awful gorges imaginable. The Indus and the shyok in summer "a mighty rushing rivers and crossing it in a ferry boat on its swirling surface causes wild excitement.". Gradually the mountains draw nearer and taller on both sides. The steep and narrow Ladakh range south of the Karakorum borders, the Indus on its right bank; on the far side of it Shyok runs parallel to the Indus for 150 miles, before the Ladakh range ends and allows it to join the main river. Twenty miles later another major tributary, the Shigar runs down to the Indus from the heights of the Karakorum near Skardu, the capital of Balistan. The Shigar is

less violent than the Shyok; it is a shorter river and its upper reaches are not dominated by sliding glaciers of the type that make the Skyok so dangerous. The Shigar draining the melt-waters of some of the famous Karakorum glaciers joins the Indus just opl-iosite Skardu. The Astor rises n~ar Burzil pass and flowing in northwesterly direction drains the area lying east of the Nanga Parbat and joins the Indus a little below BunjL The Shigar (south) drains the northern slopes of the Himadri with its tributaries and joins the Indus opposite Marrl. The Zakar with its tributaries Doda, Tsarop Lingti and Khurna drains the northern slopes of the Zakar range and joins the Indus about 40Km below Leh. The Hanle, a small left hand tributary of the Indus, drains the area lying east of Lake Mirari in Rupshu and Joins the Indus near Loma, The Gilgit river joins the Indus on its right bank after draining a long basin of high snows and glacier. Except in the end winter, the Indus Is dark gray; in contrast the Gilgit running down southeast into the new southerly run of Indus, and spacious. A little before it's Confluence with the Gilgit river, the Indus takes a sharp bend towards the south and near the western flankb"o' tl,e Nanga Parbat it turns towards the west. The valley of the Indus is deepest here; the height is 17,000fe~t above the level of the water at its bed. Himalaya to the south and Karakorum to the north of the river valley narrow together to meet the Hindu-Kush and the Pamirs. Down-stream from over (26,000ft) can be seen occasionally. The western flanks of Nanga Parbat sweep down from Gigit, Nanga Parbat (26,660)to the trough of the Indus, at some 3,000 ft, only 14 miles. In ravines so deep that the sun can reach part of them for only a few hours in the day; the river Indus slices through the lower mountains. It is a place of enormous heights and carenous depths.

The Indus: From source to mouth



The Indus continues south wards, twisting down another 50 miles of deep narrow gut between the Hindukudh and the black mountains. The mountains that wall the gorges are mostly 9,000 ft high; their precipitoiJs slopes still subjected to the disintegrating effect of extreme heat and cold. The Indus river breaks out of the mountains onto the Potwar plateau at Terbela. When a river is stopped or slowed it lets its sediment fall to the bottom; gradually its bed inches upwards. The Kabul rises comes in from the west, creating one of the most famous of all the Indus tributary valleys, the vale of Peshawar, as fertile as Kashmir. The Kabul rises high in Afghanistan; of the Hindukush, it reaches the Indus as brown and rich cocoa. For several hundred years after their confluence the two rivers keep their separate identities, brown and blue, running side by side.

The Indus runs wide and shallow across the upland plain east of Peshawar. Where Kabul river Pours Its thick brown waters into the gray Indus the plateau falls away and at the small town of Attock the Indus once more gather itself tightly together to force a channel down between a series of rocky hills. Between Attock and Kalabagh, a hundred miles down stream, the Indus runs along the bottom of deep tenth. Near the Kalabagh the Indus begin to flatten out on its last step down to the plains, the Indus is violent in summer. At last, Indus stretches itself, within a few hundred yards it is mile wide, within a mile its bed is ten miles wide. Some thirty miles below Kalabagh the last right-bank tributary of any importance, the Kurram, joins the Indus. It rises in the great mountains of the Afghan border which from the eastern side of Indus.

THE MIDDLE COURSE

The main Indus Plain starts below the Pubbies and the salt Range. This constitutes a vast stretch of flat lands, nearly 800 miles in length and more than 350 miles at its broadest point The width of the plains even at the narrowest point is more than 100 miles. It is one'of the wonders of nature both with regard to the extent of the surfaee area and the vast reservoir of ground water. The Land has a vary gentle slope, hardly a foot per mile. Small thin strips of land near the foot-hills have slops of 2 to 5fts. per mile. Except for a few insignificant out-crops in the Nouthern region and some limestion formations in the South, there is no discontinuity in the flatness of the lands.

'Punjab' means the land of the five rivers, but the Indus is not one of them for it was regarded as the western edge. It is the Indus tributaries, covering on it from the north and east, that define and characterize. The Punjab portions of the present Jhelum, Chenab, Ravi, Beas and Sutlej rivers originated after uplift of the topmost stage of the siwdik system and subsequent to the severance of the Indus from the Ganges. The Potwar plateau building moments could not but have rejuvenated the small river

lets of the southern Punjab, Which until then were discharging into the lower Indus. The Vigorous erosion resulting from this impetus enabled small streams to combine one after another and ultimately, the head waters joining together as important torrents descending from the mountains. These torrents grew in volume and formed the present fire rivers of the province, having their source in the snows of the Great Himalayas Ranges and deriving their waters from as far East as the Manasarower lake (Sutlej River) on the Kailas Ranges. The nearest tributary is the Jhelum which rise at 14,000 ft not far from the Zoji La pass. The Jhelum flows westwards and south through the Himalayas and it does so in gorges sixty miles to the south of Nanga Parbat. When it reaches the Jhelum is joining by the chenab. The chenab rises on the southern flank of the main Himalayan chain; about 150 miles south of Leh. Its course is parallels the Indus, north west, then south west. About forty miles below the confluence of the Chenab and the Jhelum, the two rivers are Joined by the Ravl The course of the Ravl. and It reaches the plains more quickly and then menders over them In a complexity of loops and bends. This Is the river on which Lahore stands. From Lahore to the junction of the Ravl with Chenab-Jhelum is 400 miles (the distant by river).

The next two rivers come in together, the Beas and the Sutlej. The Beas rises not far from the headwaters of the Chenab but takes a quite different course, west and the south. This is the river at which Alexander's army forced him to turn back to Greece. When it meets the Sutlej it is still not far from the mountains and its water retain the blue clarity of an upland river. The Sutlej is the river that rises from Lake Rakas Tel and Manasarowar. Only eight miles south of the source of the Indus (Ngangla Rangco). According to D.N. Wadia in his book "Geology of India" explained that the principal lakes Rakas Tel and Manasarowar, the reputed source of the river Indus, Sutlej and Gangas of Hindu traditions, have now been proved to be the source of the river Sutlej only William Moor Craft, the man who made a great contribution in discovering the sources of river Indus and Sutlej, had already proved that Lake Manasrowar was not the source of the Indus.

Unlike the Indus, the Sutlej runs-west from its source and so breaks out the mountains. The five rivers of the Punjab finally meet in the Pajnad sixty miles of the city of Multan. At Kalabagh the Indus is just under 700 ft above sea-level; the distance to the sea is 950 miles. The average gradient for all this distance is therefore less than nine inches per miles. As the river slows down it drops the silt it has carried at speed through the mountain gorges and gradually its bed rises above the level of the surrounding land. The Indus basin is about 365,700 square miles. During the nature stage of the river Indus,it has meanings, oxbow lakes, flood plains and active flood plains. These are the exciting features made by a river in its middle course.

THE DELTA

For out to seam sometimes as far as ten miles the greenish-blue Arabian sea is ujco(ored by the raddish-grey Indus. The center of the wide delta of Indus Cr:cr and some 40 miles (South East) of Karachi. The river delta begins at ThaUa, about 110 Km from the Arabian Sea Coast. Near the delta, the slope reduce % to Y2 ft. per mile. Here the Indus splits into several channeis (distributaries), each emptying into the sea at a different place, under water, just beyond the coastal sandbars, a deep narrow Canyon called the swatch continues the line of the continental shelf. On both sides of it the sea is shallow, less than a hundred feet deep at its head and deeping only gradually. The bed of the swatch Is 2,000 ft lower. The swatch is unique on this coast. Perhaps the Indus, the river that has cut through the highest mountains (Himalayas) has carved a last gorge In the bed of the sea.

REFERENCES

Fairley, Jean (1975). The Lion River, First Pakistani edition (1979). Reprinted in 1993, Published by 8.1. Gillani 55-The Mall, Lahore

Grolier Academic, Encyclopedia, (1985). Published by Grolier International. London.

Spate O.H.K. & Hearmonth A.T.A. (1967). India and Pakistan. A General and Regional Geography, London: Methum & Co Ltd. New York E.P. Dutton & Co. Inc.

Wadia D. N. (1966). Geology of India, 3rd. edition (revised) the English Language Book Society and Macmillan & Co Ltd. London.

WAPDA reports, 1984.

Singh R.L. (1995) INDIA, A Regional Geography, UBS Publishers, Distribution Ltd. 5-Ansari Road New Delhi-110002 National Geography Society of India.

Tourist Map of China. Promotion Department, National Tourism' administration, Cartographic publishing House, Beijing, China.

Information for Authors

The PGR is publis"ed biannually in June and December. Manuscript of research articles in English should be sent in duplicate for publication, typed on one side only and double - spaced with at least one inch margin on all sides. The recommended maximum length is 7000 words with an abstract of about 200 words in the beginning of the paper. References and notes should be arranged in alphabetical and chronological order. The illustrations (maps, diagrams and figures) should be drawn in black ink on tracing paper with stencil writing. Author should also mention their current institutional affiliation in the form of a footnote on the first page of the manuscript. . Computer composed manuscript (along with two hard copies) on Floppy Diskette in MS-Word 2000 Window98 will be preferred for speedy publication. The articles submitted for publication should be original contribution and must not have been published previously. Views and opinions expressed in PGR, are only those of the authors and do not necessarily reflect those of the Editor.. Cases relating to copy right of published matenal would entirely be the responsibility of the authors themselves and Pakistan Geographical Review would have no concern with such matters. The Editor rr··

Submit all the manuscripl
Pakistan Geographical Rev
Punjab, Quaid-e-Azam Cam

Address all communicati o
numbers and additional
Pakistan Geographical R
Campus, Lahore-54590,

Pakistani RS.400 F
Price of the Joum

A copy of the Journal and fi

Published By:
Prof. Dr. Farhat Gl

Printed By:
Fareedia Art Press
16-B, Abbot Road,
Fax: 92-42-637019