A Thesis report on

Climatic Extremes and Landslide Hazard Mapping of Puwa Watershed, Ilam

Submitted to:

Central Department of Environmental Science,

Institute of Science and Technology,

Tribhuvan University, Kirtipur, Nepal.

[A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Masters of Science in Environmental Science.]

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July 2011

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Citation: Bhattarai, M., 2011. *Climatic Extremes and Landslide Hazard Mapping of Puwa Watershed, Ilam,* MSc Thesis. Central Department of Environmental Science, Institute of Science and Technology, Tribhuvan University, Kirtipur, Nepal.

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Letter of Recommendation

This is to certify that the dissertation entitled ***"Climatic Extremes and Landslide Hazard Mapping of Puwa Watershed, Ilam"*** prepared by **Mr. Mahendra Bhattarai**, **symbol no. 5724**, for the partial fulfillment of Degree of **Masters of Science in Environmental Science** majoring in **Water Resource Development and Planning** has been carried out under my supervision and guidance. The work performed and the results presented in this dissertation are original as per the requirements of Central Department of Environmental Science, Tribhuvan University and has not been submitted for any other degree.

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Declaration

I, **Mahendra Bhattarai**, hereby declare to the evaluation committee of this dissertation that this dissertation entitled ***"Climatic Extremes and Landslide Hazard Mapping of Puwa Watershed, Ilam"*** presented herein is a genuine work, done originally by me. This work has not been published or submitted to any other university for any academic awards. Literatures and data works done by others and cited within this dissertation has been given due acknowledgements and listed in the references.

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Abstract

This study presents the climatic analysis and landslide hazard map of Puwa watershed. Puwa watershed lies in eastern Nepal within 26º51'-27º5' N and 87º50'-87º56' E with the total area of 158.9 sq km. The daily temperature and precipitation data of 43 years from 1967-2009 were analyzed. The trends in precipitation and temperature extremes have been investigated using the precipitation and temperature indices of climate extremes for this study using specially designed software, RClimDex (1.0). Similarly, landslide hazard assessment was done by the application of GIS through ARCGIS (9.3) and by using multivariate statistical analysis, mapping, and the evaluation of the hazard maps is presented. A distribution map of landslides was produced from topo-sheets and field verification. To determine the factors and classes influencing landslides, layers of topographic factors derived from a digital elevation model, soil and land use were analyzed and the results were used for hazard mapping. The effects of different samples of landslide and non-landslide groups on the critical factors and classes and subsequently on hazard maps were evaluated. Combinations of different samples yielded some minor differences in the critical factors and classes. The slope and soil type is found to be the most important factor for landslide hazard.

From the study general increasing trend was observed in temperature extremes. It is seen that the monthly maximum value of daily maximum temperature is increasing by 0.009°C while the monthly minimum value of daily minimum temperature is increasing by 0.032°C per year. Days and nights are becoming warmer and warmer as there is the negative trend of occurring cool days and cool nights. The precipitation events also shows increasing trend in total and heavy precipitation events. Very wet days (R95p) and very heavy precipitation days (R50) is in increasing trend. The extreme precipitation events thus increase the threats of many weather related disasters like flood, debris flow and landslides. Similarly, from hazard mapping it is clearly seen that 52.36% of the total study area lies in an unstable zone and 14.50% lies in highly unstable zone. The remaining 33.14% seems to be the safer place. The unmanaged agriculture practices, steep slope and the intense precipitation or climatic events might be the triggering factors for the high hazard in the area.

[Keywords: Meteorological analysis, Hazard mapping, RClimDex, GIS.]

Acknowledgement

It’s a great privilege to express my sincere gratitude and special appreciation to my supervisor Prof. Lochan Prasad Devkota, PhD, Head of the Department, Central Department of Hydrology and Meteorology for his continuous guidance, advice and encouragement. Without his constructive comments, untiring help, guidance and practical suggestions, this work would not have successfully completed. I am deeply indebted to my co-supervisor Mr. Gyan Kumar Chhipi Shrestha, Lecturer, Central Department of Environmental Science for his constructive criticism and moral support.

I would like to acknowledge all the staffs of Central Department of Environmental Science and Associate Prof. kedar Rijal, PhD, Head of the Department, Central Department of Environmental Science for their continuous encouragement and support, where I made my masters program possible. I am also especially thankful to Central Department of Environmental Science (CDES) for granting me the fellowship for pursuing me this research.

I want to give special thanks to my friends Mr. Sures Bandari, Mr. Prakash Sigdel and Mr. Mukesh Bhattarai who have patiently helped me in my field work. I am also obliged to Mr. Sudip Shrestha for his valuable help and support during the preparation of the report.

Without the cooperation of local people of Puwa Watershed, this work would not be complete and fruitful; I am highly beholden to them.

In preparation of this report, I have consulted many books, journal articles, thesis, case studies, reports and papers for which I am deeply indebted to the authors and the publications.

At last but not the least, I am proud of my parents and all the family members for their persistent support, inspiration and encouragement.

Mahendra Bhattarai

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Acronyms and Abbreviations

ºC	Degree Centigrade
CBS	Central Bureau of Statistics
CCI	Commission for Climatology
CLIVAR	Climate Variability and Predictability
CMS	Consolidated Management Services Nepal
DEM	Digital Elevation Model
DFID	Department for International Development
DHM	Department of Hydrology and Meteorology
E	East
ETCCDMI	Expert Team on Climate Change Detection, Monitoring and Indices
GDF3	Ground Fault Display 3
GIS	Geographic Information System
ICIMOD	International Centre for Integrated Mountain Development
ILWIS	Integrated Land and Water Information System
IPCC	Intergovernmental Panel on Climate Change
Km	Kilometer
LRA	Landslide Risk Assessment
m	Meter
MCT	Main Central Thrust
N	North
sps	Species
sq km	Square kilometer
TIN	Triangulated Irregular Network
UNFCCC	United Nations Framework Convention on Climate Change
VDC	Village Development Committee
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

CHAPTER I

1. INTRODUCTION

1.1 Background

It is now widely accepted that the global climate is changing, at least in part as a result of human modification of the atmosphere (Weaver, 2003). This is the single greatest challenge faced by modern world and the environmental managers. Climate change is defined as a change of climate which is attributed directly or indirectly to human activity that alters the global composition of the atmosphere. It refers to the variation in earth's global or in regional climates overtime (UNFCC, 2001). As a consequence, climate related risks had already pose challenges to the earth system and the communities. This global change has not only affected the developing country but also the developed country. According to IPCC (2007) the global average temperature rise is 0.74ºC in the last 100 years (1906-2005) and 0.13ºC per decade in the last 50 years (1956-2005).

Nepal is situated in a high energy environment because of its rugged relief, steep mountain slopes, active tectonics, intense human activities, high growth and density of human livestock population along with a subsistence agricultural economy. Nearly 83% of the country falls within the mountainous terrain while only 17% falls in the southern alluvial plains. It has thus a diverse geo-physical and climatic conditions within a short distance; and climate related changes are already been observed. These includes increase in heavy downpours, rising temperatures, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening snow free seasons on Himalayas, earlier snow melt and alteration of river flows. These changes are projected to grow.

Climate changes are already affecting water energy transportation, agriculture, ecosystems and health. These impacts are different from region to region and will grow under projected climate change. Warming seems to be consistent and continuous after the mid 1970s. In Nepal, between 1977 and 1994, average warming in annual temperature was 0.06ºC per year (Shrestha *et al.*, 1999), with more pronounced increase in higher altitude regions of middle mountains and high Himalaya then in the terai and siwalik belts. The maximum temperature is increasing faster than the minimum temperatures indicating a widening of temperature range. According to a recent study, Nepal's temperature is rising by 0.14ºC per decade (Shrestha *et al.*, 2000). There is increasing trend in precipitation in places below 1500m elevation and decreasing trend above 1500m elevation (Baidya *et al.*, 2008). Although the numbers of rainy days are decreasing high intensity rainfall events are increasing.

Apart from the global impact of climate change; high relief, steep slopes, relatively steep river gradient; and fragile and active geology make the Himalayas highly susceptible to geo-hydrological process i.e. landslides, erosion, debris torrents, flood and river channel shifting (Laban 1979; Nelson, 1984, Lakhera *et al*, 1992; Dhital *et al*. 1993). This tectonically active mountain chain of Nepal Himalaya has accelerated the rate and magnitude of occurrence and operation of geomorphic processes in Nepal. In tectonically active mountain chains, natural landslides play a fundamental role in the evolution of the landscape, providing mechanisms through which a mass balance can be achieved between uplift and erosion. Prolonged and high-intensity rains in the monsoon season are the most important factors triggering mass movements, gully erosions and floods (Starkel, 1972; Dhital *et al*. 1993). The rapid deforestation that has occurred has been linked with increased soil erosion (Eckholm, 1976; Jackson, 1983, Singh *et al*, 1983), but there is still a controversy over geologically-induced versus man-made erosion (Carson, 1985; Hamilton, 1985; Ramsay, 1985; Ives *et al*, 1987; Ives and Messerli, 1989). Cannon (2000) argued that natural disaster is a function of both natural hazard and vulnerable people and emphasized the need to understand about the interaction between hazard and people's vulnerability.

The main hazards that are repeatedly occurring and have a significant phenomenon in heavy losses of lives and properties in Nepal are floods, landslides, debris flow, river channel shifting, avalanches, droughts, earthquakes and epidemics. The occurrence of natural hazards is a serious constraint on economic development, particularly in developing countries, where the economic loss due to the impact of natural hazards often makes the difference between economic growth and stagnation. On an average, natural disasters take around 951 lives and damage property worth NRs 1,242 million every year in Nepal (DHM). Among these hazards, the overall impact caused by water induced hazards- floods, landslides, avalanches, riverbank cutting, river shifting is extremely high as compared to the loss due other hazards. It has been seen that both the water induced hazards and the losses from them have been increasing.

Landslides are the most common disasters induced either by water or earthquake in Nepal. Although the main triggering factor of such landslides is monsoonal rainfall associated with extreme weather events, a combination of both the natural and anthropogenic factors and processes determines the extent and magnitude of such disasters for any affected areas. Natural factors such as geology and topography and anthropogenic factors such as land use and settlement pattern of any locality are the key factors that determine the impacts of such disasters. Many hill slopes in Nepal are situated on or adjacent to unstable slopes and landslides which have reactivated from time to time. Nepal's vulnerability related to climate change is likely to be exacerbated by the increase in the intensity and frequency of weather hazards induced by anthropogenic climate change (IPCC, 2007).

The use of landslide hazard maps may be crucial for watershed management which enable for the prioritization of the limited resources to the areas where severe landslide problems are existed. Analysis of landslide hazard is required to asses land damages, land depreciation and sedimentation problem which affect hydro-electric dams, flood control structures, bridges, roads and irrigation channels. In this context, this study will be an added step for prevention of land degradation and climate change vulnerability assessment.

1.2 Statement of the Problem

Nepal suffers from various types of water-induced disasters as soil erosion, landslides, debris flow, flood, bank erosion etc. due to its rugged topographically weak geological formations, active seismic conditions, occasional glacier lake outburst floods, concentrated monsoon rains associated with unscientific land utilizations and human settlements. These phenomena induce severe impacts on the vital infrastructures such as roads, houses, hydropower, and irrigation and drinking water facilities and also cause a serious environmental degradation.

Generally, slope failure, debris flow and landslide or mass movements are the major water induced hazards in the watershed of hilly and mountainous region. Each year a huge amount of life and property is loss due to the landslide hazards. Beside these it also cause loss of agricultural and forest lands, decline in land productivity, and contamination of surface and ground water that poses a severe threat to the sustainable development of the country.

Hazard mapping is an important tool in predicting the probability of occurrence of any damaging phenomenon within any given area. Thus, if the prediction is significant the damage to the lives, properties, infrastructures and ecosystem can be minimized to a large extent. Therefore the study of the landslide is an important aspect in order to mitigate the loss and destruction in infrastructural and other economic development in Nepal. Also we know that climate vulnerability depends on both the severity of the projected climate change and the resilience of an impacted sector to climatic trend and weather related shocks. Vulnerability assessment helps scope the most serious risks using indices of climate change exposure, hazard intensity and socio-economic and environmental outcomes.

The population growth and density are increasing in Puwa watershed; this has affected the land use pattern. Also building of hydro electric plants has affected the stream activities and discharge. Landslide of Shangrumbha has not been stopped yet since 2020 BS. This has degraded a huge amount of the agricultural and forest land. Thus, there is immediate need of land resources planning to adopt increasing production and to manage the environmental degradation. For this purpose, this study helps to identify major landslide hazards in the specified area which helps in reducing loss of human life and property and to build plans for mitigation and develop system for early warning of hazards.

1.3 Research Question

The study is expected to answer the following questions:

- Is the temperature really increasing?
- Is the precipitation pattern of the area changing?
- Is the area in landslide prone zone?

1.4 Objectives

The main objective of the study is to analyze the meteorological parameters and to prepare the Landslide hazard map of Puwa watershed using GIS on the scale of 1:25,000. The specific objectives are as follows:

- To study the trends of climatic extremes of temperature and precipitation in Puwa watershed.
- To study landslide hazard parameters such as landslide occurrence, slope, aspect, soil type, land use pattern and drainage of the study area.
- To prepare landslide hazard map of the study area.

1.5 Scope of the Study

Landslide hazard maps identify and delineate the unstable hazard prone area. This helps in prioritization of the limited resources in the affected areas. All this will help the planners and decision makers to select locations from development projects and building infrastructures such as roads and highways, irrigation canals and bridges, hydro electric projects and flood control structures. This will not only help for the successful designing, building and implementing the projects but also reduces the unnecessary economic losses and expenditures.

Puwa watershed, located in hilly region is environmentally as well as ecologically unstable area with landslide as the most common natural hazard. Beside that there are certain hydro electric projects going under construction in this area. Thus, this study is very significant for watershed management in hilly and mountainous region as well as it provides important information about landslide with an updated computerized hazard map of the study area. It also provides the general information about the meteorological assessment.

1.6 Limitation of the Study

The study based on a map data which can be update. Land use/ land cover information has been taken from land utilization map provided by the Survey Department. In lack of scientific equipments other aspects of slope instability analyses such as infiltration rate, underground water system etc were not possible. Apart from these the data was collected within the limited time and financial resources.

The dimensions of landslides in inaccessible sites were estimated form visual observations from the nearest possible distance with maximum available view, local information and by referring topographic sheets (2687 04A, 2687 04B, 2687 04C, 2687 04D, 2787 16C and 2787 16D). The information on demography, occupation, agriculture and livestock and economy was referred to the data of CBS (2001) and other climate related data were obtained from DHM and general questionnaire with the local people.

1.7 Overview of Contents

Chapter 1 Introduction

This chapter gives a general overview of the thesis structure along with the background information, statement of the problem, research questions. It also provides the objectives, scope and limitations of the study and the general overview of contents or the thesis structure.

Chapter 2 Literature Review

This chapter consists of very short summary of previous studies related to landslide hazard mapping using GIS which were reviewed during the entire thesis work. Apart from it this chapter also contains the research and studies of climate change and meteorological analysis that is quite relevant with the study conducted here.

Chapter 3 Methodology

This chapter discuss about how the research work was done. It provides the method of data collection, tools and techniques along with the way of interpretation of the research work.

Chapter 4 Study Area

This gives the general information of the study area. It describes about the geology and geomorphology, topology and climate, basin hydrology, biological environments, socio-economic and cultural environment of the study area. Also it gives the landslide inventory map of the study area.

Chapter 5 Result

It contains the study and analytical results obtained from the research. The results are presented and interpreted with various graphs and maps in this chapter.

Chapter 6 Discussion

This explains the achievement or the outcome of the study. The chapter ends with a discussion of the advantages and disadvantages about the result that have been obtained from the study with the comparisons with previous studies.

Chapter 7 Conclusion and Recommendation

This chapter provides conclusions, a brief summary of the thesis work and the recommendations of the further work.

CHAPTER II

2. LITERATURE REVIEW

2.1 Reviews on Meteorological Aspect

Very little studies have been made in this field in Nepal. Hingane *et al.* (1985), made a detail study of the historical time series of temperature data of India and found that there is a definite warming trend in mean annual temperature with an increase of 0.4ºC during the past century.

Shrestha *et al.* (1999), carried out the trend analysis of maximum temperature in Nepal and found that the average annual warming between 1971 and 1994 was 0.06 ºC/year. The warming in the maximum temperature is found to be more pronounced in the high altitude regions.

Quadir *et al.* (2004), studied in the region around Bay of Bengal, from Nepal in north to Malaysia in south, shows that the increase in temperature is more predominant in Nepal in comparison to other countries.

Manandhar (2006), studied the climatic pattern in Nepal and found the increasing trend in mountainous region while decreasing trend in the terai belt. He explained that the negative trend in terai is due to the fog episode that appears in the winter season during the past one decade that is significantly reducing the maximum temperature.

Regmi and Adhikari (2007), found that the total precipitation and extreme events also have rising trend and projected to rise in future. The rise in frequency of climatic extremes as floods, landslides have already affected agricultural production.

Baidya *et al.* (2008), studied the trends in daily climatic extremes of Nepal with the data from 1961 to 2006 and concludes that the temperature of higher altitude is increasing more rapidly than the lower altitude. The study shows that the country's temperature is increasing by 0.06ºC/year. There is also increasing trend in precipitation in places below 1500m elevation, while decreasing trend above 1500m.

2.2 Reviews on Landslide Hazard Mapping

Landslide is commonly used to denote the downward and outward movements of slope forming materials along the surface of separation by falling, sliding and flowing at a faster rate. Varnes (1978) defined it as the downward and outward movement of slope forming materials composed of rock, soil or artificial fill. He has also classified it on the basis of types of movement and the types of material involved in it.

Type of Movement		Type of Material		
		Bed rock	Debris	Soil
			Predominantly course	Predominantly fine
Falls		Rock fall	Debris fall	Earth fall
Topples		Rock topple	Debris topple	Earth topple
Slides	Rotational		Debris slump	Earth slump
	Translational	Rock block slide	Debris block slide	Earth block slide
		Rock slide	Debris slide	Earth slide
Spreads		Rock spread	Debris spread	Earth spread
Flows		Rock flow (Deep creep)	Debris flow (Soil creep)	Earth flow (Soil creep)
Complex		Combination of two or more principal types of movement		

Fig. 1: Varnes classification of mass movement [source: Deoja *et al.* (1991)]

Hazard is the probability of occurrence of a particularly damaging phenomenon within a specified period of time and area because of a set of existing or predicted conditions (Deoja *et al.* 1991). The landslide hazard is defined as the probability of occurrence of mass movement in certain area within a specified period of time (Varnes, 1984). Landslide hazard mapping is based on the assumption that landslides occur as a result of similar geological, geographical and hydrological conditions that lead to past and present landslides. A landslide hazard map refers to an arithmetic method of portraying the spatial variation in the susceptibility of slopes to failure, based on assessment of various landslide causative factors (DPTC, 1998).

Landslide hazard zonation mapping in general includes delineating the occurrence of slope movement phenomenon in the past and predicting about the occurrence of such phenomenon in the future (Varnes, 1984). Dhital (2000) classified the landslide hazard maps into three categories: map of a region, map of a corridor and map of a size. The preparation of hazard is based on identifying various hazard components followed by a rating of these components and finally all rating values are augmented. After summing the rating of all attributes, the area was divided into different hazard zones. The low hazard is considered to be more stable whereas medium hazard may have possibility of landslide disaster. The sign of instabilities occur in the high hazard zone, which has the most possibility of failure in the future.

The study of landslide or mass movement, debris flow and its related phenomenon are important for watershed management and risk reduction in the context of mountain environment of Nepal. Thus as a subject of interest the causes and consequences of landslide or mass movement have been assessed differently in different case studies of Nepal. Some of the important studies are summarized below:

Sharma (1976), tried to explain the types, causes and distribution of landslides and soil erosion in Nepal. He also analyzed their effects on Nepalese economy and suggested the preventive measures.

Laban (1979), described in general the occurrence of landslide and in particular the relationship between ecological regions namely land unit, divided according to landscape, ecological condition and landslide occurrence based on observation of landslide counted from a light aircraft. He mentioned that geological structure and lithology were far more important in terms of landslide occurrence than by human landuse change.

Caine and Mool (1982), studied the landslide in the Kathmandu-Kakani area as part of the united nation university hazard mapping project. They explained that the main factors contributing to the development of landslides are lithology, high relief, seasonally high water tables and deforestation. They pointed that slope morphology and slope materials led them to emphases the importance of material control on the landslide of their study area. They found that the estimated rate of surface lowering by landsliding is 12 mm/yr.

Carmon (1985), has mentioned that the natural erosion rate is very high in Nepal because of the constant tectonic uplifting of the major mountain range and consequent down cutting of the river system. He also mentioned that the relationship between human activities, erosion and sedimentation process.

Manandhar and Khanal (1988), interpreted the aerial photographs for the detailed study of landslides and also prepared geomorphological maps, landuse map and profile of landslides maps of the Lele watershed in central Nepal. They also mentioned that the perception of the local people about the causes and preventive methods of landslide control.

Department of soil conservation and watershed management Nepal (1995), has published the sub-watershed management planning manual (Landslide Hazard Handbook) which has revealed that the landslide hazard map is important for watershed management. The factors named slope, landuse and land system are taken into account to assess relative susceptibility to potential landslide hazard map. It has prepared the landslide hazard map of kulekhani watershed. Thotne khola watershed in Okhaldunga and Tankhuwa watershed in Dhankuta based on slope, land use and land system.

Dhital and Upreti (1996), have examined the landslide studies and management in Nepal. They have said that landslide and mass movement phenomena are very common in Nepal. It caused heavy losses of life and property as well as environmental degradation. They also have expressed that landslide hazard maps show area likely to experience landslide in the future by correlating some of the principal factors or probability of landslide occurrence of danger in that area. They also have suggested that mitigation measures of landslide hazard in Nepal.

Dhakal (1997), based on integrated approach mapped landslide hazard zonation of Khageri watershed of Chitwan by GIS application. He also classified landslide hazard zones and found that 0.5 % land as unstable and 14.98% land moderately unstable.

Oli (1997), mapped landslide hazard of Malekhu watershed using GIS and air photo interpretation. 6 landslide scars were counted from aerial photo of 1992. He found most landslide were located in such places where there are significantly steep slopes, slopping terrace cultivation, deforested land and week geology. He also classified 4 types of zone after weighting and ranking to parameters related to landslide.

The DPTC (1996), carried out detailed investigation, monitoring, and control of the Ilam Landslide. The landslide is located on the left bank of the Mai Khola, at Km 62 of the Charaali– Ilam Road. The landslide came into existence during the road construction in 1984, and became quite hazardous during the road maintenance of 1992 and was further aggravated in the monsoon of 1995. The landslide study was carried out by topographic survey, engineering geological mapping, drilling, and monitoring of the displacement by tilt meters and extensometers. The landslide material is made up of fine soil, gravel, and weathered gneiss. Its slip surface is at a depth of 10–15 m. The landslide was controlled by constructing a series of check dams, surface drains, surface erosion control works (bioengineering), and horizontal drains.

Sapkota (1999), explained the possible relationship between landslide density and these factors like geology, landuse, aspect, slope, drainage density and rainfall. He classified different hazard zones used from Geographic Information System (GIS) operations in the Integrated Land and Water Information System (ILWIS) program.

The Landslide Risk Assessment (LRA) in the Rural Access Sector Project funded by the DFID and implemented by the Scott Wilson Kirkpatrick & Co. Ltd carried out pre-feasibility-level landslide studies in the Ilam district in 2002 and 2003.

Paudel (2008), studied on Landslide hazard zonation using GIS of Dakshinkali-Kulekhani road alignment from chainage km0+800 to km1+819. His studied showed that the major landslide causing factor was construction of road in the area above all.

Shrestha (2008), studied on GIS based landslide hazard mapping of Triyuga watershed, Eastern Nepal. In his study, three classes of landslide were identified; 6.1% of the total area of watershed falls into the high hazard zones where 75.7% of the observed landslides were recorded.

CHAPTER III

3. METHODOLOGY

3.1 Research Design

After the selection of the site of study, a sequential approach from data acquisition and literature review to report writing was necessary for the completion of the study. The study was focused on climatic extremes analysis and landslide hazard mapping of Puwa watershed. The walkover field survey was conducted from 27th January to 11th of February 2011. During this survey field verification of hazard map was done and newly invented landslides data were noted down. The flow chart of research design is as shown in the figure below.

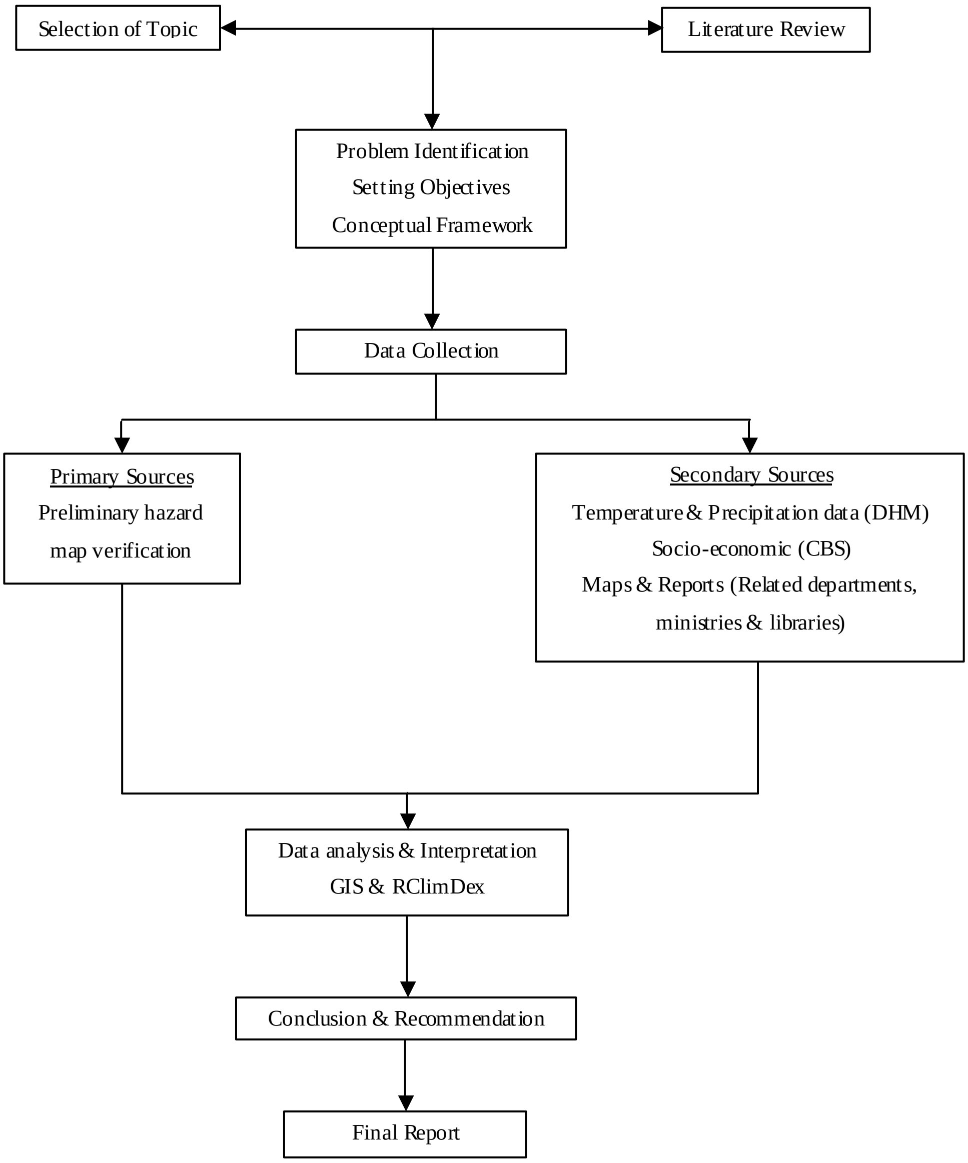

Fig. 2: Diagrammatic presentation of research design

3.2 Data Collection

The information needed for the landslide hazard mapping and meteorological analysis was obtained from three different sources.

- Published and unpublished documents, articles, literatures and journals.
- Topographic maps and aerial photographs.
- Field survey and verifications.

All the secondary data were collected reviewing literatures, reports and journals. Meteorological data, particularly rainfall and temperature of the Ilam Tea Estate station was obtained from Department of Hydrology and Meteorology. Similarly, the topological maps were collected from Department of Survey. Also the walkover field survey was conducted to prepare a surface geological map on a scale of 1:25,000 for the study area. Beside this it was also conducted for gathering information regarding landslide types, their size and distribution.

3.3 Data Analysis

It is the post-field activity and includes compilation, interpretation and analysis of all the information and data obtained during the pre-field and field study to produce the required output. Contour, slope, aspect, landuse and finally the updated landslide hazard map was prepared in the Scale of 1:25,000. The data obtained from various sources were tabulated, analyzed and were finally interpreted by using appropriate statistical tools, tables, graphs and diagrams. Following software were used for the analysis of meteorological data and preparation of hazard map.

Meteorological Data Analysis

Meteorological or the climatic extremes were analyzed with the application of RClimDex software. RClimDex (1.0) is designed to provide a user friendly interface to compute indices of climate extremes. It computes all 27 core indices recommended by the Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI) as well as some other temperature and precipitation indices with user defined thresholds. R is a free and yet very robust and powerful software for statistical analysis and graphics. It runs under both Windows and Unix environments. It also includes a data quality control procedure before computing the indices. The data have been checked for outliers, errors and the sudden jump in the series. The errors were manually checked and edited on the basis of original data provided from DHM. The Commission for Climatology (CCl) / World Climate Research Programme (WCRP) of World Meteorological organization (WMO), project on Climate Variability and Predictability (CLIVAR) and Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI) has jointly recommended 27 different climate change indices primarily focusing on extreme events for climate change monitoring and detection. Among these 27 indices, 16 are used for climatic analysis (Table: 2) and 11 are for precipitation analysis (Table: 3). These indices are derived from daily temperature and precipitation data.

For the study of climate change with a high confident result a long period of data are required. In Nepal the Hydrological and Meteorological services systematically started from 1966 and still some stations are not functioning properly in absence of regular management and maintenance. The temperature and precipitation data used for the study are of 43 years i.e. from 1967 to 2009 obtained from the meteorological station no. 1407 of Ilam Tea Estate Station located at 26.92º N, 87.90º E and elevation 1300m. The list of ETCCDMI core climate indices are presented in the annex-I.

Landslide Hazard Mapping

Landslide hazard map was prepared with the application of Geographic Information System. Geographic Information system (GIS) is a computerized information system that is used to input, retrieve, manipulate, analyze and output geographically referenced data or geo spatial data, in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities and other administrative records (Bhatta B., 2009). In this present study, GIS has been applied as a tool for restoring different thematic maps, manipulating, overlaying and processing information required.

GIS requires the input of relevant data of two types: Spatial data representing geographic features (points, lines and areas) and Attribute data (descriptive information). For this purpose in the present study the topographic maps of 1:25,000 scales were taken as a base map for contour lines, spot height, drainage, road networks, land use types, major ridge lines, and landslides.

In statistical landslide hazard analysis, the combination of factors that have led to landslides in the past are determined statistically and quantitative predictions are made for landslide free areas with similar conditions. Two different statistical approaches are basically used in landslide hazard analysis: Bivariate statistical analysis and Multivariate statistical analysis.

In this study multivariate statistical method is used to analyze the data and interpret the outcome of the result. Multivariate statistical analysis models for landslide hazard zonation were developed in Italy, mainly by Carrara (1988) and his colleagues (Carrara *et al.*, 1990, 1992). This type of analysis gives the relative contribution of each of the factors responsible for the slope movement. The slope failures are considered the result of the interplay of several factors that can vary in space and time. Multivariate analysis is performed to evaluate the relative weight of each factor contributing to the instability using a random sample of cells in the study area. As a result, a discriminant function is obtained. Each cell of the random sample will take a value of the function according to the characteristics of factors present in it. Ideally, cells associated with slope failures will have values of the discriminant function well apart from cells associated with unfailed slopes.

The variables for the derivation of landslide characteristics consisted of various thematic maps acquired from different sources. The basic data layers produced from GIS included landslide inventory and variables responsible for causing slope failures. Landslide inventory map was prepared and attribute data were assigned to individual landslide to analyze quantitatively the relationship between landslides and their causative factors. Landslide conditioning variable maps were obtained as derivative layers by spatial analysis or digitized layers of field-surveyed maps. A Triangulated Irregular Network (TIN) model was created from digital topographic map of 1:25,000 scales and was used to generate Digital Elevation Model (DEM) at a resolution of 10 x 10 m grid size. The DEM was utilized to produce very significant derivative layers, including slope angle and slope aspect, which are main predisposing factors for the landslide activity. Drainage lines were extracted from DEM by hydrologic modeling and the stream order was ranked into five different classes. Vector layers of field surveyed physical variables like lithology and land use maps were prepared. Soil map was produced by editing the existing digital polygon shapefile provided by ICIMOD. The land use layer was produced by editing the existing digital polygon shapefile with field verification and was classified into ten categories which were ranked/ reclassified on the basis of occurrence of landslide. All thematic vector layers were rasterized for analytical purpose and grid resolution of 10 m was utilized to obtain the detailed morphological information. The grid format was considered optimum for this kind of process, as the sizes of the smallest landslide occurrence represented in the analysis format was 10 m. Rasterization of linear element was done by creating appropriate buffer around the linear features. Continuous variables were transformed into discrete classes with reclassification criteria that were made between the required limited numbers of classes, which sufficiently represented the wide range of original categories in each class. Natural slope angle was classified into five categories. The slope aspect variable was classified in eight major orientations. A landslide inventory map was converted to 10 m grid file. Each cell was assigned ‘‘0’’ if no landslide is present or ‘‘1’’ if a landslide is present and ‘‘no data’’ code was assigned if the cell is outside the study area. The landslide grid file and causative variable grid files were logically compared to ensure that covered a common area then combined and converted to centre of each cell. All locations of pixel of landslides studied were used to extract from the existing data layers, the physical parameters that characterize landslide locations. A base map of point feature with 10 m distance interval was prepared and these points were centroid of the grid cells in raster layers. An algorithm was executed to extract pixel value to point layer from all raster layers of causative variables. Thus, all attributes extracted were stored in point base map file indicating the presence and absence of the landslide occurrence. The categorical variable maps (e.g. lithology) were extracted as nominal value and their corresponding pixel counts. Variables like elevation, slope angle, and slope aspect were continuous values and were further reclassified to discrete classes by using Spatial Analysis Module in GIS.

The final factor maps were ranked as in table:1 and were overlaid to prepare the final landslide hazard map which was classified into five major hazard zones, viz; Stable, Moderately Stable, Moderately Unstable, Unstable and Highly Unstable:

Table 1: Numerical ranking of factors map categories

Ranking of factor maps		
Factors	**Categories**	**Ranking**
Slope angle	0° - 15°	1
	15° - 25°	4
	25° - 35°	5
	35° - 45°	3
	>45°	2
Aspect	45° - 135° (NE, E, SE)	2
	135° - 225° (SE, S, SW)	4
	225° - 315° (SW, W, NW)	5
	315° - 45° (NW, N, NE)	1
Curvature	-307 - -40	1
	-40 - -20	2
	-20 – 0	3
	0 – 20	4
	20 – 40	2
	40 – 60	1
	>60	1
Proximity to drainage	0m – 50m	5
	50m – 100m	4
	100m – 150m	3
	150m – 200m	2
	>200m	1
Landuse pattern	Lake / River	0
	Barren land	1
	Grassland / Bushland /Cutting / Plantation	2
	Cultivation	3
	Forest	4
	Landslide	5
Soil type	Sandy / Cobble / Gravel / Boulders	1
	Loam / Loamy-boulders	2
	Complex	3
	Alluvial deposits	4
	Colluvial deposits	5

(Source: Shakoor *et al.* 2006)

CHAPTER IV

4. STUDY AREA

4.1 General Information

The Puwa watershed lies in the middle mountain of eastern Nepal, in the northern face of Ilam district. It is the sub-basin of Kankai watershed. The Puwa catchment is bounded by Sanomai and Jogmai rivers. This is a rain/spring fed Perennial River. The length of the river is 22.02 km and the total area of Puwa watershed is 158.9 sq km. The watershed at Chhintapu Dada has the highest altitude with 3234m and the lowest at Bhantar with 558m near the confluence of Puwa and Mai khola. This watershed extends between the coordinates of 26º51’30’’ N to 27º5’30’’ N and 87º50’30’’ E to 87º56’00’’ E. It lies on the topographic map number 2687 04A, 2687 04B, 2687 04C, 2687 04D, 2787 16C and 2787 16D. It suffers from various mass movements. The largest landslide is located at Sanghrumbha. It covers about 0.6 sq km and brings a lot of sediments in the Puwa Khola. The northern and southern portions of the watershed are densely forested. The central part is densely populated and is characterized by dry cultivation on upper and middle hill slopes, and wet (paddy) cultivation on river terraces and floodplains.

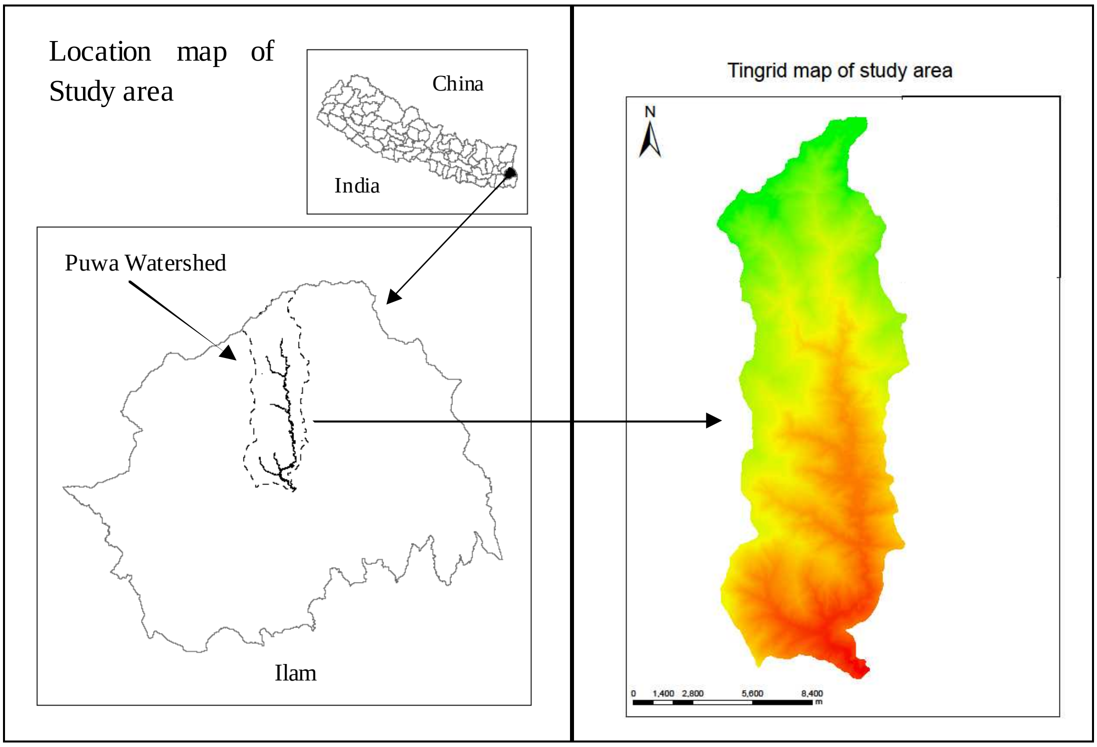

Fig. 3: Location and Tingrid map of Puwa watershed

4.2 Physical Environment

4.2.1 Topography and Climate

The river drains through the Higher Himalaya. The area is moderately to very steep and fragile with an altitude range from 3234m to 558m. Numerous small rivers and drains flow towards it and it finally joins with Mai khola. The entire river basin extends within 8 VDCs and 1 municipality of Ilam district. Upper part of the basin basically consists of granitic gneiss of Cambro-Ordovician age and the lower part consists of Quaternary rocks. The area has warm temperate rainy climate with mild winters. The temperature ranges up to 29.8ºC in the summer and 8.8ºC in the winter. The mean daily temperature at Ilam Tea Estate Meteorological Station (26.92º N, 87.90º E and elevation 1300m) has been estimated to be 23.5 ºC. Similarly the relative humidity ranges from 86.7% to 66.1%. (DHM).

4.2.2 Geology and Geomorphology

Geological processes are responsible for the formation of various rock and soil types, whereas geomorphology describes the various landforms developed on the earth's surface.

Geology

The Himalayan mountain range is divided into five main tectonic zones. Those are Tethys Himalaya, Higher Himalaya, Lesser Himalaya, Sub-Himalaya (Siwaliks) and Indo-Gangetic Plain (Terai). The study area lies in the Higher Himalaya zone. The Higher Himalaya and the Lesser Himalaya zones are separated by main central thrust (MCT). The Higher Himalayan rocks are represented by grey garnet schist, grey kyanite and sillimanite schist, banded and augen gneisses with sporadic grey to light grey quartzite bands. Most of the Higher Himalayan rocks are deeply weathered, and on them are grey, brown, and yellow residual soils of more than 3 m thickness (CMS). Many large landslides are found on the Higher Himalayan rocks.

Geomorphology

Geomorphologically, Nepal is divided into eight major zones. Those are Trans Himalaya & Inner Himalaya Valleys, Higher Himalaya, Fore Himalaya, Midlands, Mahabharat Range, Siwalik Hills (Churia Range) & Dun Valleys and Terai Plain. The study area incorporates two major physiographic regions viz. the Mahabharat Range and the Midlands.

The Mahabharat Range abruptly rises from the Siwalik Hills, reaching a maximum altitude of about 3000 m. The part of Ilam municipality and the villages Sangrumbha, Siddhithumka, and Shantidada lie on this range. This landform consists of high hills and rugged terrain with deep gorges, indicating a youthful topography. This range is very important from the hydro- meteorological aspect because it acts as a barrier to the water-laden cloud and controls the distribution of precipitation in the watershed. The south-facing slopes of this range are highly prone to landslides and debris flows because of the presence of steep slopes and the availability of abundant precipitation. Similarly, the altitude of Midlands ranges from 1000 m to 3000 m (CMS). It is characterized by a relatively mature topography. It consists of wider river valleys. The northern part of the watershed lies in this region.

4.2.3 Basin Hydrology

Puwa khola, a tributary of Mai Khola, is a spring fed Perennial River that originates from Mahabharat range at an elevation of about 3000 m above main sea level. The river flows from north to south and takes the name as Puwa khola after the confluence of Thulo Puwa and Puwamai khola at Maipokharai VDC-2. Thulo puwa, Puwamai, Jhutre, Ghatte, Satake and Rate khola are the major tributaries of Puwa khola whereas Pakh, Noran and Swame kholsa are the minor ones. The entire catchment area is about 158.9 sq km with the total length of river as 22.02 km. A single hydrological station has been in operation within Puwa watershed which is at Sajbote at an elevation of 802m and has been functioning since 1965 (DHM).

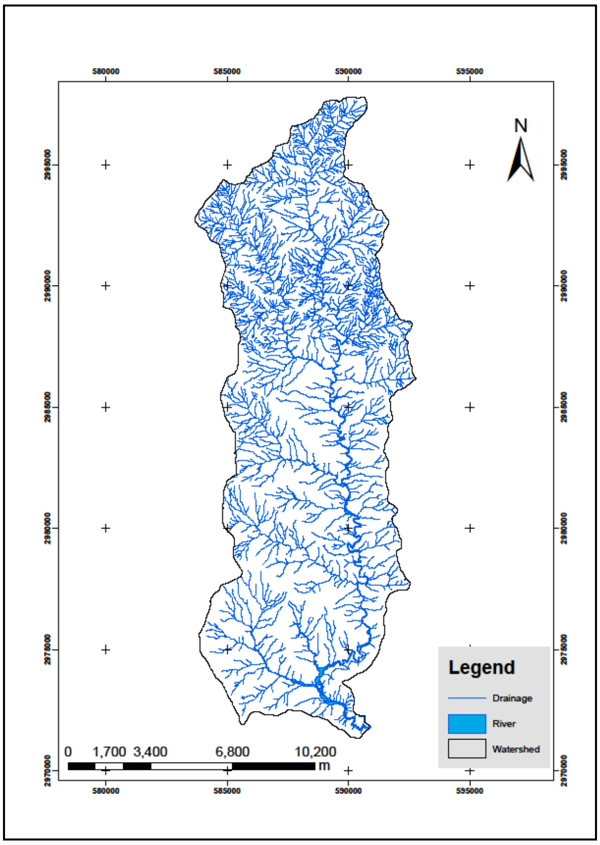

Fig. 4: River system and Drainage map of Puwa watershed

4.3 Biological Environment

The uppermost part is mostly covered by dense forest and the lower part is dominated by cultivation and the settlement area scattered within it. The area also comprises of bushland and grassland especially at the higher altitudes. The forest area is mostly dominated by Utis (*Alnus nepalensis*) and bomboo plants. Other associated species are Katus (*Castonopsis indica*), Siris (*Albizia* sps.), *Rhododendron* sps., *Pinus* sps., *Litsea* sps. Few percentage of land is covered by private and public tea plantation. Similarly, cow, buffalo, goat are the most dominant domestic species whereas jackle, hare, deer are the wild species found there.

4.4 Socio-economic and Cultural Environment

The total estimated household that lies within the watershed area is about 6,618 with the total population of 34,508 (17,351 male and 17,151 female) (CBS, 2010). Although the area is ethnically diverse, the area is dominated by Indo-Aryan (Brahmin and Chhetri) followed by Mongol (Rai, Limbo and Gurung) races. Most of the people are Hindus and

Kirats followed by Buddhists. The average literacy rate above six years age of total population is about 64%. Agriculture, especially farming of cash crops like cardamom, ginger, brushplant (amriso), akabare, tea and coffee is the major occupation and source of income. Beside this small business, cottage industries, government and private services are the other way of occupation and income sources. In recent years foreign employment trend has highly increased.

4.5 Landslide Inventory

Landslide hazard assessment and mapping was based on the analysis of existing and old landslide in the watershed. The identification and mapping was pre-requisite to perform the statistical analysis on the relation between distribution of landslides and influencing parameters. Although it was not possible to reach the location of old or existing landslides most of them are interpreted by field observation. Several new landslides were found during the field observation and their location, area and general information were collected. All that information was as far as possible precisely transformed to the topographic map scale of 1:25,000. Finally the information was converted to the digitized forms and the landslide distribution and landslide hazard maps were prepared using GIS.

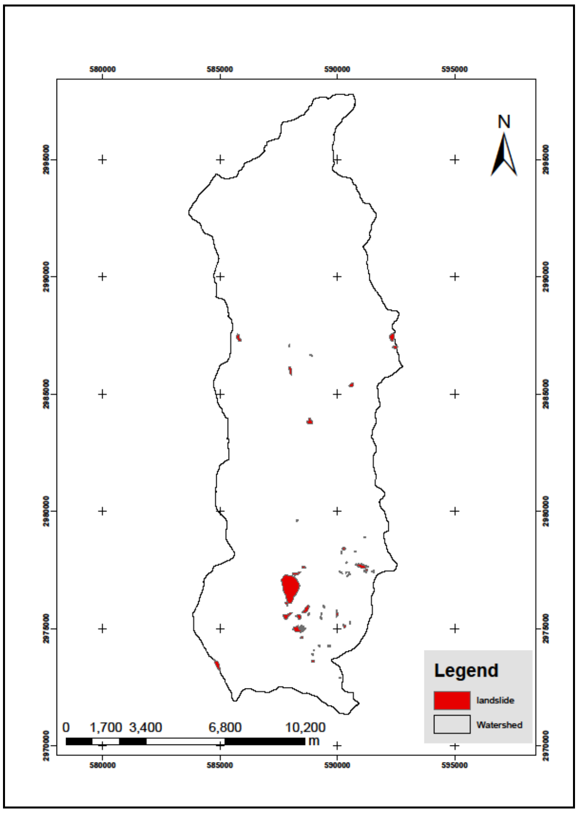

Fig. 5: Landslide Inventory map of Puwa watershed

CHAPTER V

5. RESULT

5.1 Meteorological Analysis

Temperature

The trend of temperature indices are presented in the table 2 and the description of these indices as given by ETCCDMI are given in annex-I. The table shows that there is decrease in annual occurrence of growing season length (GSL), cool nights (TN10p) and increase in warm nights (TN90p). Similar features are also observed in the trend of maximum temperature extremes; it shows that cool days (TX10p) are decreasing while warm days (TX90p) are increasing.

Table 2: Trends of temperature indices of Ilam tea estate meteorological station

Trend of temperature indices (per year)	
Station no. 1407 (Ilam tea estate)	
Indices	**Value**
SU25	2.552
TR20	0.081
GSL	-0.008
TXx	0.009
TNx	0.016
TXn	0.067
TNn	0.032
TN10p	-0.079
TX10p	-0.238
TN90p	0.106
TX90p	0.732
WSDI	1.701
CSDI	-0.076
DTR	0.061

The absolute temperature indices also exhibit a similar pattern. Figure 6 represents the pattern of the trend of the monthly maximum value of daily maximum temperature (TXx) and daily minimum temperature (TNx). This clearly shows that the increasing trend of daily minimum temperature is quite more than the increasing trend of daily maximum temperature. Similarly, it shows the increasing trend in the minimum value of daily minimum temperature (TNn) and daily maximum temperature (TXn).

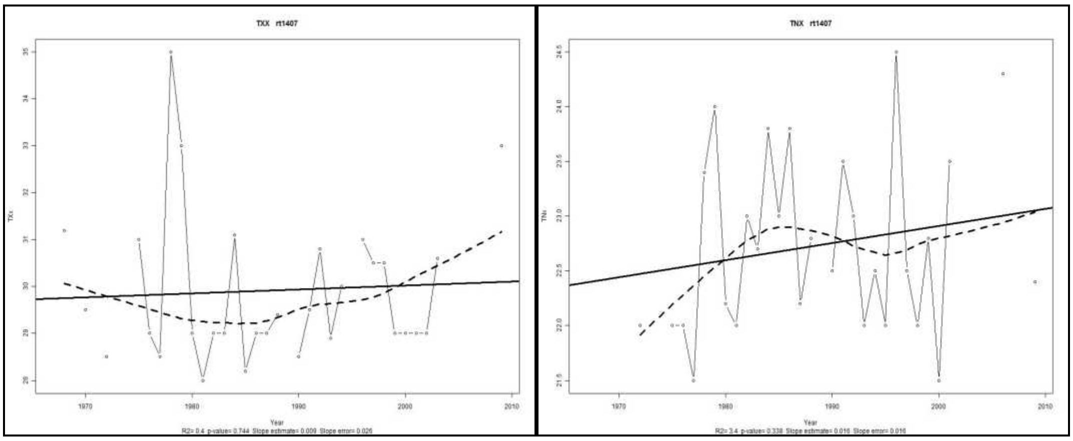

Fig. 6: Trend showing maximum value of daily maximum and minimum temperature at Ilam tea estate meteorological station

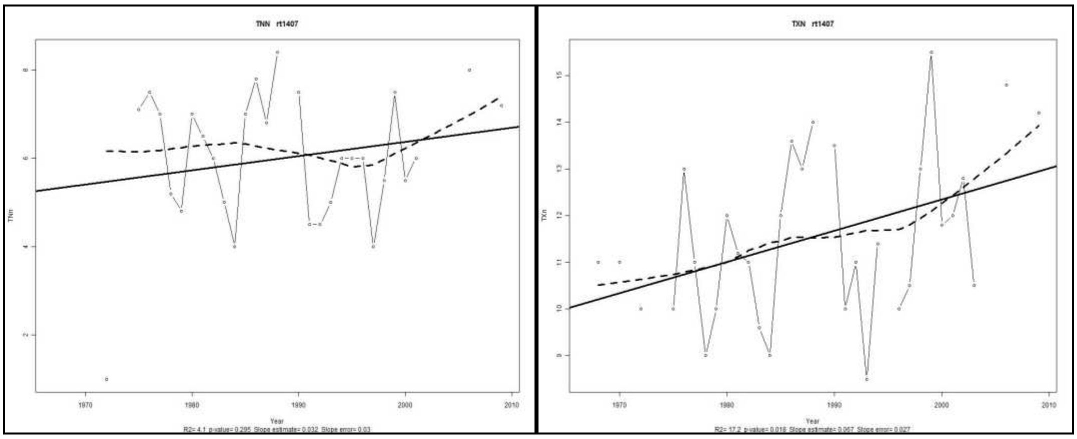

Fig. 7: Trend showing minimum value of daily maximum and minimum temperature at Ilam tea estate meteorological of station

The annual count of days with at least 6 consecutive days when maximum temperature is greater than 95th percentile is termed as warm spell duration indicator (WSDI) and the annual count of days with at least 6 consecutive days when minimum temperature is lesser than 10th percentile is termed as cold spell duration indicator (CSDI) (ETCCDMI). The analysis has clearly shown that WSDI is in increasing trend while CSDI is in decreasing trend. Similarly, summer days defined as the annual count of number of days with daily maximum temperature greater than 25ºC (SU25) and the diurnal temperature range (DTR); monthly mean difference between maximum and minimum temperature (ETCCDMI) both has a positive trend.

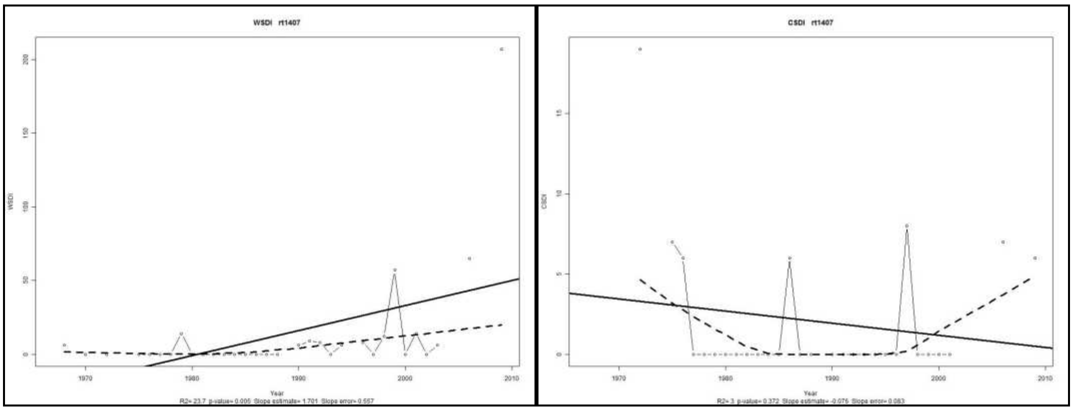

Fig. 8: Trend showing warm and cold spells duration indicators of Ilam tea estate meteorological station

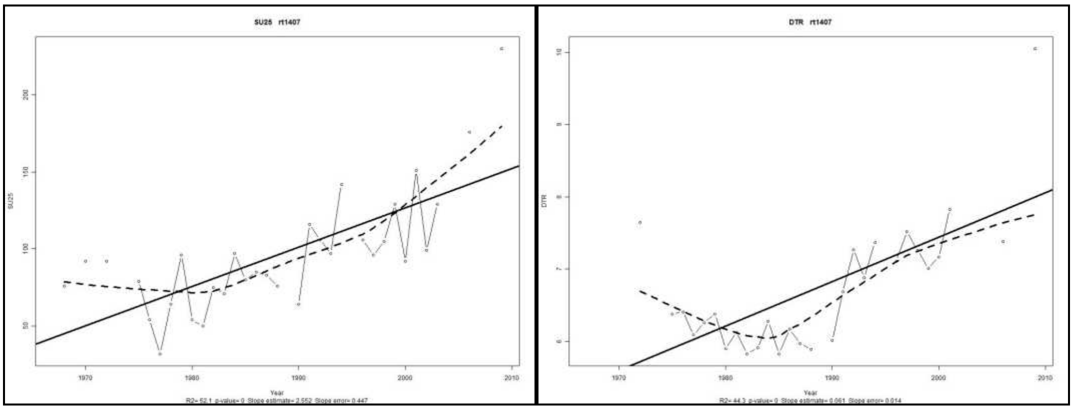

Fig. 9: Trend showing maximum temperature >25 ºC and diurnal temperature range at Ilam tea estate meteorological station

Precipitation

The trend of precipitation pattern of the station 1407 since 1967 to 2009 is as shown in the table 3 and the indices description by ETCCDMI are in annex-I. The table clearly shows that the numbers of very heavy precipitation days (R20 and R50) are in the increasing trend while R10 is in decreasing trend. This signifies the frequent occurrence of extreme precipitation events. Similarly, the trend analysis of annual precipitation in wet days (PRCPTOT) showed the increasing trend whereas the monthly maximum 1-day precipitation (RX1day) is in decreasing trend. Likewise, in comparison to extremely wet days (R99) very wet days (R95p) is in the increasing trend. The other precipitation indices like simple daily intensity index (SDII), consecutive dry days (CDD) are in increasing trend while monthly maximum consecutive 5 days precipitation (RX5) and consecutive wet days (CWD) are in decreasing trend.

Table 3: Trend of precipitation indices of Ilam tea estate meteorological station

Trend of precipitation indices (per year)	
station no. 1407 (Ilam tea estate, 1300m)	
Indices	**Value**
RX1day	-0.123
RX5day	-0.18
SDII	0.111
R10mm	-0.066
R20mm	0.056
R50mm	0.028
CDD	0.562
CWD	-0.054
R95p	1.551
R99p	-0.579
PRCPTOT	2.06

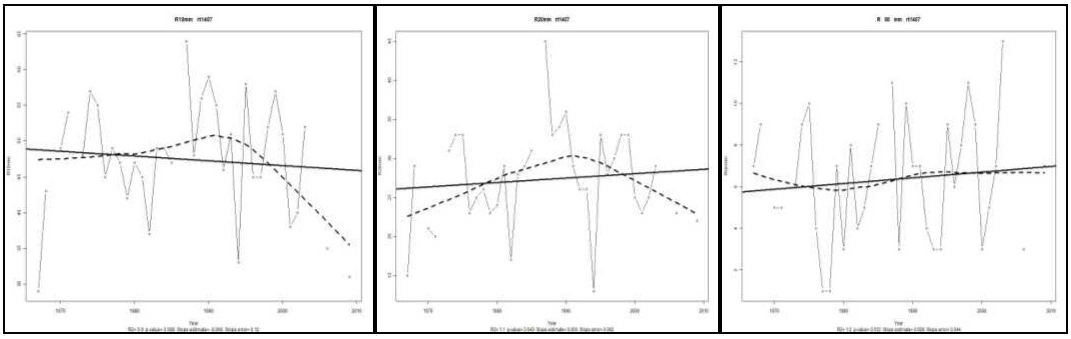

Fig. 10: Trend showing precipitation days (R10mm, R20mm, R50mm) at Ilam tea estate meteorological station

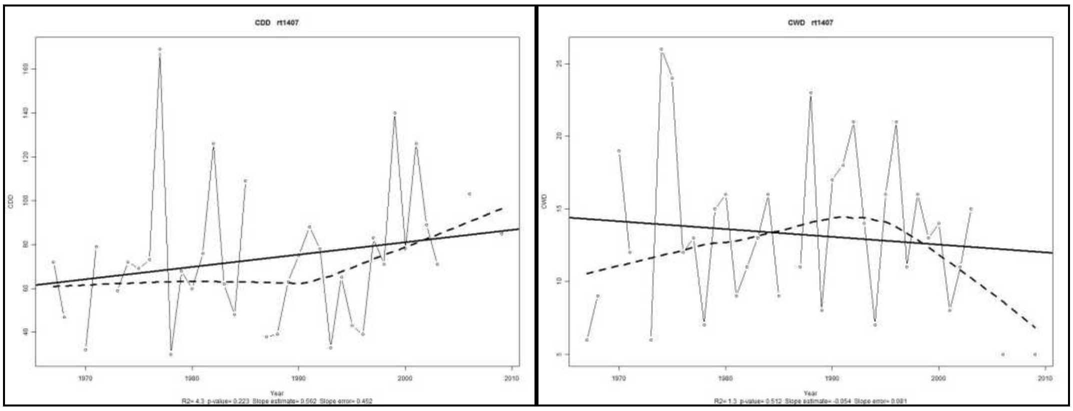

Fig. 11: Trend showing consecutive dry and wet days at Ilam tea estate station

5.2 Landslide Hazard Analysis

Landslide is the major indicator of slope instability which is the outcome of complex interaction of various factors. Some of the crucial terrain parameters used during the analysis of this study was aspect, soil, curve, drainage densities, slope and landuse pattern. Each thematic data layers were analyzed separately and were then compared. After individual analyzing each data layers were classified into five major divisions, viz; Stable, Moderately Stable, Moderately Unstable, Unstable and Highly Unstable and were ranked accordingly.

Slope

The slope map and its area coverage of the study area are given in the figure 12 and 13. Out of the total study area 15.56% falls under gentle (<15º), 32.01% falls under slopping (15º-25º), 14% under moderate (25º-35º), 35.04% under high (35º-45º) and 3.39% falls under cliff (>45º). The landslide distribution map was then superimposed on this slope map the map was again reclassified into five divisions giving a rank from 1 to 5 where 1 signifies as stable, 2 moderately stable, 3 moderately unstable, 4 unstable and 5 as highly unstable. During reclassification it has been found that moderate slope (25º-35º) gets the highest rank 5 that means highly unstable and then slopping 4, high 3, cliff 2 and finally gentle the least 1 signifying the most stable zone.

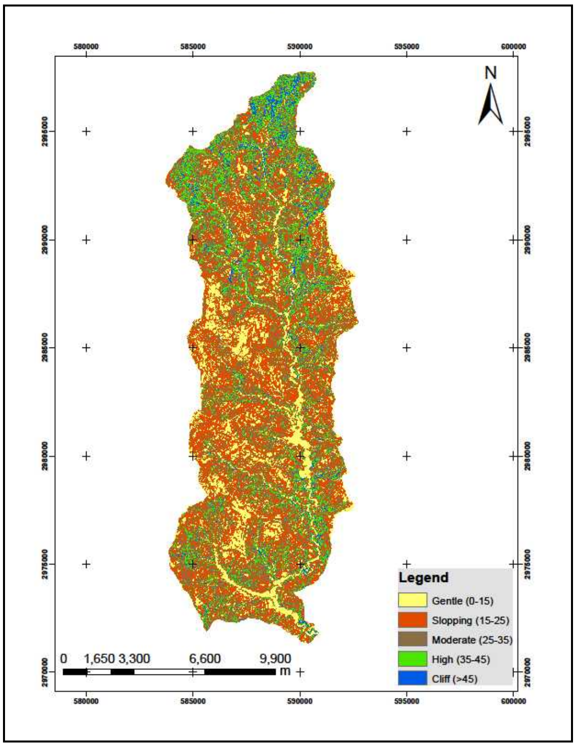

Fig. 12: Slope map of Puwa watershed

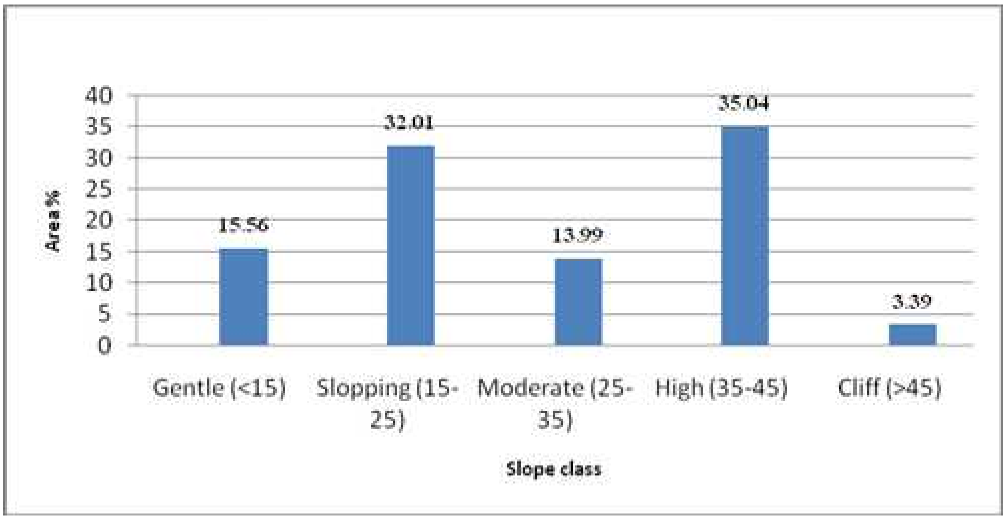

Fig. 13: Percentage of area occupied by different slope classes

Aspect

The windward and the leeward faces as well as Northern and Southern slopes of a mountain differ in their climatic conditions, it is because of the difference in the amount of rainfall and sunshine received which in turn controls the diversity, density, and the distribution of vegetation in the area. All these factors control the soil type, drainage type and susceptibility to mass wasting over an area. The aspect of a hill slope is its facing direction. The aspect map of the study area is shown in the figure 14 and figure 15 describes the area sharing of aspect categories. The highest area is covered by the slope facing southeast (32.75%). From the field observation and landslide overlapping it has been found that a range between 225-315 i.e. south, southwest and west is highly unstable zone than other parts.

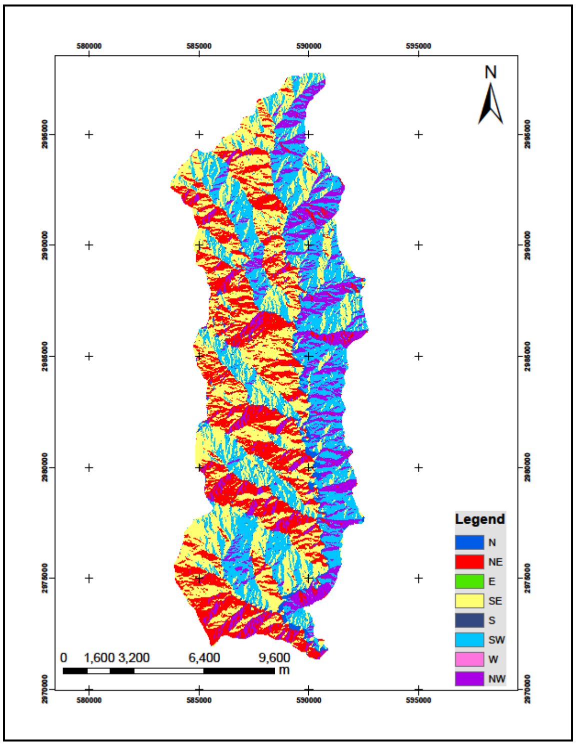

Fig. 14: Aspect map of Puwa watershed

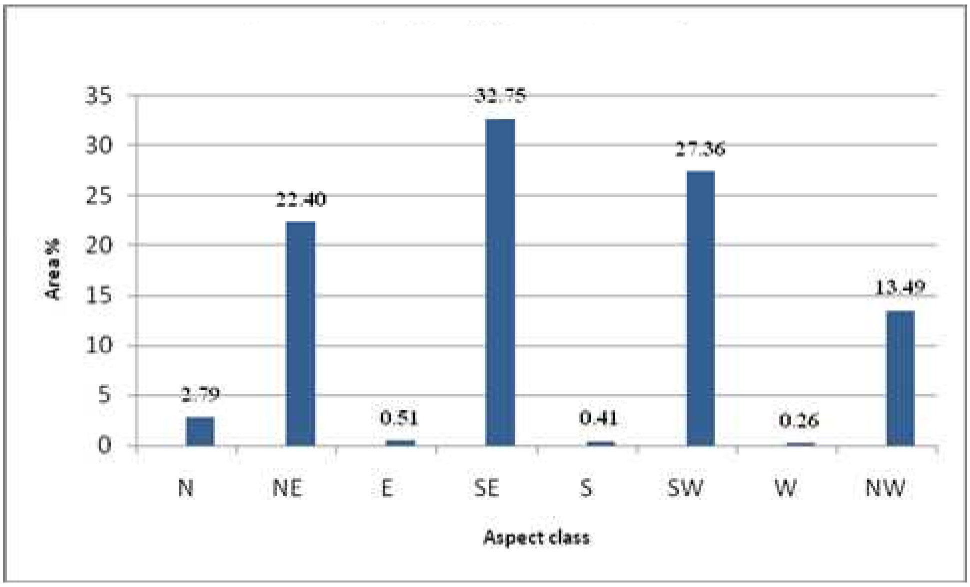

Fig. 15: Percentage of area occupied by different Aspect class

Curve

The curvature map of the Puwa watershed was prepared during the study. The whole watershed has been classified into 7 different groups that include -307- -40, -40- -20, -20-0, 0- 20, 20-40, 40-60 and >60. Thus, prepared curve was again reclassified overlapping the landslide map and was ranked accordingly.

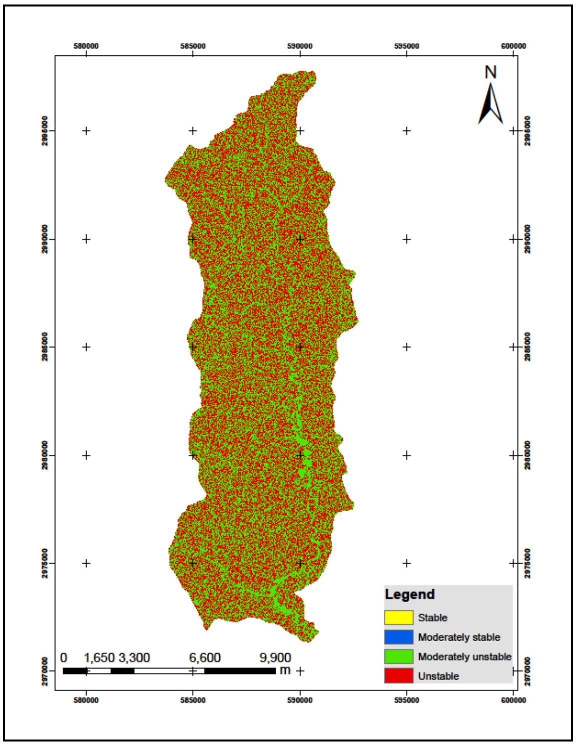

Fig. 16: A reclassified curve map of Puwa watershed

Drainage distance

The drainage distance map along with the percentage of area occupied by each class is shown in the figure 17 and 18. This plays a significant role in soil stability/instability. The land near the drainage area is generally more vulnerable to slope failure/ landslide/ debris flow or instability. This may be due to the toe cutting or high riverbed erosion. In this study, the area was classified into five different classes based on drainage density on an equal interval of 50m, those are 0-50m, 50-100m, 100-150m, 150-200m and >200m. It has been found that the highest percentage of area lies within the proximity class 0-50m which is also highly vulnerable to landslide. Similarly the drainage density was found high in the study area so the least percentage of area was covered by the distance range of >200m.

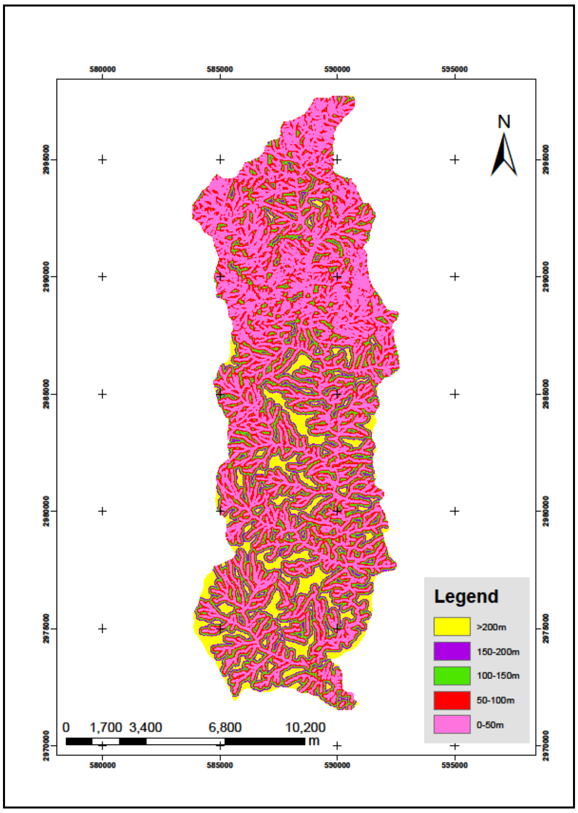

Fig. 17: A map showing proximity to drainage of Puwa watershed

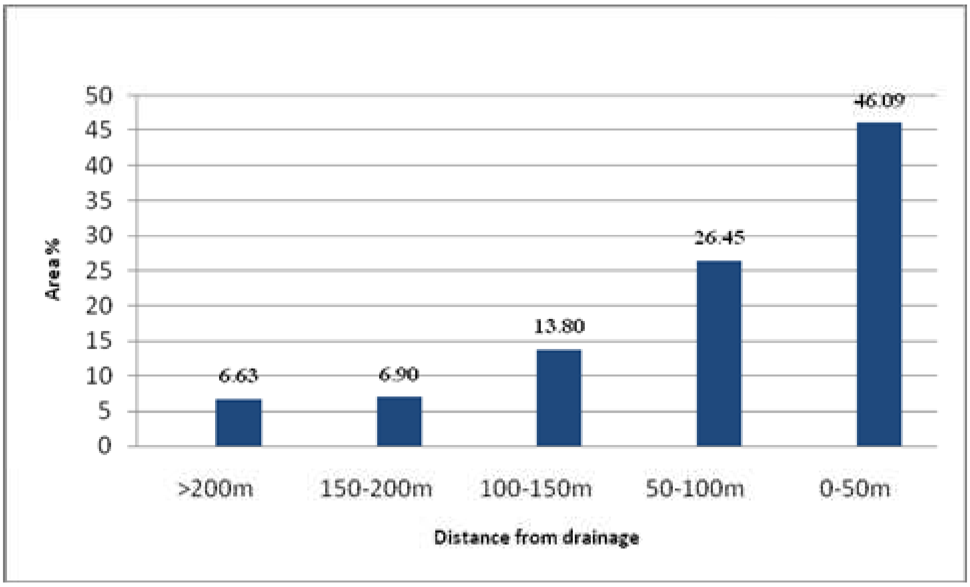

Fig. 18: Percentage of area occupied by different proximity class

Soil

Since, the study area falls under the single geological classification i.e. on Higher Himalaya so the soil map was studied. From the study it has been found that the highest percentage of area is covered by the colluvial deposit (68.83%) and the least by loamy (0.19%). The soil map and the area percentage graph are shown in the figure 19 and 20.

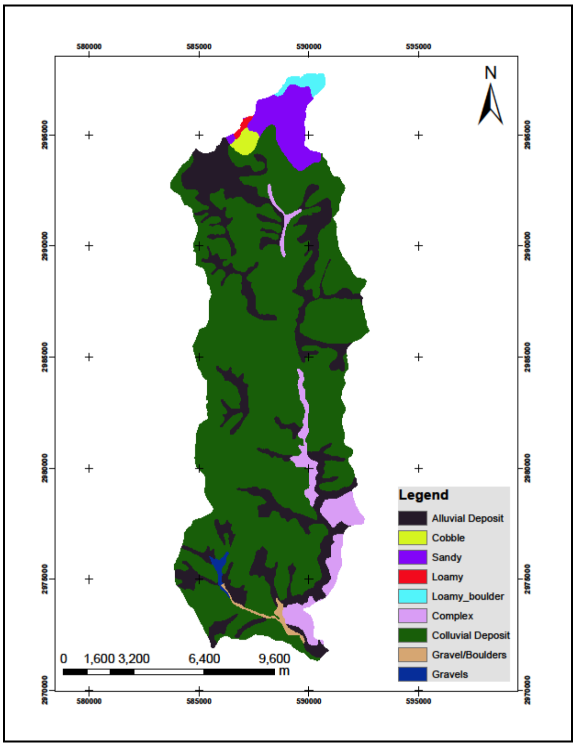

Fig. 19: Soil classification map of Puwa watershed

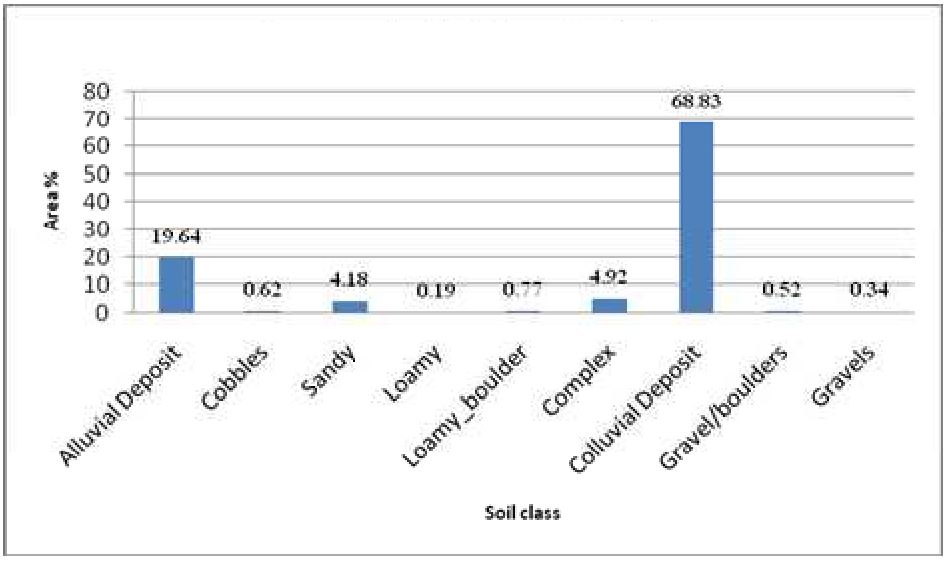

Fig. 20: Percentage of area occupied by different soil class

Landuse

The pattern of using land determines the erosion factor of that area. The landuse map of the study area is given in figure 21. From the study it has been seen that the cultivated land and the forest covers nearly the same area i.e. 45.33% and 45.10% respectively. River system and lakes covers the least percentage of land whereas landslides covers about 0.83% 0f total land.

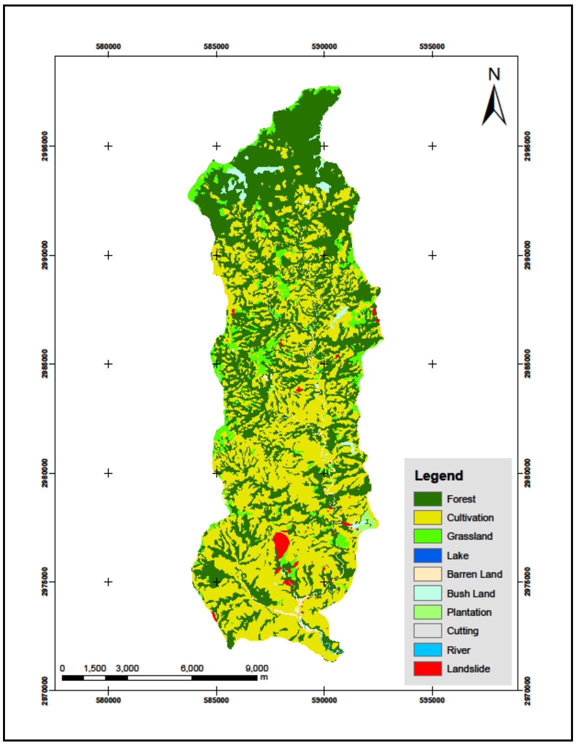

Fig. 21: Landuse map of Puwa watershed

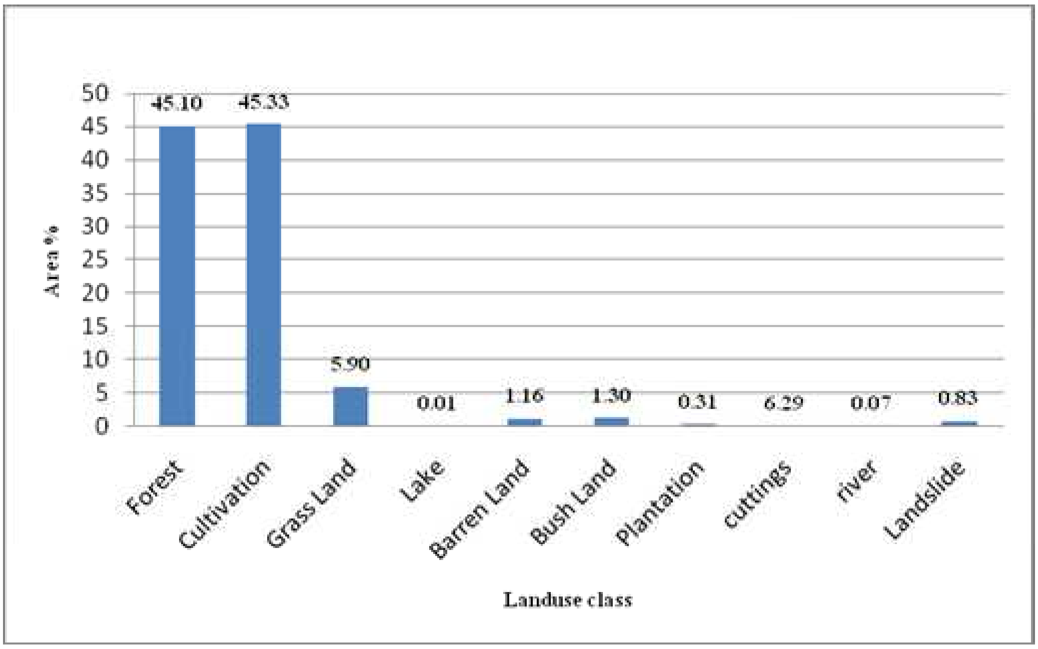

Fig. 22: Percentage of area occupied by different landuse pattern

Hazard map

After preparation of all the required thematic maps, they were reclassified and ranked into five major zones based upon the field observation and overlaying of landslide map and finally the hazard map was prepared. This hazard map is the synthesis of reclassified slope, aspect, curve, drainage distance, soil and landuse maps. From the study it has been found that 0.24 sq km of area falls under stable zone which is 0.15% of the total study area. Similarly, 6.39 sq km falls under moderately stable zone, 45.66 sq km falls under moderately unstable zone, 83.20 sq km under unstable zone and 23.03 sq km under highly unstable zone which are 4.02%, 28.74%, 52.36% and 14.49% of the total study area respectively. This hazard map can be again reclassified as low 32.91%, medium 52.36% and high 14.49% hazard zone. The final hazard map is shown in the figure 24.

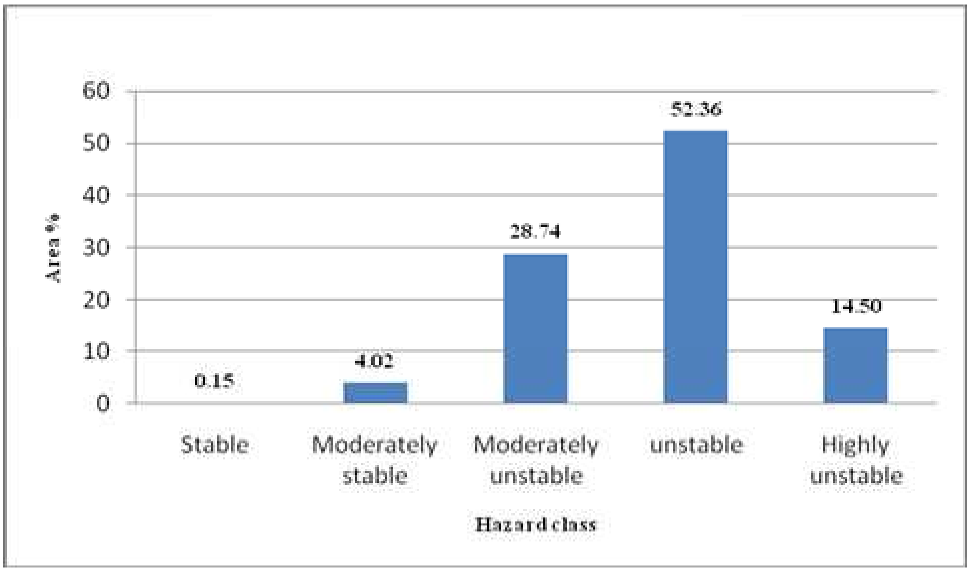

Fig. 23: Percentage of area occupied by different hazard zones

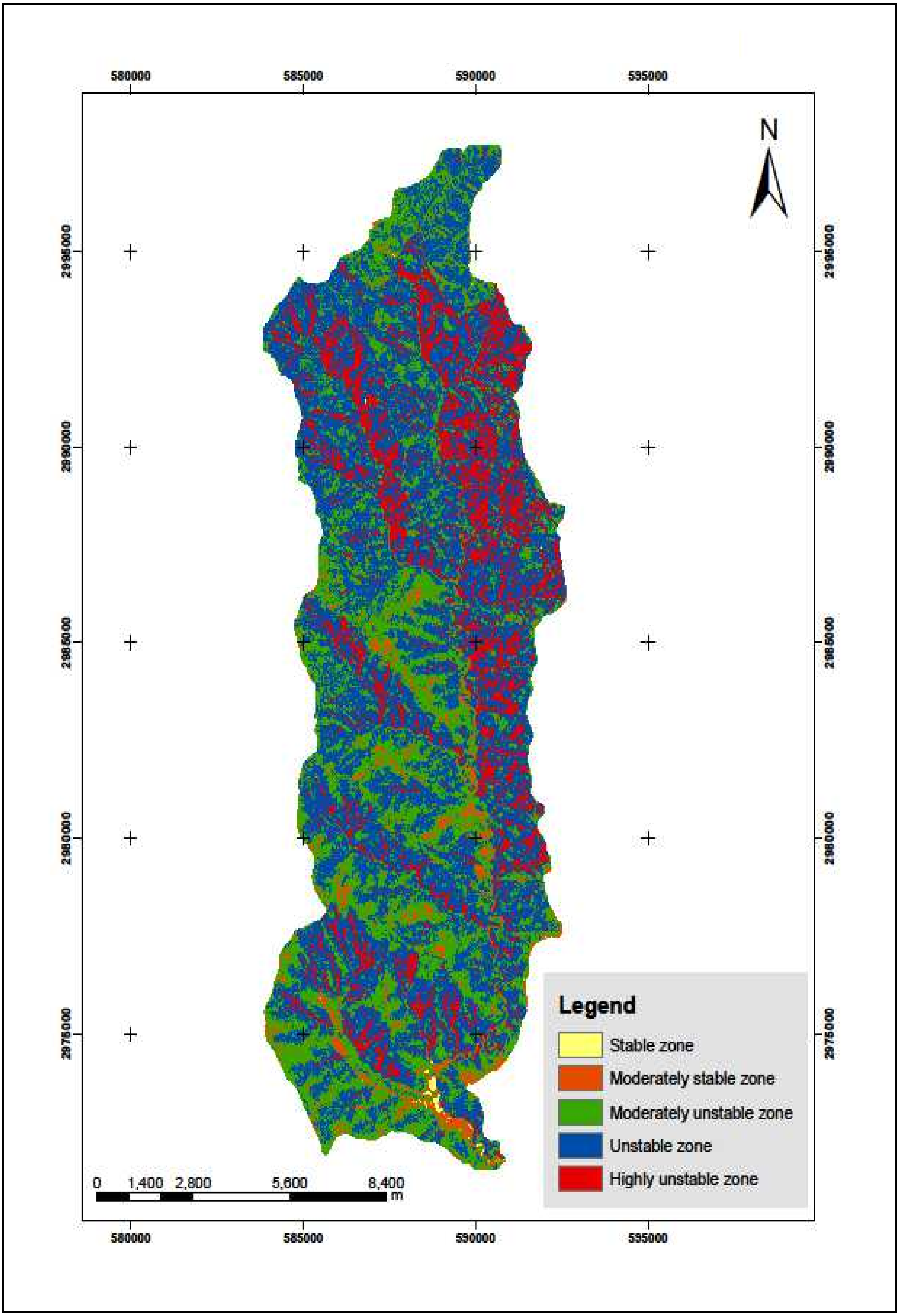

Fig. 24: Landslide hazard map of Puwa watershed

CHAPTER VI

6. DISCUSSION

6.1Meteorological Analysis

Extreme events like floods, droughts and landslides are the result of extreme meteorological and hydrological conditions. Climate science literature provides an indication of future trend and changes in the climatic conditions and events with some level of uncertainty. IPCC report clearly states that the frequency of heavy precipitation events has increased over the global arena, consistent with warming and increase of atmospheric water vapour. Cold days, cold nights have become less frequent as compared to hot days, hot nights and heat waves. Nepal lying in the southern flank of the Himalayas is affected profoundly by the monsoonal circulation of South Asia. Though small in size, it has a complex and fragile topography with altitude ranging from almost sea level in the south to the highest place on the earth (Mount Everest) in the north just within a span of about 200 km. This large north-south variation of topography gives rise to different climatic regions. These hills/mountains and the Himalayas are very sensitive to climate change and variability.

Different models adopted to predict future projections estimates that average annual temperature of Nepal will rise in the range of 0.2°C to 0.4°C when CO_2 level is doubled. Similarly, GFD3 model project general increase in precipitation for the whole Nepal with gradient from south west to north east in magnitude of 150mm to 1050 mm when CO_2 level is doubled (MoEnv, 2008). According to IPCC Fourth assessment Report 2007, the linear warming trend over the last 50 years is 0.13°C per decade. Based on the records from 1979, the mean Nepal temperature is increasing at 0.4°C per decade. Globally the annual number of warm nights/cold nights increased/decreased by about 25/20 days since 1951 (Alexander *et al.*, 2005). In the study area, the trends in maximum temperature extremes showed similar patterns of change, although of smaller magnitude. From the analysis it is seen that the monthly maximum value of daily maximum temperature is increasing by 0.009°C while the monthly minimum value of daily minimum temperature is increasing by 0.032°C per year. The positive trend clearly signifies the increasing trend of hot days and hot nights. Cool days and cool nights are decreasing by 0.238 and 0.079 days while warm days and warm nights are increasing by 0.732 and 0.106 days per year respectively. Although there is only one meteorological station within the study area, the analysis result shows a significant trend consistent with a global trend. The DTR trend also proves that the temperature is increasing in higher altitude as compared to the lowlands.

Similarly, in comparison to R10 and R20, R50 shows increasing trend signifying the occurrence of precipitation extreme events. Alexander *et al.* (2005) also found that averaged across the globe, more extreme precipitation events have been increasing. Although the consecutive wet day is in decreasing trend the annual total wet day precipitation is in the increasing trend. The number of days above 50mm of precipitation per day is increasing by 0.028 days per year. This rise in temperature, unexpected extreme events affects a various sectors like agriculture, water resource management, land resources and many others. They are even the major causative factors for most of the hazardous events.

6.2 Landslide Hazard Mapping

Landslide, like other natural hazards such as flood, earthquake and avalanche is often difficult to predict. However, landslide risk can be systematically assessed and managed. Hazard maps are usually the end product of landslide mapping but they are the basis for decision making. These decisions are usually in the form of technical counter measures, regulatory management, or combinations of the two. Classic examples of regulatory management are zoning maps which, for instance, exclude some landslide-prone areas from habitation. Landslide hazard maps have been constructed using the relationship between each landslide and causative factors. In this study, a probabilistic approach to estimate areas susceptible to landslides using GIS is presented.

The study revealed that the prone area to landslide due to the aspect category is west and south west. Similarly the most probability of occurrence of landslide seemed to be on the slope angle between 25° - 35° on the drainage distance between 0m – 50m. The large percentage of study area is covered by forest and cultivation land. The hazard mapping shows that almost 52.36% of the total study area lies in an unstable zone and 14.50% lies in highly unstable zone of the hazard map prepared after detailed investigation of the factors that might be responsible for the onset of the landslides. The majority of landslide is in forest and cultivation land. It might be due to the unmanaged agricultural practices. It also states that only plantation of trees does not reduce landslide. This shows that slope and soil category also plays a prominent role in inducing landslide. Similar case was found during hazard mapping of Oakland area, California (Pike, J.R. *et al.* 2001).

A close relationship has been found between the distance to water divide and location of the slope failures (Oyagi, 1984). Both area and length of superficial deposits show the extent where the water may infiltrate into the material susceptible to failure. The mean slope angle of the watershed indicates the capacity to help water infiltration into the soil. Likewise landuse (density of vegetation) has a twofold influence on the stability of slope: hydrological (capacity of infiltration into the soil, soil moisture, groundwater level, etc.) and mechanical (root strength) (Greenway, 1987).

6.3 Relation between Meteorological Analysis and Landslide Hazard Mapping

Precipitation is the main triggering mechanism of landslides in the study area. Several researchers like Currie, Khanh have found an increase of rainfall with altitude increases in the number of slope failures. The slope angle is the main geometric instability. The higher the angle the greater is the shearing component of the forces acting at the potential surface of failure. The geological and morphological diversity of the study area has a particular effect on the threshold angle for slope failures. The latter occur in colluvium blanketed slopes. It appears that, even though a minimum angle is needed to cause slope failures, such failures are absent on very steep slopes (>45°). This is because neither colluvium nor weathered clay can stand on these slopes. Steep slopes are made of resistant bedrock and are stable. High roughness slopes are more prone to landslides because gradient changes favor rainfall infiltration into the soil. The slope curvatures indicate the capability of water run-off concentration or dispersion.

Hilly landscapes are dissected into a branching network of valleys along which runoff and sediment transport is concentrated. The surface topography has a great bearing on the location and frequency of shallow landsliding. It is not just the local slope that matters but also the curvature of the topography and how it focuses or spreads runoff downslope. The flat areas are stable that ridges with divergent subsurface flow may be steep enough to fail but require unusually large storms to generate instability and that steep unchanneled valley axes require the smallest rainstorm to fail due convergent subsurface flow and therefore most susceptible to increase instability (Montgomery and Dietrich, 1998).

Most of the climate modeling and the study report predicts that the attribute of climate particularly change in rainfall pattern, increased temperature and extreme climatic events, weather related disasters are going to be problematic in global, regional, national and local level. It has seen that extreme events are increasing like drought, very high precipitation. This has increased the landslide prone zone. Large numbers of landslide and debris flow scars can be initiated due to heavy rainfall/ precipitation. Daily precipitation with more than 100mm causes slope instability (Caine and Mool, 1982). Besides weak geology and steep topography heavy precipitation was the main cause of landslide and debris flow in the Agra Khola catchment (Poudel, 1995). Although intensity of rainfall, presence and absence of gullies, streams and rivers are the secondary causes of landslides but it shows that the intense and continuous precipitation are major controlling factors of landslides events in Nepal. Rainfall induced shallow landslides during monsoon season are more frequent than deep seated landslides. Many extreme rainfall events such as 1993 disaster had caused major landslide events in the past (Upreti and Dhital, 1996).

CHAPTER VII

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

The study has attempted to analyze the meteorological patterns and also to prepare the landslide hazard map of the Puwa watershed. The analysis of meteorological data indicates some of the changes in climatic variables. General warming trend has been observed in the temperature extremes. Most of the extreme indices show an increasing trend. Summer days shows a positive trend i.e. the annual count of daily maximum temperature greater than 25ºC is in increasing trend of 2.552 days per year. Although the increase seems to be in small magnitude similar patterns can also be seen in monthly maximum value of daily maximum temperature, monthly maximum value of daily minimum temperature, warm days, warm spell duration indicator and diurnal temperature range. But the negative trend or the decreasing trend is observed in cool nights and cool days.

The precipitation events also shows increasing trend in total and heavy precipitation events. Very wet days i.e Precipitation >= 20mm per day and very heavy precipitation days i.e Precipitation >= 50mm per day is in increasing trend, this means there is strong evidence that it is likely to have more intense precipitation in the future. This indicates that the more weather related disasters like flood, landslide and drought can be expected in the future.

The infrastructure development in the mountain area if fail to take account the inherent instabilities in the mountain region in the landscape, the new constructions could be severely damaged or even destroyed. Equally, sustainable development planning in hill area must try and minimize damage to environment and reduce the threats to people and property from natural hazards. The stable zones are generally safe for developmental schemes while the moderate zones may have some local zones of instability that can be avoided. The highly unstable zones should be avoided for infrastructural development as far as possible. If it is not possible to avoid these areas, their initial recognition will help planners to adopt suitable preventive measures. The landslide hazard zonation maps are important tools for designing infrastructure schemes in ways to minimize environmental hazards and for planning environmental regeneration programmes and slope management for sustainable development. This study thus helps the policy makers to look seriously towards the role of warming and its consequences in water resources sector with a direct impact on agriculture, landslides and other related disasters and the people's livelihood.

7.2 Recommendations

Based on the field study and the analysis of data following recommendations are made in order to reduce the impacts aroused.

- Hazard mapping should be carried out in a large scale and cover vast expanses to make an inventory of the stability of areas such that developmental activities can be placed at proper/stable area.
- For the accuracy of the hazard map produced, more of the attributes such as: geology, soil permeability, infiltration rate etc that might be responsible for the causes of landslide can be included in the study.
- Use of new technologies such as LIDAR (Light Detection and Ranging) which improves the quality of the digital terrain representations can be used for further study.
- Topographic data should be of high resolution so that the topography of the landslide area can be properly represented.
- Rainfall distribution map according to the altitude can be prepared.
- The identified vulnerable area should be considered for future development plans in improving infrastructural development and enhancing livelihood of local peoples.
- Gullies and drains should be checked and maintained regularly.
- Preparedness and early warning system should be built up in the community.

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Annex-I

List of ETCCDMI core Climate Indices:

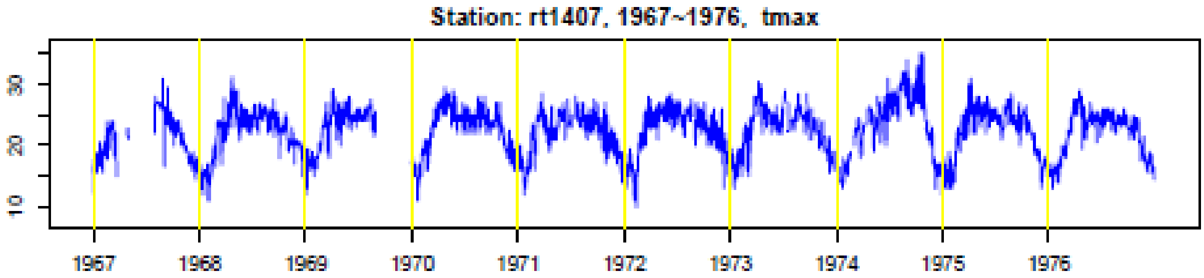
ID	Indicator name	Definitions	UNITS
FD0	Frost days	Annual count when TN(daily minimum)<0ºC	Days
SU25	Summer days	Annual count when TX(daily maximum)>25ºC	Days
ID0	Ice days	Annual count when TX(daily maximum)<0ºC	Days
TR20	Tropical nights	Annual count when TN(daily minimum)>20ºC	Days
GSL	Growing season Length	Annual (1st Jan to 31st Dec in NH, 1st July to 30th June in SH) count between first span of at least 6 days with TG>5ºC and first span after July 1 (January 1 in SH) of 6 days with TG<5ºC	Days
TXx	Max Tmax	Monthly maximum value of daily maximum temperature	ºC
TNx	Max Tmin	Monthly maximum value of daily minimum temperature	ºC
TXn	Min Tmax	Monthly minimum value of daily maximum temperature	ºC
TNn	Min Tmin	Monthly minimum value of daily minimum temperature	ºC
TN10p	Cool nights	Percentage of days when TN<10th percentile	Days
TX10p	Cool days	Percentage of days when TX<10th percentile	Days
TN90p	Warm nights	Percentage of days when TN>90th percentile	Days
TX90p	Warm days	Percentage of days when TX>90th percentile	Days
WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90th percentile	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10th percentile	Days
DTR	Diurnal temperature range	Monthly mean difference between TX and TN	ºC
RX1day	Max 1-day	Monthly maximum 1-day precipitation	Mm

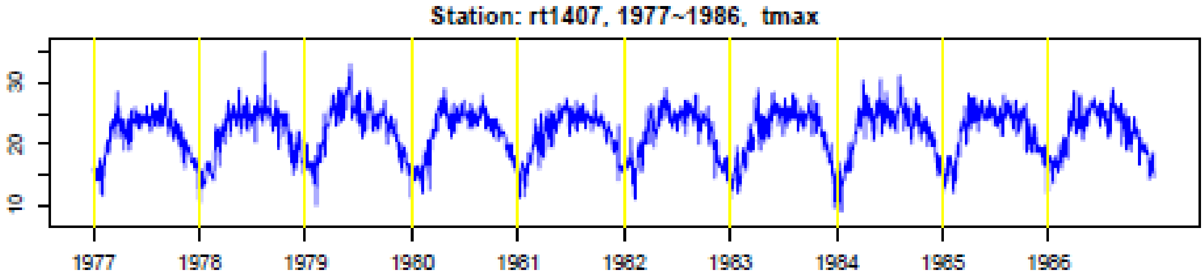
	precipitation amount		
RX5day	Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	Mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP>=1.0mm) in the year	Mm/day
R10	Number of heavy precipitation days	Annual count of days when PRCP>=10mm	Days
R20	Number of very heavy precipitation days	Annual count of days when PRCP>=20mm	Days
Rnn	Number of days above nn mm	Annual count of days when PRCP>=nn mm, nn is user defined threshold	Days
CDD	Consecutive dry days	Maximum number of consecutive days with RR<1mm	Days
CWD	Consecutive wet days	Maximum number of consecutive days with RR>=1mm	Days
R95p	Very wet days	Annual total PRCP when RR>95th percentile	Mm
R99p	Extremely wet days	Annual total PRCP when RR>99th percentile	mm
PRCPTOT	Annual total wet-day precipitation	Annual total PRCP in wet days (RR>=1mm)	mm

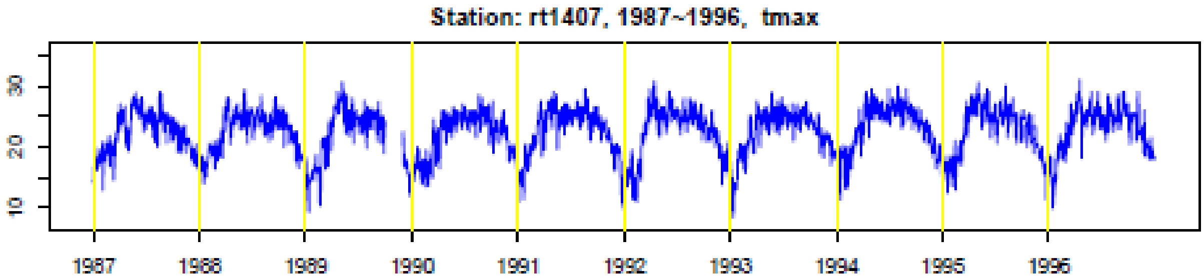
Annex-II

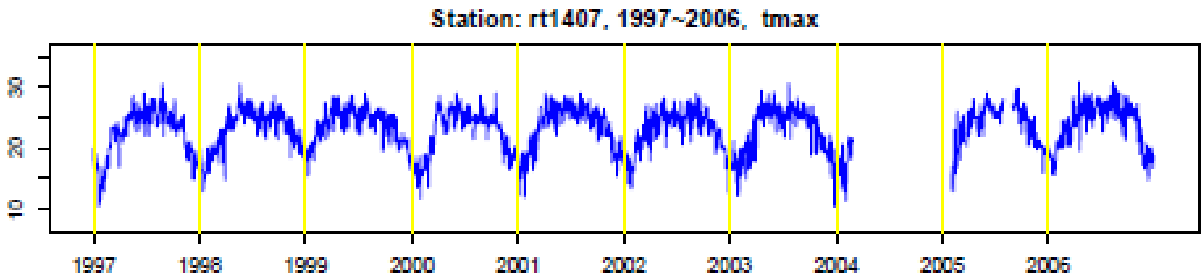
Graphical Representations of Climatic Data:

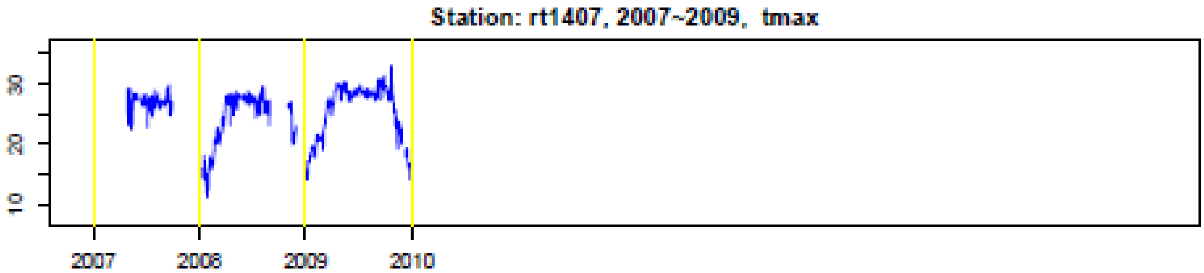
Graphical representation of daily maximum temperature:



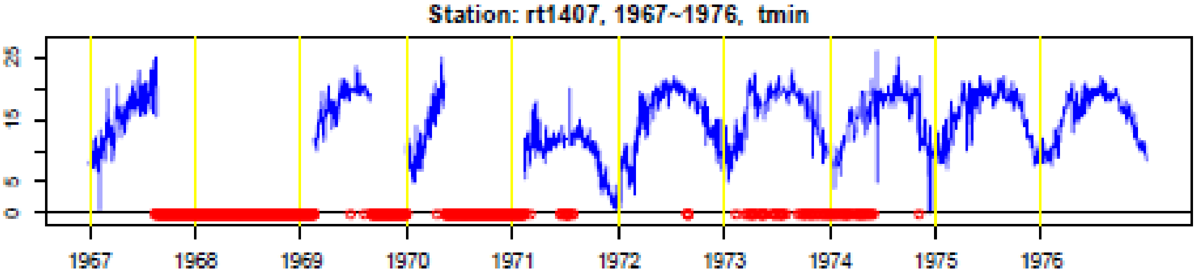


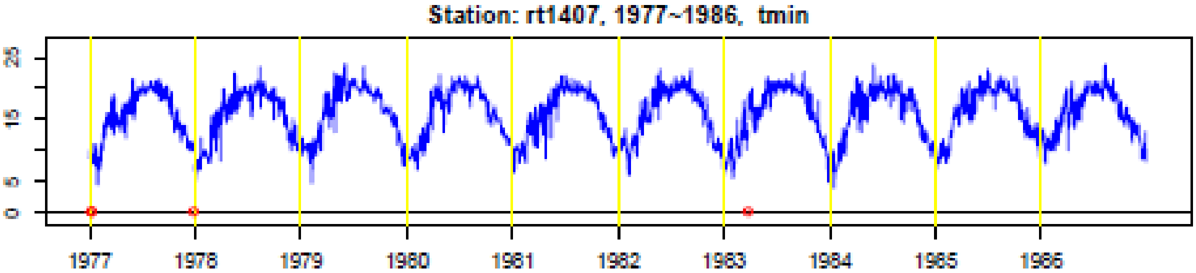


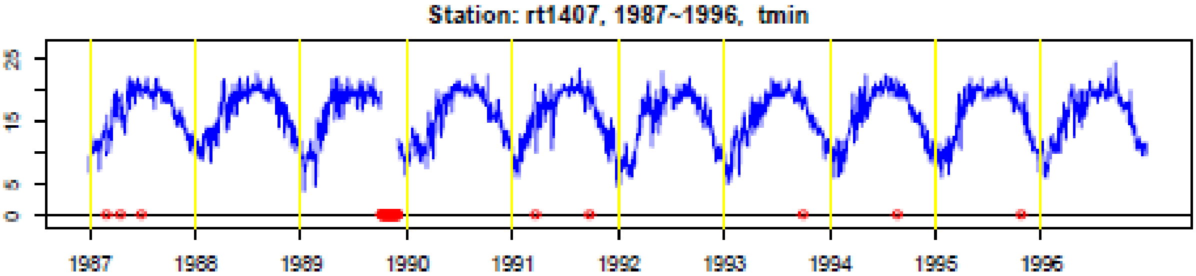


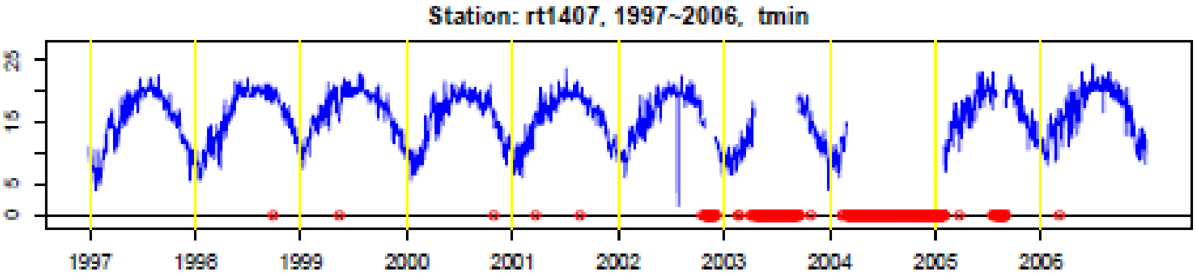


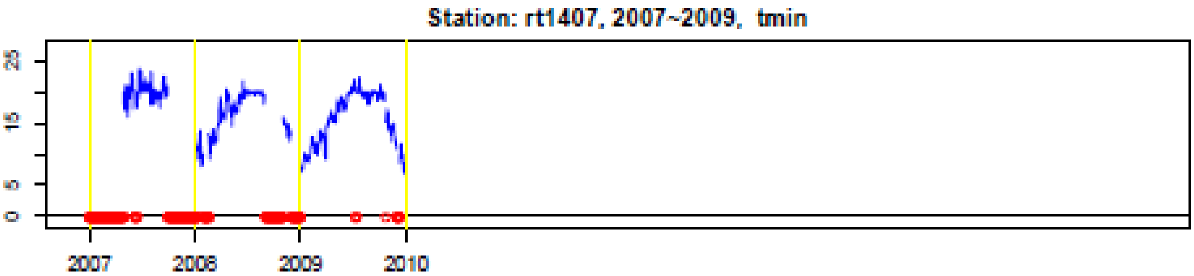
Graphical representation of daily minimum temperature:



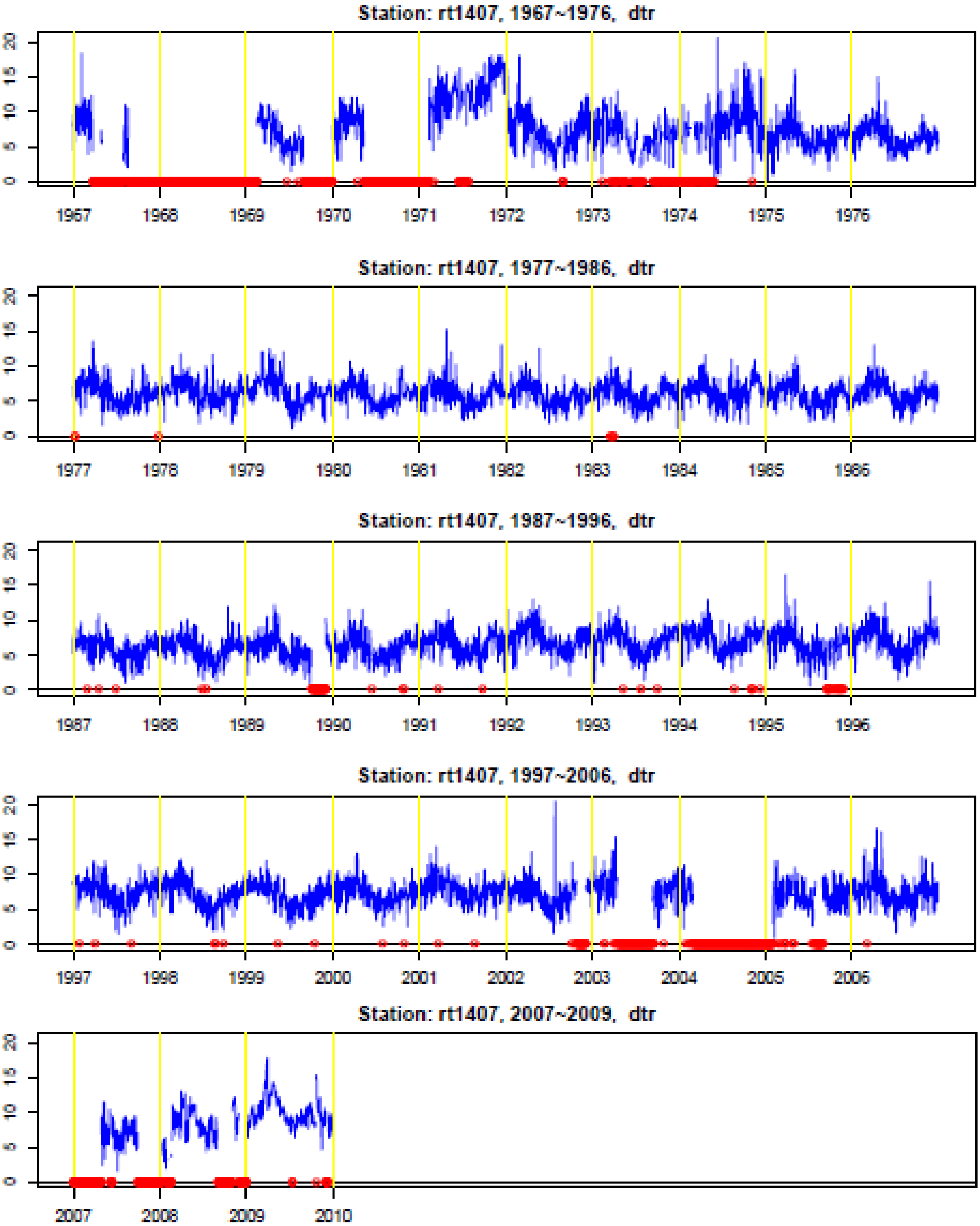




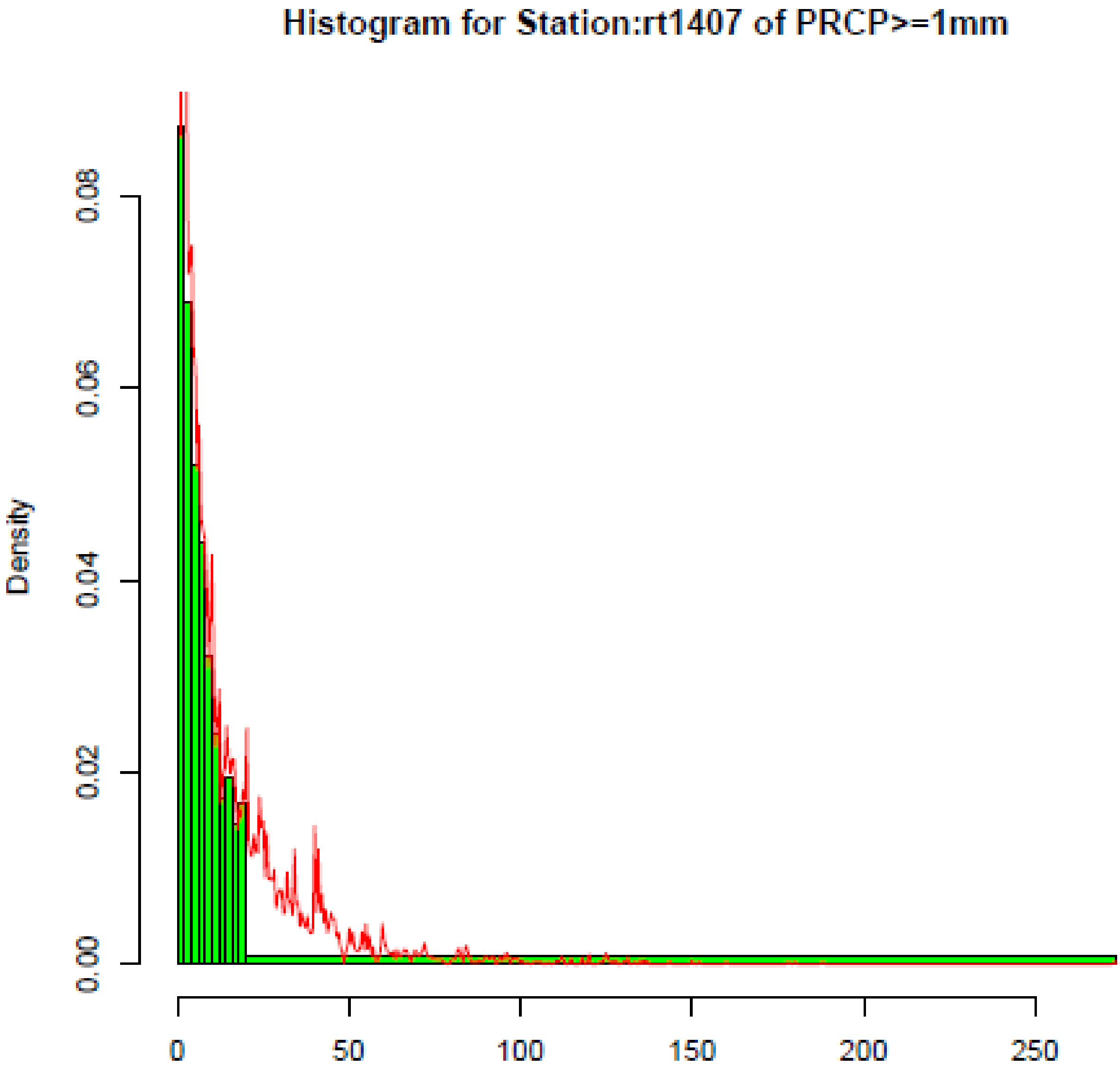


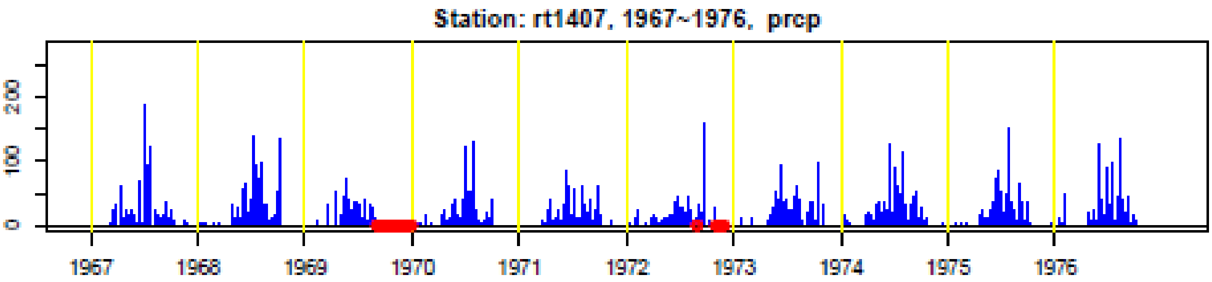


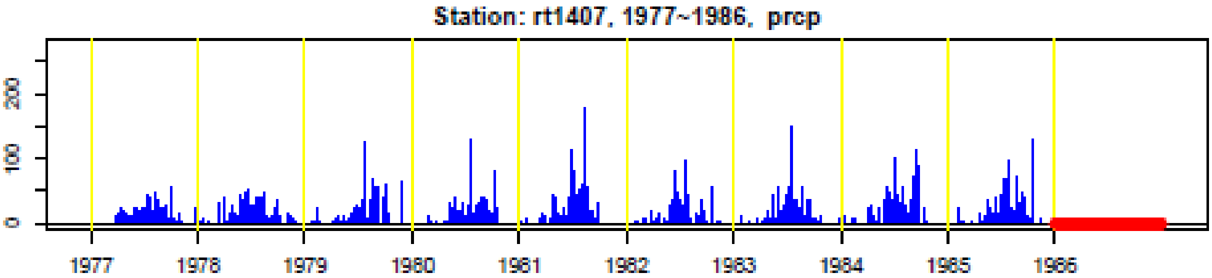
Graphical representation of diurnal temperature range:

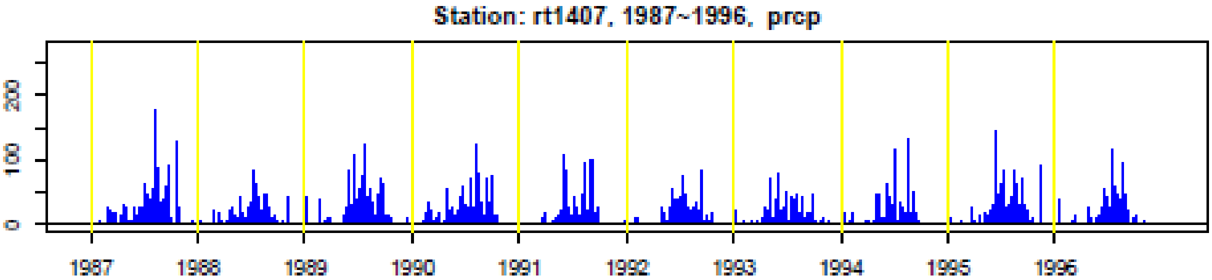


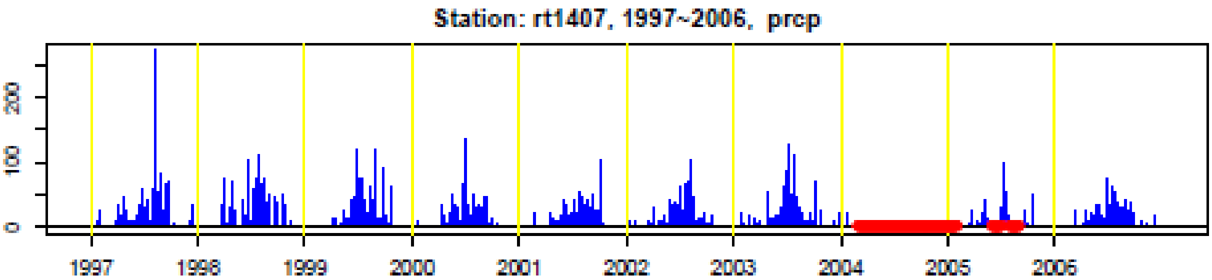
Graphical representation of precipitation:

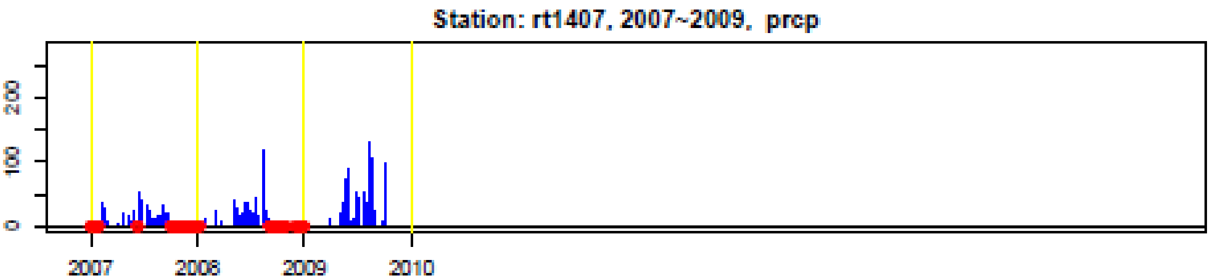



Station: rt1407, 1967~1976, prcp
0
100
200
1967 1968 1969 1970 1971 1972 1973 1974 1975 1976


Station: rt1407, 1977~1986, prcp
0
100
200
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986


Station: rt1407, 1987~1996, prcp
0
100
200
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996


Station: rt1407, 1997~2006, prcp
0
100
200
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006


Station: rt1407, 2007~2009, prcp
0
100
200
2007 2008 2009 2010

Annex-III

Data of Daily Precipitation recorded in DHM's Ilam tea estate meteorological station from 1967 – 2009:

1967												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	22.3	0	0	0	0	0	0	0
2	0	0	0	0	0	5	8	0	0	0	0	0
3	0	0	0	0	0	0	3	0	0	0	0	0
4	0	0	0	0	0	0	0	0	14	0	0	0
5	0	0	0	0	0	3	0	0	1	25	0	0
6	0	0	0	0	0	0	2.5	5	0	0	0	0
7	0	0	0	0	0	0	0	1	1	0	0	0
8	0	0	0	0	4.5	2	10	1	2	0	0	0
9	0	0	0	0	0	0	188	24.5	0	0	0	0
10	0	0	0	0	4.5	5	0	9	2	0	0	0
11	0	0	0	0	0	2	0	4.8	4	0	0	0
12	0	0	0	0	0	0	1	0	7	0	0	0
13	0	0	0	0	0	17	0	0	0	0	0	0
14	0	0	1.5	0	0	14	54	1	4	8	0	0
15	0	0	6.5	0	17	0	0	0	0	0	0	0
16	0	0	0	0	0	0	94	16	1.5	0	0	0
17	0	0	0	0	0	0	0	0	0	0	2	0
18	0	0	0	61	0	12.3	69	0	4.8	0	0	0
19	0	0	0	2.3	12	67.5	0	0	36	0	6	0
20	0	0	22.5	0	0	1	0	1.5	0	0	0	0
21	0	0	14.5	4	0	8.5	1	0	0	0	0	0
22	0	0	0	10	0	1.3	120	1	10	0	0	0
23	0	0	1.7	0	0	0	0	0	0	0	0	0
24	0	0	32.2	2.5	25	3	0	0	0	0	0	0
25	0	0	1.7	1	0	2	20	0	0	0	0	0
26	0	0	0	0	0	0	0	12	0	0	0	0
27	0	0	0	12	0	0	0	0	0	0	3	0
28	0	0	0	7.5	0	0	0	0	0	0	0	0
29	0		0	0	14	4	0	4	0	0	0	0
30	0		0	0	2	0	0	4	0	0	0	0
31	0		0		6		0	3		0		0
Total	**0**	**0**	**80.6**	**100.3**	**107.3**	**147.6**	**570.5**	**87.8**	**87.3**	**33**	**11**	**0**
1968												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**

1	0	0	0	0	15	58	21	0	0	0	0	0
2	0	0	0	0	0	20	0	17	7	0	0	0
3	0	0	0	0	10	3	3	0	9	54	0	0
4	0	0	0	0	0	9	0	0	0	136	0	0
5	0	0	0	0	0	0	2	5	6	97.5	0	0
6	0	0	0	0	0	0	2	1	0	0	0	0
7	0	0	0	0	0	24	1	0	0	0	0	0
8	0	0	0	0	0	14	0	0	0	0	0	0
9	0	0	0	0	0	63	0	96	13	9	0	0
10	0	0	0	0	0	0	0	0	0	19	0	0
11	0	0	0	0	0	0	37	1	0	0	0	0
12	0	0	1	0	0	0	44	0	0	0	0	0
13	0	0	0	0	0	0	137	0	0	0	0	0
14	2	0	0	0	2	14	2	0	0	0	0	0
15	0	0	0	0	0	8	2	0	4.5	0	0	0
16	4	0	4.4	0	0	6	22	0	0	0	0	0
17	0	0	3.6	0	0	9	1	31	0	0	0	0
18	0	0	0	0	28	20	2	3	0	0	0	0
19	0	0	0	0	0	9	33	0	0	0	0	0
20	0	0	0	0	0	0	0	2	0	0	0	0
21	0	5	0	0	0	0	29	0	9	0	0	0
22	0	0	0	0	0	0	92	1	14	0	0	0
23	0	0	0	0	0	4	6	13	3	0	0	0
24	0	0	0	0	0	0	19	23	17	0	0	0
25	0	0	0	0	0	16	71	30	33	0	0	0
26	0	0	0	8	0	0	43	21	2	0	0	0
27	0	0	0	0	10	3	0	14	9	0	0	0
28	0	0	0	30	0	0	0	0	31	0	0	0
29	3	0	0	5	1	40	1	7	26	0	0	0
30	0		0	8	1	0	3	1	0	0	0	0
31	0		0		0		2	0		0		0
Total	**9**	**5**	**9**	**51**	**67**	**320**	**575**	**266**	**183.5**	**315.5**	**0**	**0**
1969												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	4	37	0	DNA	DNA	DNA	DNA
2	0	0	0	0	15	0	10	5	DNA	DNA	DNA	DNA
3	0	0	0	0	0	0	10	3	DNA	DNA	DNA	DNA
4	0	0	0	0	0	8	0	1	DNA	DNA	DNA	DNA
5	0	0	0	0	0	25	20	1	DNA	DNA	DNA	DNA
6	0	0	0	0	6	25	2	8	DNA	DNA	DNA	DNA
7	0	0	0	0	0	16	0	1	DNA	DNA	DNA	DNA
8	0	0	0	0	0	1	4	0	DNA	DNA	DNA	DNA
9	0	0	0	0	0	9	32	11	DNA	DNA	DNA	DNA
10	0	0	0	0	0	1	10	15	DNA	DNA	DNA	DNA

11	0	0	0	0	0	10	3	0	DNA	DNA	DNA	DNA
12	0	0	0	0	43	0	0	20	DNA	DNA	DNA	DNA
13	0	0	0	0	0	0	12	30	DNA	DNA	DNA	DNA
14	0	6	0	51	0	3	2	5	DNA	DNA	DNA	DNA
15	0	0	0	0	0	0	4	2	DNA	DNA	DNA	DNA
16	0	0	0	0	0	3	0	5	DNA	DNA	DNA	DNA
17	0	0	2	18	0	0	12	29	DNA	DNA	DNA	DNA
18	0	0	0	0	0	0	8	5	DNA	DNA	DNA	DNA
19	0	0	7	0	0	0	10	10	DNA	DNA	DNA	DNA
20	0	0	3	0	0	0	2	0	DNA	DNA	DNA	DNA
21	0	0	0	0	0	0	0	2	DNA	DNA	DNA	DNA
22	0	0	0	1	0	34	0	12	DNA	DNA	DNA	DNA
23	0	0	32	0	73	0	11	2	DNA	DNA	DNA	DNA
24	0	0	3	0	9	22	5	1	DNA	DNA	DNA	DNA
25	0	0	0	0	1	7	40	1	DNA	DNA	DNA	DNA
26	0	0	0	0	0	0	2	0	DNA	DNA	DNA	DNA
27	0	0	0	0	40	5	2	1	DNA	DNA	DNA	DNA
28	0	0	0	0	0	1	27	0	DNA	DNA	DNA	DNA
29	0		0	0	5	5	8	1	DNA	DNA	DNA	DNA
30	0		0	9	6	1	1	11	DNA	DNA	DNA	DNA
31	0		0		2		3	0		DNA		DNA
Total	**0**	**6**	**47**	**79**	**200**	**180**	**277**	**182**	**DNA**	**DNA**	**DNA**	**DNA**

1970

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	3	1	0	0	0	0
2	0	0	0	0	0	14	0	7	0	6	0	0
3	0	0	0	0	0	4	6	13	0	0	1	0
4	0	0	0	0	0	6	0	25	0	0	0	0
5	0	0	0	0	3	2	0	25	0	0	0	0
6	0	0	0	0	0	16	0	12	0	0	0	0
7	0	0	0	0	12	10	11	7	0	0	0	0
8	0	0	0	0	0	4	0	10	8	0	0	0
9	0	0	0	0	0	5	11	1	15	0	0	0
10	0	0	0	0	0	2	0	2	7	0	0	0
11	0	0	4	0	0	0	0	21	8	0	0	0
12	0	0	0	0	0	0	54	13	7	0	0	0
13	0	0	0	14	1	0	17	6	0	0	0	0
14	0	0	0	0	0	0	12	2	11	0	0	0
15	0	0	0	0	0	10	0	6	18	0	0	0
16	0	0	0	0	0	0	19	4	0	0	0	0
17	0	0	0	11	33	0	24	9	1	0	0	0
18	0	0	0	0	4	0	0	0	0	0	0	0
19	0	14	0	0	0	40	52	0	0	0	0	0
20	0	0	0	0	0	0	18	3	0	0	0	0

21	4	0	0	0	0	40	0	0	10	0	0	0
22	1	0	0	25	0	10	28	2	1	0	0	0
23	0	0	0	0	0	16	46	0	0	0	0	0
24	0	0	0	0	11	8	46	2	0	0	0	0
25	2	0	0	1	41	38	131	0	2	0	0	0
26	0	0	0	0	0	10	1	0	0	0	0	0
27	2	0	0	8	0	10	1	1	12	0	0	0
28	0	0	0	2	0	50	5	2	40	0	0	0
29	0		0	0	0	120	0	5	8	0	0	0
30	0		0	0	0	0	1	4	0	0	0	0
31	0		0		20		23	0		0		0
Total	**9**	**14**	**4**	**61**	**125**	**415**	**509**	**183**	**148**	**6**	**1**	**0**

1971												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	32	0	11	0	0	0	0
2	0	0	0	3	4	0	0	11	0	0	0	0
3	0	0	0	0	6	0	0	15	0	16	0	0
4	0	0	0	15	10	0	0	2	40	1	0	0
5	0	0	0	0	10	8	0	0	2	1	0	0
6	0	0	0	0	8	0	57	6	2	0	0	0
7	0	0	0	0	12	0	0	1	3	0	0	0
8	0	0	0	0	8	10	0	16	0	1	9	0
9	0	0	0	24	0	0	6	3	0	2	0	0
10	0	0	0	17	0	0	10	2	0	3	0	0
11	0	0	0	1	0	28	12	0	8	0	0	0
12	0	0	0	22	4	84	0	5	5	0	0	0
13	0	0	0	0	0	28	10	30	3	0	0	0
14	0	0	0	12	22	26	0	10	22	0	0	0
15	0	0	0	12	4	22	0	20	2	0	0	0
16	0	0	0	11	14.5	5	8	12	0	0	0	0
17	0	0	0	5	6	0	0	15	0	0	0	0
18	0	0	0	17	0	0	12	8	0	0	0	0
19	0	0	0	26	0	0	1	15	0	0	0	0
20	0	0	0	41	0	0	0	5	0	0	0	0
21	0	0	0	0	0	60	0	5	1.5	0	0	0
22	1	0	6	0	3	3	9	20	2	0	0	0
23	0	0	0	8	2	1	6	8	3	0	0	0
24	0	0	0	0	0	19	0	0	0	0	0	0
25	0	0	0	0	0	0	10	10	5	0	0	0
26	0	0	0	9	0	16	10	0	11	0	0	0
27	0	0	0	0	6	2	0	0	2	0	0	0
28	0	1	0	0	0	8	0	2	0	0	0	0
29	0		0	0	0	0	0	16	10	0	0	0
30	0		0	0	9	0	0	8	61	0	0	0

31	0		0		11		61	15		0		0
Total	**1**	**1**	**6**	**223**	**139.5**	**352**	**212**	**271**	**182.5**	**24**	**9**	**0**
1972												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	28	2	4	0	DNA	0
2	0	0	0	0	0	0	0	0	4	0	DNA	0
3	0	0	0	0	0	0	4	0	17	0	DNA	0
4	0	0	0	0	7	2	1	0	32	0	DNA	0
5	0	5	4	0	0	2	0	0	5	0	DNA	0
6	0	0	0	16	0	2	16	24	8	0	DNA	0
7	0	0	0	0	0	0	0	6.5	0	0	DNA	0
8	0	0	0	0	0	0	4	20	0	7	DNA	0
9	0	0	0	0	0	16	2	17	0	0	DNA	0
10	0	0	0	13	0	0	7	10	17	0	DNA	0
11	0	0	0	6	10	0	13	18	19	0	DNA	0
12	0	0	0	0	0	9	0	0	3	0	DNA	0
13	0	25	0	0	0	0	0	4	2	0	DNA	0
14	0	0	0	0	0	0	2	4	0	0	DNA	0
15	0	0	0	0	5	4	28	3	0	0	DNA	0
16	0	0	0	3.2	1	7	0	0	0	0	DNA	0
17	4	0	0	0	1	34	0	4	0	0	DNA	0
18	0	0	0	2	2	26	12	0	0	0	DNA	0
19	0	0	0	0	5	1	6.5	0	0	0	DNA	0
20	0	0	0	0	10	5	4	8	0	5	DNA	0
21	0	0	0	0	4	20	12.5	0	0	5	DNA	0
22	0	0	0	0	0	45	20	6	0	0	DNA	0
23	0	0	0	0	0	40	0	10	0	0	DNA	0
24	0	0	0	0	0	23	1.5	0	50	0	DNA	0
25	0	0	0	0	2	0	1.5	0	4	0	DNA	0
26	0	0	0	0	12	14	2	8	160	0	DNA	0
27	0	0	11	4	17	14	26	DNA	45	0	DNA	0
28	0	0	0	0	0	24	40	DNA	0	0	DNA	0
29	10.5	0	0	4	0	4	40	DNA	0	0	DNA	0
30	0		1	0	0	0	45	DNA	0	27	DNA	0
31	0		0		6		10	DNA		0		0
Total	**14.5**	**30**	**16**	**48.2**	**82**	**292**	**326**	**DNA**	**370**	**44**	**DNA**	**0**
1973												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	5	0	0	0	0	1	0	0
2	0	0	0	0	0	0	4	0	0	38	0	0
3	0	0	0	0	0	5	0	60	0	4	32	0
4	0	0	0	0	0	0	19	0	0	2	0	0
5	0	0	0	0	0	40	0	8	0	0	0	0
6	0	0	0	0	0	0	0	10	21	0	0	0

7	0	0	3	0	16	16	22	44	18	0	0	0
8	0	0	11	0	8	7	0	20	2	0	0	0
9	0	0	0	0	0	0	0	9	0	0	0	0
10	0	0	0	0	0	0	0	0	10	6	0	0
11	0	0	0	0	0	1	0	40	21	0	0	0
12	0	0	0	0	2.5	0	0	0	0	60	0	0
13	0	0	0	0	8	19	0	0	6	96	0	0
14	0	0	0	0	0	0	0	0	0	9	0	0
15	0	0	0	0	3	64	5	0	34	0	0	0
16	0	0	0	0	0	92	0	0	6	0	0	0
17	0	0	0	0	28	33	0	18	22	0	0	0
18	0	0	0	0	0	36	0	2	0	0	0	0
19	0	0	0	0	2	3	20	0	13	0	0	0
20	0	0	0	0	4	0	15	0	0	0	0	0
21	0	0	0	0	0	0	20	0	0	0	0	0
22	0	0	0	0	51	0	25	0	0	0	0	0
23	0	0	0	8	0	0	4	0	1.5	0	0	0
24	0	0	0	1	0	0	28	0	7	0	0	0
25	0	0	0	0	0	7	0	0	20	0	0	0
26	0	0	0	0	1	10	36	9	22	0	0	0
27	0	0	0	0	0	40	15	0	0	0	0	0
28	0	0	0	0	32	10	8	0	2	0	0	0
29	12		0	0	0	5	15	0	0	0	0	0
30	0		0	0	4	15	27	0	0	0	0	0
31	0		0		0		44	0		0		0
Total	**12**	**0**	**14**	**9**	**164.5**	**403**	**307**	**220**	**205.5**	**216**	**32**	**0**
1974												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	2	0	17	4	2	8	6	0	0
2	0	0	0	19	0	1	91	33	45.5	4	0	0
3	0	0	0	6	0	0	24	28	4	0	0	0
4	0	0	0	0	30	22	7	24	2	11	0	0
5	0	0	0	2	0	14	0.5	50	10	1	0	0
6	0	0	0	0	0	1	20	25	1	26	0	0
7	0	0	0	0	0	16	13	4	0	0	0	0
8	0	0	0	0	0	0.5	5	0	0	0	0	0
9	0	0	0	0	0	0	8	0	15	1	0	0
10	0	0	0	6	20	12	4	0	1	0	0	0
11	0	0	0	0	0	1	0	0	3	5	0	0
12	0	0	0	0	4	0	0	0	5	9	0	0
13	0	0	0	0	36	0	5	0	4	0	0	0
14	0	0	0	0	0	125	20	30	1	5	0	0
15	14	0	0	0	12	0	45	0	51	0	0	0
16	0	0	0	0	0	0	15	4	7	0	0	0

17	0	0	0	0	0	6	19	3	1	0	0	0
18	0	0	0	14	20	2	60	0	6	0	0	2
19	0	0	0	0	4	0	2	8	1	11	0	0
20	0	0	0	0	2	21	8	3	4	0	0	0
21	0	0	0	0	0	9	5	8	0	0	0	0
22	0	0	0	0	0	9	40	0	10	0	0	0
23	0	0	0	0	0	9	5	0	3	0	0	0
24	0	0	0	0	0	5	16	2	0	0	0	0
25	8	0	11	0	0	0	50	1	0	0	0	0
26	0	0	3	0	0	10	9	23.5	0	0	0	0
27	0	0	0	8	4	1	26	31	0	0	0	0
28	2	0	0	2	0	18	112	1.5	0	0	0	0
29	0		15	0	0	4.5	52	0	0	0	0	0
30	0		6	0	0	12	54	15	13	0	0	0
31	0		0		38		20	20		0		0
Total	**24**	**0**	**35**	**59**	**170**	**316**	**739.5**	**316**	**195.5**	**79**	**0**	**2**
1975												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	16	6	32	66	5	0	0
2	8	0	0	0	0	14	34	2	28	6	0	0
3	0	0	3	0	1	0	52	2	19	0	0	0
4	0	0	0	0	12	0	2.5	0	0	0	0	0
5	0	0	0	0	0	0	2	0	12	0	0	0
6	0	0	0	0	0	0	2	38	0	0	0	0
7	0	0	0	0	1	34	0	0	29	2	0	0
8	0	0	0	0	0	0	12	0	30	0	0	0
9	0	0	0	0	0	2	0	0	10	0	0	0
10	0	0	0	0	0	11.5	0	0	0	2	0	0
11	0	0	0	0	10	0	1	0	0	0	0	0
12	0	0	0	0	1	10	16	2	3	0	0	0
13	0	0	0	0	10	72	20	0	23	0	0	0.5
14	0	4	0	0	0	53	9	0	26	0	0	0
15	0	0	0	0	0	4.1	3	0	35	0	0	0.5
16	0	0	0	0	0	12	4	8	5	0	0	0
17	0	0	0	0	0	0	4	7	7	0	0	0
18	0	0	0	0	2	50	20	0	2	0	0	0
19	0	0	0	0	0	4.1	20	22	7	0	0	1.5
20	0	0	0	0	0	22.1	18	4	2	0	0	0
21	0	0	0	11	12	28.1	12	2	2	0	0	0
22	1	0	0	2	4	7	50	2	0	0	0	0
23	0	0	0	2	0	0	8	0	0	0	0	0
24	0	0	0	17	0	24	3	7	0	0	0	0
25	0	0	0	19	1	84	3	2	0	0	0	0
26	0	0	0	22	0	0	152	3	38	0	0	0

27	0	0	0	0	0	0	84	0	34	0	0	0
28	0	0	0	0	12	0	64	1	2	0	0	0
29	0		0	0	0	44	12	0	2	0	0	0
30	0		0	0	24	1.1	2	0	2	0	0	0
31	4		0		18.2		30	0		0		0
Total	**13**	**4**	**3**	**73**	**108.2**	**493**	**645.5**	**134**	**384**	**15**	**0**	**2.5**

1976

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	0	1.5	25	0	15	0	0	0
2	0	0	0	0	0	9	32	0	0	0	0	0
3	0	0	0	0	0	2.5	8	1	5	0	0	0
4	0	0	0	0	0	3	0.6	20.5	23	0	0	0
5	0	0	0	0	0	0	17	44	2	0	0	0
6	0	47.5	0	0	0	0	0.4	0	0.5	1	0	0
7	0	0	0	0	0	0	4.3	12.5	0	0	0	0
8	0	1	0	0	7.5	5.9	2	34	0	9	0	0
9	0	0	0	0	1	1.5	12	6	0	0	0	0
10	0	0	0	0	1	25	9	0	44	0	0	0
11	0	0	0	0	3	40	99	135	0	0	0	0
12	0	0	0	0	4	14.7	11.5	0	0	0	0	0
13	0	0	0	0	0	14	23	9.7	0	0	0	0
14	0	0	0	0	0	4	1	41	0	0	0	0
15	0	0	0	0	24	2	20.5	17	0	0	0	0
16	0	0	0	0	0	3	3.5	0	0	0	0	0
17	0	0	0	0	0	16	11.5	2.5	0	0	0	0
18	0	0	0	0	0	1	0	40	0	0	0	0
19	10	0	0	0	2.5	8	1	41	1.5	0	0	0
20	0	0	0	0	2	0	0	6	0	0	0	0
21	0	0	0	0	6.5	0	1	18.5	4	0	0	0
22	0	0	0	2	0	0	0.5	24	0	0	0	0
23	0	0	0	2	1	4.5	8	23	0	0	0	0
24	0	0	0	2	1	90	0	1	2	0.5	0	0
25	0	0	0	1.5	0	0	2	0	0	0	0	0
26	4.2	0	0	19	5.5	0	0	0	0	0	0	0
27	0	0	0	15.5	2	0	3.5	0	17	0	0	0
28	0	0	0	10	18	0	6	1.5	10	0	0	0
29	0	0	0	10	0	10.5	0.5	18.7	0.5	0	0	0
30	0		0	1	125	45	16	2	0	0	0	0
31	0		0		2.5		8.3	0.5		0		0
Total	**14.2**	**48.5**	**0**	**63**	**206.5**	**301.1**	**327.1**	**499.4**	**124.5**	**10.5**	**0**	**0**

1977

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	11	0	0	21.7	0.6	0	36	0	0
2	0	0	0	2	2	0	0	5.5	22.5	33	0	0

3	0	0	0	1	4	1	17	18	0	17	0	0
4	0	0	0	0	0	0	0	0	0	4.5	16	0
5	0	0	0	2	0	20	0	0	3.5	33	1	0
6	0	0	0	2	16	1	0	1.5	4.3	55	0	0
7	0	0	0	0	7	12.5	9	18	5	0	0	0
8	0	0	0	0	2	21	0	1.5	0	0	3	0
9	0	0	0	0	11.5	1	7.4	1	2.5	5	0	0
10	0	0	0	13	6	3.5	0	33	0	1	0	0
11	0	0	0	0	1.5	1.5	0.7	0	5	1	0	0
12	0	0	0	0	0	12	2	1	2	0	0	0
13	0	0	0	0	0	3	5	47	7.5	0	0	0
14	0	0	0	0	1.5	18	45	20	0	0	0	0
15	0	0	0	24	0	11	14	20	0	0	0	0
16	0	0	0	1	3	0	3	2	14	0	0	0
17	0	0	0	24	0	1.5	3	4	0	0	0	0
18	0	0	0	2	2	0	0.5	2	25	0	0	0
19	0	0	0	17	0	6	6.7	17	1	0	0	0
20	0	0	0	0	10.5	2.6	12.5	0	0	0	0	0
21	0	0	0	0	0	0.4	29	11	7	3.8	0	0
22	0	0	0	0	0	0.3	41	36.2	0	0	0	0
23	0	0	0	7	0	0	2	5	4	0	0	0
24	0	0	0	19	1.5	4	21	2.5	0	0	0	0
25	0	0	0	0	0.8	0	19	2	0	0	0	0
26	0	0	0	0	19.2	0	1.2	24	0	0	0	0
27	0	0	4	0	0.7	1	2.3	13	0	0	0	0
28	0	0	0	0	21	3.7	8	22	0	0	0	23
29	0		0	0	2	21.8	1.8	5	0	0	0	0
30	0		0	0	0	0	2	0	3.5	0	0	0
31	0		0		0		6.5	0		0		0
Total	**0**	**0**	**4**	**125**	**112.2**	**146.8**	**281.3**	**312.8**	**106.8**	**189.3**	**20**	**23**

1978

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	2	0	0.5	37.5	0	26.5	0	0
2	1.5	0	0	0	22	25.5	0	1.5	2.5	25	0	0
3	0	0	0	0	0	11	8	3	1	0	16	0.5
4	0	0	0	0	13.5	35	24	0	2.5	0	0	0
5	0	0	0	0	0	0	10	3	5	6	0	0
6	0	0	0	0	0	0	13	2.3	0.5	9	0	0
7	0	0	0	0	0	0	5.5	7	4	0	0	0
8	0	0	0	0	6.5	3	9	1.5	3.5	0	0	0
9	0	1.5	0	0	2.4	7	0	37.5	8	0	2	0
10	0	0	0	0	0	48	0	25	10	0	0	0
11	0	0	0	0	16.5	1.5	0	0	1	0	0	0
12	0	0	30	0	3.4	15.5	17	6.5	0	0	0	0

13	0	0	26	0	0	0.5	0	0	0	0	0	0
14	1.5	0	0	1	0	2	0	0	9	0	0	0
15	0	0	0	0	5	10	28.7	1.5	3	0	11.3	0
16	0	0	0	0	6.5	3.5	23	29	12	0	0	0
17	0	0	0	14.2	10	5.5	20	1	6.5	0	0	0
18	0	0	0	1.5	0	2.8	40	9	1	0	0	0
19	0	0	8.5	1.4	0	51	2	3.5	18.5	0	0	0
20	0	0	0	0	11.5	0	39	47	1	0	3.4	0
21	0	0	0	0	0	1.5	2	0	0	0	4.5	0
22	6	0	0	7	3.5	1	0	0	2	0	0	0
23	0	0	0	0	42	9	5	0.5	0	0	0	0
24	0	0	0	1	10	5	2	12	0	0	0	0
25	0	0	0	0	0	2.5	4	0	23	0	0	0
26	0	0	0	28	0	5	0	0	0	0	0	0
27	0	0	0	0	0	3.5	6	6.1	35	0	0	0
28	0	0	0	0	0	0	17	0	0	0	0	0
29	0		0	10	18.5	0	9.3	0	0	0	0	0
30	0		0	0	0	27	0	0	2	0	0	0
31	0		40		7		0	3		0		0
Total	**9**	**1.5**	**104.5**	**64.1**	**180.3**	**276.3**	**285**	**237.4**	**151**	**66.5**	**37.2**	**0.5**

1979

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	18	4	19	5	0	65
2	0	0	0	0	0	0	12	5	1	0	0	5
3	0	0	0	0	0	0	2	4	0	0	0	0
4	0	0	0	0	2	1	0	0	11.5	2	0	0
5	0	0	0	0	0	0	0	0	37.5	60	0	0
6	0	0	0	0	0	0	1	0	4	2.5	0	0
7	0	0	0	0	0	0	1	0	2.5	0	0	0
8	0	24	0	0	0	1.5	0	1.5	20.5	1.5	0	0
9	0	1.5	0	0	0	2	0	33	0	17	0	0
10	0	0	0	0	2	2	3	0	24.5	14.5	0	0
11	0	0	0	1	0	6	24	0	56	6	0	0
12	0	0	0	0	0	13	17	3.5	2	0	0	0
13	0	0	0	0	0	12.5	21	5	0	0.5	0	0
14	0	0	0	0	6.5	3	4.5	1	0	0	0	0
15	0	0	0	0	1.5	0	14	2	0	0	0	0
16	0	0	0	8	12	9	7	10	0	2	0	0
17	0	0	0	5	0	0	21	3	0	0	0	0
18	0	0	0	0	0	18.5	35	0.5	0	0	0	0
19	0	0	0	0	0	0	12.5	2.5	0	0	0	0
20	0	2	0	1.5	1.9	16.5	9	24	0	0	0	0
21	0	0	0	3	0	0	13	67	0	0	0	0
22	0	0	0	0	0	23	2	1	0	0	0	0

23	0	0	0	0	1.5	0	34	20.5	0	0	0	0
24	0	0	0	0	0	3	125	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	10	0	0	0	0	0
27	0	0	0	2.5	0	13	8	1	0	0	0	0
28	0	0	0	0	5.2	27.5	23	1	0	0	1	0
29	1		0	9	0	0	53	8.5	0	0	2	0
30	1.3		0	11	0	3	2	3	40	0	5	0
31	0		0		0		3	56		0		7
Total	**2.3**	**27.5**	**0**	**41**	**32.6**	**154.5**	**475**	**257**	**218.5**	**111**	**8**	**77**

1980

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	16	0	10	6	8	0	0
2	0	0	11.5	0	0	19.5	2	2	2	1.5	0	0
3	0	T	5	T	T	14	9.5	16	0	0	0	0
4	0	0	T	0	2	0	1	T	25	0	0	0
5	0	0	T	0	0	0	3	0	0	0	0	0
6	0	0	1	0	30	0	0	2	41	0	0	0
7	0	0	T	0	0	1	6	8	0	0	0	0
8	0	0	3	0	T	6.5	8	0	0	0	0	0
9	0	0	T	0	T	4	12	27	0	82	0	0
10	0	0	T	0	3	15	25	14	0	0	0	0
11	0	0	T	0	1	2.5	15.5	6.5	0	2	0	0
12	0	0	0	0	2.5	T	10	1.5	0	0	0	0
13	0	0	0	0	5	7	2	22	34	1.5	0	0
14	0	0	0	0	2	9	1	3.5	26	0	0	0
15	0	0	0	0	2	6	3	0.5	26	5	0	0
16	0	0	0	0	0	20	T	21	T	0	0	0
17	0	0	0	0	0	0.5	10	8	0	0	0	0
18	0	0	T	0	0	0	130	7	14.5	0	0	0
19	0	0	0	0	1.5	10.5	4.5	T	17.5	0	0	0
20	0	0	0	0	3	24.9	57	7	0.5	0	0	0
21	0	0	0	1	24	30.5	42.5	21	0	0	0	0
22	0	0	0	0	19	3	32.5	30.5	9	9	0	0
23	0	0	2	0	3	0.5	4.5	10.5	T	0	0	0
24	0	0	0	0	3.5	17	2.5	1.5	2.5	22	0	0
25	0	0	0	0	3	T	0	T	0	0	0	0
26	0	0	0	0	11.5	T	0	0	0	T	0	0
27	0	0	0	0	1.5	T	0	2	0	0	0	0
28	0	0	0	0	10.5	T	1	41	T	0	0	0
29	0		0	0	39	T	6	4	T	0	0	0
30	0		0	0	10	1	6.5	8	16	0	0	0
31	0		0		11		7	0		0		0
Total	**0**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**0**	**0**

1981												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	9.5	5	6	82	20	3	0	0	0
2	0	0	0	3	7	0	40	60	11	0	0	0
3	0	0	0	0	14	21	112	T	T	0	0	0
4	0	0	0	0	T	0	57	0	9	0	0	0
5	0	0	0	0	0	T	82	0	0	0	0	0
6	0	0	0	0	0	6.5	40	0	0	0	0	0
7	0	0	0	0	0	T	T	0	7.5	0	0	0
8	4	0	0	0	41	1.5	8.5	0	6	0	0	0
9	0	0	0	0	13	T	1	0	14	0	0	0
10	0	0	0	0	20	10	T	0	T	0	0	0
11	0	0	0	0	T	T	1	18	17	0	0	0
12	0	0	0	0	5	11	T	180	7.5	0	0	0
13	0	0	0	0	3	6.5	6	T	3.5	0	0	0
14	0	0	5.5	0	3	T	1	8	T	0	0	0
15	0	0	T	0	4.5	T	6.5	T	4.5	0	0	0
16	0	0	T	1.5	T	10	43	0	2.5	0	0	0
17	0	0	16	T	6	0.5	3	6	0	0	0	0
18	0	0	T	8	T	5	24	6	0	0	0	0
19	0	0	0	T	13.5	40	17	0	0	0	0	0
20	0	0	0	1.7	0	2	8	T	0	0	0	0
21	0	0	0	0	0	7.5	T	55	0	0	0	0
22	0	0	0	0	3.5	24	T	10	0	0	0	0
23	0	0	0	0	0	39	0.5	5	0	0	0	0
24	0	0	0	T	0.5	3	9	30.5	0	0	0	0
25	8	0	0	10	0	T	T	5	0	0	0	0
26	0	0	0	5.5	T	7.5	26	8	0	0	0	0
27	0	0	0	5	9	T	29	2	0	0	0	0
28	0	0	6.5	3	10	42	53	2	0	0	0	0
29	0		0	3	9	31.5	0	T	21	0	0	0
30	0		0	45	T	32	0	18	30	0	0	0
31	0		T		T		34	1.5		0		0
Total	**12**	**0**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**0**	**0**	**0**

1982												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	T	0	3	0	0	4.3	1.6	0	1	0	0
2	0	T	7	4	0	3.5	4.3	T	0	0	0	0
3	0	0	0	0	0	10.5	T	45	0	0	0	0
4	0	2.5	0	0	0	5	27.3	1.5	8	0	0	0
5	0	0	0	0	0	1.5	8.1	T	0	0	0	0
6	0	T	T	0	0	T	34	T	9.5	0	T	0
7	0	0	4.5	0	0	2	11.3	1.8	0	0	3	0
8	0	0	0	0	0	7.5	5.4	4.8	0	0	0	0

9	0	2	0	0	0	5	6.6	1.4	0	0	0	0
10	0	T	0	0	0	1	13.8	T	6.5	0	0	0
11	0	0	0	0	0	35.5	T	T	18.4	0	1	0
12	0	0	0	0	0	T	24.8	0	3	0	0	0
13	0	0	0	0	7.5	3	1.7	0	12	0	T	0
14	0	0	0	0	0	1	7.9	0	14.5	0	0	0
15	0	0	0	0	0	15	4.4	0	6.3	0	0	0
16	0	0	0	0	0	1	T	0	15	0	T	0
17	0	0	0	6	0	0	0.3	0	33.5	0	0.8	0
18	0	0	0	0	0	20	3	0	7.6	0	0	0
19	0	0	0	15	0	80	0	0	7.5	0	0	0
20	0	0	0	1.5	0	13.5	27.4	T	1.2	0	0	0
21	0	0	0	8	1	2	92	T	0	0	0	0
22	0	0	0	T	2	T	14.2	0	11	0	0	0
23	0	0	0	T	0	0	14	0	11	55	T	0
24	0	0	0	9	1.5	14	95	13.3	T	0	0	0
25	0	0	0	8.5	0	14.4	3.4	0	T	6	0	0
26	0	0	0	4	0	45.7	9.4	7.6	20	0	0	0
27	0	0	20	0	0	T	2	1.5	0	0	0	0
28	0	0	0	0	28.4	41.4	0.7	6.6	0	0	0	0
29	0		0	0	4	7	10.6	T	0	0	0	0
30	0		0	0	T	T	T	7.9	0	0	0	0
31	0		2		10		10.3	6.5		0		0
Total	**0**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**62**	**DNA**	**0**

1983

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	0	5.5	9	0	0	0
2	8	0	0	0	7	4	35.5	3	0	T	0	0
3	T	0	0	0	T	2	41	5	11.3	1	0	0
4	0	0	0	0	T	55	34.5	T	0	0.8	0	0
5	0	0	0	0	0	11.5	23.3	3.7	0	0	0	0
6	0	0	0	0	0	T	12	0	0	0	0	0
7	0	0	0	0	0	2	2.5	0	6	1.3	0	0
8	0	0	0	0	3.2	T	1.5	2.6	7	0	0	0
9	0	0	0	0	7.4	6	56	0	1.5	0	0	0
10	0	0	0	0	T	3	7	35	0	7	0	0
11	0	0	0	4	0	0	0	12	4	1	0	0
12	0	0	0	0	0	20	0	11.5	2.8	4.4	0	0
13	0	0	0	0	45	0	3	3	3	T	0	0
14	0	0	0	0	T	5	49	0.4	37	0	0	0
15	0	0	0	0	0.5	0	150	24	0	0	0	0
16	0	0	0	T	1	0	67	T	0	0	0	0
17	0	0	0	5	12	16	11.5	4	33	0	0	0
18	0	0	0	0	10	T	7	10	25	1.3	0	0

19	0	0	0	3	7	T	1	2	12	0	0	0
20	0	0	0	0	24.5	T	18	4	0	0	0	0
21	0	0	7	0	0.5	0	T	T	0	0	0	0
22	0	1	0	0	3	0	28	18	2	0	0	0
23	0	0	0	0	7.5	0	19.4	14	3.5	0	0	0
24	0	0	0	20	0	26	29	55	0	10.5	0	0
25	0	0	0	T	T	2	36	42	4.5	T	0	0
26	0	0	0	0	T	15.5	25.5	2	0	0	0	2
27	0	0	0	0	0	37	6.4	T	0	0	0	6
28	0	0	0	0	0	44	1.8	5.5	0	0	0	2
29	9.5		0	0	0	28.4	10.6	11.5	0	0	0	0
30	T		0	T	15	2	2	2	0	0	0	0
31	0		0		6		2	11.5		0		0
Total	**DNA**	**1**	**7**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**161.6**	**DNA**	**0**	**10**
1984												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	T	1	T	T	0	0	0	0	0
2	0	0	0	0	0	0	7	0	6.5	0	0	0
3	0	0	0	0	0	0	1.5	24	0	0	0	0
4	0	0	0	0	0	0	60	T	4.7	0	0	0
5	0	0	0	0	0	0	2	0	34.5	0	0	0
6	0	0	0	0	2	8	4	0	12	0	0	0
7	0	0	0	0	0	8	18	0	3.5	0	0	0
8	0	0	0	0	0	56	9	0	72	0	0	0
9	0	0	0	0	0	37	100	8	4.5	0	0	0
10	0	0	0	0	5	35	5	15	0	0	0	0
11	0	0	0	23	23.5	15.3	43	0	0	0	0	0
12	0	4.4	0	26	1	8	19	0	11	0	0	0
13	0	0	0	0	0.4	10	41	1.5	5	0	0	0
14	0	0	0	0	1.5	0	18	27.5	5.5	0	0	0
15	0	0	0	0	5.5	0	3	0	0	2	0	0
16	10	0	0	0	3	14.5	1	1.5	0	21.5	0	0
17	7.3	0	0	0	T	32.5	7.3	1.3	0	0	0	0
18	0.3	0	0	0	0	T	0	3.5	41	0	0	0
19	0	0	0	0	T	T	30.3	0	112.5	T	0	0
20	T	6.3	0	0	0	43	0	7.6	18.5	0	0	0
21	T	7	0	0	0	48	0	3.5	90	0	0	0
22	0	0	0	0	0	1	10.2	14	0	1.5	0	0
23	0	0	0	12	0	4.8	0	12.5	0	0	0	0
24	0	0	0	0	0	1	0	11	0	0	0	0
25	0	0	0	0	0	T	8	0	0	0	0	0
26	0	0	0	0	0	13.5	25	13.5	0	0	0	0
27	0	0.1	0	5.5	1	1	29.5	34.5	0	0	0	0

28	0	0	T	0	1.5	1	19.6	2	0	0	0	0
29	0		0	0	T	1	0	0	0	0	0	0
30	0		0	1	36.5	34.1	54.3	0	0	0	0	0
31	0		0		5.4		35	1.5		0		0
Total	**DNA**	**17.8**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**421.2**	**DNA**	**0**	**0**
1985												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	1	0	0	0	0	0	29	0	0	0
2	0	0	0	0	2	5	0	0	0	10	0	0
3	0	0	0	0	0	2.5	0	0	7.5	0	0	0
4	0	0	0	0	0	5	0	10	29.5	0	0	0
5	0	0	0	0	0	0	42.5	0	2	0	0	0
6	0	0	0	0	0	0	41.5	0	14	0	0	0
7	0	0	0	0	6.5	0	0	0	18.5	0	0	0
8	0	24.5	0	0	0	13	32	0	0	0	0	0
9	0	3	0	0	0	2	0	22	0	7	0	0
10	0	0	0	0	0	2	0	3	0	0	0	0
11	0	0	0	0	6	0	0	0	46	0	7	0
12	0	0	0	0	8.5	0	66	0	0	0	0	0
13	0	0	0	0	0	0	61	4	0	0	0	0
14	0	0	0	0	0	21	43.5	0	7	0	0	0
15	0	0	0	0	0	0	39.5	0	3	0	0	0
16	0	0	0	0	0	40	0	0	47	0	0	0
17	0	1.5	0	0	0	31	5	0	0	55	0	0
18	0	0	0	0	18.5	5	0	0	0	127	0	0
19	0	0	0	15.5	7.5	16	0	0	0	0	0	0
20	0	0	0	0	35	11.5	0	17.4	3	0	0	0
21	0	0	0	0	28	4.5	19	0	0	0	0	0
22	0	0	0	6.5	0	5	1	0	39	0	0	0
23	0	0	0	8	0	0	26.5	15.5	5	0	0	0
24	0	0	0	0	0	0	69.5	2	0	0	0	0
25	0	0	1	0	23	0	53.5	0	13	0	0	0
26	0	0	0	0	0	0	13.5	72	0	0	0	0
27	0	0	0	2.5	0	0	96	0	0	0	0	0
28	0	0	0	0	0	6.5	86	0	0	0	0	25
29	0		0	0	0	23.5	36	0	0	0	0	0
30	0		0	0	0	12	0	15	0	0	0	0
31	0		0		8		0	9.5		0		0
Total	**0**	**29**	**2**	**32.5**	**143**	**205.5**	**732**	**170.4**	**263.5**	**199**	**7**	**25**
1986												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	18	4	19	5	0	65
2	0	0	0	0	0	0	12	5	1	T	0	5
3	0	0	0	0	0	0	2	4	0	T	0	T

4	0	0	0	0	2	1	T	T	11.5	2	0	T
5	0	0	0	0	0	0	T	0	37.5	60	0	0
6	0	0	0	0	0	0	1	0	4	2.5	0	0
7	0	0	0	0	0	0	1	0	2.5	T	0	0
8	0	24	0	0	0	1.5	0	1.5	20.5	1.5	0	0
9	0	1.5	0	0	0	2	T	33	T	17	0	0
10	0	T	0	0	2	2	3	T	24.5	14.5	0	0
11	0	T	0	1	0	6	24	0	56	6	0	0
12	0	T	0	0	0	13	17	3.5	2	T	0	0
13	0	0	0	0	0	12.5	21	5	0	0.5	0	0
14	0	0	0	0	6.5	3	4.5	1	0	T	0	0
15	0	0	0	0	1.5	0	14	2	0	0	0	0
16	0	0	0	8	12	9	7	10	0	2	0	0
17	0	0	0	5	0	T	21	3	0	0	0	0
18	0	0	0	T	0	18.5	35	0.5	0	0	0	0
19	0	0	0	T	0	T	12.5	2.5	0	0	0	0
20	0	2	0	1.5	1.9	16.5	9	24	0	0	0	0
21	0	0	0	3	0	T	13	67	0	0	0	0
22	0	0	0	0	0	23	2	1	0	0	0	0
23	0	0	0	0	1.5	T	34	20.5	0	0	0	0
24	0	0	0	0	0	3	125	T	0	0	0	0
25	0	0	0	0	0	T	T	T	0	0	0	0
26	0	0	0	0	0	T	10	T	0	0	0	0
27	0	0	0	2.5	0	13	8	1	0	0	0	0
28	0	0	0	T	5.2	27.5	23	1	T	0	1	0
29	1		0	9	0	T	53	8.5	T	0	2	0
30	1.3		0	11	0	3	2	3	40	0	5	0
31	T		0		0		3	56		0		7
Total	**DNA**	**DNA**	**0**	**DNA**	**32.6**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**8**	**DNA**

1987

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	6	19.5	0	24	46	32	0	0	0
2	0	0	0	0	14	0	62	41	33	9	0	0
3	0	0	0	0	24	0	41	43	4	0	2	0
4	0	0	0	0	21.5	0	15.5	34	5	3	24	0
5	0	6	0	0	0	0	0	5.5	3.5	0	0	0
6	0	0	0	0	0	12.5	10	0	13.5	0	0	0
7	0	0	21.5	0	0	13	3	4.5	2.5	0	0	0
8	0	0	0	0	0	7	30.5	2	36.5	0	0	0
9	0	0	1	0	0	2	8	7	0	0	0	0
10	0	0	0	0	4	13	27	85	0	0	0	0
11	0	0	2	0	0	0	7.5	178	21	0	0	0
12	0	0	0	0	0	8	26.5	72	43	0	0	0
13	0	0	10	0	0	9.5	2	94	1	0	0	4

14	0	0	0	0	0	0	45	35	0	0	0	0
15	0	0	4.5	0	0	6.5	3	0	0	0	0	0
16	0	0	0	0	0	0	1	0	0	0	0	0
17	0	0	19	0	0	0	0	87	0	0	0	0
18	0	0	0	15	0	8	2	31	0	2.5	0	0
19	0	0	0	3	0	4	0	0	57	4	0	0
20	0	0	0	0	0	16	0	22	81	126	0	0
21	0	0	0	0	0	24	0	15	7.5	2	0	0
22	0	0	0	0	4	18	0	5.5	0	0	0	0
23	0	0	0	29	2	23	0	0	26	0	0	0
24	0	0	0	0	0	27.5	20.5	0	0	0	0	0
25	0	0	0	3	0	19	40	0	6.5	0	0	0
26	0	0	0	4	0	7	0	17	90	0	0	0
27	0	0	17	9	0	3	0	8	2.5	0	0	0
28	0	27.5	0	0	0	6	56	3	0	0	0	0
29	0		0	3	1	0	2	18.5	0	2	0	0
30	2		0	0	26	23	1	0	4	24.5	0	0
31	3		0		19		20.5	3.5		0		0
Total	**5**	**33.5**	**75**	**72**	**135**	**250**	**448**	**857.5**	**469.5**	**173**	**26**	**4**

1988

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	0	0	34	0	0	0	0	0
2	0	0	0	0	0	0	6	0	5	0	0	0
3	0	0	0	0	5.5	0	1	1	0	3	0	0
4	0	0	0	0	12.5	0	20.5	5.5	2.5	0	0	0
5	0	0	0	0	4	17	27	21.5	25	0	7	0
6	0	0	0	0	0	0	81	19.5	5.8	0	42	0
7	0	0	0	0	8	0	3	0	9.5	0	0	0
8	0	0	0	0	2.5	5.5	82	0	3.5	0	0	0
9	0	0	0	0	1.5	0	2	16.5	4	0	0	0
10	0	0	7	0	1	0	5	7	1	0	0	0
11	0	0	0	0	0	5	8	40	0	0	0	0
12	0	0	10.5	0	0	6.5	24	20	2	0	0	0
13	6	0	16	1	0	0	11.5	34	0	0	0	0
14	0	0	0	4	8	2	0	4.5	0	1	0	0
15	0	T	0	0	0	11	0	46	0	0	0	0
16	0	0	0	0	0	8	27.5	3	6	0	0	0
17	0	0	0	0	0	7	21	4	5.5	0	0	0
18	0	0	0	21	11	7	21	23	0	0	0	0
19	0	0	0	0	1	0	0	26	0	0	0	0
20	0	0	5.5	0	6	0	3	21.5	0	6	0	0
21	0	0	0	0	31	0	63	2	9.5	0	0	0
22	0	0	0	0	31.5	0	8	9.5	1.5	0	0	0
23	0	0	0	12	43	1.5	7	5.5	12.5	0	0	0

24	0	23	0	8	0	0	1	4.5	0	0	0	0
25	0	0	0	0	10	25	4	43	0	0	0	0
26	0	0	0	25	8	2	20	46	6.5	0	0	0
27	0	0	0	0	0	1	2	5	1	0	0	0
28	0	0	0	0	0	7	2	26	0	0	0	0
29	0	1	0	0	15.5	0	0	25	0	0	0	0
30	0		0	7.5	0	3	18	13	0	0	0	0
31	0		0		0		42	9		0		0
Total	**6**	**DNA**	**39**	**78.5**	**200**	**108.5**	**544.5**	**481.5**	**100.8**	**10**	**49**	**0**
1989												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	8.5	0	0	2	41	14	0	2	0
2	0	0	0	0	0	22	1	2	0	0	1	0
3	0	0	0	0	0	2	0	0	0	0	0	0
4	0	0	0	0	0	45	0	14.5	0	0	0	0
5	0	0	0	0	0	28	0	0	45	0	0	0
6	0	0	0	0	0	19	41	0	25.544	0	0	0
7	0	0	0	0	0	13.5	55	8.5	0	0	0	0
8	0	0	0	0	0	3	2	54	0	14.5	0	0
9	42	0	0	0	0	3	1	0	0	13.5	0	0
10	2	0	0	0	0	0	0	16.5	13	3	0	0
11	0	0	0	0	0	0	0	2	41	0	0	0
12	0	0	6	0	2	0	26.5	8	3	1	0	0
13	0	0	0	0	1	2	0	0	45	0	0	0
14	0	0	0	0	14.5	27	41	0	4	0	0	10.5
15	0	0	6.5	0	4.5	106	75	6.5	0	0	0	0
16	0	0	0	0	6	40	11	0	0	0	0	0
17	0	0	0	0	0	0	13	33.5	63	0	0	0
18	0	0	0	0	1	28	5	2	69	8.5	0	0
19	0	10	8	0	0	7.5	15	4	2	0	0	0
20	0	36.5	2	0	24	0	0	2	11.5	7	0	0
21	0	0	0	0	6	7	17	22.5	60	0	0	0
22	0	0	0	0	2	0	2	11.5	0	0	0	0
23	0	0	0	0	1	0	7	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	1	19	0	0	0	0	0	0	0
26	0	0	0	0	15	0	0	0	0	1	0	0
27	0	0	0	0	7	0	124	0	13	0	0	1
28	0	0	0	0	85	38	19	0	40	0	0	0
29	0		0	0	5.5	0	3	4	62	0	0	0
30	0		2	0	0	37	40	0	2	0	0	0
31	0		0	0	0		10.5	2		0		0
Total	**44**	**46.5**	**24.5**	**9.5**	**193.5**	**428**	**511**	**234.5**	**513.044**	**48.5**	**3**	**11.5**
1990												

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	54	20	1	10	0	0	0	0
2	0	0	0	0	0	23	0	2	0	0	0	0
3	0	0	0	0	2	10	7	14	0	0	0	0
4	0	0	0	17	0	1	23	0	0	10.5	0	0
5	0	0	0	4	4.5	0	30	0	5	0	0	0
6	0	0	0	0	0	5.5	6	8	15	0	0	0
7	0	0	0	0	6.5	0	18	0	0	0	0	0
8	0	0	0	2	5.5	4	20	6	0	6	0	0
9	0	0	21	0	1	3	27	30	71	7	0	0
10	0	0	2	0	2	23	2	0	20	11.5	0	0
11	0	4	3	0	8	41	8	8	0	0	0	0
12	0	0	4.5	0	0	0	4	123	20	0	0	0
13	0	0	0	0	20	0	10	80	4	0	0	0
14	0	16.5	0	0	2	0	17	0	5	10	0	0
15	0	2	0	0	0	8.5	9.5	0	0	15	0	0
16	0	0	0	0	0	0	6	0	15	0	0	0
17	0	0	0	0	25.5	44	5	0	35	2	0	0
18	0	0	0	0	0	37	10	0	0	0	0	0
19	0	0	0	7	25	3	71	0	0	0	0	0
20	0	1	7	0	16	15	0	0	0	0	0	0
21	0	0	0	0	2	29	0	0	2	0	0	0
22	0	0	0	0	0	8.5	0	0	14	0	0	0
23	0	0	0	0	0	40	25	4	30	0	0	0
24	0	0	0	0	9	5	0	0	5	0	0	0
25	0	0	8	0	0	2	0	0	5	0	0	0
26	0	32.5	1	4	0	3	0	27	76	0	0	0
27	0	0	0	5	12	60	24	32	20	0	0	0
28	0	0	0	0	7	30	3	5	10	0	0	0
29	0		0	15.5	0	6	27	0	15	0	0	0
30	0		0	3.5	3	2	17	0	0	0	0	0
31	0		0	0	0		0	0		0		0
Total	**0**	**56**	**46.5**	**58**	**205**	**423.5**	**370.5**	**349**	**367**	**62**	**0**	**0**

1991

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25	0	0	16.5	1	0	0	15	4	0	0	0
2	5	0	0	4	0	0	8	46	14	0	0	0
3	20	0	0	0	0	0	3	42	32	0	0	0
4	0	0	2	0	0	0	43	12	98	0	0	0
5	0	1.5	0	0	0	0	13	20	0	0	0	0
6	0	0	0	0	9.5	108	34	8	0	0	0	0
7	0	0	0	0	2	24.5	38	10	4	0	0	0
8	0	0	0	0	0	0	15	16	42	0	0	0
9	0	0	0	0	0	32	11	4	99	0	0	0

10	0	0	0	0	0	83	13	2	66	0	0	0
11	0	0	0	0	0	0	1	3	0	0	0	0
12	0	0	0	0	0	6.5	2	0	1	0	0	0
13	0	0	0	0	0	18	1	0	4	0	0	0
14	0	0	0	0	0	59	26.5	0	1	0	0	0
15	0	0	0	0	0	19	16	30	0	0	0	0
16	0	0	0	0	13	10	2	94	16	0	0	0
17	0	0	0	0	0	27	2.5	8	4	0	0	0
18	0	0	0	0	0	26	5.5	0	0	0	0	0
19	0	0	0	0	5	0	3	0	2	0	0	0
20	0	0	0	0	0	12	0	0	0	0	0	0
21	0	0	0	0	0	16	4	0	0	0	0	0
22	0	0	10	0	22.5	11	1	9	0	0	0	0
23	0	0	5	0	2.5	12	8	2	2	0	0	0
24	0	0	0	0	8	13	0	0	0	0	0	0
25	0	0	0	2.5	0	0	0	20	13	0	0	4
26	0	1	0	0	0	2	0	2	26	0	0	4
27	0	0	0	0	0	2	0	24	25	0	0	2
28	0	0	0	1	4	0	0	0	0	0	0	2
29	0		0	0	28.5	0	13	0	0	0	0	0
30	0		0	6	0	15	0	0	0	0	0	0
31	0		0		10		0	3		0		0
Total	**50**	**2.5**	**17**	**30**	**106**	**496**	**263.5**	**370**	**453**	**0**	**0**	**12**

1992

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	10	0	0	0	0	0	6.4	8.4	0	0	0
2	0	1	0	0	12.6	0	4	2.6	0	0	0	0
3	0	0	0	0	16	0	14	0	0	4	0	0
4	0	0	0	0	16	0	42	8	0	0	0	1
5	0	0	0	0	0	0	12.4	2	0	0	0	0
6	0	1	0	0	0	0	2	23	20	0	0	0
7	0	0	0	0	0	0	24	0	0	0	0	0
8	0	10	0	0	0	2	42	6.5	3	0	0	0
9	0	0	0	0	0	0	4	0	0	0	0	0
10	0	0	0	0	12	54	22	5	0	0	0	0
11	0	0	0	0	16	4	26	0	2.4	0	0	0
12	1	0	0	0	0	2	66	0	84	0	0	0
13	0	0	0	0	0	2	6	0	23.6	6	0	0
14	0	0	0	0	0	0.7	2	0	8	0	0	0
15	0	0	0	0	6	4.6	10	0	0	0	0	0
16	0	0	0	0	0	0	76.5	24	11	16	0	0
17	0	0	0	0	0	0	28	20	20.7	2	0	0
18	0	0	0	0	0.6	38	6.4	2	0	0	0	0
19	0	0	0	0	0	2	4	0	2	0	0	0

20	0	0	0	0	0	40	5.2	0.6	0	0	0	0
21	0	0	0	0	6	1	8	0	0	0	0	0
22	2.6	0	0	0	2.6	0.8	2	32.4	0	0	0	0
23	0	0	0	0	1.6	30	0	14.4	0	0	0	0
24	0	0	0	0	0	6	47.2	13.2	0	0	0	0
25	0	0	0	0	0.4	4	0	1.6	0	0	0	0
26	0	0	0	0	11.8	8	12	28	5	0	0	0
27	0	0	0	24	0	7	24.4	0	7	0	0	0
28	0	0	0	2	26.8	5	6.1	0	13	0	0	0
29	0	0	0	16	0	0	16	4.6	4	0	0	0
30	0		0	0	0	0	26	0	0.2	0	0	0
31	0		0		4		18.2	3.2		0		0
Total	**3.6**	**22**	**0**	**42**	**132.4**	**211.1**	**556.4**	**197.5**	**212.3**	**28**	**0**	**1**

1993

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	3.4	0	0	0	77.8	34	3.2	0.4	2.2	0	0
2	0	0	6.4	0	3	7.4	2.2	0	0.2	32	0	0
3	0	0	0	0	69	0.2	51	5	10.8	1.2	0	0
4	0	0	0	0	7	0	13.4	4.6	0	6.8	0	0
5	0	0	0	0	0.4	32.2	3.8	10.4	1.7	1.4	0	0
6	0	0	0	0	5	0	0	28.6	0	0	10.4	0
7	1.2	0	0	0	1.2	14	4.6	41.2	8.6	0	0.4	0
8	20.3	0	0	0	0	3.2	0	17.6	13.6	0	0.5	0
9	0	0	0	0	0	22	0	46.8	1	0	0	0
10	0	0	0	0	9	17.4	0	19.4	5	0	0	0
11	0	0	0	0	8.9	0.2	0	18.6	0	0	0	0
12	0	0	0	10.3	0.3	0.6	0.2	2.8	0	0	0	0
13	0	0	0	7.6	0	0	0	0.2	0.4	0	0	0
14	0	0	0	1.2	0.6	0	19.4	14.2	19.2	2.6	0	0
15	0	0	0	0	0	0	19.5	17.2	3.2	0	0	0
16	0	0	0	2	0	1.2	4.2	0.6	1.5	1	0	0
17	0	0	0	0	0.4	0	19	2	0	0	4	0
18	0	0	0	0	3	1.2	1.6	3.6	0	0	1	0
19	0	0	0	0	0	26.6	5.4	4.6	0	0	0	0
20	0	0	0	0	2.2	5.6	34	0	7.2	0	0	0
21	0	0	0	24	5.2	7.6	7	0	4	0	0	0
22	0	0	0	0	0	0	43	11.8	8.6	0	0	0
23	0	0	0	0	0	16.4	7.4	42.8	16	0	0	0
24	0	0	0	17.2	27.8	0	4.4	20	46.2	3.4	0	0
25	0	0	0.8	2	0	3.4	3.4	12.2	6.4	0	0	0
26	0	0	4.6	22	0	18.2	2.4	3.2	11.2	0	0	0
27	0	0	0	0	0	28.4	35.6	1.8	45.8	0	0	0
28	0	0	0	0	37.7	0.4	0.6	2.4	18.2	0	0	0
29	0		0	4.2	1.4	0.1	8.4	2	0.6	0	0	0

30	0		0	0	5.3	29.2	6.4	8.4	3.2	0	0	0
31	0		0		4.4		38.4	2.4		0		0
Total	**21.5**	**3.4**	**11.8**	**90.5**	**191.8**	**313.3**	**369.3**	**347.6**	**233**	**50.6**	**16.3**	**0**
1994												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	4.8	9	0	17	0	0	0
2	0	6	0	0	0	9.4	114.6	0	4.2	0	0	0
3	0	2	0	5.6	0	0.4	8	18.4	1.2	0	0	0
4	0	0	0	1.7	45.6	0	0	15.6	0	0	0	0
5	0	0	0	0	7.6	6	3.4	0	0.4	0	0	0
6	0	0	0	0	0	0	1.7	6.4	0	0	0	0
7	0	0	0	0	0	0.4	9.4	5.8	0	0	0	0
8	0	0	0	0	0	13	2	0	0	0	0	0
9	0	16	0	0	46	0	0.6	11.2	49	0	0	0
10	0	15.2	0	0	2	64.4	5.6	11.4	3	0	0	0
11	0	0	0	0	6.6	0	2.6	0.4	2.4	0	0	0
12	0	0	0	0	0	19	0	5	1.2	0	0.6	0
13	0	0	0	0	0	6.2	0	2.4	6.4	0	0	0
14	0	0	0	0	0	5	0.4	19.4	17	0	0	0
15	0	0	0	0	2.2	3.4	0	131.2	0.2	0	0	0
16	18.2	0	0	0	2	0.2	0	0	0	0	0	0
17	15.4	0	0	0	0.6	0.2	0	0	3.6	0	0	3
18	0	0	0	0	0	41.2	0	2.4	6.6	0	0	0
19	0	0	0	0	1.2	18	13.2	0	4	0	0	0
20	0	0	1	0	2	0	12	30.2	6	0	0	0
21	0	0	2	5.6	0	3.8	4.6	9.2	5.4	0	0	0
22	0	0	0	0	8.6	2	5.2	0	7	0	0	0
23	0	0	0	0.4	4.2	2.8	6	12.2	0	0	0	0
24	0	0	0	0	0	20.6	6.4	0	1	0	0	0
25	0	0	0	0	9.8	17.4	32.6	4.2	0	0	0	0
26	0		0	0	0	1.4	0	0	0	0	0	0
27	0		0	0	0.6	0	17.6	3	0	0	0	0
28	0		4.5	0	0	30.4	27.6	0	0	0	0	0
29	0		0	0	3.8	10.2	26.4	0	0	0	2	0
30	0		0	3	2.4	1	4	0	0	0	0	0
31	0		0		3.4		2	0		0		0
Total	**33.6**	**39.2**	**7.5**	**16.3**	**148.6**	**281.2**	**314.9**	**288.4**	**135.6**	**0**	**2.6**	**3**
1995												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0.8	19.8	25.6	0	0	0	0
2	0	0	0	0	0	5.6	10.2	0.4	0	0	0	0
3	0	0	0	0	0	29.6	43.5	0	4.6	0	0	0
4	0	0	0	0	0	2	8.4	0.1	13.4	0	0	0
5	0	0	0	0	0	0	62.4	0	6.6	0.6	0	0

6	0	2.2	0	0	0	7.6	66.4	0	21.2	0	0	0
7	0	0	0	0	0	0.2	82	34	31.6	0	0	0
8	0	0	0	0	0	0	6	0.6	0	0	0	0
9	3.2	0	0	0	3.8	15.4	34	43.2	0	0	0	0
10	0	0	0	0	0	0	14.6	0	0	0	59.8	0
11	0	0	0	0	15.8	5.8	38	10.2	5.6	0	91	0
12	0	0	0	0	0	2.4	13.6	2	2.6	6.6	5	0
13	9.2	0	0	0	9.4	7	0.6	84.2	2.4	0.2	0	0
14	0	0	0	0	12.8	13	9.2	7.2	0	10	0	0
15	0	4.6	0	0	1.2	19.6	20.6	11.8	71.6	0	0	0
16	0	6.4	0	0	0	41.4	0.6	40.6	0	0	0	0
17	0	0	0	0	5.6	143.4	16.2	2.1	0.6	0	0	0
18	1.2	0	0	0	0	46.6	14	2	8	0	0	0
19	0	0	0	0	5.8	2.6	23.8	41.2	29.4	0	0	0
20	0	0	0	0	5.4	8.4	10.2	41.8	0.4	0	0	0
21	0	0	0	14.8	0	2.4	4.6	8.2	0	0	0	0
22	0	0	0	0	0.2	28.4	2.4	1.4	3.6	0	0	0
23	0	0.6	0	0	0	14	0.1	0	6	0	0	0
24	0	0	0	0	0	27.4	0	0	19.6	0	0	0
25	0	0	0	0	0.2	2.2	0.4	64	0	0	0	0
26	0	0	0	0	5.6	5.2	3.4	3	2	0	0	14.4
27	0	0	0	2.2	0	0.8	30	0	0	0	0	0
28	0	0	27.4	1.4	0	12.4	6	0	23.4	0	0	0
29	0		3.2	0	22.6	17	7.6	10.8	14.2	0	0	0
30	0		4.2	0	0	3.6	0	0	10.2	0	0	0
31	0		0		0		25.2	0		0		0
Total	**13.6**	**13.8**	**34.8**	**18.4**	**88.4**	**464.8**	**573.8**	**434.4**	**277**	**17.4**	**155.8**	**14.4**

1996

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	4	13.4	3.6	21.2	0	0	0
2	0	0	0	0	8.2	6.4	25	0	9.5	0	0	0
3	0	0	0	0	0.2	7.2	9.8	45.2	10.6	0	0	0
4	0	0	0	0	0	13.8	7.4	30.2	21.6	0	0	0
5	0	0	0	0	0	0	6.4	3.2	3	12	0	0
6	0	0	0	0	0	0	0	1.4	7.2	2.2	0	0
7	0	0	0	0	0	2	1.2	8.6	2	3	0	0
8	0	0	4	0	5.4	0	3.6	5	0	8	0	0
9	0	0	14	0	0	0	7	38.6	0	0	0	0
10	0	0	0	0	0	0	2.4	5.2	0	0	0	0
11	0	0	0	0	0	24.8	14	26	0	0	0	0
12	0	2	1.6	0	0.4	3.2	35.8	14.6	0	0	0	0
13	38.8	0	7.6	0	0	18.6	114.8	14.7	0	0	0	0
14	4	0	0	0	0	17.2	56	13.8	0	0	0	0
15	0	0	0	0	0.4	20	1.6	5.6	0	0	0	0

16	0	0	0	0	0	53.4	13.4	41	0	0	0	0
17	0	0	0	0	0	0.4	47	4.6	0	0	0	0
18	0	0	0	0	0	0.8	32	95.6	0	0	0	0
19	0	0	0	0	0	0	7.2	61.2	0	0	0	0
20	0	0	0	0	5.4	1	58.8	2.8	0	0	0	0
21	0	0	0	0	7.6	8.6	4	2	2	0	0	0
22	0	0	0	1.6	0	4.6	1	14.4	3.6	0	0	0
23	0	0	0	0	1	1	27.2	6.4	8	0	0	0
24	0	0	0	0	6.4	1	0	0	6.8	0	0	0
25	0	0	0	0	5.2	5.2	0	0	0	0	0	0
26	0	0.8	0	3.2	8.6	27.4	24.2	3.7	5.2	0	0	0
27	0	3.4	0	26	2.8	6	17.6	0	0	0	0	0
28	0	0	0	10.2	0	41	12.2	0	0.2	2	0	0
29	0	0	0	0	2.4	0	0	4.5	0	3.6	0	0
30	0		0	10.4	1.6	27.4	2.2	24	0	0	0	0
31	0		0		5.4		0.4	44.8		0		0
Total	**42.8**	**6.2**	**27.2**	**51.4**	**61**	**295**	**545.6**	**520.7**	**100.9**	**30.8**	**0**	**0**
1997												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0.2	0	0	1.6	3.8	16.2	0	0	0
2	0	26.8	0	9.2	0.6	0	29	6.4	16.4	0	0	7.4
3	0	0	0	0	0	0	0.1	7.4	1	0	0	0
4	0	0.4	0	2.2	0	0	5.2	1.2	0	0	0	0
5	0	0	0	0	0	0	9	59.2	1	0	0	0
6	0	0	0	0	0	2.4	10.4	14	2.4	0	0	0
7	0	0	0	0	0	3	5.6	2	23.8	0	0	0
8	0	0	0	0	0.1	0	6.4	0	0.2	0	0	0
9	0	0	0	31	0.2	0	3.6	0	22.8	0	0	3
10	0	0	0	0	9.8	16.2	28	273.2	0	0	0	7.6
11	0	0	0	1.2	0	0	2	2.4	0	2.4	0	18
12	0	0	0	4.8	0	0	41.4	2.4	7.6	0	0	0.2
13	0	0	0	0	0	7	7.6	26.4	59.4	0	0	0
14	0	0	0	18	0	6	14.6	1.4	1.2	0	0	0
15	0	0	0	1.8	0	2	0	5.2	35	0	0	34.6
16	0	0	0	0	0	4	0	0	0.6	0	0	0
17	0	0	0	0	4.7	0.8	16.6	36	66.6	0	0	0
18	0	0	0	0	0	32.4	1.4	55.2	4.4	0	0	0
19	0	0	0	0	4.8	22.8	0.2	0	14.4	0	0	0
20	0	0	0	0	0	21.6	7	0	69.6	0	0	0
21	10.4	0	0	16.4	0	24	6	0	37.2	0	0	0
22	0	0	0	0	0	22.6	1.2	11.4	8	0	0	0
23	0	0	0	0	0	0	0	4.2	0	0	0	0
24	0	0	0	0	1.2	0	5	0.8	0	0	0	0
25	0	0	0	0	9.2	0	4.6	0	0	0	0	0

26	0	0	0	44.6	3.6	5	4.6	82.4	18.2	0	0	0
27	0	0	0	16	0.6	0.6	0.4	0	0	0	0	0
28	0	0	0	0	6	2.4	0	0	42	0	0	0
29	0		9.2	24	8.8	21	9.6	4.2	0.8	0	0	0
30	0		0	5.2	0	55.6	2.4	6.4	0	1.6	0	0
31	0		1.2		0		7.4	36.4		0		0
Total	**10.4**	**27.2**	**10.4**	**174.6**	**49.6**	**249.4**	**230.9**	**642**	**448.8**	**4**	**0**	**70.8**
1998												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	40.2	32.4	0	4.6	2.8	0	0	0
2	0	0	0	0	0	15	6.4	0.2	4	17.8	0	0
3	0	0	0	0	14.6	0	6.4	6.6	51	2.6	0	0
4	0	0	0	0.2	0	42.3	4.4	8.8	0.2	0.4	0	0
5	0	0	0	1.2	1.2	0	0	65.6	7.8	0.2	0	0
6	0	0	0	20.4	24	0	0	2	44	0	0	0
7	0	0	0	0.1	0	0	10.2	4.8	0.4	0	0	0
8	0	0	0	0	16.2	0	47.3	0.6	0	0	0	0
9	0	0	0	5.2	0	0	1.8	10.8	0	0	0	0
10	0	0	0	0	0	0	0	2.8	0	0	9.2	0
11	0	0	0	0	2.6	0	22.8	34.2	0	2	9.8	0
12	0	0	0	0	0	0	59.4	6.6	0	0	0	0
13	0	0	0	0	0	10.4	8.2	10.4	0	0	0	0
14	0	0	0	0	0	2	4.4	20	0	0	0	0
15	0	0	0	0	0	0	20.2	72.2	0	0	0	0
16	0	0	0	0	0	14	5.2	2.4	0	0	0	0
17	0	0	0	1.4	0	15.2	5.2	16.2	0	0	0.6	0
18	0	0	0	0	0	5.2	33.2	14.4	9.2	0	0	0
19	0	0	0	6.6	0	102	12.2	5.2	0	49.4	2.2	0
20	0	0	0	29	0	50.2	74.1	2.4	0	0	0	0
21	0	0	0	0	0	20	12	2.1	44.4	0	0	0
22	0	0	0	0	0	3.2	0	3.2	1.8	0	0	0
23	0	0	0	0	0	0	6.2	4.5	0.2	33	0	0
24	0	0	34	2	0	2	16.2	10	4	1.4	0	0
25	0	2	0	3.4	0	0	73	0	0	0	0	0
26	0	0	0.6	0	0.4	0	7.2	38	0	0	0	0
27	0	0	0	70.2	0	0	110.2	2	0	0	0	0
28	0	0	0	2.4	0	7.8	2.6	4.2	17.6	0	0	0
29	0		0	22.8	0	8.2	4.6	18	36.4	0	0	0
30	0		75.4	2	0	0	0.1	4	0.2	0	0	0
31	0		14.4		0		8	42		0		0
Total	**0**	**2**	**124.4**	**166.9**	**99.2**	**329.9**	**561.5**	**418.8**	**224**	**106.8**	**0**	**0**
1999												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0.6	0	0	29.8	0	0.4	0.4	0	0

2	0	0	0	0	2.6	0	73.8	4.4	0.8	0.8	0	0
3	0	0	0	0	1.4	0	71.8	20.4	40.4	0	0	0
4	0	0	0	0	0	2.4	23.4	0	0	14.6	0	0
5	0	0	0	0	5.6	0	4	0	0	2.2	0	0
6	0	0	0	0	0	0	0.2	0	13.8	2.6	0	0
7	0	0	0	0	0	0	52.4	16.4	2.4	0.8	0	0
8	0	0	0	0	0	11.8	2.4	3.2	0	0	0	0
9	0	0	0	12.2	6.2	42.8	3.6	16.6	3.8	0	0	0
10	0	0	0	0	0.6	5.8	9.4	16.2	14.4	0	0	0
11	0	0	0	0	3.2	10.8	12	16.4	6.6	0	0	1.4
12	0	0	0	4.1	0	39.2	72.2	39.8	0.6	0	0	0
13	0	0	0	12.3	8.4	1.8	22.2	31.2	9.4	0	0	0
14	0	0	0	9.1	25.4	2.2	0.3	61.6	0.4	0	0	0
15	0	0	0	0	7.8	0	1.2	36.8	0.6	0	0	0
16	0	0	0	0	0	0	3	11.6	0.8	0	0	0
17	0	0	0	0	0	3.4	46.4	4.6	4	6.2	0	0
18	0	0	0	0	0	0.4	2.2	24.4	13.6	0	0	0
19	0	0	0	0	4.8	17	8.3	41.6	0	60	0	0
20	0	0	0	0	0	3.8	2	0	0	36.6	0	0
21	0	0	0	0	14.4	23.8	0	11.8	0.4	0	0	0
22	0	0	0	0.1	3.6	47.2	9	0	6.8	0	0	0
23	0	0	0	0	1.6	13.4	40.6	0.6	0	0	0	0
24	0	0	0	0.1	1.6	39.2	13.2	21.4	0	0	0	0
25	0	0	0	0	12.4	2.4	2.4	16.4	34.8	0	0	0
26	0	0	0	0	7.8	2.4	0.2	119.8	88.4	0	0	0
27	0	0	0	0	0	49.4	6.2	23.6	3.6	0	0	0
28	0		0	0	2.2	117.8	1.3	0.3	0	0	0	0
29	0		0	0	0	0.4	0.3	15	0	0	0	0
30	0.6		0	0	12.8	2.8	0.4	13.2	20.2	0	0	0
31	0		0		0.2		2.4	0.1		0		0
Total	**0.6**	**0**	**0**	**38.5**	**122.6**	**440.2**	**516.6**	**567.4**	**266.2**	**124.2**	**0**	**1.4**

2000

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	5.8	2.2	33.4	19.2	24.4	0	0	0
2	0	0	0	0	1.4	0.2	16.6	41.6	1.6	13.8	0	0
3	0	0	0	0	0.4	0	24.4	16.4	0	0	0	0
4	0	0	0	0	0	2.2	4.2	2.2	7.4	0	0	0
5	0	0	0	0	0	0	0.4	29.8	17.2	0	0	0
6	0	0.1	0	0	0	29.2	49.8	0	4.4	0	0	0
7	0	0	0	0	2.4	24	1.2	0	0	0	0	0
8	0	0	0	0	4.6	0.1	0	15.2	44.5	0	0	0
9	0	0	0	0	0	2.4	31.8	15.8	2.2	0	0	0
10	0	0	0	0	20.6	1.2	3.6	2.4	0	0	0	0
11	0	0	0	0	0	3.8	1.6	0	46.8	0	0	0

12	0	0	0	5.6	0	0	0	18.4	0	0	0	0
13	0	0	0	0	0	0.3	15.8	2.8	0	0	0	0
14	0	0	0	31.6	0	0.8	2.4	18.4	0	0	0	0
15	0	0	0	0	29.6	6.4	4.6	14.2	10.2	0	0	0
16	0	0	0	0	18.6	0.4	0	0	6.6	0	0	0
17	0	0	0	0	1.6	1.4	0	0	9.6	0	0	0
18	0	0	0	14.6	12	0	1.6	0	1.6	0	0	0
19	0	0	0	0	1.4	10.8	8.2	0	0	0	0	0
20	0	0	0	0	1.6	0.2	4.4	20.2	0	2.6	0	0
21	0	0	0	0	51.2	64.2	17.8	31.4	4.6	0	0	0
22	0	0	0	0	20.6	19.8	0	0	2.4	0	0	0
23	0	0	0	0	34.2	16.2	0	3.2	0	0	0	0
24	7.8	0	0	0	0	10.4	0	5.6	3.2	0	0	0
25	0.4	0	0	2.6	0.2	5.8	47.8	0	0	0	0	0
26	0	0	0	0	10.2	9.6	11.4	2.7	0	0	0	0
27	0	0	0	0	6.8	2.4	3.4	26.5	0	0	0	0
28	0	0	0	0	19.4	5.8	0	0	0	0	0	0
29	0	0	0	0	13.8	26.6	17.2	2.6	0	0	0	0
30	0		0	0	0.8	133.2	0	27.8	0	0	0	0
31	0		0		0		8.2	15.8		0		0
Total	**8.2**	**0.1**	**0**	**54.4**	**257.2**	**379.6**	**309.8**	**332.2**	**186.7**	**16.4**	**0**	**0**

2001

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	1.4	0	1.2	10	22.8	26.2	0	0
2	0	0	0	T	0	1.6	0	45	2.2	10.4	0	0
3	0	0	0	0	0	42	0	0	6.6	7.4	0	0
4	0	0	0	0	4.2	0	0	0	6.4	41.4	0	0
5	0	0	0	0	0	0	4	0	24.4	82	0	0
6	0	0	0	0	T	6.4	0	0	50.5	104	0	0
7	0	0	0	0	0	34.2	12	0	1.6	0	0	0
8	0	0	0	0	4	2.6	0	0	3.6	0	0	0
9	0	0	0	0	2.6	0	2	0	0	0	0	0
10	0	0	0	0	9.6	0	42	0	3.4	57	0	0
11	0	0	0	0	4.6	T	6.2	T	0	0	0	0
12	0	0	0	0	1.6	12	4.2	T	14.8	0	0	0
13	0	0	0	0	0	0	4	0	0	0	0	0
14	0	0	0	20.1	0	0	0	T	0	0	0	0
15	0	0	0	0	1.6	0	19	2	0	0	0	0
16	0	0	0	T	T	0	5.6	32	0	0	0	0
17	0	0	0	0	0	0	T	1.8	26	0	0	0
18	0	0	0	0	3.4	0	0	0	0	0	0	0
19	0	0	0	0	6.4	0	0	4.2	T	5	0	0
20	0	0	0	0	12.4	17.8	3.4	16.4	0	0	0	0
21	0	0	0	0	0	17.6	2.4	0	0	0	0	0

22	0	0	0	0	2	0	3.4	19.6	0	0	0	0
23	0	0	0	0	6.2	4	0	0	0	0	T	0
24	0	22.5	0	0	0	1	1	41.2	0	0	0	0
25	0	2	0	0	17.8	0	6	0	0	0	0	0
26	0	0	0	0	8	0	T	0	0	0	0	0
27	0	0	0	0	0	1.6	29.4	25.6	0	0	0	0
28	0	0	0	0	0	19	4	2.2	20.8	0	0	0
29	0		0	0	4	0	18.4	30	0	0	0	0
30	0		0	14.4	0	8.6	55	0	5.4	0	0	0
31	0		0		7.4		31	0		0		0
Total	**0**	**24.5**	**0**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**333.4**	**DNA**	**0**
2002												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	3.4	0	0	62.4	0	0	0	0	0
2	0	0	0	28.2	0	0	6.8	4.6	T	0	0	0
3	0	0	0	5.2	2.2	20.8	10.6	10.2	11.2	0	0	0
4	0	0	2.2	4	9.8	3.6	4.8	0	2	0	0	0
5	0	0	0	0	0	8	0	8.2	T	0	0	0
6	0	0	0	0	0	9.6	26.6	0	0	0	0	0
7	0	0	0	0	0	22.2	1.2	0	0	0	0	0
8	0	0	0	0	0	4	4.2	0	0	0	0	0
9	0	0	0	1.6	0	1	1.4	100.6	0	6	0	0
10	0	0	0	0	17.8	2.4	7	10.6	14	0	0	0
11	0	0	0	0	1	33.6	6	2	12.6	0	0	0
12	0	0	0	2	4	0	2.6	84.2	1	0	0	0
13	0	0	0	0	0	4	0	8.8	0	0	0	0
14	0	0	0	0	0	14.4	5.8	0	0	0	0	0
15	0	0	0	0	1.6	33.4	22.8	0	2	0	0	0
16	T	0	0	2	0	0	0	1.2	0	0	0	0
17	9	0	0	1.2	0	4	0	4.8	0	0	0	0
18	0	0	7.2	1	4.2	35.2	6.2	11.6	0	0	0	0
19	0	0	0	0	0	8.6	5.4	1.2	0	16.4	0	0
20	0	0	0	0	0	0	0	23.8	0	0	0	0
21	0	0	0	0	0	0	14.6	44.2	0	6.2	0	0
22	0	0	0	8.8	0	0	10.1	14.4	5.8	0	0	0
23	0	0	1.6	0	0	24	65	0	0	0	0	0
24	0	0	0	0.6	0	0	56.2	5.8	4.2	0	0	0
25	0	0	0	0	42	0	40.4	0	4.6	0	0	0
26	0	0	0	0	0	6	32.6	0	20.8	0	0	0
27	0	0	0	4.2	3.4	0.6	10.8	6.4	0	0	0	0
28	9.6	0	T	0	0	34	67	0	2.6	0	0	0
29	5		2.4	0	6.8	26.8	68.2	4.8	2.4	0	0	0
30	0		0	3.4		6.8	32.2	0	0	0	0	0
31	0		0				13.2	0		0		0

Total	**DNA**	**0**	**DNA**	**65.6**	**92.8**	**303**	**584.1**	**347.4**	**DNA**	**28.6**	**0**	**0**
2003												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	9	19.2	0	8.8	0	0	28	53.4	7.2	9.8	0	0
2	0	5.6	0	0	0	0	2.8	10.4	0	0	0	0
3	0	0	0	0	12.8	16.2	4.8	5	0	0	0	0
4	0	0	0	4	1.2	0	19.8	0	0	0	0	0
5	0	0	0	0	0	0	2	0	0	0	0	0
6	0	0	0	0	0	12.8	69.4	7.8	3.4	0	0	0
7	0	0	0	0	0	2.2	6.2	0	0	0	0	0
8	0	0	0	0	0	0	70	43.4	0	0	0	0
9	0	0	0	0	0	0	125	31.2	0	25.4	0	0
10	0	0	0	0	0	30.8	89.2	26.6	0	70.4	0	9.4
11	0	0	0	0	0	5.8	9	0	0	0	0	0
12	0	0	0	0	0	0	0	6.4	0	0	0	0
13	0	0	11.8	0	0	10.8	2.6	0	0	0	0	0
14	0	0	0	0	0	5	0	0	0	0	0	0
15	0	0	0	T	0	0	0	3	0	0	0	0
16	0	0	0	0	12	0	0	0	9.8	0	0	0
17	0	0	0	0	0	0	3.6	2.4	7.4	0	0	0
18	0	0	0	0	0	0	50.2	19.6	0	0	0	0
19	0	0	3.6	0	2.2	0	6.6	29	21	0	0	0
20	0	16.4	0	0	0	34.8	1.2	10	0	0	0	0
21	0	0	0	0	14.4	0	4.6	0	0	0	0	0
22	0	0	0	0	0	4	42.8	0	11.2	0	0	0
23	0	0	0	0	15	26.4	0	0	0	0	0	0
24	0	0	0	0	0	59.8	0	12.4	17.4	0	0	0
25	0	0	0	0	0	0	10	0	0	14.6	0	0
26	0	0	3.2	54	13	0	37	0	5.5	26	0	0
27	0	0	5.2	2.8	0	39.8	77	10.4	0	2.6	0	0
28	0	0	0	0	0	51.4	0	21.8	0	0	0	4.6
29	0		0	0	0	2.8	5.2	0	2.8	0	0	22.6
30	7.6		0	10.2	3	84.5	6.2	0	5.8	0	0	0
31	0		9.6		0		111	4.6		0		0
Total	**16.6**	**41.2**	**33.4**	**DNA**	**73.6**	**387.1**	**784.2**	**297.4**	**91.5**	**148.8**	**0**	**36.6**
2004												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
2	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
3	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
4	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
5	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
6	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
7	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA

8	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
9	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
10	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
11	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
12	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
13	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
14	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
15	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
16	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
17	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
18	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
19	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
20	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
21	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
22	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
23	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
24	19	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
25	8.4	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
26	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
27	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
28	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
29	0	0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
30	0		DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
31	0		DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
Total	**27.4**	**0**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**	**DNA**

2005

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	DNA	0	0	0	10	DNA	27	DNA	0	0	0	0
2	DNA	0	0	0	5	DNA	19	DNA	0	2	0	0
3	DNA	0	0	0	22	DNA	0	DNA	0	3.2	0	0
4	DNA	0	0	0	43	DNA	0	DNA	0	0	0	0
5	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
6	DNA	0	0	0	0	DNA	3	DNA	0	0	0	0
7	DNA	0	0	7	4	DNA	0	DNA	0	0	0	0
8	DNA	0	0	0	3.2	DNA	0	DNA	0	0	0	0
9	DNA	0	0	0	7	DNA	98	DNA	0	0	0	0
10	DNA	0	0	3.4	0	DNA	0	DNA	0	0	0	0
11	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
12	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
13	DNA	0	0	0	0	DNA	5	DNA	0	0	0	0
14	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
15	DNA	0	0	0	0	DNA	22	DNA	0	0	0	0
16	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
17	DNA	0	0	0	3.2	DNA	0	DNA	0	0	0	0

18	DNA	0	4	0	2	DNA	10	DNA	8	0	0	0
19	DNA	0	2	0	0	DNA	0	DNA	0	0	0	0
20	DNA	0	0	0	14	DNA	20.6	DNA	0	0	0	0
21	DNA	0	0	4	0	DNA	55	DNA	24.5	4	0	0
22	DNA	0	0	0	0	DNA	0	DNA	7.1	50	0	0
23	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
24	DNA	0	24	1	4.3	DNA	0	DNA	0	1	0	0
25	DNA	0	0	0	0	DNA	0	DNA	0	0	0	0
26	DNA	0	0	6	0	DNA	12.6	DNA	2.3	0	0	0
27	DNA	0	0	2	0	DNA	0	DNA	0	0	0	0
28	DNA	0	0	12	0	DNA	0	DNA	0	0	0	0
29	DNA		0	0	0	DNA	0	DNA	0	0	0	0
30	DNA		0	15	0	DNA	0	DNA	0	0	0	0
31	DNA		0		2.2		18.4	DNA		0		0
Total	**DNA**	**0**	**30**	**50.4**	**119.9**	**DNA**	**290.6**	**DNA**	**41.9**	**60.2**	**0**	**0**

2006

Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	0	0	3.8	0.1	0	0
2	0	0	0	0	0	1.4	9.2	0	0	0	0	0
3	0	0	0	0	0	29.1	19	7.1	5.3	0.4	0	0
4	0	0	0	0	0	0	8.6	0	7.3	0	0	0
5	0	1.2	0	0	0	0	0	26	0	0	0	0
6	0	0	0	0	0	16	0	0	0	0	0	0
7	0	0	0	4	0	11	17.2	1	0	1.4	0	0
8	0	0	0	0	0	0	31	28.1	3	0	0	0
9	0	0	0	0	19	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	23.8	0	0	0
11	0	0	0	0	0	0	16	0	0	0	5.6	14.6
12	0	0	4.1	0	0	0	3.4	2	0	0	0	0
13	0	0	25	0	18.4	0	0	0	1.2	0	0	0
14	0	0	0	0	2.1	0	60	0	0	0.5	0	0
15	0	0	0	0	0	0	0	0	39	0	0	0
16	0	0	2	0	0	0	22	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	20.3	4.1	0	0	0	7.1	0	0	0
19	0	0	0	26.3	0	0	14.6	0	0	0	0	0
20	0	0	0	0	8.4	0	0	28.2	0	0	0	0
21	0	0	0	1.4	0	0	0	0	0	7.2	0	0
22	0	0	0	0	4.3	0	32	7.4	8.5	0	0	0
23	0	0	0	5.3	3	12.3	0	0	0	0	0	0
24	0	0	0	0	6.1	0	7	0	22.2	0	0	0
25	0	0	0	10.2	34.2	10	0	0	0	0	0	0
26	0	0	0	0	0	0	52.5	28.5	0	2	0	0
27	0	0	0	0	9.3	20.4	0	5	0	0	0	0

28	0	0	0	0	1.2	0	0	0	0	0	0	0
29	0		0	0	32.1	74.4	0	22.2	0	0	0	0
30	0		0	0	5.4	9.1	35.2	42.4	0	0	0	0
31	0		0		9		0	0		0		0
Total	**0**	**1.2**	**31.1**	**67.5**	**156.6**	**183.7**	**327.7**	**197.9**	**121.2**	**11.6**	**5.6**	**14.6**
2007												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	DNA	0	0	0	0	6.3	0	10.2	0	DNA	DNA	DNA
2	DNA	0	0	0	0	0	0	0	0	DNA	DNA	DNA
3	DNA	0	8	0	0	22.2	0	0	0	DNA	DNA	DNA
4	DNA	0	0	0	0	0	0	0	30.8	DNA	DNA	DNA
5	DNA	2.2	0	0	0	0	0	0	0	DNA	DNA	DNA
6	DNA	0	0	0	0	0	0	0	0	DNA	DNA	DNA
7	DNA	34.2	0	0	0	DNA	0	12.8	0	DNA	DNA	DNA
8	DNA	11.3	0	2.8	0	DNA	0	0	0	DNA	DNA	DNA
9	DNA	4.4	0	0	12	DNA	0	0	0	DNA	DNA	DNA
10	DNA	0	0	0	0	DNA	0	0	0	DNA	DNA	DNA
11	DNA	0	0	0	17	DNA	0	0	15.2	DNA	DNA	DNA
12	DNA	8.8	0	0	0	DNA	0	0	0	DNA	DNA	DNA
13	DNA	0	0	0	0	DNA	11.8	0	0	DNA	DNA	DNA
14	DNA	0	0	0	0	DNA	0	0	0	DNA	DNA	DNA
15	DNA	0	0	0	13.2	51	0	0	0	DNA	DNA	DNA
16	DNA	0	0	0	1.2	38	12	0	0	DNA	DNA	DNA
17	DNA	0	0	0	0	0	32	0	20.1	DNA	DNA	DNA
18	DNA	0	0	1.2	8	0	10	15.4	0	DNA	DNA	DNA
19	DNA	26.1	0	0	0	0	15	0	0	DNA	DNA	DNA
20	DNA	0	0	21	0	0	20.2	0	0	DNA	DNA	DNA
21	DNA	0	0	0	0	0	16	0	0	DNA	DNA	DNA
22	DNA	0	0	0	0	0	5	0	0	DNA	DNA	DNA
23	DNA	0	0	2.3	0	26.1	23	0	0	DNA	DNA	DNA
24	DNA	0	0	0	0	0	16.4	0	20.4	DNA	DNA	DNA
25	DNA	0	0	0	0	39.8	9.2	0	0	DNA	DNA	DNA
26	DNA	0	0	0	0	0	4	0	0	DNA	DNA	DNA
27	DNA	0	0	0	0	34.6	4.8	16.2	0	DNA	DNA	DNA
28	DNA	0	0	0	0	0	9.2	0	0	DNA	DNA	DNA
29	DNA		0	0	0	0	6.4	0	0	DNA	DNA	DNA
30	DNA		0	0	0	14.8	5.2	0	0	DNA	DNA	DNA
31	DNA		0		0		6.4	0		DNA		DNA
Total	**DNA**	**87**	**8**	**27.3**	**51.4**	**DNA**	**206.6**	**54.6**	**86.5**	**DNA**	**DNA**	**DNA**

2008												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	DNA	0	0	0	0	0	6	0	DNA	DNA	0	DNA
2	DNA	0	0	0	0	0	0	0	DNA	DNA	0	DNA
3	DNA	0	0	0	0	0	0	0	DNA	DNA	0	DNA
4	DNA	0	22	0	0	0	0	0	DNA	DNA	0	DNA
5	DNA	0	4.4	0	0	0	22.6	0	DNA	DNA	0	DNA
6	DNA	0	0	0	4.9	0	0	0	DNA	DNA	0	DNA
7	DNA	0	0	0	8.2	18	0	0	DNA	DNA	0	DNA
8	DNA	0	0	0	0	0	0	0	DNA	DNA	0	DNA
9	DNA	0	0	0	0	36.4	0	0	DNA	DNA	0	DNA
10	DNA	0	0	0	40.4	0	0	0	DNA	DNA	0	DNA
11	0	0	0	0	35.2	0	0	0	DNA	DNA	0	DNA
12	0	0	0	0	27.6	8.4	0	0	DNA	DNA	0	DNA
13	0	0	0	0	0	30.4	20.6	38.6	DNA	DNA	0	DNA
14	0	0	0	0	0	35.6	19.4	0	DNA	DNA	0	DNA
15	0	0	0	0	0	37.9	0	0	DNA	DNA	0	DNA
16	0	0	0	0	0	3.6	0	0	DNA	DNA	0	DNA
17	0	0	0	0	0	0	0	15.2	DNA	DNA	0	DNA
18	0	0	0	0	25	0	0	84.2	DNA	DNA	0	DNA
19	0	0	0	0	0	20.1	5.8	118	DNA	DNA	0	DNA
20	0	0	0	0	0	34.5	15.2	4.6	DNA	DNA	0	DNA
21	0	0	0	0	0	0	45.4	0	DNA	DNA	0	DNA
22	0	0	6.6	0	0	0	23.2	0	DNA	DNA	0	DNA
23	0	0	0	0	16.6	9.2	0	0	DNA	DNA	0	DNA
24	0	0	0	0	0	0	0	0	DNA	DNA	0	DNA
25	0	0	0	0	0	0	0	0	DNA	DNA	0	DNA
26	0	0	0	0	0	31.8	0	16.2	DNA	DNA	0	DNA
27	11.4	0	0	0	0	25	14.2	18.4	DNA	DNA	0	DNA
28	0	0	0	0	0	10.2	13.9	25	DNA	DNA	0	DNA
29	0	0	0	0	0	8.4	0	0	DNA	DNA	0	DNA
30	0		0	0	0	8.4	0	8.4	DNA	DNA	0	DNA
31	0				18.1		0	10	DNA	DNA		DNA
Total	**DNA**	**0**	**33**	**0**	**176**	**317.9**	**186.3**	**338.6**	**DNA**	**DNA**	**0**	**DNA**

2009												
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	19	0	0	4.5	0	0	0	0
3	0	0	0	0	6.8	0	14.8	11	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	13.6	0	0	34	0	0	0	0
6	0	0	0	0	0	0	0	0	0	96	0	0
7	0	0	0	0	0	6.2	46.1	16	0	24.5	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0.8	0	0	34.6	0	0	0	0
10	0	0	0	0	0	0	36.2	10	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	19	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	34.8	0	0	128	0	0	0	0
16	0	0	0	0	0	0	0	4	0	0	0	0
17	0	0	0	0	0	0	0	7	0	0	0	0
18	0	0	0	0	0	0	0	22	0	0	0	0
19	0	0	0	0	0	0	0	105	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	13.3	51.2	41	0	0	0	0
22	0	0	0	0	6.2	0	0	0	0	0	0	0
23	0	0	0	0	3.2	24.8	0	0	0	0	0	0
24	0	0	0	0	6.7	0	0	0	0	0	0	0
25	0	0	0	0	0	0	24.8	0	0	0	0	0
26	0	0	0	0	73	0	40.1	0	0	0	0	0
27	0	0	10.2	0	88	51.8	22.8	0	0	0	0	0
28	0	0	0	0	0	0	23.8	0	0	0	0	0
29	0		0	0	0	0	38	22	8.2	0	0	0
30	0		0	0	0	0	0	0	0	0	0	0
31	0		0	0	0		0	0		0		0
Total	**0**	**0**	**10.2**	**0**	**271.1**	**96.1**	**297.8**	**439.1**	**8.2**	**120.5**	**0**	**0**

Annex-IV

Data of Temperature recorded in DHM's Ilam tea estate meteorological station:

Minimum Temperature												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1980	9	10.5	13.6	19.2	17.2	20.2	20.4	19.9	19.5	16	14.7	11.8
1981	9.4	11.1	13.8	15	17.4	19.6	20.1	20	19.5	17.5	14.1	10.8
1982	11	9.9	13.4	16.1	19.4	19.6	20.1	20.5	19.5	17.2	13.4	10.2
1983	8.5	9.5	14	16.4	17.6	19.9	20.3	20.4	19.6	18.4	14.8	10.1
1984	8.2	10.8	16.3	18.1	18.4	20.2	19.5	20.2	18.4	17.8	13.7	10.8
1985	9.7	10.6	15.8	18.1	17.8	19.9	20	20.4	19.2	17.6	13.8	12.2
1986	11.2	11.9	15.8	16.1	17.2	20	19.7	20.3	18.4	15.7	13.7	10.8
1987	10.5	11.8	14.5	17.1	18.5	20.2	20.1	19.6	19.3	17.4	14.8	12
1988	10.4	12.2	14	17.8	18.7	19.9	20.1	20.2	19.9	17.8	15.2	12.2
1989	8.7	9.8	14.2	18.3	19	19.5	19.4	19.5	19	19.2	DNA	9.8
1990	10.9	10.3	12.1	15.4	18	20.1	20.1	20.2	19.4	16.9	15.6	12
1991	8.8	12	15	17	17.5	19.6	20.3	20.3	19.5	17	13.1	10.3
1992	8.6	7.8	14	17.5	16.3	19.1	18.5	19.6	19.1	17	14.1	10
1993	7.7	11.5	13.3	16.1	17.4	19.3	19.8	19.9	18.9	16.9	14.1	11.4
1994	10	9.1	14.2	16.7	18.5	20	20.6	20.4	19.5	16.4	14.1	10.3
1995	8.7	10	13.7	18.1	19.8	19.8	20	19.9	19.2	17.5	14.3	10.3
1996	8.7	11.3	14.5	17.7	17.8	19.2	19.8	20.2	19.8	17.5	14.2	10.9
1997	7.7	8.3	13.9	14.5	17.6	19.2	20.2	20.1	18.5	16.1	13.4	9.7
1998	8.1	10.4	11.4	14.9	18.4	20.1	19.8	20.1	19.5	18.4	15.8	12.5
1999	10.7	14.3	16.2	18.9	18.2	20.2	20.3	19.7	18.9	17.5	14.5	12
2000	9.4	9	13.6	16.2	17.8	19.2	19.4	19.1	18	17.8	13.7	10.9
2001	9	11	14.1	17.2	17.4	19	19.6	19.6	18.2	16.7	14.2	10.8
2002	9.1	11.8	14.7	15.8	17.9	19.5	19.3	19.5	18.7	16.4	DNA	10.1
2003	8.5	9.3	11.9	14.9	DNA	DNA	DNA	DNA	18.3	16.7	12.9	10.1
2004	8.9	11	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
2005	DNA	11.3	15	17.1	17.8	20.2	19.7	DNA	20	17.5	14.6	12.4
2006	10.7	13.7	15.4	16.6	18.3	20.2	20.6	20.6	19.7	18	13.7	11
2007	DNA	DNA	DNA	DNA	19.3	20.3	20.8	19.5	20.1	DNA	DNA	DNA
2008	10.2	11.8	14	17.5	17.1	19.6	19.9	19.6	DNA	DNA	14.2	DNA
2009	8.8	11.1	11.9	15.7	17.5	18.9	20.4	19.3	19.8	18.6	13.6	8.9
Maximum Temperature												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1980	14.9	16.7	20.8	26.5	24	24.8	24.6	24.5	24.5	22.9	20.9	17.9
1981	14.9	18.2	20.9	22.5	23.9	25.5	24.6	24.9	24.4	23.5	21.1	17.4

1982	17.1	16.2	20.8	23.3	26.2	24.4	24.6	25.2	24.2	23.4	18.7	16.1
1983	14.7	16.4	21	23.5	23.6	25.5	24.6	25.2	24.5	24.6	21.9	16.1
1984	14.3	17.4	23	26	24.4	25.7	24	26.2	23.7	23.5	21.9	17.6
1985	15.7	16.4	22.4	25.6	24.9	25.2	24	25.5	24.1	23.2	20.4	17.5
1986	16.6	18.1	23.1	24.1	24.6	25.7	24.2	25.6	23.5	22.1	20	17.1
1987	17.6	19	20.3	24.3	25.3	25.6	24.5	24.4	24.2	22.2	21.3	18.6
1988	16.6	19	20.9	25	25	25.3	24.3	23.9	24.8	24	22	18.4
1989	14.7	16.3	21.1	25.7	26.3	24.6	23.8	24.7	23.7	23.7	DNA	16.4
1990	16.9	16.2	19.6	22.4	24.1	24.7	24.6	25.1	24.8	22.9	23	18.6
1991	15.3	19.1	22.9	24.8	25.3	25.2	25.7	25.9	24.6	24.1	20.8	17.1
1992	16	15	22.9	26.8	24.5	26.3	25.1	25.3	24.7	23.3	21.7	17.4
1993	14.1	18.8	21.6	24.7	24.9	25.3	25	24.7	25	23.7	21.3	19.7
1994	18.2	17.3	22.1	25.4	26.6	25.8	26.4	26.2	25.8	23.9	21.7	18.5
1995	15.9	17.3	21.9	26.5	27	25.4	24.7	25.4	24	23.8	21.6	17.3
1996	15.4	19.5	23.3	26.3	25.4	25	24.4	25.3	26.1	24.1	22.7	19.3
1997	16.3	16.5	22.4	22.5	25.6	25.8	26	25.8	24.7	24.3	21.6	18.1
1998	16.6	18.8	20.5	24.3	26.3	26.2	25	24.9	25.5	25.1	22.8	20.4
1999	18.9	22.6	24.4	26.8	25.2	26.1	25.5	25	25.1	23.9	22	19.9
2000	16.7	17	22	25.4	25.4	25.8	25.1	24.6	24.5	24.5	20.7	18.5
2001	16.7	19.5	23.4	26	26	26.5	26	26.4	25.1	24.6	21.8	18.9
2002	16.9	19.9	22.8	23.7	25.4	25.1	24.6	25.6	25.4	24.3	22.6	18.5
2003	16.8	17.9	20.7	25.3	26.3	25.8	25.3	26	25.2	23.8	21.1	18.9
2004	16.9	18.9	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
2005	DNA	18.7	22.6	25	25.1	26.8	25.9	DNA	27.1	24.5	21.8	19.6
2006	18.2	21.2	23.4	25.5	26.5	26.5	26.7	27.5	25.6	26.1	21.6	18.4
2007	DNA	DNA	DNA	DNA	26.3	27.4	26.8	27	27.3	DNA	DNA	DNA
2008	14.7	17.5	22.7	27.2	27.6	27.7	26.8	26.8	DNA	DNA	23.9	DNA
2009	17.5	20.5	24.7	28.3	28.9	28.4	28.7	28.2	29.8	28.6	22.7	17.1

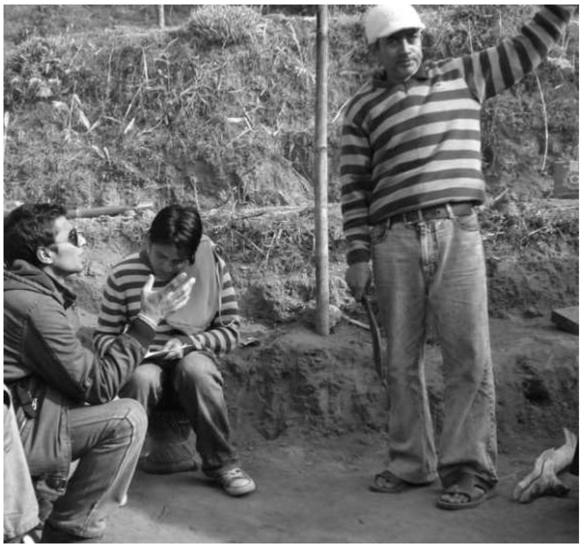
Annex-V

Plates:

W-E View of Sanghrumbha landslide

N-S View of Sanghrumbha landslide

Landslide inside forest



Landslide inventory questionnaire with local

Recording GPS location of Landslide