Hydrology in
Mountainous Regions I

HYDROLOGICAL MEASUREMENTS
THE WATER CYCLE

Edited by

H. LANG
Geographisches Institut ETH, Abteilung Hydrologie,
Winterthurerstrasse 190, CH-8057 Zürich, Switzerland

A. MUSY
Institut d'Aménagement des Terres et des Eaux, Ecole
Polytechnique Fédérale de Lausanne, GR Ecublens,
CH-1015 Lausanne, Switzerland

Proceedings of two international symposia, the Symposium on Improved Methods of Hydrological Measurements in Mountain Areas (S1) and the Symposium on Quantitative and Qualitative Water Cycle Aspects in Heterogeneous Basins (S2), held at Lausanne, Switzerland, 27 August–1 September 1990. The symposia were part of the International Conference on Water Resources in Mountainous Regions jointly convened by the International Association of Hydrological Sciences (IAHS) and the International Association of Hydrogeologists (IAH).

IAHS Publication No. 193
CONTENTS

Preface to papers for the Symposium on Improved Methods of Hydrological Measurements in Mountain Areas  Herbert Lang v

Preface (in French) to papers for the Symposium on Quantitative and Qualitative Water Cycle Aspects in Heterogeneous Basins  A. Musy vii

Symposium on Improved Methods of Hydrological Measurements in Mountain Areas

TOPIC A: RELIABILITY OF PRECIPITATION MEASUREMENTS

Evaluation of precipitation gauges for measuring precipitation on mountainous watersheds  C. L. Hanson 3

Methods of estimating precipitation inputs to the Balquhidder experimental basins, Scotland  R. C. Johnson, J. R. Blackie & J. A. Hudson 7

Simulation of weather radar ground clutters in a mountainous area using a digitized elevation model  T. Lebel 15

Amount and variability of cloud moisture input in a tropical cloud forest  T. Stadmüller & N. Agudelo 25

Rainfall variations in mountainous regions  G. du T. de Villiers 33

TOPIC B: METHODS OF DIRECT ESTIMATION OF EVAPORATION

Atmosphere and surface control on evaporation from alpine tundra in the Canadian Cordillera  W. G. Bailey, I. R. Saunders & J. D. Bowers 45

Evaporation measurements in the Alpine basin Gletsch during the ALFEX/RHONEX project  A. Bernath 53

On the spatial variability of hydrologic processes in a small mountainous basin  G. Peschke, K. Miegel, Ch. Etzenberg & H. Hebentanz 61

Evaluation of evaporation models for alpine tundra, British Columbia, Canada  I. R. Sanders & W. G. Bailey 71

A lysimeter for the measurement of evaporation from high altitude grass  I. R. Wright 79

TOPIC C: ASSESSMENT OF SNOW AND GLACIERS AS WATER BALANCE AND RIVER FLOW COMPONENTS

Bilan hydrologique du bassin versant de la Massa et bilan de masse des glaciers d'Aletsch (Alpes bernoises, Suisse)  M. Aellen & M. Funk 89

Modelling discharge of glacierized basins assisted by direct measurements of glacier mass balance  L. N. Braun & M. Aellen 99
Modalités de fonte de neige en moyenne montagne et alimentation du karst sous-jacent  P. Chauve, J. Mania & D. Moindrot 107

On the influence of Alpine glaciers on runoff  Jiyoung Chen & Atsumu Ohmura 117

Estimation of Alpine glacier water resources and their change since the 1870s  Jiyoung Chen & Atsumu Ohmura 127

Contribution de la neige et des glaciers dans le débit des rivières: suivi par télédétection spatiale  J. P. Dedieu 137

Improving methods for measurement and estimation of snow storage in alpine watersheds  Kelly Elder & Jeff Dozier 147

Improved methods of assessment of snow and glaciers as water balance and river flow components  Angela M. Gurnell 157

A lysimetric snow pillow station at Kühltai/Tyrol  R. Kimbauer & G. Blöschl 173

Methods for the computations of onset date and daily hydrograph of the outburst from the Mertzbacher Lake, Tien-shan  V. G. Konovalov 181

Role of glacier and snow cover melting in runoff variations from the small basins in Pamir and the Alps  F. I. Pertziger 189

Point modelling of snow cover water equivalent based on observed variables of the standard meteorological networks  M. B. Rohrer & H. Lang 197

**TOPIC D: IMPROVED METHODS OF MEASURING DISCHARGE IN MOUNTAIN RIVERS, INCLUDING PROBLEMS OF BED LOAD**

Acoustic sensors (hydrophones) as indicators for bed load transport in a mountain torrent  R. Bänziger & H. Burch 207

Determination of discharge rates in turbulent streams by salt tracer dilution applying a microcomputer system. Comparison with current meter measurements  R. Benischke & T. Harum 215

Experiences and results from using a big-frame bed load sampler for coarse material bed load  K. Bunte 223

Mesures des débits solides et liquides sur des bassins versants expérimentaux de montagne  J. P. Cambon, N. Mathys, M. Meunier & J. E. Olivier 231

Seuil jaugeur adapté aux petits bassins versants à fort transport solide  O. Cayla, P. Jehanno & M. Ouaar 239

Refinements in dilution gauging for mountain streams  Kelly Elder, Richard Kattelmann & Rob Ferguson 247

Flow measurement under difficult measuring conditions: field experience with the salt dilution method  A. Gees 255

Reliability of bed load measurements in mountain rivers  B. V. Georgiev 263

Utilisation de mesures journalières de la turbidité pour l’estimation des flux de matières en suspension. L’exemple des fleuves andins de Bolivie  J. L. Guyot & H. Calle 271
Choice and calibration of streamflow structures for two mountain experimental basins  J. A. Hudson, R. C. Johnson & J. R. Blackie  275

Measurement of coarse sediment transport in a small Alpine stream  M. A. Lenzi, L. Marchi & G. R. Scussel  283

Overflow weirs as gauging stations in mountain brooks  H. Moschen  291

Hydrological and sediment monitoring in mountainous pilot watersheds in Sefid Rud basin in Iran  R. Pavlovic, S. Prohaska, M. Behbehani, B. Babakhanloh & S. Damavandi  299

Spatial and temporal variation of flow resistance in an Alpine river  P. E. Stüve  307

Comparison of bed load yield estimates for a glacial meltwater stream  J. Warburton  315

Symposium on Quantitative and Qualitative Water Cycle Aspects in Heterogeneous Basins

**TOPIC A: QUANTITATIVE SPACE-TIME WATER VARIABILITY**

Méthodes d’étude de la variabilité spatiale du cycle hydrique dans le petit bassin du Ringelbach  B. Ambroise  327

The importance of hydrological networks for estimating average flows in Alpine regions  H. Aschwanden  335

Investigations of the precipitation conditions in the central part of the Tianshan mountains  Felix P. Blumer  343


Synthèse régionale pluviométrique en région montagneuse  O. Cayla & M. Taibi  357

Variability of runoff from partially-glacierised Alpine basins  David N. Collins & David P. Taylor  365

Interêt de la densité de drainage pour régionaliser les données hydrologiques en zone montagneuse  J. Humbert  373


New findings from the investigation of the runoff regime in the Police Cretaceous basin in the Bohemian Massif  K. Sarga & F. Stepička  389

Factors controlling the spatial variability of direct annual runoff as a percentage of total runoff  L. Solín  399

Estimation of monthly precipitation by geographical factors and meteorological variables  Keiichi Yamada  405

Tracking rainfall impulses through progressively larger drainage basins in steep forested terrain  Robert R. Ziemer & Raymond M. Rice  413
TOPIC B: QUALITATIVE SPACE-TIME WATER VARIABILITY

Polycyclic aromatic hydrocarbons as pollutants of the aquatic environment in the Sudety Mts, southwestern Poland  T. Bąbelek & J. Grochmalicka-Mikołajczyk

Hydrograph and chemograph separation of bulk meltwaters draining the upper Arolla Glacier, Valais, Switzerland  G. H. Brown & M. Tranter

Seasonal and annual variations of suspended sediment transport in meltwaters draining from an Alpine glacier  David N. Collins

Image synchrone de la composition isotopique de la couverture neigeuse des Alpes de Suisse occidentale  M. Dray, A. Parriaux & J. D. Dubois

Qualitative determination of drainage basin storage in nine drainage basins of the Basque Country, northern Spain  J. Garcia Muñiz, I. Antuguedad Auzmendi & J. Llamas Siendones

The significance of suspended sediment pulses for estimating suspended sediment load and identifying suspended sediment sources in Alpine glacier basins  A. M. Gurnell & J. Warburton

Environmental contamination and other anthropogenic impacts on Otamiri and Nwaore rivers, Owerri, Nigeria  K. M. Ibe Sr., A. H. O. Sowa & O. C. Osundu

Extreme conditions of streamwater chemistry in a partly forested mountainous region  Hans M. Keller

Principal characteristics of fold-mountain hydrogeology  A. V. Kudelsky

Chemical composition of precipitation in a prealpine area of eastern Switzerland  O. Langenegger

Chemical composition of snow cover on the western Swiss Alps  Aurèle Parriaux, Jean-Daniel Dubois & Martial Dray

Acidification studies at northern Black Forest cirque lakes  H. Thies

TOPIC C: HYDROLOGICAL MODELLING IN REGIONS OF RUGGED RELIEF

The effect of space-time rainfall variability on unit hydrograph parameters  Š. Blažková

Modélisation des petits bassins versants au moyen de lois probabilistiques: exemple des crues  O. Cayla, M. Demmak & M. Touat

Application of the Preissmann scheme on flood propagation in river systems in difficult terrain  K. W. Chau

Snowmelt assessment in a complex system of reservoirs (Comunidad de Madrid)  Francisco Cubillo

Application of the Kennessey method for the determination of the runoff coefficient and evaluation of aquifer recharge in mountain regions  D. Farina & A. Gaspari

Annual precipitation and regional effects on daily precipitation model parameters  C. L. Hanson & D. A. Woolhiser
A comparative assessment of two approaches to evaluate anthropogenic effects on flood events in mountainous regions  J-P. Jordan, V. Laglaine & Ph. Hohl

Use of satellite data for hydrologic modelling of a mountain watershed  G. W. Kite

Estimation des débits moyens mensuels sur cours d'eau alpins non mesurés: application à la Dranse de Bagnes  G. Luyet

Runoff modelling in complex three-dimensional terrain  I. D. Moore, R. B. Grayson & J. P. Wilson

Hydrological modelling in regions of rugged relief  Ch. Obled

Application du modèle couplé à discrétisation spatiale au bassin de la Fecht, Vosges (France)  J. L. Perrin, B. Ambroise & J. Humbert

Simulation of daily runoff in a mountainous catchment using the Tank model  K. S. Ramasastri

Snowmelt runoff forecasts in Colorado with remote sensing  A. Rango, V. van Katwijk & J. Martinec

Prise en compte de la variabilité spatiale des pluies efficaces par un modèle semi-global: extension de la méthode DPFT à des cas bi-entrées  J. Y. Rodriguez & Ch. Obled

Modélisation pluie-débit de bassins à relief accident: le rôle de la variabilité spatiale de la pluie  D. Sempere Torres & Ch. Obled


The "Hydrograph GGI-90" model and its application for mountain basins  Yu. B. Vinogradov

Application of the unit hydrograph model to Swiss catchments  R. Weingartner

The formation and calculation of cold region runoff in the Qilian mountains  Z. H. Yang

A conceptual distributed model for large-scale mountainous basins  Fumio Yoshino, Junichi Yoshitani & Masayuki Sugiura

Simulation of daily runoff in the Urumqi River basin with the improved Tank model  Zhang Guowei, Shang Sichen & Wang Xinqi

**TOPIC D: Interaction between Acid Rain and Pedological and Geological Basin Characteristics**

Formalization of proton balances in elementary basins based upon the alkalinity concept and graph properties  G. Bourrie & F. Lelong

The influence of forest decline and soil acidification on water yield from forest catchments of the northern Black Forest, FR Germany  H. J. Caspary

A multivariate model of solute behaviour for an episodic acid stream in the Black Forest, FR Germany  H. Meesenburg
Fate of atmospheric deposition in small forested catchments depending on local factors  H. Sager, J. Bittersohl, T. Haarhoff, I. Haberger, K. Moritz, A. Knorr & H-H. Lechler  

Groundwater contributions to the hydrochemistry of an alpine basin  Mark Williams, Richard Kattelmann & John Melack  

**TOPIC E: ASSESSMENT OF THE UTILIZATION POTENTIAL OF SURFACE WATER RESOURCES**  

Surface water potential and its utilisation in India  Subhra Chakravarty  

Evaluation des potentialités d'utilisation des eaux de surface en Suisse  A. Goetz  

La régularisation du Lac Léman  P. Grandjean  

Hydrology and development of the Arun River, Nepal  Richard Kattelmann  

Water and energy in Austria  S. Radler  

Methods for evaluating hydro potential  H. W. Weiss & A. O. Faeh  

**TOPIC F: GENERAL PAPER**  

Quantitative and qualitative water cycle aspects in heterogeneous basins  H. J. Morel-Seytoux