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Meteorology, Hydrology, and Glaciology of Nepal

BIBLIOGRAPHY

Mountain Natural Resources' Division
International Centre for Integrated Mountain Development

Published by

International Centre for Integrated Mountain Development
G.P.O. Box 3226,
Kathmandu, Nepal

Preface

Information on studies related to Meteorology, Hydrology, and Glaciology in the countries of the Hindu Kush-Himalayas is of interest not only to the subject matter specialists but also to a wide range of experts and researchers from various fields, as they are of vital importance for planning, development, and management of natural resources and a wide range of economic activities. However, such information is not only sparse but often widely scattered and not easily accessible. Considering such needs and difficulties, the Mountain Natural Resources' Division of ICIMOD has prepared the present volume of **Bibliography on Meteorology, Hydrology, and Glaciology of Nepal** as a first step towards filling this gap. This endeavour has been supported by a grant from the Swiss Development Cooperation (SDC), Nepal, which helped in the preparation and publication of this Bibliography. Depending upon the availability of resources, production of similar volumes is also planned for other countries of the Hindu Kush-Himalayas.

The bibliographic references included in this volume are collected from abstracts published in various journals and proceedings of seminars. Altogether 280 documents, consisting of published and semi-published literature, have been included in this bibliography, including journal articles, reports, and case studies. The year of publication ranges from 1960 to 1994. All the references included in this bibliography are related only to Nepal.

The bibliographic details of the references are arranged systematically under headings entitled Meteorology (including Hydro-meteorology), Hydrology (including Glacial-hydrology), and Glaciology. Within each subject, entries are arranged alphabetically by author(s) and under author(s) by title. To facilitate quick and easy access to individual citations, author and title indexes are provided at the end. In the indexes, back reference is made to sequentially arranged entry numbers in the main body. As far as possible, the location of the documents has also been provided.

This Bibliography has been prepared with the assistance of Mr. L.P. Devkota and Mr. R.M. Rajbhandari, both lecturers at the Department of Meteorology, Tri-chandra Campus, Tribhuvan University, under the supervision of Prof. S.R. Chalise of the Mountain Natural Resources' Division of ICIMOD and editorial assistance has been provided by Mr. R.B. Shrestha (Librarian) and Archana Singh Karki (Public Relations' Officer) of ICIMOD.

An attempt was made to annotate all bibliographic references entered. However, owing to certain limiting factors this was not possible and you will find some gaps and mistakes in this publication. Titles of the documents are given as published, without further editing. Comments and suggestions from the readers are therefore welcome and will be incorporated to produce a better version in the second edition.

Contents

Meteorology

Meteorology

001 *Acharya, L.M.* **Frequency analysis of 24 hour maximum precipitation of Kathmandu.** In: Majupuria, T.C. (ed.), Nepal: Nature's paradise, Bangkok, White Lotus, 1984, 59-63p.

002 *Acharya, L.M.* **Precipitation distribution in Nepal in 1992.** In: Annual Disaster Review 1992, Kathmandu, Water Induced Disaster Prevention Technical Centre, 1993, 37-44p.

003 *Acharya, L.M.* **Precipitation over Nepal 1993 : An overview.** In: Annual Disaster Review 1993, Kathmandu, Water Induced Disaster Prevention Technical Centre, 1994.

004 *Ageta, Y.* **Characterstics of precipitation during monsoon season in Khumbu Himal.** Seppyo, Vol. 38, Special Issue, 1976, 84-88p.

Loc: ICIMOD, DOM

Based upon the observations taken at fifty different sites in Imja Khola catchment, ranging from the bottom of the valley to the glaciers near the ridge, the author has presented the behaviour of precipitation during monsoon season in the Himalayas. The nocturnal precipitation observed has also been related to the diurnal variation of clouds caused by the local circulation associated with the orographic condition.

005 *Basnet, K.* **Temperature variation in Nepal.** The Himalayan Review, Vol. 20-23, (1989 - 1992), 25-34p.

Loc: NGS, ICIMOD

In this paper an attempt has been made to analyse the variation in the distribution of temperature in Nepal.

006 *Berthillot, E.* **Une intérpretation climatique des données météorologiques du Népal.** Grenoble, Université Scientifique et Médicale, thèse doct. 3éme cycle, 96p.

007 *Bishop, B.C., Barry, C.; Angstrom, A.K., Drummond, A.J., Roche, J.* **Solar radiation measurements in the high Himalayas (Everest region).** Journal of Applied Meteorology 5, (1966), 94-104p.

Loc: DOM

This paper discusses the solar radiation data assembled during the Himalayan Scientific and Mountaineering Expedition of 1960-61, led by Sir Edmund Hillary, and the American Mt. Everest Expedition of 1963 led by Norman Dyhrenfurth.

008 *Boesch, H.* **Zwei jahre wetterbeobachtungen in Nepal (1961-1963) [Two years of weather observation in Nepal (1961 - 1963)].** Geographica Helvetica, Number 3, 1964.

009 *Chalise, S.R.* **Ecology and climate in the mountain system - A review.** Kathmandu, International Centre for Integrated Mountain Development, Working Paper No. 12, 1986, 60p.

Loc: ICIMOD

In this paper an attempt has been made to consider climate as a resource for development. The general features of the climate in the Himalayas are described basically against the background of precipitation distribution. The paper contains elaborate discussions on the general climatic features of Nepal. Finally, a detailed scenario of the development of meteorology and hydrology in Nepal is presented.

010 *Chalise, S.R.* **Mountain environments and climate change in the Hindu Kush-Himalayas.** In: Martin Beniston (ed.), Mountain environments in changing climates. London and New York, Routledge, 1994, 383-404p.

Loc: ICIMOD

In this paper, an attempt has been made to consider climate and climatic change as factors affecting the Himalayan environment. The paper starts with a brief discussion on the general aspects of the climate and ecology of the Hindu

Kush-Himalayas. It is interesting to note that a comparison is made of the distribution of monthly means of noon-time temperatures (1802 - 1803 and 1968 - 1990) in Kathmandu. Some implications of the potential impact of climate change on mountain environments in the HKH are also discussed.

011 *Chhetri, T.B.* **Evaporation study over Nepal.** M.Sc. Dissertation, Kathmandu, Tribhuvan University, 1993, 83p.

Loc: CDOM

In this dissertation, evaporation distribution over Nepal and its rate during various seasons are presented. It also deals with the latitudinal, longitudinal, and altitudinal distribution of evaporation in Nepal.

012 *Devkota, L.P.* **An isentropic investigation of the monsoon trough displacement and corresponding rainfall distribution in Nepal.** M.S. Thesis, USA, The University of Wisconsin, 1992, 57p.

Loc: DOM

In this thesis, the temporal and spatial distribution of summer rainfall over south Asia is studied through analyses of the distribution of the sea-level pressure, wind vector, atmospheric heating, mass transport potential, absolute vorticity, and precipitation minus evaporation (P-E) for July 1988. The diagnostics are derived in an isentropic coordinate system using ESMWF/TOGA analysis. The active break epochs of the Indian monsoon are determined through an analysis of the Hovemoller diagrams of sea-level pressure, the distribution of vertically integrated heating, and P - E.

013 *Devkota, L.P.* **On-set of summer monsoon in Nepal.** The Himalayan Review, Vol. XV, 1983-84, 11-20p.

Loc: NGS

The paper deals with the on-set of summer monsoon in Nepal during 1981. It examines the use of synoptic and upper air flow patterns to find out the on-set date. It concludes that the formation of depression over the Bay of Bengal and its movements accelerated the northward shift of the monsoon trough, which started monsoon rainfall in Nepal.

014 *Dhar, O.N.* **The diurnal variation of rainfall at Barakshetra and Kathmandu during monsoon months.** Indian Journal of Meteorology and Geophysics, 11, 1960, 153-56p.

015 *Dhar, O.N.; Soman, M.K.; Mulye, S.S.* **Distribution of rainfall in the Himalayan and sub-Himalayan regions during 'breaks' in monsoon.** In: Proceedings of Hydrological Aspects of Mountainous Watersheds, India, Roorkee, University of Roorkee, 1982, I-22 - I-26p.

Loc: ICIMOD

In this paper, the distribution of rainfall over the Koshi Himalayas and their submontane area to the south has been studied for all the 'break' monsoon situations that occurred during the period from 1949 to 69. Only those 'break' situations having a duration of 3 days or more are considered.

016 *Dittmann, E.* **Statistical studies on the structure of precipitation in Nepal.** In: Studies on the climatology and phytogeography of the Himalayas, Selections from Khumbu Himal, Nepal Research Centre, Kathmandu, 1988, 1-20 p.

This paper presents several aspects of the distribution of precipitation in Nepal. The study includes regional rainfall in southern Nepal, time-series precipitation distribution, rainfall variability, and daily precipitation variation in the Kathmandu valley.

017 *Dobremez, J. F.* Le Népal: Écologie et biogeographic (French language). Paris, CNRS, 1976, 355p.

Loc: ICIMOD

The first and pioneering study published in French on the ecology and biogeography of Nepal. Comprehensive and systematic analysis of available climatic data (temperature, precipitation, humidity, and radiation) and

bioclimatic classification of Nepal are given in the first chapter of this book (31-91p), which also includes information on all types of climatic stations operating at that time.

018 *Domroes, M.* **Temporal and spatial variation of rainfall in the Himalayas with particular reference to mountain ecosystems.** Journal of the Nepal Research Centre 2/3, 1979, 49-67p.

Loc: ICIMOD

This paper investigates the reasoning behind the weaker regime of monsoon in the Himalayas, non-uniform Himalayan climate, and orographic effect on the Himalayan climate. The investigation is primarily based on temporal and spatial analyses of rainfall in the Himalayas. Finally, some important aspects of the ecological implications of rainfall are also discussed.

019 *ERDC.* **Preliminary study of sunshine duration and wind speed in some sample districts of Nepal.** Kathmandu, Tribhuvan University, Institute of Science and Technology, ERDG, 1979.

020 *Flohn, H.* **Contributions on the meteorology of the Himalayas,** In: Studies on the climatology and phytogeography of the Himalayas, selections from Khumbu Himal, Nepal Research Centre, Kathmandu, 1988, 21-58 p.

Loc: ICIMOD

The study is mainly based upon the thermal circulation of the Himalayas, with Tibet as the heat source. Temperature distribution, heat budget, and precipitation regime of the Himalayas are studied.

021 *Ghimire, B.R.; Upadhyay, B.P.* **General climatology & pollution concentration in Kathmandu valley.** Presented: International Conference on Tropical Meteorology and Air Pollution, Delhi, India, (1988), 7p.

022 *Gill, G.J.* **But how does it compare with the real data?** In: Research report series Number 16, Kathmandu, HMG, Ministry of Agriculture/Winrock International, 1992, 20p.

Loc: ICIMOD

This paper analyses different temporal patterns of rainfall at Lumle (West Nepal) using bar diagrams.

023 *Glaciological Expedition of Nepal.* **Meterological Data in Shorong Himal, East Nepal.** Seppyo, Vol. 41, Special Issue, 1980, 111p.

Loc: ICIMOD, DOM

This paper presents the monthly rainfall and snowmelt amount and the mean and extreme air temperatures at Shorong Himal during the period from May to Sept. 1978.

024 *Higuchi, K.* **Effect of nocturnal precipitation on the mass balance of the Rikha Samba glacier, Hidden valley, Nepal.** Seppyo, Vol. 39, Special Issue. 1977, 43-49p.

Loc: ICIMOD, DOM

More than 75% of the annual precipitation in Nepal occurs during the monsoon season. About 60% of the total precipitation during the monsoon season occurs mainly at night and in the form of snow in the ablation area of the Rikha Samba glacier and in the day time it is in the form of rain. The author has focussed his study mainly on the mass balance of the Rikha Samba glacier, precipitation in the Hidden Valley, temperature condition for change of precipitation form, and the effect of nocturnal precipitation on the ablation area of Rikha Samba glacier.

025 *Higuchi, K.; Ageta, Y.; Yasunari, T.; Inoue, J.* **Characteristics of precipitation during the monsoon season in high mountain areas of the Nepal Himalaya.** In: Hydrological Aspects of Alpine and High Mountain Areas, IAHS Publ. No. 138, United Kingdom, Oxfordshire, Institute of Hydrology, July 1992, 21-30p.

026 *Hindman, E.E.* **Air motions in the Khumbu Himal and possible soaring flights.** Tech. Soaring, 18, 1994.

027 *Hindman, E.E.* **Ascending Mt. Everest through soaring flight.** Tech. Soaring, 10, 1990, 44-52p.

028 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1966,** Kathmandu, Department of Hydrology and Meteorology, 1968, 194p.

Loc: DHM, ICIMOD

In this publication air temperature and precipitation data for 1966 are tabulated.

029 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1967 and 1968,** Kathmandu, Department of Hydrology and Meteorology, 1971, 89p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, and precipitation data are tabulated for 1967 and 1968.

030 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1969.** Kathmandu, Department of Hydrology and Meteorology, 1972, 47p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, and precipitation data for 1969 are tabulated.

031 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1970.** Kathmandu, Department of Hydrology and Meteorology, 1973, 54p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, and precipitation data for 1970 are tabulated.

032 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, Vol. I, 1971-1975.** Kathmandu, Department of Hydrology and Meteorology, 1977, 366p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, and precipitation data for the period from 1971 to 1975 are tabulated.

033 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, Vol. II, (1921 - 1975), Special supplement, Kathmandu Valley.** Kathmandu, Department of Hydrology and Meteorology, 1977, 129p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, and the wind of Kathmandu for the period from 1921 to 1975 are tabulated.

034 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, Vol. III, (1967 - 1975), Special supplement, Kathmandu Valley.** Kathmandu, Department of Hydrology and Meteorology, 1977, 26p

Loc: DHM

In this publication air temperature, relative humidity, and the wind of Kathmandu for the period from 1967-1975 are tabulated.

035 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, Vol. I, 1976 - 1980.** Kathmandu, Department of Hydrology and Meteorology, 1982, 410p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, vapour pressure, and precipitation data for the period from 1976-1980 are tabulated.

036 *HMG, Department of Hydrology and Meteorology.* **Climatological records of**

Nepal, Vol. I, 1981 - 1982. Kathmandu, Department of Hydrology and Meteorology, 1984, 174p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, vapour pressure, and precipitation data for the period from 1981 to 1982 are tabulated.

037 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, Vol. I, 1983 - 1984.** Kathmandu, Department of Hydrology and Meteorology, 1986, 187p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, vapour pressure, and precipitation data for the period from 1983 to1984 are tabulated.

038 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1976-1984, supplemental data, Vol. II.** Kathmandu, Department of Hydrology and Meteorology, 1986, 51p.

Loc: DHM, ICIMOD

In this publication evaporation, sunshine, wind, and soil temperature data for the period from 1976 to 1984 are tabulated.

039 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1985 - 1986.** Kathmandu, Department of Hydrology and Meteorology, 1988, 232p.

Loc: DHM, ICIMOD

In this publication air temperature, relative humidity, vapour pressure, and precipitation data for the period from 1985 to 1986 are tabulated.

040 *HMG, Department of Hydrology and Meteorology.* **Climatological records of Nepal, 1987 - 1990.** Kathmandu, Department of Hydrology and Meteorology, 1992, 253p

Loc: DHM, ICIMOD

In this publication precipitation data for the period from 1987-1990 are tabulated.

041 *Horman, K.* **Computer-based climatological maps for high mountain areas.** MEM (Mountain Environmental Management) series no. 18, Kathmandu, ICIMOD, 1994, 33 p.

Loc: ICIMOD

In this paper, computer-based climatological maps of the Himalayas are presented. The author also discusses the techniques for the develoment of spatial climatic regression models and their application in the computation of climatological grid data sets and finally climatological maps.

042 *Howell, J.; Sunwar, I.; Kafle, I.* **The 1990 monsoon on the Koshi zone roads.** Roughton and Partners, Eastern Region Interim Project, Dharan, 1990, 59p.

Loc: ICIMOD

043 *Ikegami, K.; Higuchi, K.; Ono, A.* **Preliminary report on the vertical distribution of aerosol particles over the Nepal Himalaya.** Seppyo, Vol. 41, Special Issue, 1980, 86-89p.

Loc: ICIMOD, DOM

Aircraft observation of aerosol particles was undertaken over the Nepal Himalayas on October 22, 1978. Analysis of the samplings of aerosols taken at ground level (1320masl), 2000m, 3000m and 5000masl over Kathmandu, and 5600m and 7800masl over Langtang valley are presented. The collected particles are classified into four types and their characteristics are discussed.

044 *Ikegami, K.; Inoue, J.; Higuchi, K.; Ono, A.* **Atmospheric aerosol particles observed in high altitude Himalayas.**

Seppyo, Vol. 40, Special Issue, 1978, 50-55p.

Loc: ICIMOD, DOM

Studies of the atmospheric aerosol particles are important from the point of view of cloud physics, atmospheric optics, and air pollution. Aerosol observation was carried out at Lhajung (4420m), Shorong (4900m), and Muktinath (3700m). From the physical appearance and chemical tests of individual particles under an electronic microscope, it was concluded that the particles mostly contained sulfate during the monsoon season.

045 *Inoue, J.* **Climate of Khumbu Himal.** Seppyo, Vol. 38, Special Issue, 1976, 66-73p.

Loc: ICIMOD, DOM

Based upon the meteorological data from 1973 to 1974 at Lhajung (4420m), the author illustrates that, in Khumbu Himal, there exists marked rainy and dry seasons with 70 - 80% of the precipitation occurring in the monsoon season. The mean annual temperature of Lhajung is nearly 0^{o} C. The climate of Lhajung fits "the polar climate due to high altitude" under Koeppen's classification. Precipitation, radiation, temperature, humidity, and wind are also discussed separately.

046 *Inoue, J.* **An extraordinary gale at the end of winter in the Himalayas.** Seppyo, Vol. 38, Special Issue, 1976, 102-104p.

Loc: ICIMOD, DOM

A strong gale of 25m/s was observed on March 20, 1974, at Lhajung station. The author suggests that the gale, which continued for half a day, was probably due to the foehn wind from the Tibetan Plateau.

047 *Inoue, J.* **Gales over the Nepal Himalayas in 1976.** Seppyo, Vol. 40, Special Issue, 1978, 56-59p.

Loc: ICIMOD, DOM

Over a four-year observation period in the Nepal Himalayas, three extraordinary gales were recorded. A synoptic analysis of the gales is presented and discussed. The gale, which is northerly, is thought to have been caused by the foehn wind. It concludes that cyclogenesis over the Himalayas is a necessary condition for the occurrence of a gale.

048 *Inoue, J.; Hayashi, T.* **On the wind energy in the Himalayas.** Seppyo, Vol. 41, Special Issue, 1980, 100-103p.

Loc: ICIMOD, DOM

In this paper, the wind power in the mountains and valleys of the Nepal Himalayas is estimated through parametarisation of the wind speed distribution according to the Weibull distribution. The calculations were estimated for winter, summer, monsoon and pre-monsoon. The data at Lhajung station (4,420m) in Khumbu Himal, East Nepal, from April 1973 to Dec. 1974 were used.

049 *Joshi, D.P.* **Climate of Kathmandu: A bioclimatic analysis.** Cahiers Nepalais Documents (CNRS, Paris), 10, 33-46p.

050 *Joshi, D.P.* **The climate of Namche Bazar: A bioclimatic analysis.** Mountain Research and Development ,Vol. 2, No. 4, 1982, 399-403p.

Loc: ICIMOD

The climate of Namche Bazar is classified as a humid and tropical region based on the seasonal occurrence of rains, range in annual precipitation, number of rainy days in the year, and length of dry season in the months. Statistical analysis of a probable year is also made.

051 *Kraus, H.* **The climate of Nepal.** In: Studies on the climatology and phytogeography of the Himalaya, Selections from Khumbu Himal. Kathmandu, Nepal Research Centre, 1988, 59-96p.

Loc:ICIMOD

In this paper an attempt has been made to describe the climate of Nepal. The study is mainly based upon the general circulation of the atmosphere over India and Nepal as well as the data from meteorological observations made in

Nepal. Finally, climatic classification of some stations based upon Koeppen is presented.

052 *Lambert, L.; Chitrakar, B.* **Variation of potential evapotranspiration with elevation in Nepal.** Mountain Research and Development, Vol. 9, No. 2, 1989, 145-152p.

Loc: ICIMOD

The paper analyses potential evapotranspiration (PET) in Nepal by using a form of the Penman method. The PET values for each month regressed against elevation give quite consistent, good correlations.

053 *Maie, M.* **Meteorological data in the Numbur area.** Namuta M. (ed.), Ecological Study and Mountaineering of Mt. Numbur in Eastern Nepal, 1963. Japan, Chiba, Himalayan Expedition of Chiba University, 1965, 124-154p.

Loc: ICIMOD

This paper presents three-hourly data of the wind, cloud, temperature, relative humidity, and weather of the Numbur area during the expedition period.

054 *Malla, U.M.* **Climatic elements and seasons in Kathmandu valley.** The Himalayan Review, 21st International Geographical Congress, Special Issue. Kathmandu, Nepal Geographical Society, 1968, 53-77p.

Loc: NGS

This is one of the pioneering works on the climate of Nepal. In this paper a seasonal analysis of the climatic elements of Kathmandu valley is presented. The elements include temperature, pressure, wind, relative humidity, cloud, and rainfall. The rainfall data are for the period from 1949 to 1967. A table containing the seasonal mean of the data used in the analysis is also given.

055 *Mitsudera, M.; Numata, M.* **Meteorology of Eastern Nepal.** Journal of the College of Arts and Sciences, Natural Sciences Series, Vol. 5, No. 1. Japan, Chiba University, Natural, 1967, 75-83p.

Loc: ICIMOD

The authors have analysed wind direction, air temperature, and humidity distribution by using the data measured by the Chiba University Himalayan expedition to the Mt. Numbur area in the southern-most part of the Rolwaling Himal during April to June of 1963. However, the treatment of such data is very difficult because the observation network moved day to day. Various plates showing distribution of clouds during the expedition are also presented.

056 *Nakajima, C.* **Movement and development of the clouds over Khumbu Himal in winter.** Seppyo, Vol. 38, Special Issue, 1976, 89-92p.

Loc: ICIMOD, DOM

By taking photographs of the clouds at periodic intervals over Khumbu Himal, the thickness of the cloud is estimated. The alto-cumulus cloud formed during a clear afternoon is estimated to be about 100-200m thick. The thickness of the cloud formed during winter season, when the weather condition is changing from clear to cloudy, is estimated at 500-1000m.

057 *Nakajima, C.* **On climatic change in South Asia.** In: International Symposium on Recent Climatic Change and Food Production, 1976, 3-16p.

Loc: ICIMOD

In this paper, five-year moving averages of monthly rainfall at 30 stations in South Asia are presented. The standard deviations of monthly rainfall are also calculated. The variability of rainfall according to place and season are discussed from the synoptic point of view. Interaction between large and small-scale phenomena and the relationship between atmospheric circulation in the middle and low latitudes are also discussed.

058 *Nakajima, C.; Chalise, S.R.; Shrestha , M.L.* **On the fog in the Kathmandu valley.** Seppyo, Vol. 41, Special Issue, 1980, 90-99p.

Loc: ICIMOD, DOM

Fogs are virtually a daily phenomenon in Kathmandu valley during the winter season. The study of fog is important from the point of view of aviation (air, land, or sea), because visibility plays an important role. Most of the early morning flights in the valley are delayed due to fog. In this paper, photographs of fogs (December 1976) taken at certain intervals at two different locations in Kathmandu Valley are depicted. The mechanism of fog formation in the valley on the basis of meteorological data is analysed for January 1978. It suggests that fog can be forcasted by meteorological analysis.

059 *Nakajima, C.; Inoue, J.; Yasunari, T.* **On the climate of the Himalayas.** Annulas of DPRI, Japan, Kyoto University, No. 19A, 1-30p.

This paper summarises the history of studies on the climate of the Himalayas. The meteorological data from April 1973 to March 1975 were observed by the authors at Lhajung (4420m) in Khumbu Himal. These data are analysed and the influences of the Tibetan high and the subtropical jet streams are discussed. On the basis of climatic conditions, the growth of the glaciers is also discussed. The thickness of the valley wind over Khumbu Himal is estimated from photographs. Spectral analyses are made and discussed.

060 *Nakajima, C.; Shrestha, M.L.; Basnyat, M.B.* **Synoptic analyses of precipitation over Nepal and India.** Seppyo, Vol. 38, Special Issue, 1976, 50-58p.

Loc: ICIMOD, DOM

Synoptic analysis of the precipitation for the month of August and December 1974 is presented in this paper. It was observed that the types of precipitation during the summer season differed in the north of the Bay of Bengal Coast and the high mountain area. The authors suggest that this might be due to the possibility of the intrusion of the monsoon wind into the high mountain area affected by the behaviour of the westerly current in middle latitudes. The authors conclude that, to understand the precipitation in Nepal, the interaction of the middle and low lattitude atmospheric circulation and also the local behaviour of the mountain and valley winds in relation to the orographic conditions must be studied.

061 *Nayaju, R.P.* **Extreme rainfall analysis for Pokhara and Kathmandu.** In: Report of the seminar on information exchange in the field of disaster prevention/preparedness - HMG/DPTC/ UNDP, Kathmandu, 29 - 30 March, 1993, 24-30p.

Loc: DOM

In this paper ten years of annual extreme rainfall values for different seasons in Pokhara and thirteen years in Kathmandu are used to develop simple extreme rainfall models.

062 *Nayava, J.L.* **Areal rainfall in the Kathmandu valley.** Mausam, 32, 4, 1981, 343-348p.

Loc: DOM

The mesoscale variation of rainfall in the Kathmandu valley and surrounding regions has been computed for 1225 grid points. The effect of orography has been considered an important factor in areas like Kathmandu valley where sharp topographical variations occur within small distances.

063 *Nayava, J.L.* **Brief notes on climates of Nepal and their implications for agricultural development.** In: Proceedings of Eight Summer Crops Workshop, Nepal, Rampur, Jan. 25 - 29, 1981, 1-10p.

064 *Nayava, J.L.* **Climate of Nepal.** The Himalayan Review, Vol. 11, 1974, 15-20p.

065 *Nayava, J.L.* **Estimation of temperature over Nepal.** The Himalayan Review, Vol. 14, 1983, 13-24 p.

066 *Nayava, J.L.* **Heavy rainfall over Nepal.** Weather, Vol. 29, 1974, 443-450p.

Loc: DOM

This paper contains a study of heavy rainfall during 1968.

067 *Nayava, J.L.* **Rainfall in Nepal.** The Himalayan Review, Vol. 12, 1980, 1-18p.

Loc: NGS, ICIMOD

This paper briefly decribes the general features of the atmospheric circulation over Nepal for all four seasons. Thirty years of mean rainfall data have been used for few places in Nepal. However, 68 stations covering different regions over a minimum period of 20 years are used. Special emphasis is given to mean monsoonal rainfall. The paper concludes that, in general, the intensity of rainfall is much higher in lower elevations than in higher elevations.

068 *Nayava, J.L.* **The summer monsoon in Nepal and southern Asia.** M.Sc. dissertation, England, Birmingham University, 1974.

069 *Nayava, J.L.* **A topoclimatological investigation of solar radiation in the Kathmandu valley, Nepal.** The Australian Meteorological Magazine, Vol. 28, No. 2, 1980, 79-95p.

Loc: ICIMOD

In this paper, the mean monthly isopleths of clear and average day insolation for Kathmandu valley are plotted and discussed. A computer model was used to separate direct, diffuse, and circum solar diffuse components from the observations of the total global radiation at the Tribhuvan International Airport. Direct and diffuse components are combined with sunshine hour data to estimate average or mean monthly insolation on horizontal and sloping surfaces.

070 *Nayava, J.L.* **Topoclimatology of the Kathmandu valley.** In: Proceedings of the Tenth New Zealand Geography Conference and 49th ANZAAS Congress, Geographical Sciences, New Zealand, Auckland, Geog. Soc. Conf. Ser No. 10, 1979, 33-38p.

Loc: DOM

The monthly mean insolation, precipitation, and maximum and minimum temperatures were estimated for a grid net using 394 grid points to study the topoclimatology of the Kathmandu valley. The estimation procedures used regression methods and theoretical models.

071 *Neininger, B.; Reinhardt, M.; Kuettemer, J.* **Valley circulations as measured in the Himalayas by instrumented motor glider.** GARP Publication Series No. 27, WMO/TD No. 108, 501-508p.

072 *Ohata, T.; Higuchi, K.* **Valley wind revealed by wind-shaped trees at Kali Gandaki valley.** Seppyo, Vol. 40, Special Issue, 1978, 37-41p.

Loc: ICIMOD, DOM

Strong valley winds occur in the Kali Gandaki Valley. The trees are deformed by the valley wind. This paper studies the valley wind, based upon wind-shaped trees. The most strongly deformed trees were found between Larjung and Jomsom. The deformations were weak along the tributaries of the Kali Gandaki.

073 *Ohata, T.; Higuchi, K.; Ikegami, K.* **Mountain-valley wind system in the Khumbu Himal, East Nepal.** Journal of Meteorological Society of Japan 59, 1981, 753-762p.

074 *Rajopadhaya, D.K.; Acharya, L.M.* **Wet spell and persistance of rainy days in Kathmandu valley.** In: Proceedings of the National Conference on Science and Technology, Kathmandu , Royal Nepal Academy of Science and Technology (April 24-29, 1988), Kathmandu, RONAST, 1989, 521-525p.

Loc: RONAST, ICIMOD

Newton's Raphson method is used to find the rainfall pattern by using logarithmic series. It was found that the difference between the calculated and observed frequencies of wet spell are not significant in July and October.

075 *Reiter, E.R.; Heuberger, H.* **A Synoptic example of the retreat of the Indian summer monsoon.** Geografiska Annaler, Nr. 1, 1960, 17-35p.

Loc: ICIMOD

The paper is divided into two parts. The first part basically describes the general weather condition, high level winds, temperatures, humidity, and precipitations encountered by the Australin Cho-Oyu expedition in 1954. The Cho-Oyu lies approximately 30km northwest of Mount Everest, close to the Nangpa pass which leads from Nepal into Tibet. The second part of the paper describes the previous works undertaken by other scientists on the role of Jet stream on the monsoon. The paper concludes that the travelling disturbances, which move with the Jet stream, carry along their own patterns of vertical motions and thus account for winter precipitation.

076 *Seko, K.* **Seasonal variation of altitudinal dependance of precipitation in Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 5, 1987, 41-47p.

Loc: ICIMOD, DOM

In this paper the precipitation in Langtang valley is analysed focussing mainly on the orographic effects on the altitudinal distribution of precipitation. It was observed that there existed remarkable seasonal difference in the altitudinal dependance of precipitation. The article mainly focusses on the seasonal variation of precipitation, precipitation caused by local circulation, and precipitation associated with synoptic scale disturbances.

077 *Seko, K.; Takahashi, S.* **Characteristics of winter precipitation and its effects on glaciers in Nepal Himalaya.** Bulletin of Glacier Research 9, 1991, 9-16p.

Loc: ICIMOD, DOM

Mass balance associated with winter time precipitation in the Nepal Himalayas is studied in this paper. The authors found that glacier fluctution follows the fluctuation of air temperature rather than precipitation.

078 *Shrestha, D.L.* **On the scale of impacts of unprecedented havoc due to heavy downpour in Nepal during July 1993.** Presented: Int'l UNESCO Symposium on Water Resources Planning in a Changing World, Karlshruhe, Germany, June 1994,9p.

Loc: ICIMOD

Even though the worst natural disasters are caused by heavy monsoonal rainfall, study in this field has been ignored by planners. In July 1993, Nepal witnessed heavy rainfall. Most of the districts in the hilly and *terai* regions in Central and Eastern Nepal were hit by devastating floods and landslides. A death toll of human lives of over 2,000 and heavy loss of property and resources was reported. The capital city, Kathmandu, was ruptured from its supplies due to severe damage of the main highways and the sweeping away of major bridges. In this paper, an attempt has been made to identify the implication of such events, which are not uncommon in this region. The July event is described fully with some synoptic description and its major impacts on the Kulekhani Hydel Station and the Bagamati Irrigation project.

079 *Shrestha, K.D.* **Minimum temperature forcasting at the Kathmandu airport.** M.Sc. Dissertation, Kathmandu, Tribhuvan University, February 1991, 102p

080 *Shrestha, M.L.; Fujii, Y.; Nakawo, M.* **Climate of hidden valley, Mukut Himal, during the monsoon in 1974.** Seppyo, Vol. 38, Special Issue, 1976, 105-108p.

Loc: ICIMOD, DOM

To understand the climate of a region, it is necessary to study the different meteorological variables such as pressure, temperature, evaporation, etc. In this connection, in 1974, a temporary station was set up in Mukut Himal at an elevation of 5055m. The results obtained from the observatory regarding diurnal pressure variation, daily mean maximum and minimum temperatures, daily precipitation, and daily evaporation are presented in this paper. The authors suggest that the monsoon season in the

hidden valley is from the middle of July to August.

081 *Shrestha, M.L.; Murakami, T.* **Intraseasonal fluctuations in low-level meridional winds over the Indian ocean and monsoonal convection over South Asia.** Tellus, 40 A, 1988, 120-132p.

Loc: DOM

A conceptual precipitation runoff model was originally developed for the Scandinavian catchment. Necessary changes were made and applied to the 38% glacierised basin of the Langtang Khola. The model requires daily values of air temperature and precipitation. Among other parameters of the water balance, the model allows the simulation of snow storage and glacier mass balance at various elevations as well as of the daily discharge. The paper discusses the method and data. Finally, the results obtained from the model pretaining to snow cover, glacier mass balance, water balance of the basin, changes in snow and ice storage, etc are presented and discussed.

082 *Smadja, J.* **Studies of climatic and human impacts and their relationship on a mountain slope above Salme in the Himalayan middle mountains, Nepal.** Mountain Research and Development 12 (1), 1992, 1-28p.

Loc: ICIMOD

This paper shows, with evidence from the Salme slope, the relationship between human pressure, monsoon rains, and erosion in the Middle Mountains of Central Nepal. Observations on selected climatic parameters for a period of five years are also given.

083 *Sthapit, K.M.; Bhattarai, R.* **Agro-climatic classification system for Nepal.** Kathmandu, Department of Soil Conservation and Watershed Management, Watershed Management Project, 1988, 7-24p.

084 *Subrahmanyam, V.P.; Upadhyay, B.P.* **A Study of rainfall patterns in Nepal.** In: Proceedings of Hydrological Investigations during the last 25 years in India, Waltair, Andhra University, May 1982, 43-50 p.

Loc: CDOM

Nepal being a mountainuous country, the distribution of rainfall is not linear. In this paper an attempt has been made to study the annual and seasonal rainfall patterns assuming the four seasons to be those specified by the Nepal Meteorological Services. Since rainfall varies from season to season as well as from region to region, a detailed statistical study on rainfall characteristics, such as variability, intensity and number of rainy days, and their maps, are presented and discussed.

085 *Takahashi, S.; Motoyama, H.; Kawashima, K.; Morinaga, Y.; Seko, K.; Lida, H.; Kubota, H.; Tuladhar, N.R.* **Meteorological features in Langtang valley, Nepal Himalayas, 1985 - 1986.** Bulletin of Glacier Research 5, 1987 35-40p.

Loc: ICIMOD, DOM

Based upon meteorological data from July 1985 to July 1986 at Kyangchen (3920m), the meteorological conditions, such as precipitation, temperature, humidity, wind, radiation, etc, are discussed. Finally, the climate of this district is outlined.

086 *Takahashi, S.; Motoyama, H.; Kawashima, K.; Morinaga, Y.; Seko, K.; Lida, H.; Kubota, H.; Tuladhar, N.R.* **Summary of meteorological data at Kyangchen in Langtang valley, Nepal Himalayas, 1985 - 1986.** Bulletin of Glacier Research 5, 1987, 121-128p.

Loc: ICIMOD, DOM

Meteorological observations of the Langtang valley were made from July 1985 to July 1986. The instruments used, the data types, and measurements are summarised in this paper.

087 *Thapa, K.B.; Acharya, L.M.* **Study of drought over Nepal.** Kathmandu, Tribhuvan University, Rector's Office, Research Division, 1993.

088 *Thompson, A.H.; Devkota, L.P.* **Weather behavior during the Manasulu-Ganesh expedition.** In: Martson, R.A. (ed.) Environment and Society in the Manasulu-Ganesh Region of the Central Nepal Himalayas. A final report of the 1987 Manasalu Ganesh expedition, University of Idaho, Foundation for Glacier and Environmental Research, 1989, 7-23p

Loc: DOM, ICIMOD

During the fall of 1987, an expedition was conducted jointly by the University of Idaho and the Foundation for Glacier and Enviromental Research to Manaslu and Ganesh Himal of Nepal. During the expedition period, meteorological studies were carried out and a final report on the same is presented in this paper. The report describes the observations, together with the conditions and limitations in taking them. The general trends of meteorological events during the expedition period are also provided. Finally, the severe storm that occurred from 17-19 October, 1987, is discussed.

089 *Thyer, N.* **Looking at Western Nepal's climates.** Bulletin of American Meterological Society, Vol. 66, No. 6, June 1985.

Loc: ICIMOD

This article discusses the working environment, the present state of climatology, some recent findings, and the prospects for future development in the study of climate in western Nepal.

090 *Troll, C.* **The climatic and phytogeographical division of the Himalayan system.** In: Studies on the climatology and phytogeography of the Himalaya, selections from Khumbu Himal, Kathmandu, Nepal Research Centre, 1988, 97 - 151 p.

Loc: ICIMOD

In order to study the geographical and climatic position of the Himalayas, the three dimensional landscape divisions are presented. The paper also deals with topoclimatic as well as edaphic-micro climatic differentiations in vegetation.

091 *Ueno, K.; Shiraiwa, T.; Yamada, T.* **Precipitation environment in the Langtang valley, Nepal Himalayas.** In: Young, G.J. (ed.) Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium, (Nov. 1992), IAHS pub. No. 218, UK, Oxfordshire, Institute of Hydrology, 1993, 207-219p.

Loc: DHM, ICIMOD

The characterstics of precipitation distribution, particularly with their temporal and spatial variations are investigated through intensive observations around Langtang valley in the monsoon season. The effects of cyclonic activities on winter precipitation in Kathmandu are also examined.

092 *Ueno, K.; Yamada, T.* **Diurnal variation of precipitation in Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 8, 1990, 93-101p.

Loc: ICIMOD

In this paper, the characteristics of diurnal variation of precipitation in the Langtang valley are investigated using 10-minute precipitation data during the late monsoon season up to the post-monsoon season in 1987. Three types of precipitation are classified and their distributions are discussed. Finally, the lapse rate of surface air temperature along the mountain slope is also discussed.

093 *Ueno, K.; Yamada, T.* **Diurnal variation of precipitation in Langtang valley, Nepal Himalayas.** In: Glacial studies in Langtang valley: Report of the Glaciological Expedition of Nepal Himalayas, 1987-88, Japan, Sapporo, Glaciological Expedition of Nepal Project, 1989, 47-58p.

Loc: ICIMOD

In this paper, the characteristics of spatial as well as temporal diurnal variation of precipitation in the Langtang valley are investigated using 10-minute precipitation data from the late-monsoon to the post-monsoon season of 1987. The lapse rate of temperature along the mountain slope is also investigated.

094 *Upadhyay, B.P.* **Distribution of solar radiation in Nepal.** Presented at the Regional Training Seminar on the Presentation and Use of Meteorological Data for Solar and Wind Energy, WMO, Kathmandu, 1991, 7p.

095 *Upadhyay, B.P.; Ghimire, B.R.* **Application of meteorological parameters using gamma probability model for crop scheduling and management in Nepal.** Presented at the Second Science Congress, Kathmandu, Royal Nepal Academy of Science and Technology, June 1994, 7p.

096 *Weickmann, L.* **Large-scale analysis of meteorological phenomena for the period of the "First Himalayan Soaring Expedition".** Tech. Soaring, 12, 1988, 44-51p.

097 *Yasunari, T.* **Air-borne measurement of the surface temperature over Nepal Himalayas.** Seppyo, Vol. 41, Special Issue, 1980, 82-85p.

Loc: ICIMOD, DOM

In the post-monsoon period of 1976, a geological expedition team measured the air temperature over Shorong, Khumbu, and Langtang Himal by air craft using infrared (IR) radio meter. The results are reported in this paper.

098 *Yasunari, T.* **Heavy snowfalls in Nepal Himalayas in December, 1977.** In: Proceedings of the Symposium of the Japan Society of Snow and Ice in 1981, 99 p.

099 *Yasunari, T.* **Seasonal weather variations in Khumbu Himal.** Seppyo, Vol. 38, Special Issue, 1976, 74-83p.

Loc: ICIMOD, DOM

In this paper the author has used two-year data (Apr. 1973 to Mar. 1975) at a station called Lhajung which is 4420m above sea level. The data used while studying the seasonal weather trends of Khumbu Himal relate to daily precipitation, cloud, temperature, humidity, and 500 mb weather chart. The author suggests that the seasonal weather variation in high altitude Himalayas is mainly affected by the Tibetan high in the monsoon season and the subtropical jet stream in other seasons. It is also suggested that the moisture supply to this region in the monsoon season is from the Indian Ocean.

100 *Yasunari, T.* **Spectral analysis of monsoonal precipitation in the Nepal Himalayas.** Seppyo, Vol. 38, Special Issue, 1976, 59-65p.

Loc: ICIMOD, DOM

A spectral analysis of precipitation data of the Nepal Himalayas is made in this paper. By carrying out power spectral analysis, the author found out that there exists a predominant perodicity of around 10 days and a secondary periodicity of about 5 days. The 10-day periodicity is related to the oscillation of the Tibetan high.

101 *Yasunari, T.; Inoue, J.* **Characteristics of monsoonal precipitation around peaks and ridges in Shorong and Khumbu Himal.** Seppyo, Vol. 40, Special Issue, 1978, 26-32p.

Loc: ICIMOD, DOM

The primary precipitation data during the summer monsoon of 1976 around peaks and ridges of high altitudes in Shorong and Khumbu Himal are observed. These data are compared with the precipitation at Lhajung. The statistical features of precipitation as a function of time is studied along with distribution of precipitation along the slope of different glaciers .

102 *Yasunari, T.; Nakajima, C.* **Air-borne measurements of the temperature field over the Nepal Himalayas: A preliminary observation.** Seppyo, Vol, 40, Special Issue, 1978, 33-36p.

Loc: ICIMOD, DOM

The authors have measured air temperature over the Shorong-Khumbu region and from Langtang Himal to the Indian plains using thermister and

psychrometer set up on a Pilatus Turbo Porter aircraft. The observation made revealed that the air temperature over the Himalayas is affected by high altitude orography and surface conditions.

103 *Braun, L.N.; Grabs, W.; Rana, B.* **Application of a conceptual precipitation runoff model in the Langtang Khola basin, Nepal Himalayas.** In: Young, G.J. (ed.) Snow and Glacier Hydrology: Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, 1993, 221-237p.

Loc: DHM, DOM, ICIMOD

A conceptual precipitation runoff model was originally developed for the Scandinavian catchment. Necessary changes were made and applied to the 38% glacierised basin of the Langtang Khola. The model requires daily values of air temperature and precipitation. Among other parameters of the water balance, the model allows the simulation of snow storage and glacier mass balance at various elevations as well as of the daily discharge. The paper discusses the method and data. Finally, the results obtained from the model such as snow cover, glacier mass balance, water balance of the basin, changes in snow and ice storage, etc are presented and discussed.

104 *Chalise, S.R.; Adhikary, S.P.; Shankar, K.* **Research in meteorology and hydrology, Tribhuvan University.** Journal, Vol x, No. 1, Special Issue, Kathmandu, Tribhuvan University, Research Division, July 1978.

Loc: ICIMOD

In this paper the historical background, the present situation, and the development of meteorology and hydrology in Nepal is analysed. Strategies for research and development of meteorology and hydrology in Nepal are also discussed.

105 *Dhital, M.R.; Khanal, N.; Thapa, K.B.* **The role of extreme weather events, mass movements, and land use changes in increasing natural hazards: A report of the preliminary field assessment and workshop on causes of the recent damages incurred in South-Central Nepal (July 19-20, 1993).** Kathmandu, International Centre for Integrated Mountain Development, 1993, 123p.

Loc: ICIMOD

This is a field report which contains the description of the natural event of July 19-20, 1993, in south-central Nepal. The report also contains the final overall assessment of the field work as well as the workshop discussions.

106 *Dongol, R. M.* **A study of water balance of the Koshi river basin.** M.Sc. Dissertation, Kathmandu, Tribhuvan University, Jan 1993, 85p.

Loc: CDOM

In this dissertation, the water balance of the Koshi river basin is presented and discussed. The Koshi river basin covers land mass within both Nepal and Tibet. In this study only those areas lying in Nepal are considered.

107 *Fukushima, Y.; Watanabe, O.; Higuchi, K.* **Estimation of streamflow change by global warming in a glacier-covered high mountain area of the Nepal Himalayas.** In: Proceedings of the Vienna Symposium (Aug. 1991), IAHS Publ. No. 205, United Kingdom, Oxfordshire, Institute of Hydrology, 1991, 181-188p.

108 *Rajbhandari, R.M.* **Some aspects of hydrometeorological study over Karnali river basin.** M.Sc. Dissertation, India, Waltair, Andhra University, 1981, 42p.

Loc: DOM

In this dissertation, a study of the precipitation in the Karnali river basin of west Nepal is presented. Seasonal and annual precipitation distribution maps are presented and discussed in detail. Along with the precipitation maps, preciptation variability maps are also presented and discussed. Finally, the relationship between precipitation and runoff of the basin is also discussed. The relationship between runoff and precipitation is determined through regression analysis.

109 *Rajbhandari, R.M.* **To prepare a climatic map of the Bagmati zone based upon Thornthwaite's method using GIS technology.** In: Project paper on GIS Training for Professionals, Kathmandu,

International Centre for Integrated Mountain Development, 1992, 8p.

Loc: ICIMOD, DOM

This is a paper presented at the end of the training as project work. In this paper the author has tried to classify the climate of the Bagmati Zone using the GIS technique. Due to boundary problems, the study focusses mainly on the Nuwakot District. Almost all meteorological stations located in the Bagmati Zone are considered. The classification is based upon the book-keeping procedure developed by W.C. Thornthwaite.

110 *Sharma, K.P.* **Hydrological and meteorological services to mitigate natural disaster.** In: Report on Information Exchange in the Field of Disaster Prevention/Preparedness - Kathmandu, HMG/DPTC/UNDP, March 1993, 80-84p.

111 *Subrahmanyam, V.P.; Upadhyay, B.P.* **Water balance and agricultural operation in Nepal.** Presented at the National Seminar on integrated farming in India, India, Kolhapur, Shivaji University, Dept. of Geography, 1982, 8p.

112 *Subrahmanyam, V.P.; Upadhyay, B.P.* **Water balance and climatic types of Nepal.** In: Proceedings of "Hydrological Investigations during the last 25 years in India", India, Waltair, Andhra University, Association of Hydrologists of India, May 1982, 163-170p

Loc: DOM

Thornthwaite's method of climatic classification is used in this paper to study the climate types of Nepal. Potential evapotranspiration, actual evapotranspiration, water surplus, and water deficiency maps as obtained from the water budget table are presented and discussed. Finally, the climatic classification map of Nepal, based on moisture regime and thermal regime, is also presented and discussed.

113 *Subrahmanyam, V.P.; Upadhyay, B.P.* **Water balance and water potential of the Koshi River basin in Nepal.** In: Proceedings of the National Seminar on Assessment, Development and Management of Ground Water Resources, New Delhi, Central Ground Water Board, Ministry of Irrigation, Govt. of India, April 1983, 113-153p.

Loc: CDOM

This paper describes the hydrometeorological features and the water potential of the Koshi river basin using the water balance procedure. The hydrometeorological elements, namely, actual evapotranspiration, water deficiency, and water surplus of the basin for a normal year are climatically computed employing Thornthwaite's book-keeping procedure. Based on the water-budget computations, the climate types of the stations in the river basin are presented and their implications considered from the point of view of water resource development.

114 *Subrahmanyam, V.P.; Upadhyay, B.P.; Rajbhandari, R.M.* **Hydrometeorology and water balance of the Karnali river basin in Nepal.** In: Proceedings of the Seminar on "Hydrology", India, Andhra Pradesh, Osmania University, June 1983, 73-80p.

Loc: CDOM

Thornthwaite's well-known, water balance (1948) procedure is used to study the water potential of the Karnali river basin. Precipitation data belonging to twenty-four stations are used to analyse the rainfall pattern both on an annual basis and for different seasons. Regression formula between potential evapotranspiration and height are derived for each individual month from the available number of temperature stations. Using these formula, potential evapotranspiration values are calculated for all other stations having known elevations. Seasonal as well as annual potential evapotranspiration maps are presented. The derived elements of water balance, namely, actual evapotranspiration, water surplus, and water deficiency are presented. The monthly water balance of the river throughout the year is graphically presented and discussed. Lastly, the climate types of the Karnali river basin, based on moisture regime according to the 1955 scheme of Thornthwaite, are presented.

115 *Upadhyay, B.P.* **Water balance of Nepal with reference to water resources and agricultural development.** Ph.D. thesis, India, Waltair, Andhra University, 1984, 320p.

116 *Upadhyay, B.P.; Subrahmanyam, V.P.* **Estimation of water yields on the Himalayan rivers of Nepal by water balance procedure.** Presented: National Symposium on Water Balance and National Development, India, Waltair, Andhra University, Dept. of Meteorology and Oceanography, 1983, 7p.

Hydrology

117 *Alford, D.* **Hydrological aspects of the Himalayan region.** ICIMOD Occasional Paper No. 18, Kathmandu, International Centre for Integrated Mountain Development, 1992, 68p.

Loc: ICIMOD

This paper deals with the impact of human use of the natural environment on the hydrological regime of watersheds in the Himalayas. Analysis of existing data of the Koshi watershed of eastern Nepal, as an illustration of the interaction that has an impact on the water budget of a mountainous watershed, is also carried out.

118 *Bastola, S.N.* **Water resources development of the mighty Himalayan rivers (Indus, Ganga-Yamuna, Brahmaputra rivers).** Kathmandu, Bastola, S., 1994, 335p.

Loc. ICIMOD

A historical perspective of water resources is presented in this book. A detailed scenario of water resource development in Nepal and its sources are also presented.

119 *Binnie and Partners.* **Master plan for the water supply and sewerage of greater Kathmandu and Bhaktapur.** Kathmandu, WHO, UNDP (Special Fund Project), Nepal 0025, Vol. IIB, 1973.

120 *Bruijnzeel, L.A. ; Bremmer, C.N.* **Highland-Lowland interactions in the Ganges Brahmaputra river basin: A review of published literature,** ICIMOD Occasional Paper No. 11, Kathmandu, International Centre for Integrated Mountain Development, 1989, 136p.

Loc. ICIMOD

This is a review of published literature. The paper covers the river systems, geology and geomorphology, climate and vegetation, and land use of the study area. The paper also focusses on the role of forests and land use in the upland in relation to flooding, dry season flow, and sedimentation in the lowland .

121 *Caine, N.; Mool, P.K.* **Channel geometry and flow estimates for two small mountain streams in the middle hills, Nepal.** Mountain Research and Development, Vol. 1, 1981, 23-243p.

Loc: ICIMOD, WECS

The study is conducted in the middle hills of Kathmandu - Kakani area. By measuring channel conditions at 43 stations on Thulo Khola and Ghatte Khola, the peak discharge for the 1979 monsoon (a season of approximately normal precipitation) is estimated. It is also concluded that the variations in the channels and the flows they carry in this tropical, high-relief area conform to the patterns established by other studies.

122 *Chalise, S.R.* **Regional co-operation in hydrological research and training in the Hindu Kush-Himalayas.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium, (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 37-47p.

Loc: DHM, CDOM, ICIMOD

The paper considers research needs in the Hindu Kush-Himalayan region and stresses the need for regional cooperation in hydrological research. Particular emphasis is placed on the development of a regional programme on Mountain Hydrology under the auspices of UNESCO and ICIMOD.

123 *Chyurlia, J.P.* **Water resources report, LRMP,** Ottawa, Kenting Earth Sciences Limited, LRMP, 1984, 271p.

Loc: ICIMOD

124 *Day, J.B.W.* **A Preliminary assessment of ground water resources of the Terai east of the Duney hills, Nawal Parasi district, Nepal.** London, Institute of Geol. Sciences. Department of Hydrology, 1974, 9p.

125 *Fukushima, Y.; Kawashima, K.; Suzuki, M.; Ohata, T.; Motoyama, H.; Kubota, H.;*

Bajracharya, O.R. **The Hydrological data of Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 5, 1987, 115-120p.

Loc: ICIMOD

Observations of the discharge from glacier-covered watersheds were carried out for a year starting in July 1985 at three sites in Langtang valley. The observation sites, the method, and the instruments used are discussed in this paper.

126 *Fushimi, H.; Ikegami, K.; Higuchi, K.; Shankar, K.* **Nepal case studies: Catastrophic floods.** Techniques for predictions of runoff from area, IAHS Publ. No. 149, United Kingdom, Oxfordshire, Institute of Hydrology, 1985, 125-130p.

127 *Galay, V.* **Erosion and sedimentation in the Nepal Himalaya - An assessment of river processes.** Kathmandu, Water and Energy Commission Secretariat, 1987, 214p.

Loc: ICIMOD

128 *Gole, C.V.; Chitale, S.V.* **Inland delta building of the Kosi river.** Journal of Hydraulics Division, Proceedings of the American Society of Civil Engineers, 92 (HY2), 1966, 111-126p.

129 *Gyawali, D.* **Water in Nepal: An interdisciplinary look at resource uncertainties, evolving problems, and future prospects.** East-West Environment and Policy Institute Occasional paper 8, Honolulu, East-West Centre, East-West Environment and Policy Institute, 1989, 146p.

Loc. ICIMOD

This monograph surveys the water situation in Nepal in terms of its supply and use. The monograph also points out the difficulties that arise when making decisions related to water resources.

130 *Higuchi, K.; Ageta, Y.; Kodama, H.* **Water discharge of Imja Khola in Khumbu Himal.** Seppyo, Vol. 38, Special Issue, 1976, 22-26p.

Loc: ICIMOD, DOM

Water discharge in perennial rivers is believed to contain large contributions of melt-water from the glaciers in the Himalayas. Studies of such river basins are important for a general assessment and rational use of water resources. The annual discharge of this drainage showed a tendency to increase in summer and decrease in winter. It was also found that the mean daily air temperature had a good correlation with the variation of daily discharge in summer but not in winter.

131 *HMG, Department of Hydrology and Meteorology.* **Methodologies for estimating hydrologic characteristics of ungauged locations in Nepal,** Vol 1 & II, Seq. No 4/4/250990/1/1, Kathmandu, DHM/WECS, Sept 1990.

132 *HMG, Department of Hydrology and Meteorology.* **Report of the regional workshop on hydrology of mountainous areas,** Kathmandu, HMG/ICIMOD/ UNESCO, (11-14, Dec. 1989), 1989, 17p.

Loc: ICIMOD

133 *HMG, Department of Hydrology and Meteorology.* **Compilation of surface records of Nepal through December 31, 1965.** Kathmandu, Department of Hydrology and Meteorology, 1967, 66p.

Loc: DHM, ICIMOD

This publication contains monthly and yearly discharge data for various rivers of Nepal.

134 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 1, 1966, Kathmandu, Department of Hydrology and Meteorology, 1967, 66p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1966.

135 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 2, 1967, Kathmandu, Department of Hydrology and Meteorology, 1968, 71p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1967.

136 *HMG, Department of Hydrology and Meteorology* **Surface water records.** Supplement No. 3, 1968, Kathmandu, Department of Hydrology and Meteorology, 1969, 63p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1968.

137 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 4, 1969, Kathmandu, Department of Hydrology and Meteorology, 1972, 59p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1969.

138 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 5, 1970, Kathmandu, Department of Hydrology and Meteorology, 1972, 51p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1970.

139 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 6, 1971, Kathmandu, Department of Hydrology and Meteorology, 1973, 61p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1971.

140 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 7, 1972, Kathmandu, Department of Hydrology and Meteorology, 1974, 59p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1972.

141 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 8, 1973, Kathmandu, Department of Hydrology and Meteorology, 1979, 66p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1973.

142 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 9, 1974, Kathmandu, Department of Hydrology and Meteorology, 1980. 51p

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1974.

143 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 10, 1975, Kathmandu, Department of Hydrology and Meteorology, 1983, 57p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1975.

144 *HMG, Department of Hydrology and Meteorology.* **Surface water records.** Supplement No. 11, 1976, Kathmandu, Department of Hydrology and Meteorology, 1984, 54p.

Loc: DHM, ICIMOD

This publication contains the mean monthly discharge and the maximum and minimum daily discharge data for the year 1976.

145 *HMG, Department of Irrigation.* **Ground water resources investigation in Lumbini Zone, Western Terai, Nepal.** Kathmandu, Dept. of Irigation and Kathmandu, U.S. Aid, 1976.

146 *HMG, Department of Tourism.* **Lakes of Nepal,** Kathmandu, Department of Tourism, 1973, 25p.

147 *ICIMOD.* **Report of the 1st consultative meeting of the regional working group on mountain hydrology.** In: Mountain Hydrology in the Hindu Kush-Himalayan Region, Kathmandu, UNESCO/IHP/ICIMOD, 24-26 Oct. 1990, 15p.

Loc: ICIMOD

This report presents the highlights of the regional workshop on hydrology of mountainous areas held in Kathmandu during December 1989. Various recommendations from the workshop are also presented.

148 *ICIMOD.* **Report of the 2nd consultative meeting of the regional working group on mountain hydrology.** In: Mountain Hydrology in the Hindu Kush-Himalayan Region, Kathmandu, UNESCO/HMG/ICIMOD, 16-18 Mar. 1992, 23p.

Loc: ICIMOD

This report presents the highlights of the second consultative meeting of the regional working group on mountain hydrology. Various recommendations of the regional working group are also given.

149 *Karmacharya, J.L.* **Hydrological studies of Nepal.** Kathmandu, Water and Energy Commission Secretariat, N. Report 4/2/150382/1/1, Seq. No. 103, 1982

150 *Kattelmann, R.* **Conflicts and co-operation over floods in the Himalaya - Ganges region.** Water International, Vol.15, No. 4, 1990, 189-194p.

Loc: ICIMOD

In this paper the author has discussed the degraded watershed conditions in the Himalayan foothills and resulting flood damage in the plains caused by the tributaries of the Ganges. Measures to control such floods in the plains are suggested.

151 *Kattelmann, R.* **Exporting Himalayan flood** In: International and transboundary water resources issues, Maryland, American Water Resources Association, 1990, 101-110p.

The author has raised the controversy about land use practices over high mountain areas and the resulting floods in the low lying plains. He highlights the importance of regional cooperation in exchanging hydrological data to better understand the hydrologic system of the Himalayan headwaters of the tributaries of the Ganges and the Brahmaputra.

152 *Kattelmann, R.* **Hydrologic regime of the Sapta Koshi basin, Nepal.** IAHS Volume on Large River Basin, IAHS-TUGG, Aug. 1991.

The conversion of forests into agricultural land and pastures in the Middle Hills of Nepal has been blamed for the increase in flood damage

downstream in India. In this paper, the author has examined the physical basis of the controversy. The author found out that the annual runoff has increased in the Sapta Koshi and so has the precipitation in the basin. There is no obvious trend in the rank of annual floods over the past two decades.

153 *Kattelmann, R.* **Hydrology and development of the Arun river, Nepal.** Lang, H.; Musy, A. (ed.), Hydrology in Mountainous Regions, IAHS Publ. No. 193, United Kingdom, Oxfordshire, Institute of Hydrology, 1990, 777-784p.

Loc: ICIMOD

The Arun river drains large areas in Tibet and Nepal. It is characterised by steep gradient and relatively high dry-season flow and little information is available on the hydrology of the Arun basin. In this paper, the author illustrates the unique features of Himalayan hydrology that must be considered when assessing the potential for water resource development in this region.

154 *Kattelmann, R.* **Mountain hazards and hydro-electric development in the Nepal Himalaya: Water for development.** In: Proceedings of the sixth IWRA world congress on water resources, Vol. I, 1988.

155 *Kattelmann, R.* **Uncertainty in assessing Himalayan water resources.** Mountain Research and Development, Vol. 7, No. 2, 1987, 279-286p.

Loc: ICIMOD

The importance of a variety of hydrological data for water resources' development is highlighted. A combined programme of data and report compilation, application of existing hydrologic techniques, and new research initiatives is suggested to reduce the uncertainty associated with hydrologic estimates in the Himalayas.

156 *Motoyama, H.; Yamada, T.* **Hydrological observations in Langtang valley, Nepal Himalayas, during 1987 monsoon - post monsoon season.** In: Glacial Studies in Langtang Valley - Report of the Glaciological Expedition of Nepal 1987-88, Japan, Sapporo, Glaciological Expedition of Nepal Project, 1989, 5-11p.

Loc: ICIMOD

Air temperature, precipitation, streamflow, and electric conductivity of stream water from glaciers were observed at two sites of Langtang valley of the Nepal Himalayas from August to October 1987. The fluctuations in glacier surface level and melting rate were also observed on the Yala glacier. In this paper various analyses of the collected data are undertaken to study the specific electric conductivity, equilibrium line, and the melting factor.

157 *Motoyama, H.; Yamada, T.* **Hydrological observations in Langtang valley, Nepal Himalayas, during 1987 post-monsoon season.** Bulletin of Glacier Research 7, 1989, 195-201p.

Loc: ICIMOD

Air temperature, precipitation, streamflow and electric conductivity of stream water from glaciers were observed at two sites of Langtang valley of the Nepal Himalayas from August to October 1987. The fluctuations of glacier surface level and melting rate were also observed on the Yala glacier. In this paper various analyses of the collected data are undertaken to study the specific electric conductivity, equilibrium line, and the melting factor.

158 *Nakawo, M.; Fujii, Y.; Shrestha, M.L.* **Water discharge of Rikha Samba Khola in the hidden valley, Mukut Himal.** Seppyo, Vol. 38, Special Issue, 1976, 27-30p.

Loc: ICIMOD, DOM

The study is based upon observations made of the water level of Rikha Samba Khola from July 16 to September 7, 1974. From this data, the river discharge is estimated from the stage discharge curve. The paper also deals with the suspended material present in the river from the river water sample taken during the observation period.

159 *Nepal Electricty Department.* **Gandaki river basin power study, basin study, hydrology and sedimentation.** Kathmandu, Nepal Electricity Department, Main Report, Vol. I, July 1974.

160 *Pradhan, P.P.* **River training works under the department of irrigation.** Report of the seminar on information exchange in the field of disaster prevention/ preparedness, Kathmandu, HMG/DPTC/ UNDP, 29 - 30 March, 1993, 160-162p.

161 *Shah, P.P.* **Water resources of Nepal.** Kathmandu, HMG, Dept. of Information, 1976, 78 p.

162 *Shankar, K.* **Hydrological network and hydrometric problems in Nepal.** Paper submitted to the regional workshop on hydrology of mountainous areas (unpublished), Kathmandu, HMG/UNESCO/ ICIMOD, December 1989, 17p.

Loc: ICIMOD

163 *Shankar, K.* **Mountain hydrology in reference to the Hindu Kush-Himalayan region.** Working paper prepared for the regional working group meeting on mountain hydrology, Kathmandu, UNESCO/ IHP/ICIMOD, 24-26 Oct. 1990, 29p.

This paper discusses the features and problems of the Hindu Kush-Himalayan region associated with mountain watershed hydrology.

164 *Shankar, K.* **Status and role of mountain hydrology in the Hindu Kush-Himalayan region.** In: MEM discussion paper No. 10, Kathmandu, ICIMOD, 1991, 34p.

Loc: ICIMOD

In this paper the hydrological processes of the Hindu Kush-Himalayas are discussed. According to the author, insufficient information for proper assessment of water resources, typical hydrological disasters, and degradation of the environment are some of the basic problems.

165 *Shankar, K.* **Water resources development with references to surface water hydrology in Nepal.** Kathmandu, HMG, Department of Hydrology and Meteorology, 1976, 15p.

166 *Sharma, C.K.* **A Glimpse of the ground water resources of Nepal.** Kathmandu, Dept. of Irrigation, Ground Water Project, 1970, 10p.

167 *Sharma, C.K.* **Ground water resources of Nepal.** Kathmandu, Mrs. Sangeeta Sharma, 1974, 162p.

Loc: ICIMOD

In this book the author has tried to analyse the utility and limitation of different possible sources of irrigation in Nepal. The book is especially useful for planners and engineers who are seeking to know the realities of the irrigation-related problems of Nepal.

168 *Sharma, C.K.* **The problem of sediment load in the development of water resources.** Mountain Research and Development, Vol. 7, No. 3, 1987, 316-318p.

Loc: ICIMOD

In this paper, the problems of heavy sediment loads and decreasing rates of flow are presented. The paper also deals with natural factors such as topography, geology, rainfall, glacial lake outbursts, and seismic events as well as human factors including deforestation and the construction of roads and canals which affect sedimentation. Techniques of controlling river flow are also suggested.

169 *Sharma, C.K.* **River Systems of Nepal.** Kathmandu, Mrs. Sangeeta Sharma, 1977, 214p.

Loc: ICIMOD

In this book, the author has tried to give some ideas about the river systems of Nepal. The book deals mainly with origin, development, and characteristics of the river systems of Nepal. The book also highlights the water resources and economic development of Nepal.

170 *Sharma, C.K.* **Water and energy resources of the Himalayan block (Nepal, Bhutan, Bangladesh, Pakistan and India).** Kathmandu, Mrs. Sangeeta Sharma, 1983, 477p.

Loc: ICIMOD

171 *Spreafico, M.; Grabs, W.E.* **Determination of discharge with fluorescence tracers in the Nepal Himalayas.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993. 17-27p.

Loc: DHM, CDOM, ICIMOD

The determination of discharge from snow and glacier-fed rivers in the Nepal Himalayas is of prime importance for the estimation of snow and glacier-melt runoff needed for improved water-resources' management. Because the conventional current meter method is not suitable to measure discharge in many steep rivers in Nepal, an operational tracer measurement system, consisting of field and laboratory equipment, has been adapted to Nepalese conditions. An application-oriented training and education programme has been designed and implemented. The method used can be fully integrated into the operational hydrological surveys in developing countries.

172 *Suzuki, M.; Fukushima, Y.; Kawashima, K.; Ohata, T.; Motoyama, H.; Kubota, H.* **Stream water temperature observations in Langtang Khola, Nepal Himalayas.** Bulletin of Glacier Research 5, 1987, 25-28p.

Loc: ICIMOD

Stream water temperature was measured in Langtang Khola in order to describe the hydrological conditions in high altitude watersheds having glaciers. The authors found that the water temperature of the Langtang Khola has a gentle seasonal variation attributed to the large contribution of the water from glaciers throughout the year.

173 *Swarzenski, W.V.; Babcock, H.M.* **Ground water resources investigation program for the Western Terai, Nepal.** Kathmandu, Dept. of Irrigation, 1968, 57p.

174 *Upadhyay, S.P.; Sapkota, B.N.* **Water resources development in Nepal.** In: Ali, M.; Radosevich, G.E.; Khan, A.A. (ed.), Water resources policy for Asia. Rotterdam, A.A. Balkema, 1987, 91-104p.

Loc. ICIMOD

The paper highlights the development policy of water resources of the government of Nepal. The paper also points out the problems experienced in the use of water resources.

175 *Wager, L.R.* **The Arun river drainage pattern and the rise of the Himalaya.** Geographical Journal 89 (3), 239-250p.

176 *Zollinger, F.* **The Sapta Koshi: Unsolved problems of flood control in the Nepalese Terai.** Kathmandu, Deptartment of Soil Conservation and Watershed Management, 1979, 94p.

Loc: ICIMOD

177 *Adhikary, S.* **Estimation of snowmelt runoff during premonsoon months in Langtang Khola watershed.** M.Sc. Dissertation, Kathmandu, Tribhuvan University, 1994, 69p.

Loc: CDOM

In this thesis, the degree day method and the melt due to rainfall are utilised to estimate the snowmelt runoff in the Langtang watershed.

178 *Damen, M.* **Study on potential outburst flooding of Tsao Rolpa glacier lake, Rolwaling valley, East Nepal.** ITC Draft Report, 1992, 58p.

179 *Fukushima, Y.; Kawashima, K.; Suzuki, M.; Ohata, T.; Motoyama, H.; Kubota, H.; Yamada, T.; Bajracharya, O.R.* **Runoff characteristics in three glacier-covered watersheds of Langtang valley, Nepal Himalaya.** Bulletin of Glacier Research 5, 1987, 11-18p.

Loc: ICIMOD

Based upon the hydrological observations carried out in Langtang valley from July 1985 to June 1986, discharge analyses are carried out for three rivers in Langtang valley, namely, Langtang Khola, Liring Khola, and Khyimjung. In this paper the temporal variation of discharge is presented. The authors attribute this to rapid snowmelt and icemelt concluding that the variation in discharge from glacier-covered watersheds depends mainly on the variation of air temperature rather than the distribution of precipitation.

180 *Grabs, W.E.; Pokhrel, A.P.* **Establishment of measuring services for snow and glacier hydrology in Nepal - Conceptual and operational aspects.** In: Young G.J. (ed.) Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 3-16p.

Loc: DHM, CDOM, ICIMOD

The paper focusses on the conceptual design and implementation of the Snow and Glacier Hydrology Project of the Department of Hydrology and Meteorology, Nepal. Since 1987, six hydrometeorological stations have been established in altitudes ranging from 2,400 to 4,300m above sea level. The climatic differences of the Nepal Himalayas as recorded from the stations so far are briefly outlined in their regional context.

181 *HMG, Department of Hydrology and Meteorolgoy.* **Snow and glacier hydrology yearbook for 1987/1989.** Kathmandu, HMG, Department of Hydrology and Meteorology, Snow and Glacier Hydrology Unit, 1990, 74p.

182 *HMG, Department of Hydrology and Meteorology.* **Snow and glacier hydrology yearbook.** Supplement I & II, Kathmandu, HMG, Department of Hydrology and Meteorology, Snow and Glacier Hydrology Unit, 1991

183 *HMG, Department of Hydrology and Meteorology.* **Snow and glacier hydrology yearbook 1987-1992.** Kathmandu, HMG, Department of Hydrology and Meteorology, Snow and Glacier Hydrology Unit, 1993. 167p

184 *HMG, Water and Energy Commission Secretariat.* **Dudh Koshi river 1985 GLOF study survey report.** Report No 1/3/840587/1/1, Seq. No. 257, Kathmandu, HMG, Water and Energy Commission Secretariat, 1987

185 *HMG, Water and Energy Commission Secretariat.* **Preliminary study of glacier lake outburst floods in the Nepal Himalayas.** Phase I Interim Report, Kathmandu, HMG, Water and Energy Commission Secretariat, 1987, 250p.

Loc: ICIMOD

186 *Ives, J.D.* **Glacial lake outburst floods and risk engineering in the Himalaya.** ICIMOD Occasional Paper No. 5, Kathmandu, International Centre for Integrated Mountain Development, 1986, 42p.

Loc: ICIMOD

The paper reviews the Langmoche disaster in Khumbu Himal, which occurred on 4 August, 1985, destroying a small hydel project in the Everest region. It also emphasises the need for practical field research to understand these spectacular natural events in the Hindu Kush-Himalayas.

187 *Kattelmann, R.* **Role of snowmelt in generating stream flow during spring in East Nepal.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 103-112p.

Loc: DHM, CDOM, ICIMOD

Snowmelt runoff has been assumed to provide relief from the low flows of winter for one to two months before rainfall-runoff provides high flows in summer. This paper examines changes in recorded streamflow during the period from March through June in seven tributaries of the Koshi. It is inferred that streamflow increased by about 10 to 15 % from March to April and by 45 to 65% from April to May in most of the rivers studied.

188 *Meon, G.; Schwarz, W.* **Estimation of glacier lake outburst flood and its impact on a hydro project in Nepal.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 331-339p.

Loc: DHM, CDOM, ICIMOD

Glacier lake dams consisting of unconsolidated material are prone to failure and may cause disastrous surges of water heavily charged with debris. Consideration of potential glacier lake outburst floods is therefore essential. In this paper, as an example, a study of such a flood is carried out for the Arun river from the point of view of a hydropower project.

189 *Mool, P.K.* **Glacier lake outburst floods and some examples of Nepal.** In: Report of the Seminar on Information Exchange in the Field of Disaster Prevention/Preperedness - Kathmandu, HMG/DPTC/UNDP, 29 - 30 March 1993, 31-53p.

190 *Motoyama, H.; Ohata, T.; Yamada, T.* **Winter runoff in the glacialized drainage basin in Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 5, 1987, 29-23p.

Loc: ICIMOD

Hydrological and meteorological observations were carried out in the glacial watershed of Langtang valley from July 1985 to July 1986. In this paper the authors focus their attention on the low flow of water that occurs in winter without inflow of rain water and melt water from snow and glacier surfaces.

191 *Murakami, S.; Ozawa, H.; Yamada, T.* **Permeability coefficient of water in snow and firn at the accumulation area of Yala glacier, Nepal Himalaya.** In: Glacial studies in Langtang valley, report of the Glaciological Expedition of Nepal Himalayas 1987-88 Japan, Sapporo, Glaciological Expedition of Nepal Project, 1989, 13-18p.

Loc: ICIMOD

The permeability of water in snow and firn was measured *in situ* by means of the ordinary falling head method using fresh cone samples obtained at the accumulation area in Yala glacier, Nepal Himalayas, in the post-monsoon season of 1987. In this paper the value of the permeability coefficient is discussed in relation to the grain size of the sample.

192 *Sharma, K.P.* **Role of meltwater in major river systems of Nepal.** In: Young, G.J. (ed.), Snow & Glacier Hydrology,

Proceedings of the Kahtmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 113-122p.

Loc: DHM, CDOM, ICIMOD

Karnali, Narayani, and Koshi are the three major river systems in Nepal. More than 50% of the drainage area lies above 3000m above sea level. Analyses of these river systems are made during the low flow period. It was observed that the lowest flow period is during February and March. The snowfed rivers showed distinct rise in the pre-monsoon period with the contribution exceeding 30% in May.

193 *Thapa, K.B.* **Estimation of snowmelt runoff in Himalayan catchments incorporating remote sensing data.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium, Nov. 1992, IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 69-74p.

Loc: DHM, CDOM, ICIMOD

This paper presents the results of hydrological investigations based on photo interpretation of the Himalayan catchments in and around Nepal along with the functional relationships of pre-monsoonal snowmelt-runoff with temperature and snow-covered area. Available landsat images, temperature and streamflow data have been analysed from 1975 to 1989. The study demonstrates the operational value of satellite data for predicting spring runoff of remote Himalayan catchments.

194 *Vuichard, D.; Zimmermann, M.* **The 1985 catastrophic drainage of a moraindammed lake, Khumbu Himal, Nepal: Causes and consequences.** Mountain Research and Development , Vol. 7, No. 2, 1987, 91-110p.

Loc: ICIMOD

The paper focusses on hazard assessment of the moraine-dammed glacial lake burst in the Khumbu area of eastern Nepal on 4 August, 1985. The paper also emphasises the need for monitoring such events.

195 *Vuichard, D.; Zimmermann, M.* **The Langmoche flash-flood, Khumbu Himal, Nepal.** Mountain Research and Development, Vol 6, No. 1, 1986, 90-93p.

Loc: ICIMOD

This paper is a preliminary report of a reconnaissance study of the Khumbu Himal area flash-flood on 4 August, 1985, which was contributed by the United Nations University, Mountain Hazards Mapping Project. An attempt is made to estimate the damage to land, property, and vegetation. Geomorphological damage due to flash-floods is also discussed in brief.

196 *Wushiki, H.* **Deuterium content of stream waters of glacier origin in the Himalayas.** Seppyo, Vol. 39, Special Issue, 1977, 40-42p.

Loc: ICIMOD, DOM

In this paper, measurement of the deuterium contents of samples taken from August 1974 to July 1975 in the Imja Khola has been provided. The monthly deuterium content of this river has been presented along with the deuterium content in six other rivers in Sunkoshi. It has been concluded that each river has a characteristic deuterium content and this varies drastically from river to river.

197 *Yamada, T.* **Preliminary report on glacier lake outburst flood in the Nepal Himalayas.** Report No. 4/1/291191/1/1, Seq. No. 387, Kathmandu, HMG, Water and Energy Commission Secretariat, 1991, 30p and Photographs.

198 *Yamada, T.* **Report for the first research expedition to Imja glacier lake.** Report No. 3/4/120892/1/1, Seq. No. 412, Kathmandu, HMG, Water and Energy Commission Secretriat, 1992, 14p.

199 *Yamada, T.; Motoyama, H.* **Contribution of glacier melt-water to runoff in glacialized watersheds in the**

Langtang valley, Nepal Himalayas. Bulletin of Glacier Research 6, 1988, 65-74p.

Loc: ICIMOD

The study is based upon hydrological and meteorological data observed over a year at Langtang Khola and Lirung Khola in the watershed of Langtang valley area. To estimate the contribution of snowmelt water to runoff a simple method is used. Precipitation, temperature, and distribution of watersheds from the topographical map of Langtang Himal are used as input for the study.

200 *Yamada, T.; Motoyama, H.; Thapa, K.B.* **Role of glacier melt-water in discharge from the glacial watersheds of Langtang valley.** Data Centre for Glacial Research, 1984, 61-71p.

201 *Yamada, T.; Sharma, C.K.* **Glacier lakes and outburst floods in the Nepal Himalaya.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov.1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 319-330p.

Loc: DHM, CDOM, ICIMOD

Severe floods caused by glacier outbursts have been frequent in the Nepal Himalayas. Potentially dangerous glaciers were identified from flight observations which were undertaken during the pre-monsoon season and the post-monsoon season of 1991. Hazard records of glacier lake outburst floods are presented. Dangerous glacier lakes in the Nepal Himalayas as observed from the aircraft are also discussed. Finally, the potential of the Imja glacier lake, a typical example of the most dangerous glacier lakes, is assessed.

Glaciology

202 *Ageta, Y.* **Characterstics of mass balance of the summer-accumulation type glacier in the Nepal Himalayas. (Japanese language)** Seppyo, Vol. 45, 1982, 81-90p.

Loc: ICIMOD, DOM

203 *Ageta, Y.; Higuchi, K.* **Estimation of mass balance components of a summer-accumulation type glacier in the Nepal Himalayas.** Geografika Annaler, 66A, 1984, 249-255p.

204 *Ageta, Y.; Kadota, T.* **Predictions of changes of glacier mass balance in the Nepal Himalaya and Tibetan plateau.** Annals of Glaciology,16, 1992, 89-94p.

205 *Ageta, Y.; Ohata, T.; Tanaka, Y.; Ikegami, K.; Higuchi, K.* **Mass balance of glacier AX010 in Shorong Himal during the summer monsoon season, east Nepal.** Seppyo, Vol. 41, Special Issue, 1980, 34-41p.

Loc: ICIMOD, DOM

The study is based upon the observation of mass balance of glacier AX010 at the southern front of the Nepal Himalayas from June to September of 1978. The paper discusses the method of observation, meteorological conditions during the observation period, and the relationship between precipitation and surface temperature. Finally the mass balance of the glacier during the summer season is presented and discussed.

206 *Ageta, Y.; Satow, K.* **Study of the mass balance of small glaciers in Khumbu Himal during the summer monsoon season.** Seppyo, Vol. 40, Special Issue, 1978, 4-11p.

Loc: ICIMOD, DOM

With the aid of glaciological observations, glacier mass balance in the Nepal Himalayas is studied. There was a considerable amount of deposit of snow due to the summer snowfall. The mass balance from July to September is calculated by considering the ice amount to be superimposed on the glacier ice of sub-zero temperature. It is concluded that the mass balance for the whole area is positive and this is attributed mainly to the accumulation in late summer.

207 *Bahadur, J.* **The Himalayas: A third polar region.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 181-190p.

Loc: DHM, CDOM, ICIMOD

The 1963 American Scientific Expedition to Everest suggested that the Himalayas are effectively a third pole. In this article, some salient aspects of the Himalayas and polar environments are dealt with and similarities between the Himalayas and the Arctic and the Antarctic are investigated.

208 *Budhathoki, K.P.* **Determination of snow cover from landsat imagery.** Kathmandu, HMG, National Remote Sensing Centre, 1983, 186-191p.

Loc. DHM

In this paper, a method of determining the change in snow cover from 1972 to 1975 and from 1975 to 1977 is presented. The Tamor watershed is taken as a case study.

209 *Dhar, O.N.; Kulkarni, A.K.; Mandal, B.N.* **Snow survey experiments in the upper Tamur basin, East Nepal.** In: Joshi, S.C.; Haigh, M.J.; Pangtey, Y.P.S.; Dani, D.D. (ed.), Nepal Himalaya Geo-ecological Perspectives, Nainital, Himalayan Research Group, 1986, 422-431p.

Loc. ICIMOD

This paper deals with the snow survey experiments in the upper Tamur basin (eastern Nepal). Data of the snow survey observation from 1947 to 1949 are also given.

210 *Fujii, Y.* **Field experiment on glacier ablation under a layer of debris cover.**

Seppyo, Vol. 39, Special Issue, 1977, 20-21p.

Loc: ICIMOD, DOM

In order to examine the role of supraglacial debris during ablation, a field experiment was carried out on a snowpatch beside the Rikha Samba glacier. The paper provides some results from this field experiment

211 *Fujii, Y.; Higuchi, K.* **Statistical analyses of the forms of the glaciers in the Khumbu Region.** Seppyo, Vol. 39, Special Issue, 1977, 7-14p.

Loc: ICIMOD, DOM

In this paper, statistical analyses are carried out on the relationship between the glacier forms and their relation to basin morphology. The paper mainly deals with the preliminary statistics of the glacier inventory, correlation coefficients between the dimensions of glaciers and their basins, and multiple regression analysis of glacier forms.

212 *Fujii, Y.; Nakawo, M.; Shrestha, M.L.* **Mass balance studies of the glaciers in hidden valley, Mukut Himal.** Seppyo, Vol. 38, Special Issue, 1976, 17-21p.

Loc: ICIMOD, DOM

As a part of the Glaciological Expedition in the summer of 1974, measurements of glacier accumulation and ablation were carried out using the stake method. Mass balance study of the Rikha Samba glacier and glacier G3 in the hidden valley showed that the summer balance over the whole area of the Rikha Shamba glacier is slightly positive. The winter snow layer observed as a dirt layer in a pit is so thin that the summer balance approximates the net balance. The total amount of precipitation over the area above the firn line in the glacier basin is very close to the summer balance over the accumulation area.

213 *Fushimi, H.* **Stratigraphic studies of the Gyajo glacier, Khumbu Himal.** Seppyo, Vol. 40, Special Issue, 1978, 17-20p.

Loc: ICIMOD, DOM

Stratigraphic studies were carried out on the Gyajo glacier in Khumbu Himal, east Nepal, from June to December 1970. The formation of superimposed ice was observed and the stratigraphic studies showed the monthly change in snow deposit. Remarkable additions occurred at the end of the summer season with simultaneous formation of superimposed ice.

214 *Fushimi, H.* **Structural studies of glaciers in the Khumbu Himal.** Seppyo, Vol. 39, Special Issue, 1977, 30-39p.

Loc: ICIMOD, DOM

Glaciers in the Nepal Himalayas are different from other regions of the world. They are composed of immense quantities of rock debris, sand, and clays, and the flow is controlled by unique geological structures which have a great influence on the topography and climate of the Nepal Himalayas. In this paper, the authors have classified the glacier in the Khumbu region according to structural characterstics.

215 *Fushimi, H.; Ohata, T.* **Fluctutations of glaciers from 1970 to 1978 in the Khumbu Himal, east Nepal.** Seppyo, Vol. 41, Special Issue, 1980. 71-81p.

Loc: ICIMOD, DOM

In this paper, the fluctutation rate of 15 glaciers in the Dudh Koshi region, east Nepal, is determined from 1970 to 1980. The glaciers are classified into retreating, stationary, advancing, and irregular categories. The classifications is mainly related to the slope of the glaciers.

216 *Fushimi, H.; Ohata, T.; Higuchi, K.* **Recent fluctuations of glaciers in the eastern part of the Nepal Himalayas.** In: Proceedings of the Canberra Symposium (Dec. 1979), IAHS Publ. No. 131, United Kingdom, Oxfordshire, Institute of Hydrology, 21-29p.

217 *Fushimi, H.; Yoshida, M.; Watanabe, O.* **Distributions and grain sizes of supraglacial debris in the Khumbu glacier, Khumbu region.** Seppyo, Vol. 41, Special Issue, 1980, 18-27p.

Loc: ICIMOD, DOM

The Khumbu glacier, east Nepal, is a typical debris-covered glacier on the south side of the great Himalayas. Results obtained from the occurrences, distributions, and grain size measurements of the supraglacial debris are presented and discussed in this paper.

218 *Glaciological Expedition of Nepal.* **Glaciological data of the Khumbu glacier in 1978 (with 5 seperate sheets).** Seppyo, Vol. 41, Sepcial Issue, 1980, 107-110p.

Loc: ICIMOD, DOM

The glaciological data include: maps of topography and surface conditions of the ablation area; map of the ablation area; topographic maps of the detailed research area of flow observations; data of ablation measurments; and large boulder distribution in the research area.

219 *Glaciological Expedition of Nepal.* **Outline of glaciological expedition of Nepal : Langtang Himal project, 1987 - 88.** In: Glacial studies in Langtang Valley: A report of the Glaciological Expedition of the Nepal Himalayas, 1987-88, Japan, Sapporo, Glaciological Expedition of Nepal Project, 1989, 1-3p.

Loc: ICIMOD

An outline of the glaciological expedition of the Nepal Himalayas by Japanese scientists is presented in this paper.

220 *Higuchi, K.* **Glacial studies in Langtang valley.** Data Centre for Glacial Research, 1984, Publ No. 2, 136p.

221 *Higuchi, K.* **Nepal-Japan cooperation in research on glaciers and climates of the Nepal Himalayas.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 29-36p.

Loc: DHM, CDOM, ICIMOD

Glaciological expeditions in Nepal (GEN) have been undertaken by Japanese scientists since 1973 with cooperation from HMG of Nepal. In this paper, the expeditions are divided into three phases and each phase is discussed.

222 *Higuchi, K.* **Outline of the glaciological expedition to Nepal (1).** Seppyo, Vol. 38, Special Issue, 1976, 1-5p.

Loc: ICIMOD, DOM

An outline of the glaciological expedition of Nepal during 1973 and 1974 is given in this paper.

223 *Higuchi, K.* **Outline of the glaciological expedition to Nepal (2).** Seppyo, Vol. 39, Special Issue, 1977, 1-2p.

Loc: ICIMOD, DOM

An outline of the glaciological expedition of Nepal during 1975 is given in this paper.

224 *Higuchi, K.* **Outline of the glaciological expedition to Nepal, (3).** Seppyo, Vol. 40, Special Issue, 1978, 1-3p.

Loc: ICIMOD, DOM

An outline of the glaciological expedition of Nepal during 1976 is given in this paper.

225 *Higuchi, K.* **Outline of the glaciological expedition to Nepal, (4).** Seppyo, Vol. 41, Special Issue, 1980, 1-4p.

Loc: ICIMOD, DOM

An outline of the glaciological expedition of Nepal during 1978 is given in this paper.

226 *Higuchi, K.* **Snow crystals observed at Lhajung station in Khumbu region.** Seppyo, Vol. 38, Special Issue, 1976, 93-101p.

Loc: ICIMOD, DOM

The shape and size of snow crystals that fell during January 1-2, 1975, are discussed in this paper.

227 *Higuchi, K; Ageta, Y.; Inoue, J.* **Snow crystals observations at Mt. Yalung Kang, Kangchenjunga region, east Nepal.** Seppyo, Vol. 40, Special Issue, 1978, 45-49p.

Loc: ICIMOD, DOM

In this paper, a study of the shape and size of snow crystals on April 23 and May 17, 1973, is presented. The snow crystals were observed by making plastic replicas at 6470m altitude on Mt. Yalung Kang. The temporal variation of the shape and size of the snow crystals is analysed in this paper and the altitudes of the tops of the precipitating clouds and their thickness are also estimated.

228 *Higuchi, K.; Fujii, Y.; Nakawo, M.; Shrestha, M.L.* **Observation of snow particles at hidden valley, Mukut Himal.** Seppyo, Vol. 40, Special Issue, 1978, 42-44p.

Loc: ICIMOD, DOM

Snow particles observed during the monsoon season in the Base Camp (5,055m) and Camp III (5,610m) are presented. The observed snow particles were of single snow crystals, snow flakes, and graupels. Finally, the altitudes of the tops of the precipitating clouds are estimated on the basis of observations of steller crystals.

229 *Higuchi, K.; Fushimi, H.; Ohata, T.; Iwata, S.; Iowaza, T.; Yokoyama, K.; Higuchi, H.; Nagoshi, A.* **Preliminary report on the glacier inventory in the Dudh Koshi region.** Seppyo, Vol. 40, Special Issue, 1978, 78-79p.

Loc: ICIMOD, DOM

This paper discusses the glacier inventory compiled for 664 glaciers in all parts of the Dudh Koshi region of eastern Nepal on the basis of field observations and aerial photographs. Numbering and mapping of all glaciers are also discussed.

230 *Higuchi, K.; Fushimi, H.; Ohata, T.; Takenaka, S.; Iwata, S.; Yokoyama, K.; Higuchi, H.; Nagoshi, A.; Iowaza, T.* **Glacier inventory in the Dudh Koshi region, east Nepal.** In: World Glacier Inventory, Proceedings of the Alet Schgentrum workshop (September 1978), IAHS Publ. No. 126, United Kingdom, Oxfordshire, Institute of Hydrology, 1980, 95-103p.

231 *Higuchi, K.; Iowaza, T.; Higuchi, H.* **Flight observations for the inventory of glaciers in the Nepal Himalayas.** Seppyo, Vol. 38, Special Issue, 1976, 6-9p.

Loc: ICIMOD, DOM

Air flights for photographing glaciers in the Nepal Himalayas were undertaken eight times during the period from 1972 to 1975. The oblique aerial photographs of the glaciers in the Khumbu region taken during these flights are yet to be compared with the glacier inventory undertaken by Muller (1970).

232 *HMG, Department of Tourism.* **The Himalayas of Nepal.** Kathmandu, Department of Tourism, 1974, 20p.

233 *Ikegami, K.; Ageta, Y.* **Ice flow of glacier AX010 in the Nepal Himalayas.** Bulletin of Glacier Research 9, 1991, 17-22p.

Loc: ICIMOD

In this paper observation results of horizontal flow and emergence-submergence flow from May 1978 to September 1979 in east Nepal are described. Finally, the ice thickness is calculated from the ice flow data.

234 *Ikegami, K.; Inoue, J.* **Mass balance studies on Kongma glacier, Khumbu Himal.** Seppyo, Vol. 40, Special Issue, 1978, 12-16p.

Loc: ICIMOD, DOM

Mass balance of the Kongma glacier and Khumbu Himal (a small debris-free type glacier) is presented on the basis of observation from September 1973 to September 1976. The observation showed positive balance during the summer monsoon season due to monsoonal snowfall. In winter, the change is small and during pre-monsoon season negative balance

occurs. A photographic interpretation of the thickness of the Kogma glacier is presented.

235 *Inoue, J.* **Mass budget of Khumbu glacier.** Seppyo, Vol. 39, Special Issue, 1977, 15-19p.

Loc: ICIMOD, DOM

The author estimates the mass budget of the Khumbu glacier on the basis of ablation observed at the lower part of the glacier. The accumulation is calculated assuming that there is uniform precipitation on the glacier surface.

236 *Inoue, J.; Nagoshi, A.* **A stratigraphic study of the snow cover in Khumbu Himal.** Seppyo, Vol. 39, Special Issue, 1977, 26-29p.

Loc: ICIMOD, DOM

Snow pit studies of two glaciers are conducted, namely, Dzonglha glacier and Kongma glacier in the Nepal Himalayas for different seasons. The paper mainly deals with snow stratifiction for the monsoon and post-monsoon seasons.

237 *Inoue, J.; Yoshida, M.* **Ablation and heat exchanges over the Khumbu glacier.** Seppyo, Vol. 41, Special Issue, 1980, 26-33p.

Loc: ICIMOD, DOM

In this paper, the role of supraglacial debris on the ablation area based upon the observational data of ablation and heat exchange is presented. The glacier is classified into four areas based on the characteristics of supraglacial debris. Different methods suitable for each area are employed while measuring the ablation. The relationship between ablation and solar radiation is also examined for two areas.

238 *Iwata, S.; Watanabe, O.; Fushimi, H.* **Surface morphology in the ablation area of the Khumbu glacier.** Seppyo, Vol. 41, Special Issue, 1980, 9-17p.

Loc: ICIMOD, DOM

The surface morphology of the ablation area of the Khumbu glacier in east Nepal is surveyed and the details are mapped. The complex surface morphologies, large debris covered cones, large hollows, and irregular uneven surfaces are identified on the map. The irregular uneven surfaces are subdivided into eleven morphological units. The surface morphology is seen to change both in transverse and in longitudinal directions.

239 *Kadota, T.; Ageta, Y.* **On the relation between climate and retreat of glacier AX010 in the Nepal Himalayas from 1978 to 1989.** Bulletin Glacier Research 10, 1992, 1-10p.

Loc: ICIMOD, DOM

From 1978 to 1989, the terminus of glacier AX010 in Shorong region retreated about 30 m. This retreat is equivalent to 12 m thinning of ice thickness around the glacier terminus. This thinning is evaluated by using simple models of glacier mass balance and ice flow. The average climatic condition around the glacier is also estimated.

240 *Kadota, T.: Seko, K.; Ageta, Y.* **Shrinkage of glacier AX010 since 1978, Shorong Himal, east Nepal.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 145-154p.

Loc: CDOM, DHM, ICIMOD

The glacier AX010 retreated by 30m during 1978 to 1989 and 28m from 1989 to 1991, resulting in a volume loss of about 3 million cubic metres. Using an empirical mass balance model and flow model, the relationship between retreat and climatic conditions during the period from 1978 to 1989 is discussed. The authors also claim that, in the Nepal Himalayas, no other study relating to change of glacier volume has been done so far and the results presented will form the basic data for further study on the relationship between climate and glaciers in the Himalayas.

241 *Kamiyama, K.; Kitoaka, K.; Watanabe, O.* **Characterstics of Yala glacier from the**

viewpoint of Tritium content. Journal of Geography Res. 91 (D 11), 1986, 11841-11844p.

242 *Kappenberger, G.; Steinegger, U.; Braun, L.N.; Kostka, R.* **Recent changes in glacier tongues in the Langtang Khola basin, Nepal, determined by terrestrial photogrammetry.** In: Young, G.J. (ed.), Snow and Glacier Hydrology: Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Pub. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 95-101p.

Loc: DHM, CDOM, ICIMOD

An analysis of aerial and terrestrial photographs by means of digital image processing allows inferences to be made about glacier fluctuations, even in areas where no accurate geodetic surveys are available over longer time periods. An approximate determination of the displacement of five glacier tongues in the Langtang Khola basin has been made for the period between 1980 and 1991. The results show that fluctuations occurred only on south-facing glaciers.

243 *Kayastha, R.B.* **Sensitivity of glacier mass balance to meteorological conditions in the Himalayas.** M.Sc. Thesis, Japan, Nagoya, Nagoya University, 1994, 90p.

Loc: CDOM,

In this thesis, a model is developed to study the mass balance of glaciers in the Himalayas, with emphasis on the sensitivity to input parameters and climatic variables. The model is based on the energy balance at the surface taking into consideration the areal distribution of the meteorological elements and the topographic effect. The model is tested against observation results on glacier AX010 in the Nepal Himalayas for the summer of 1978. Sensitivity tests of the mass balance to the meteorological elements are also carried out.

244 *Kodama, H.; Mae, S.* **The Flow of glaciers in the Khumbu region.** Seppyo, Vol. 38, Special Issue, 1976, 31-36p.

Loc: ICIMOD, DOM

In this paper, the results of the measurements of surface velocity of the glacier in the Khumbu region during different seasons are discussed. The surface of the Kongma glacier is found to have moved upwards and this strange motion of the ice is also discussed.

245 *Kohshima, S.* **Formation of dirt layers and surface dust by micro-plant growth in Yala glacier, Nepal Himalayas.** Bulletin of Glacier Research 5, 1987, 63-68p.

Loc: ICIMOD

This paper discusses the process of dirt layer formation in the Yala glacier from biological observations and analysis of surface dust and dirt layer dust particles in glacial strata.

246 *Kohshima, S.; Seko, K.; Yoshimura, Y.* **Biotic acceleration of glacier melting in Yala glacier, Langtang region, Nepal Himalayas.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, United Kingdom, Oxfordshire, Institute of Hydrology, 1993, 309-316p.

Loc: DHM, CDOM, ICIMOD

The microbial production on the glacier surface is so large during the monsoon season that the surface of the ablation area is covered with a dark coloured mud-like material which mainly consists of algae and bacteria. This material reduces the surface albedo of the glacier and accelerates glacier melting. In this paper, the impact of this process on heat balance of the glacier is assessed. The study area is the Yala glacier in Langtang valley during the monsoon season of 1991.

247 *Lanzhou Institute of Glaciology and Geocryology, Chinese Academy of Sciences, Water and Energy Commission Secretariat, and Nepal Electricity Authority.* **Report on first expedition to glaciers and glacier lakes in the Pumqu (Arun) and Poiqu (Bhote-Sunkosi) river basins, Xizang (Tibet), China, Sino-Nepalese investigation**

of glacier lake outburst floods in the Himalayas. Chaohai, L.; Sharma, C.K.; Mayor-mora, R..; Xing, H. (ed.), Beijing, Science Press, 1988, 192p.

Loc: ICIMOD

The first joint Sino-Nepalese GLOF study expedition to the upper reaches of the Punqu (Arun) and Poiqu (Bhote Koshi) river basins and Xizang (Tibet) took place from April 14 to June 21, 1987. This technical report contains the observations made during the expedition and presents their findings and recommendations.

248 *Lida, H.; Endo, Y.; Kohshima, S.; Motoyama, H.; Watanabe, O.* **Characterstics of snow cover and formation process of dirt layer in the accumulation area of Yala glacier, Langtang Himal, Nepal.** Bulletin of Glacier Research 5, 1987, 55-62p.

Loc: ICIMOD

This paper presents the study on the formation process of the dirt layer on the basis of long-term observations made (summer 1985 to spring 1986) in the accumulation area of the glacier in the Himalayas. The author summarises that distinct dirt layers are formed by dry fallout during the dry period from the post-monsoon season to the pre-monsoon season.

249 *Mae, S.* **Ice temperature of Khumbu glacier.** Seppyo, Vol. 38, Special Issue, 1976, 37-38p.

Loc: ICIMOD, DOM

In this paper, results of the thermal drilling at 5360m above sea level on August 1974 in Khumbu glacier are discussed. It is observed that there are seven layers down to the maximum depth. It is also observed that the temperature at a depth of 2m is - 2° C and at 2.7m depth it is 5.3° C. It also concludes that the ice temperature above the deepest layer is below melting point.

250 *Miller, M.M.* **Glacio-meteorology on Mt. Everest in 1963; the Khumbu glacier of Chomoloongma in Northeastern Nepal.** Weatherwise 17 (4), 1964, 168-189p.

251 *Miller, M.M.* **Tritium in Mt. Everest ice - Annual glacier accumulation and climatology at great equatorial latitudes.** Journal of Geophys. Res. 70, 1965, 3885-3888p.

252 *Miller, M.M.; Marston, R.A.* **Glacial response to climate change and epeirogeny in the Nepalese Himalayas.** In: Martson, R. A. (ed.), Environment and Society in the Manaslu - Ganesh Region of the Central Nepal Himalayas, A final report of the Manasalu-Ganesh expedition, Idaho, University of Idaho and Foundation for Glacier and Environmental Research, USA, 1989, 65-88p.

Loc: ICIMOD

This report contains the characteristics of both ancient and modern glaciers on the southern flank of Manaslu and Ganesh Himal. A comparison of these characteristics with Langtang and Khumbu Himal and also with Alaska-Canada boundary ranges is presented.

253 *Moribayashi, S. (Nikko Exploration & Development Co.)* **Transverse profiles of Khumbu glacier obtained by gravity observation.** Seppyo, Vol. 40, Special Issue, 1978, 21-25p.

Loc: ICIMOD, DOM

In this paper, the transverse profiles of the Khumbu glacier obtained by the gravitational method are provided. The thickness of the ice is estimated at 100m in the middle part and 220m, 1km downstream of the ice fall in the upper part.

254 *Moribayashi, S.; Higuchi, K.* **Characterstics of glacier in Khumbu region and their recent variations.** Seppyo, Vol. 39, Special Issue, 1977, 3-6p.

Loc: ICIMOD, DOM

The Khumbu region glaciers are classified into two types, namely, "debris-covered type glacier" and "clean type glacier". In this paper, the characteristics of both types of glacier are studied.

255 *Morinaga, Y.; Seko, K.; Takahashi, S.* **Seasonal variation of snowline in Langtang valley, Nepal Himalayas, 1985 - 1986.** Bulletin of Glacier Research 5, 1987, 49-53p.

Loc: ICIMOD, DOM

The seasonal variation of the snowline in Langtang valley is studied on the basis of photographs taken during different seasons. The snowline is compared with the altitude of 0°C air temperature derived from the observational data obtained at the valley station.

256 *Motoyama, H.; Ohata, T.; Endo, Y.; Lida, H.* **Air temperature and snow depth on Yala glacier of Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 8, 1990, 55-60p.

Loc: ICIMOD

Observations of air temperature and snow depth were carried out for 9 months on the Yala glacier, Langtang Himal, Nepal. A comparison of air temperatures at Yala glacier (5,250m) and at Kyangchen (3,920 m) is presented in this paper. The authors found that the snow depths on these two places are linearly related.

257 *Nakawo, M.* **Supraglacial debris of G2 glacier in the hidden valley, Mukut Himal.** Journal of glaciology 22 (87), 1979, 273-283p.

258 *Nakawo, M.; Fujii, Y.; Shrestha, M.L.* **Flow of glaciers in the hidden valley, Mukut Himal.** Seppyo, Vol. 38, Special Issue, 1976, 39-43p.

Loc: ICIMOD, DOM

The paper presents the observations made of the surface flow of the Rikha Samba and other glaciers. The authors measured the movement of the glaciers for one month and found out that the Rikha Samba glacier moved 1 - 2 m/month and, on the glacier-like ice mass close to Rikha Samba glacier, no movement was observed.

259 *Nakawo, M.; Iwata, S.; Watanabe, O.; Yoshida, M.* **Process which distribute supraglacial debris on the Khumbu glacier, Nepal Hamalayas.** Annals of Glaciology 8, 1986, 129-131p.

260 *Nakawo, M.; Morohoshi, T; Uehara, S.* **Satellite data utilization for estimating ablation of debris covered glaciers.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, UK, Oxfordshire, Institute of Hydrology, 1993, 75-83p.

Loc: DHM, CDOM, ICIMOD

By interpreting the MESSR data of MOS - 1 satellite, the areas of snow, bare ice, or debris are identified. The areas of granitic debris and schistose debris are also identified. The TM data of the LANDSAT satellite are used to obtain the surface temperature of the debris. The paper describes briefly an outline for estimating ablation under supraglacial debris with the aid of satellite data.

261 *Ohata, T.; Fukushima, Y.; Suzuki, M.; Motoyama, H.; Kawashima, K.; Kubota, H.* **Suspended sediment yield in a glaciated watershed of Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 5, 1987, 19-24p.

Loc: ICIMOD

This paper presents the results of investigations of the characteristics of suspended sediments and the annual suspended sediment yield carried out in Langtang Khola, Nepal Himalayas. The authors have found that the particle size in Langtang Khola is finer than in the Tenjin river which does not have glaciers. It is also estimated that almost all the suspended sediments are discharged from June to September.

262 *Ohata, T.; Higuchi, K.* **Heat balance study on glacier AX010 in Shorong Himal, East Nepal.** Seppyo, Vol. 41, Special Issue, 1980, 42-47p.

Loc: ICIMOD, DOM

The heat balance of the small glacier AX010 in Shorong Himal under weather conditions having an air temperature of 2.3° C (average), low

humidity, low wind speed (1.2 m/s), and high cloud amount is presented in this paper.

263 *Ohata, T.; Motoyama, H.; Lida, H.* **Snow surveys on the slope facing north of Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 8, 1990, 29-30p.

Loc: ICIMOD

The snow depth and the water equivalent of snow cover were measured by the team of the Glaciological Expedition of Nepal, Langtang project, in the winter and spring seasons of 1987. Distribution of these quantities with altitude are discussed in this paper.

264 *Ono, Y.* **Recent fluctuations of the Yala glacier, Langtang Himal, reconstructed from annual moraine ridges.** Zeitschrift fur Gletscherkunde and Glazialgeologie 21, 1985, 251-258p.

265 *Ozawa, H.; Yamada, T.* **Contributions of internal accumulation to mass balance & conditions of superimposed ice formation in Yala glacier, Nepal Himalayas.** In: Glacial studies in Langtang Valley: report of the Glaciological Expedition of Nepal Himalayas, 1987-1988, Japan, Sapporo, Glaciological Expedition of Nepal Project, 1989, 31-46p.

Loc: ICIMOD

This paper presents the investigations made of the contributions of meltwater freezing in surface snow layers to mass balance as internal accumulation and to the superimposed ice formation in Yala glacier, Nepal Himalayas, on the basis of the field observations conducted in August to October 1987 and the computer simulation using a simple one-dimensional heat conduction model.

266 *Shiraiwa, T.; Ueno, K.; Yamada, T.* **Distribution of mass input on glaciers in the Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 10, 1992, 21-30p.

Loc: ICIMOD

In this paper, investigations made of the distribution of glacier mass input, by means of meteorological observations and snow surveys in the Langtang Valley are presented.

267 *Shiraiwa, T., Ueno, K.; Yamada T.* **Spatial variations of glacier mass input in the Langtang valley, Nepal Himalayas.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, UK, Oxfordshire, Institute of Hydrology, 1993, 285-288p.

Loc: DHM, CDOM, ICIMOD

Spatial distribution of the glacier remains uncertain due to insufficient field observation. In order to overcome this problem, observations of air temperature and precipitation were carried out on three glacier fields at about 5,100 masl. The concluding results are presented as an extended abstract of the paper.

268 *Shiraiwa, T.; Yamada, T.* **Glacier inventory of the Langtang valley, Nepal Himalayas.** Japan, Institute of Low Temperature Science, Data Report, Ser. A,50, 1991, 47-72p

All glaciers in the Langtang valley are catalogued according to ID number and some of the plates of the glaciers are also presented.

269 *Steinegger, U.; Braun, L.N., Kappenberger, G.; Tartari, G.* **Assessment of annual snow accumulation over the past 10 years at high elevations in the Langtang region.** In: Young, G.J. (ed.), Snow and Glacier Hydrology, Proceedings of the Kathmandu Symposium (Nov. 1992), IAHS Publ. No. 218, UK, Oxfordshire, Institute of Hydrology, 1993, 155-165p.

Loc: DHM, CDOM, ICIMOD

Stratigraphic observations made of crevasses and field measurements in snow pits on three glaciers in Langtang valley show two firn layers. A shallow dirty layer is formed during the winter season and a thick clean layer is formed in summer. Melting and runoff occurs from up to 5500m above sea level in the pre-monsoon

season. The variety of contamination that is stored in the snow layers is also analysed for organic, inorganic, and tritium contents.

270 *Upadhyay, B.P.* **Importance of glacial studies in Nepal.** Presented: Symposium on Studies of Snow and Ice in Asia, Nagoya, Japan, 1979, 5p.

271 *Upadhyay, B.P.* **Some results of glacier research in the Nepal Himalayas.** Presented at the first National Symposium on Seasonal Snow Cover, New Delhi, Manali, Snow and Avalanche Study Establishment, 1983, 7p.

272 *Watanabe, O; Fushimi, H.; Inoue, J.; Iwata, S,; Ikegami, K.; Tanaka, Y.; Yoshida, M.; Upadhyay, B.P.* **Outline of studies on supraglacial debris of the Khumbu glacier, Khumbu region.** Seppyo, Vol. 41, Special Issue, 1980, 5-8p.

Loc: ICIMOD, DOM

This paper describes the morphologic features of the Khumbu glacier.

273 *Watanabe, O.; Higuchi, K.* **Glaciological studies in Asiatic highland region during 1985-1986.** Bulletin of Glacier Research 5, 1987, 1-10p.

Loc: ICIMOD

Glacio-hydrological, glacio-meteorological, and glaciological observations in the Nepal Himalayas were carried out during 1985 - 86 as part of a project to study the glaciology of the Asiatic highland region. This paper summarises the activities undertaken and the observations made by the expedition.

274 *Watanabe, O.; Iwata, S.; Fushimi, H.* **Topographic characteristics in the ablation area of the Khumbu glacier, Nepal Himalaya.** Annals of Glaciology 8, 1986, 177-180p.

275 *Watanabe, O. ; Shiraiwa, T. ; Ono, Y.* **Distribution of periglacial landforms in the Langtang valley, Nepal Himalayas.** Bulletin of Glacier Research 7, 1989, 209-220p.

Loc: ICIMOD

The spatial and altitudinal distribution of the active periglacial landforms are mapped in the Langtang valley, central Nepal Himalayas. Several inactive landforms are also mapped. In this paper, the periglacial belt of the Langtang valley, which spreads between the timberline and the equilibrium line, is subdivided into 4 belts and discussed.

276 *Wushiki, H.* **Altitude effect on the deuterium content of the local rains and snows in the Himalayas.** Seppyo, Vol. 39, Special Issue, 1977, 57-59p.

Loc: ICIMOD, DOM

An attempt has been made to study the altitude effect of precipitation on the deuterium content. To do so, two sampling projects were undertaken to collect precipitation waters. One, a long-term sampling, by simple rain gauges installed along the mountain slopes, and the other, simultaneous daily precipitation sampling at two different altitudes at about 1000 masl.

277 *Wushiki, H.* **Deuterium content in the Himalayan precipitation at Khumbu district observed in 1974/1975.** Seppyo, Vol. 39, Special Issue, 1977, 50-56p.

Loc: ICIMOD, DOM

The study is based upon the 129 water samples collected at Lhajung (4420m) from April 1974 to March 1975. The deuterium content of each sample measured by spectrometer showed high deuterium content during pre-monsoon and the lowest in mid-monsoon. The author attributes this to the direct transport of water vapour from the Indian Ocean to the Himalayas without much rainfall on the way.

278 *Wushiki, H.* **Ice cliffs and exposed stratigraphy of Kongma glacier, Khumbu.** Seppyo, Vol. 39, Special Issue, 1977, 22-25p.

Loc: ICIMOD, DOM

The ice cliffs in Kongma glacier are sketched in this paper. These sketches are arranged numerically for easy comparision.

279 *Yamada, T.* **Outline of glaciological studies in the Nepal Himalayas, 1989.** Bulletin of Glacier Research 9, 1991, 51-54p.

Loc: ICIMOD

Some Japanese scientists carried out research work through the Glaciological Expedition of Nepal, 1989, as part of their project called 'Glaciological Studies in Asian Highland Regions'. The hydrological and meteorological station in Langtang Himal has been continuously maintained since 1985. Glacier fluctuations for over ten years have also been observed in the Khumbu, Shorong, and Langtang regions.

280 *Yamada, T., Shiraiwa, T.; Lida, H.; Kadota, T.; Watanabe, O.; Rana, B.; Ageta, Y.; Fushimi, H.* **Fluctuations of the glaciers from the 1970s to 1989 in Khumbu, Shorong and Langtang regions, Nepal Himalayas.** Bulletin of Glacier Research 10, 1992, 11-19p.

Loc: ICIMOD

As a part of the Geological Expedition of Nepal, fluctuations of glaciers were investigated by means of ground surveys in the Khumbu, Shorong, and Langtang regions. According to surveys conducted from 1970s to 1989, almost all glaciers have shrunk a great deal.

Annex I
List of Locations and Abbreviations

CDOM Central Department of Meteorology
Tribhuvan University
Kirtipur, Kathmandu

DHM Department of Hydrology and Meteorology
HMG Nepal, Babar Mahal, Kathmandu

DOM Department of Meteorology
Trichandra Campus, Ghantaghar, Kathmandu

DSC Department of Soil Conservation and Watershed Management
HMG Nepal, Babar Mahal, Kathmandu

GEN Glaciological Expedition of Nepal
Sapporo, Japan

IAHS International Association of Hydrological Sciences
IAHS Press, Institute of Hydrology, Oxfordshire,
United Kingdom

ICIMOD International Centre for Integrated Mountain Development
P.O.Box # 3266, Kathmandu

LRMP Land Resources Mapping Project
Babar Mahal, Kathmandu

Loc Location

NEA Nepal Electricity Authority
Ratna Park, Kathmandu

NGS Nepal Geographical Society
Department of Geography
Trichandra Campus, Ghantaghar, Kathmandu

NRSC National Remote Sensing Centre
Babar Mahal, Kathmandu

SEPPYO Journal of the Japanese Society of Snow and Ice
Nagoya University, Nagoya, Japan

WECS Water and Energy Commission Secretariat
HMG/NEPAL, Singha Durbar, Kathmandu

Annex II
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Annexes

Participating Countries of the Hindu Kush-Himalayan Region

- Afghanistan
- Bhutan
- India
- Nepal
- Bangladesh
- China
- Myanmar
- Pakistan

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