

5-4 水文・気象資料整備事業

(1) 経緯

水文資料整備

- 1961年 :UN特別基金によるカルナリ川流域プロジェクト（コンサルタント：日本工
営）を通じ、系統的な水文観測の開始
- 1962年 : USAIDプロジェクトによる本格的な水文資料収集事業の開始
- 1982-87年 :Development of Operational Hydrology Services (UNDP/WMO)
の実施
- 1988年-未定 :Nepal-India Flood Forecasting Project
- 1990-92年 :Snow and Glacier Hydrology Project (German Technical Agency :
GTZ)
- 実施中 :German Volunteer Services (GVS) による水文・気象資料の観測・管
理指導

気象資料整備

- 1921年 : 英国統治のもとカトマンズに降雨観測所を設置
- 1947年 : インド国政府気象局 (Indian Meteorological Dept.) へ移管
- 1966年 : 水文・気象局設立に伴う気象資料の一元管理の開始
- 1968年 : 気象年報 (Climatological Records of Nepal) 1966年版の出版
- 1969-72年 : 気象年報 1967-69年版の出版
- 1973年 : 気象年報 1970年版の出版
- 1974-87年 : 気象資料サービス拡充のためWMOプロジェクトの実施
気象年報 1971-84年版の出版
- 1978-87年 : Agrometeorology and Instrument Maintenance Projects (WMO)
- 1988年 : 気象年報 1985-86年版の出版

計画事業：UNDPプロジェクト

- (a) 一般公共、農業及び関連分野への総合的な天気情報サービス強化：1991年後半
- (b) 流砂観測網の構築、流砂試験場の補強、流出土砂量の評価：1991年後半
- (c) 太陽及び風エネルギーの開発及び利用に必要なデータベースの提供：1992年後半

(2) Development of Operational Hydrology Servicesの概要

- 1) 目的 : ネパール国において各種の開発活動に際して必要な水文資料解析及び予警
報に対する増加しつつある需要に応えるため
- 2) 資金源 : ネパール国政府及びUNDP

- 3) 実施工程 : 1982年6月から1987年12月まで (実施済み)
- 4) 事業 : パソコンの供与 (IBM PC/XT : 5台) ほか
- 5) 関係者 : Dr. Mandeville、Patan在住 (当プロジェクトの事情をよく知っているとのこと)

(3) Nepal - India Flood Forecasting Project の概要

ネパールとインドの協調プロジェクトで、10年以上前から懸案になっていたものであるが、1988年9月にインド側ミッションがネパールを訪れ、この際、ネパール側がインドへの資料提供に合意し、具体化したものとのことである。

事業の内容は具体的な文書が入手できず不明であるが、ネパール政府担当者の話によると、ネパール全土にテレメータ化した18カ所の水位・流量観測所、40カ所余りの降雨観測所を設置することを目指している。インド側の役割は、(a) 機材供与 (水位計、雨量計、テレメータ) 及び (b) 要員の育成で、ネパール側は管理小屋を建設することになっている。

事業の実施スケジュールは確定していないとのことで、ネパール側は数箇所の管理小屋を建設済みであるが、まだインド側からの機材供与はなく、供与の目途も立っていないようである。

(4) Snow and Glacier Hydrology Project の概要

1) 目的 :

- (a) ヒマラヤ地域の雪氷水文の面的広がり と 地域的変化に関する水文、気象及び現場資料の収集、整理
- (b) 氷河湖決壊流出等の機構の確認と解析
- (c) ネパールにおける雪氷水文のあらゆる分野のセンターとしての Snow and Glacier Hydrology Unit (SGHU : 雪氷水文研究所) の開発
- (d) 氷雪研究に関する世界的な情報の収集
- (e) 研究機関及び非研究機関並びに研究者との連携の確立とその維持

2) 資金源 : ネパール国政府及び German Technical Agency (GTZ)

3) 実施工程 : 1990年から1992年中期まで (30カ月)

4) 事業 :

- (a) 3観測所 (Langtang、Khumbu/ Everest、Annapurna) を設置し、現在観測実施中
- (b) 水文・気象資料 (上記3観測所の1987年から1989年までの資料) を整理済み
- (c) 追加3観測所 (Arun 流域、Seti 上流域、Karnali/Bheri 流域) の設置及び観測の予定

5) 関係者 : Mr. W. E. Grabs、GTZ Project Leader

(5) German Volunteer Services (GVS) の概要

ネパール国の水文・気象観測、資料管理を指導するため、GVSから4名の技師が派遣され、DHMの中央及び地方事務所で活動している。GVS技師の氏名は次のとおりである。

Rudiger Heidebrecht	: カトマンズ
Frank Nepassus	: ダウン
Stefan Koeste	: ポカラ
Ivad Buchheiste	: スルケット

5-5 現状の問題点

気象資料については、天気予報、航空気象等の定常的な要求に応え得るよう比較的良く整備されており、地方事務所（全国5カ所）を経由する資料収集システムと特定資料をカトマンズの空港観測所へ直接伝達するワイヤレスによる通信システムが確立されている。主要な問題点として(1) 予算不足のためシステムの維持が難しい、(2) 観測機器の更新が困難、(3) 記録の処理が遅延していることなどが挙げられている。

水文資料の整備状況は良くない。主な問題点として、(1) システムの維持が困難なため欠測を含めて観測値の信頼性が低い、(2) 洪水時の時間資料がほとんどないことなどからプロジェクトの調査に対応できていない、(3) 記録の処理が遅延し利用に支障をきたしている、(4) 洪水時のオンラインデータがなく、洪水があっても状況把握に相当の日数がかかることなどが挙げられる。

これらの問題点は、主に次に示す要員の量的・質的不足、施設・機器の不備、観測所へのアクセス難、洪水時記録体制の不備、予算の不足に起因するものである。

1) 要員の量的・質的不足

- (a) 観測所要員の不足
- (b) 観測所点検・整備のできる技術員の不足
- (c) 観測機器修理のできる技術員の不足
- (d) 水文解析・調査のできる人材の不足
- (e) 流砂、水質分析のできる人材の不足
- (f) コンピューター操作のできる人材の不足

2) 施設・機器の不備

- (a) 観測所の点検・整備、流量観測のための現場詰所の不備
- (b) 観測機器の調整（キャリブレーション）、修理のできる施設の不備
- (c) 修理及び修理部品調達が遅延
- (d) 維持部品（水位計自記紙等）の補給難
- (e) 流砂、水質分析施設の不備
- (f) 洪水、地すべり、流砂等による水文観測施設の損傷

3) 水文観測所へのアクセス難

- (a) 洪水時に冠水、土砂崩れ等のため接近できない観測所がある
- (b) 観測所の点検整備、流量観測の実施難
- (c) 観測記録の回収に長期間を要する
- (d) 山地部観測所の設置、維持管理が困難

4) 洪水時記録体制の不備

- (a) リアルタイム通信システムがなく、情報収集が遅れる
- (b) 定時観測のため洪水ピークが記録できない
- (c) 自記水位記録の読み取り処理が遅れている

5) 予算の不足

- (a) 観測、資料管理に必要な要員の確保が困難
- (b) 施設・機器の不備が発見されても補修できない
- (c) 所管の全観測所の維持管理が困難なため、DHMは観測所数を減らし、集中管理を図ろうとしている

6. 本格調査の内容

6-1 調査の背景及び目的

ネパール国にとって水資源は、農業、電力開発をはじめとする同国の経済発展のために重要な資源であるが、同時に洪水、土石流、侵食等の災害の要因でもあり、国民とのかかわりは深い。さらに同国の降雨は国内にとどまらず、ガンジス河下流域諸国（インド、バングラデシュ）の洪水の原因にもなっているといわれている。こうした状況の中で、同国の総合的な水資源開発・洪水対策を主目的とした河川管理は、同国の農工業生産能力の増大にとり重要な意味を持つだけでなく、南西アジア地域にとっても不可欠なものとなっている。

しかしながら、これら水資源開発・洪水対策計画策定の基礎資料として不可欠な水文・気象資料の整備状況は、観測施設の整備水準の低さに加え、データの収集、整理、管理システムが未整理のため不十分であり、全国規模での適正な河川管理を行ううえで、観測網及びデータ管理システムの再構築が急務となっている。

以上のような背景のもとに、同国は国内水文・気象資料の総合管理機関として1987年に水文・気象局を新設したことを契機に、全国規模での水文・気象資料整備を進めていくための計画を策定することに関して、日本国政府に技術協力を求める要請を行ってきた。

本調査の目的は、ネパール国政府のこの要請に基づき、全国規模の水文・気象観測システム及び資料管理システムの整備、拡充、強化を内容とする国内水文・気象資料整備計画を策定することにある。

6-2 調査の基本方針

- 1) 水文・気象資料整備計画は、水資源開発及び治水事業に資することを主目的とする。したがって、調査にあたっては、これらと最も関係の深い水位・流量及び降雨資料の整備を重点課題として検討するが、流砂、水質資料についても付随的に検討する。気象資料については、既存システムについてレビューする程度とする。
- 2) 水位・流量・降雨資料については、日資料及び時間資料の整備を図るものとする。日資料は主に水資源賦存量の評価に資するもので、時間資料は洪水、土砂流出等の把握に資するものである。
- 3) 水文・気象資料整備計画として、当面の目標とすべき長期計画 (Long Term Programme) と、当面実施すべき短期計画 (Immediate Programme) を策定する。さらにモデルシステムを実施し、結果を計画策定に反映するとともに、資機材の補強及び技術移転を図る。
- 4) 長期計画は、ネパール国における水文・気象資料整備活動にあたり当面の目標とすべき姿 (マスタープラン) を設定するもので、計画には、プロジェクトを構成する観測、収集、整理、保管、提供のすべての業務を含む。長期計画における観測網の整備水準は、観測所間の補完等

により水文・気象状況の全国的な把握を可能にする最小限度のものとする。計画にあたっては、地形、水系による水文・気象などの地域特性を考慮するのはもちろん、既存の水資源及び治水に関する計画及びポテンシャルプロジェクト等の地域分布についても配慮するものとする。

- 5) 短期計画として、長期計画から緊急度、優先度の高い事業を選定し、より詳細で具体的な整備・拡充計画を策定する。短期計画の策定にあたっては、施設の機能面からの検討に加え、ネパール国政府が配分可能な施設の維持運営費の規模及び維持用資材の補給についても配慮し、整備水準を定めるものとする。
- 6) モデルシステム構築の目的は、(1) より実践的な長期計画及び短期計画の策定に資する、(2) 観測、資料管理の実務を通して技術の移転を図る、(3) モデルシステムの建設を通じ資機材、施設の補強を図る点にある。普通水文資料の収集、整理の迅速化、自記降雨、水文記録の観測、収集、整理が現状の重要課題である。モデルシステムの実施を通じて、基本的な資料の1年以内整理、洪水時資料の即日収集等の方法についても検討する必要がある。モデルシステムの計画実施にあたっては、緊急及び具体的プロジェクト及び治水砂防センター事業との関連をも考慮するものとする。モデルシステム業務の一環として次の作業を行う。

● 観測所の設置

- ・ 雨量観測所 10カ所
- ・ 水位・流量観測所 5カ所

● 流速計キャリブレーション施設の建設 1カ所

● 水文・気象資料の整理促進の業務

なお、観測所の設置箇所数は想定数であり、第1年次現地調査により確定するものとする。

6-3 対象地域及び範囲

調査対象地域はネパール国全土とする。

6-4 調査項目及び内容

(1) 既存資料の収集・整理

現地踏査を実施し、水文・気象観測所及び資料管理の実情を把握するとともに、調査に必要な資料・情報を収集・整理する。収集・整理する資料として、次の事項が考えられる。

- 1) 社会・経済：人口、国内総生産（GDP）、行政区分等
- 2) 水文・気象：雨量、水位・流量、気温、湿度、蒸発量、風向・風速、日射量等
- 3) 地形・地質：地形図、地質図、航空写真等
- 4) 流域・河川状況：流域と河川の現状、河川災害（洪水、土砂等）
- 5) 治水・洪水予報：対策の現状と計画、計画策定の方針等

- 6) 流域保全：対策の現状と計画、計画策定の方針等
- 7) 水資源：河川水質及び水利用の現状と計画、計画策定の方針等
- 8) その他の開発計画：既存の計画、計画策定の方針等
- 9) 土地利用：現状及び将来計画
- 10) 通信・交通施設：観測・記録収集・システム維持管理等に利用し得る施設の現状と将来計画
- 11) その他の関連資料

(2) 既存システムの現状及び問題点の整理

現地踏査及び資料収集・整理結果に基づき、既存の水文・気象観測システム及び資料管理システムの現状及び問題点を整理する。既存システムの現状を明らかにするため、下記項目の調査を行う。

1) 水文・気象観測システム

- (a) 観測所の配置（数、分布）
- (b) 観測機器の機種及び稼働状況
- (c) 観測人の技術レベル、教育指導状況
- (d) 観測方法、観測基準
- (e) 維持補修点検体制
- (f) 観測組織

2) 水文・気象資料管理システム

- (a) データ収集
- (b) データ処理
- (c) データ管理
- (d) 機器の機種、容量
- (e) データ収集、整理、管理組織
- (f) 水文・気象資料整理促進業務の作業量把握

3) 水文特性の検討

代表地域を選定して、下記の諸検討を実施し、調査対象地域の降雨及び流出の特性を把握し、観測網計画の資料とする。

- (a) 降雨特性の検討
- (b) 流域特性の検討
- (c) 流出特性の検討

これらの調査結果に基づき、既存システムの問題点を整理し、モデルシステムの計画並びに水文・気象資料整備事業の長期計画及び短期計画策定のための基礎資料とする。

(3) 長期計画 (Long Teme Programme) の策定

- 1) 長期計画策定の基本方針設定：長期計画策定の基本となる整備目的、水準等の考え方を検討整理する。
 - 2) 長期計画の概念設計：ネパール国全土にわたる降雨・流量資料整備のための観測システム及び資料管理システムの概念設計を行う。概念設計では、下記の事項を検討し明らかにする。なお、システムは、降雨資料及び流量資料につき、日資料及び時間資料について検討するものとする。また、河川流出土砂、水質に関する資料の整備体制についても検討するものとする。
 - (a) システムを構成する観測所の配置と観測項目
 - (b) 資料・管理システムと観測所、地方事務所 (Regional Office)、中央事務所 (Kathmandu) 等の役割及び作業項目
 - (c) 資料収集方式：観測所、地方事務所、中央事務所
 - (d) 観測・記録方式と機器の種類
 - (e) 資料の整理方式と機器の種類
 - (f) 資料の保管・提供方式と必要機器の種類
 - 3) 代替案の検討：上記の検討にあたっては、システム及び各段階での方式につき広く代替案を設定し、比較検討を行い、最良の案を選定するものとする。
 - 4) 事業費積算：概念設計結果に基づき、長期計画の実施に要する概略事業費を積算する
 - 5) 組織及び体制の整備：観測システム及び資料・管理システムを効果的に運営するための組織及び維持管理のための体制について計画し提案する。
 - 6) 優先事業の選定：短期計画 (Immediate Programme) として取り上げるべき優先事業を、施設の維持管理費及び維持用資材等の調達可能性についても考慮し選定する。優先事業の選定には次の検討が含まれる。
 - (a) 長期計画の実実施計画 (Implementation Schedule) の検討：整備施設規模及び方式・機器の水準による段階的実施計画の検討を行う
 - (b) 水文・気象特性、既存資料の賦存状況及び関連プロジェクトの緊急性等に配慮した基幹観測所、施設の選定
 - (c) システム維持管理用資材の調達可能性の検討
 - (d) システム維持管理費の調達可能性の検討
- ### (4) モデルシステムの構築
- 1) モデルシステムの計画。
 - (a) 調査項目の設定：既存システムの問題点と長期計画の構想を踏まえ、モデルシステムを用いて調査すべき事項を整理する
 - (b) システムの計画：モデルシステムを構成する観測所、観測・記録方式、資料収集・整理方式、資料保管・提供方式等の基本的な事項について検討し設定する

- (c) モデルシステム実施に必要な資機材及び観測等の基礎調査の項目と内容の検討
 - (d) 事業費概略見積
 - (e) 工程検討
 - (f) 以上の検討成果をモデルシステム実施計画書としてとりまとめる
- 2) モデルシステムの設計。
- (a) 測量等の基礎調査の計画、発注、監理
 - (b) 施設設計：設計図、工事発注書類、工費見積を含む
 - (c) 資料の記録、収集、整理、保管方式及び様式の設計：できる限り既存の方式及び様式との整合を図り、現行の観測、資料整理活動に混乱を生じないように配慮する必要がある
- 3) 施設の設置：モデルシステムに含まれる諸施設を稼働可能な状態に設置する。施設設置作業のうち、観測所設置、流速計キャリブレーション施設建設等の土木工事を伴うものについては再委託するものとし、発注手続き及び工事監理を行う。
- 4) モデルシステムの実施。
- (a) モデルシステムを用いて降雨、水位、流量の観測、資料収集、整理、保管業務を実施指導する
 - (b) 流速計のキャリブレーション作業を実施指導する
 - (c) 既存水文・気象資料の整理促進業務を行う
 - 降雨資料：日資料、時間資料
 - 水位資料：日（定時）資料、時間資料
 - 流観資料：H-Q曲線
 - 流量資料：日資料、時間資料、ピーク流量
 - (d) 以上の業務を通じて、観測・資料整理システムの実務上の問題点を調査し、とりまとめる
- 5) システムの維持管理マニュアルの作成：既存システムの問題点及びモデルシステムの実施を通じて得た実務上の問題点に立脚し、既存システム及びモデルシステムの運営、維持、管理上の改善策につき検討し、維持管理マニュアルとしてとりまとめる。このマニュアルはモデルシステムを含む既存システムの維持管理に資するもので、将来、短期計画等のシステム拡充に伴い必要に応じ改訂されるべきものである。
- 6) モデルシステムによる要員育成：モデルシステムの実施に伴う各段階の作業を通じてネパール側関係者に技術の移転を図り、要員の育成に努める。
- (5) 短期計画 (Immediate Programme) の策定
- 長期計画から選定された優先事業で構成される短期計画の、より詳細で具体的な計画を策定する。
- 1) 概略設計。
- (a) 計画の基本方針及び施設設計基準の設定

- (b) システムの設計：観測所の配置と機能、資料収集・整理システムの計画、資料保管・提供システムの計画、年間及び洪水時業務スケジュール
 - (c) 観測施設の設計：観測・記録方式と機器の種類、記録様式
 - (d) 資料収集・整理システムの設計：収集方式、整理方式、関連機器の種類、整理様式
 - (e) 資料保管・提供システムの設計：保管方式、提供方式、関連機器の種類、保管・提供に係る様式
 - (f) ワークショップ施設の設計：施設の機能、規模、必要資機材
 - (g) 施設の維持・管理業務の設計：定期整備点検業務、故障時の対応、資材補給、要員配置
- 2) 事業費積算：事業費及び維持管理費の積算。
 - 3) 実施計画：全体工期、工程、年度毎事業費、資金調達等に関する計画の策定。
 - 4) 組織及び体制の整備：現状の組織及び体制の問題点を明らかにし、改善策について検討し提案する。
 - 5) 事業評価：短期計画の実施に伴い期待される事業効果を評価する。

6-5 調査工程

調査は、ネパール国内での現地調査と、日本国内で行われる解析作業とで構成される。本調査は平成3年度から平成5年度にまたがる約28カ月間を予定する。調査工程（案）を図6-1に示す。

6-6 報告書

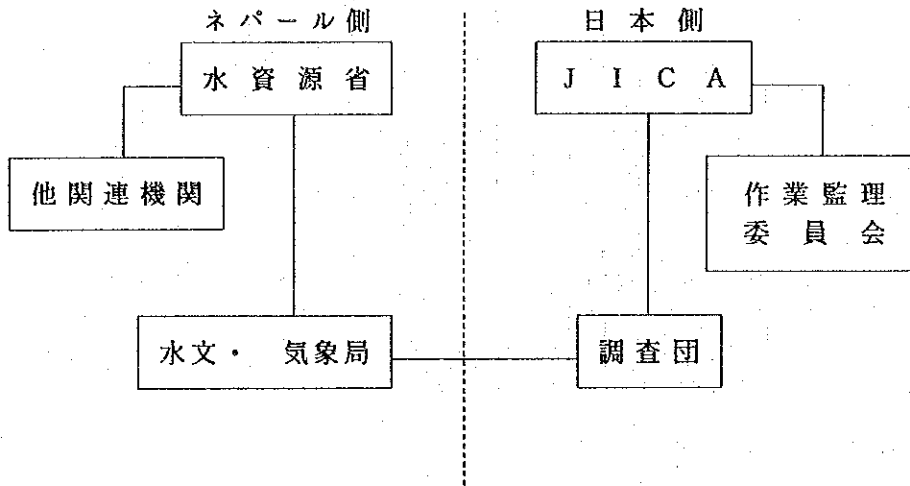
以下の報告書を作成し、ネパール側に提出のうえ、説明・協議等を行う。

- (1) インセプション・レポート (30部)：調査開始後1カ月以内に提出
- (2) プロGRESS・レポート (30部)：3カ月以内に提出
- (3) インテリム・レポート (30部)：8カ月以内に提出
- (4) プロGRESS・レポート (30部)：13カ月以内に提出
- (5) インテリム・レポート (30部)：15カ月以内に提出
- (6) プロGRESS・レポート (30部)：21カ月以内に提出
- (7) ドラフト・ファイナル・レポート (30部)：25カ月以内に提出
同レポートに対するネパール側のコメントは同レポート提出後30日以内にJICAに通知される。
- (8) ファイナル・レポート (50部)：同レポートは、ドラフト・ファイナル・レポートに対するネパール側のコメントを得てから45日以内に、コメントを吟味、検討のうえ提出する。

6-7 調査の実施体制

本件調査のネパール側担当官庁は水資源省 (Ministry of Water Resources) で、実施機関は水文・気象局 (Department of Hydrology and Meteorology) である。

本件調査の実施体制の概要は次のとおりである。



6-8 要員計画案 (担当分野)

本件調査の主要担当分野は次のとおりである。

- 1) 総括 : 調査団の総括、渉外
- 2) 水文 : 水文システムの計画、資料update
- 3) 気象 : 気象システムの検討、資料update
- 4) 水資源 : 水資源開発計画資料の検討
- 5) 治水 : 治水、砂防計画資料の検討
- 6) 観測システム : 観測機器・方式の検討 (ハード)
- 7) 処理システム : 資料処理システムの検討、設計 (ソフト)、資料update
- 8) 施設設計 : モデルシステムの設計、工費積算
- 9) 施設建設 : 工事発注手続き、施工監理
- 10) プロジェクト評価 : 事業評価

6-9 調査用資機材

本件調査の実施に必要な資機材として、とりあえず以下のとおり想定するが、本格調査の第1年次現地調査による検討を経て確定するものとする。

1) 自記雨量計	10台
2) 自記水位計	5台
3) 流速計	5台
4) 量水標	30m
5) 浮子	200本
6) 流量観測機材（ワイヤー、固定装置、ウインチ等）	1式
7) パソコン	3台
8) デジタイザー（自記紙読取り用）	5台
9) 流速計キャリブレーション用機材、施設	1式

6-10 調査実施上の留意点

調査実施にあたっては次の点に留意するものとする。

- 1) 本件調査の実施機関である水文・気象局は、プロジェクトに関する企画調整機能を持っていないため、プロジェクト情報の収集・整理に際しては、必要に応じ、適正な体制を確立するものとする。
- 2) システム整備の主要目的の1つである治水計画資料の収集・整理にあたっては、水系一貫の観点から、必要に応じネパール国内において、インド及びバングラデシュに関する治水計画資料も収集・整理する。特に支川洪水の本川への影響度、下流の洪水予報計画について重点的に整理する。
- 3) 既存システムの現状及び問題点の整理に際しては、1982年から1987年にかけて行われたUNDPプロジェクトの内容、成果について十分吟味を行う。

また、整備計画の策定にあたっては、ネパール・インド洪水予警報プロジェクト、ドイツ政府援助による雪氷水文プロジェクト及びボランティアサービス業務等の既存の事業計画との整合についても配慮する。

附 属 资 料

附属資料 A ネパール王国政府からの技術協力要請書 (TOR)

HIS MAJESTY'S GOVERNMENT OF NEPAL
MINISTRY OF WATER RESOURCES
DEPARTMENT OF HYDROLOGY AND METEOROLOGY

REQUEST FOR TECHNICAL ASSISTANCE
FOR
NATIONWIDE HYDRO-METEOROLOGICAL DATA
MANAGEMENT PROJECT

JULY 1989

TECHNICAL AID PROPOSAL
FOR
NATIONWIDE HYDRO-METEOROLOGICAL DATA
MANAGEMENT PROJECT

1. PROJECT TITLE

Nationwide Hydro-Meteorological Data Management
Project

2. LOCATION

Whole Country of the Kingdom of Nepal

3. EXECUTING AGENCY

Department of Hydrology and Meteorology,
Ministry of Water Resources

4. PROPOSED SOURCE OF ASSISTANCE

Government of Japan, through a Technical Assistance
Program of Japan International Cooperation Agency (JICA)

5. OBJECTIVES OF THE PROJECT

The Project aims at establishing a well-organized data collection, processing and management system on hydrology and meteorology on a nationwide scale. This objective would be achieved by provisions of two (2) systems; namely, (i) hydro-meteorological observation network system and (ii) data management system.

The primary objective of the systems establishment will be to acquire and store on a long-term basis the basic information and records necessary for formation of the country's proper river management and water utilization programs.

6. BACKGROUND

The Kingdom of Nepal, lying in the monsoon region, suffers from heavy flood damage every rainy season. Furthermore, the flood yields cause extensive inundation in the neighboring countries of India and Bangladesh, since all rivers in Nepal, four (4) major rivers of the Koshi, Gandaki, Karnali and Mahakali included, are tributaries of the Ganges river which flows down through India and Bangladesh. Further, it has been recognized that the implementation of proper development programme concerning river management and water utilization would be indispensable in Nepal not only for augmentation of agriculture, forest, hydropower and industrial production capacity of Nepal but also for watershed management in the deteriorous river basins.

On the other hand, available data on hydrology and meteorology are insufficient in Nepal for the reasons of (i) shortage in number and uneven distribution of existing gauging stations: in total 269 rain gauges and 77 stream gauges regularly operated now, and (ii) deficiency of data compilation capacity. Water resources development programmes have been successively made for several river basins with assistance of international agencies and the necessity of a nationwide hydro-meteorological data collection/management project (the Project) has been strongly pointed out in each program. But, the Project has been left behind, except for a partial achievement made in "Development of Operation of Hydrology" conducted under an assistance of UNDP during the period of 1984 through 1987.

His Majesty's Government of Nepal (HMGN) newly organized the Department of Hydrology and Meteorology (DHM) under the Ministry of Water Resources (MWRs), as a principal national agency on hydro-meteorological data management for the Kingdom of Nepal, at the time of the administrative reorganization in 1987 to support national water policies. DHM, however, is facing difficulties to begin an intensive execution of the nationwide data arrangement due to its technical and funding constraint.

7 EFFECTS OF THE PROJECT

The following effects would be produced directly or indirectly through the implementation of the proposed Project;

- (a) Hydro-meteorological data are indispensable for formulation and enforcement of national development programs regarding river management, water utilization and land development. The data collection and management systems so established under the Project would contribute much to accomplishing the DHM goal most effectively, and consequently contribute to HMGN's establishment of future river management and development programmes.
- (b) The data to be obtained from the new observation network system would offer useful information necessary for taking proper countermeasures for flood inundation not only in the country but also in the neighboring countries.
- (c) The network system above would, furthermore, give good opportunities to many provincial engineers and staffs for transfer of various relevant knowledges, since the observation and data management work shall be performed on a nation wide scale under their constant participation in the new system.

8. DESCRIPTION OF THE PROJECT

Proposed project under cover of this aid proposal is to acquire technical assistances primarily for planning and design of the observation network and data management systems as Phase 1 activity, and further for implementation and establishment of the systems including equipment, under the Phase 2 of the Project.

9. PROPOSED SCOPE OF TECHNICAL ASSISTANCE

The Project is proposed to be undertaken under a technical assistance programmes to be provided by the Government of Japan.

9.1 Terms of Reference

The Terms of Reference (TOR) for the proposed Project are given in Appendix. The TOR envisages that a Consultant Team comprising expatriate experts of various fields will be dispatched to Nepal to handle substantial parts of the Project.

9.2 Scope of Works

Major works for the Project are briefly itemized below. Further details are described in the TOR attached hereto.

(1) Phase 1: Study on System Development Plan

1) Hydro-Meteorological observation network system

- Review of present conditions on existing network system,
- Formulation of improvement and/or expansion plans for three time frames; namely, (i) long term plan for a time span upto 2000, (ii) mid-term plan for a time span towards year 1995 and (iii) immediate programme to be implemented under Phase 2 of this project,
- Selection of optimum observation method and equipment,
- Recommendation of organizational and institutional enhancement, including staff training plan under this project, and
- Preparation of workshop service expansion plan.

2) Hydro-Meteorological data management system

- Review of methods/procedures and facilities presently employed by DHM.
 - Preparation of hydro-meteorological data base format and forecast of data quantity to be handled in the new system and computational needs, and
 - Planning of new system configuration.
- 3) Preparation of preliminary design and tender documents, covering:
- (a) Supply and installation of facilities and equipment to be required for immediate programme, which would include the installation of the following facility/equipment.
 - Improvement of the existing 15 synoptic cum field inspection stations at a minimum extent required to achieve the objective of the Project
 - Installation of new gauges, comprising 30 rain gauges and 10 streamflow gauges.
 - Rehabilitation of existing rain and streamflow gauges, estimated to be some 70 stations.
 - (b) Reinforcement of observation equipment workshop facilities.
 - (c) Rehabilitation of existing chemical laboratory in Kathmandu to improve sediment analysis program and start water quality analysis for selected river basins, and reinforcement of sediment analysis system at field offices
 - (d) Provision of data management system facilities such as computer hardwares and data transmission equipment:

- A central system at the DHM head office in Kathmandu for handling nationwide data
- Local data processing and data transmitting systems, one set each at the existing 15 synoptic cum field inspection stations

(2) Phase 2: System Establishment and Guidance

Equipment and facilities listed in (1).3.(a) will be furnished in this phase. The associated technical services will cover;

- 1) Development of computer programs to be installed into the new management system
- 2) Assistance to DHM's supervision works on installation and testing of all equipment to be provided for the data management system.
- 3) Staff training relevant to the establishment of the new systems, including transfer of computer softwares.

9.3 Schedule of Works

The works will be conducted within thirty (30) months, as shown in Fig. 3 of TOR: the first fifteen (15) months will be allotted to the Phase 1 study on system development plan and the latter 15 months for the phase 2 works on the installation of the system.

9.4 Expertise Input

Input of the following expatriate experts and engineers will be required for executing the Project:

Expert/Engineer	Estimated M/M

Team leader (Hydro-meteorologist)	9
2-Meteorologist	28
2-Hydrologist	34
Civil Engineer	6
Computer specialist /system design engineer	22
Data base expert	14
Telecommunications engineer	10
Observation equipment expert	11
Architect	3

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10. UNDERTAKING BY GOJ AND HMGN

10.1 Assistance from the Government of Japan (GOJ)

HMGN hopes that the following assistance will be provided by GOJ:

- (a) Dispatch of the study team
- (b) Field survey and investigation relevant to the study
- (c) Supply and installation of system equipment and facilities

10.2 Undertaking by HMGN

HMGN will provide all necessary assistance and support to the project activities both in office and on field. The details of HMGN's undertakings are described in TOR attached hereto.

On the HMGN side, DHM will act as counterpart agency of the Project and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the works.

DHM will provide counterpart personnel, data and information relevant to the study, and suitable office space with equipments in Kathmandu and in regional offices as necessary.

APPENDIX

Draft Terms of Reference

for

Nationwide Hydro-Meteorological Data

Management Project

TERMS OF REFERENCE
FOR
NATIONWIDE HYDRO-METEOROLOGICAL DATA
MANAGEMENT PROJECT

1. Introduction

The Kingdom of Nepal, lying in the monsoon region, suffers from heavy flood damage every rainy season. Furthermore, the flood yields cause extensive inundation in the neighboring countries of India and Bangladesh, since all rivers in Nepal, four (4) major rivers of the Koshi, Gandaki, Karnali and Mahakali included, are tributaries of the Ganges river which flows down through India and Bangladesh. Further, it has been recognized that the implementation of proper development programme concerning river management and water utilization would be indispensable in Nepal not only for augmentation of agriculture, forest, hydropower and industrial production capacity of Nepal but also for watershed management in the deteriorative river basins.

On the other hand, available data on hydrology and meteorology are insufficient in Nepal for the reasons of (i) shortage in number and uneven distribution of existing gauging stations; in total 269 rain gauges and (77) stream gauges regularly operated now (see Figures 1 and 2), and (ii) deficiency of data compilation capacity. Water resources development programmes have been successively made for several river basins with assistance of international agencies and the necessity of a nationwide hydro-meteorological data collection/management project (the Project) has been strongly pointed out in each program. But, the Project has been left behind. As a similar project, "Development of Operational Hydrology" is only enumerated: the project was conducted under an assistance of UNDP during the period of 1984 through 1987 with the main aims of (i) compilation of existing hydrological data up to 1985 (ii) manpower training and (iii) rehabilitation of stations to a limited extent.

His Majesty's Government of Nepal (HMGN) newly organized the Department of Hydrology and Meteorology (DHM) under the Ministry of Water Resources (MWRs), as principal national agency on hydro-meteorological data management for the Kingdom of Nepal, at the time of the administrative reorganization in 1987 to support national water policies. DHM, however, is obliged to be prevented from intensive execution of the nationwide data

arrangement due to its technical and funding constraint. Thus, the need for the Project has become pressing.

DHM will be acting as the Executing Agency for the Project on the part of HMGN.

2. Objective of the Project

The Project aims at establishing a well-organized data collection, processing and management system on hydrology and meteorology on a nationwide scale. This objective would be achieved by provisions of two (2) systems; namely, (i) hydro-meteorological observation network system and (ii) data management system, which would be extensively established over the whole regions of Nepal.

The primary objective of the systems establishment will be to acquire and store on a long-term basis the basic information and records necessary for formation of the country's proper river management and water utilization programs. In this study, only a limited emphasis is given to the aspects of weather forecasting and real-time flood forecasting systems, which would require a large investment and hence be handled under separate programs, though the basic configuration of their future systems will be taken into account in the study under this Project.

3 Description of the Project

Technical assistance will be required primarily for planning and design of the system as Phase 1 activity, covering the following:

(1) Observation network system

Hydro-meteorological observation will be conducted over the whole of Nepal through the following:

- Improvement and expansion of the present network system in order to resolve its problems of shortage in number and uneven distribution of existing gauging stations and to perform reliable and stable observation works with back support from state-of-the-art technology, and

- Enhancement of organization and institution required for smooth and systematic implementation of operation and maintenance, including buildup of workshop services to observation equipment and/or instruments.

(2) Data management system

The management system will newly established, introducing advanced computer facilities under the full utilization of existing facilities. The system will have the following three (3) functions:

- decentralization of original data processing for reduction of the workloads of the DHM's head office in Kathmandu, and accomplishment of local computerization,
- Data transmission with data-stored diskette and, if practical, on telephone circuit line for simplification of data entry works into a data base system to be provided at the DHM's head office, and
- data processing, storage and management by the data base system for centralized and systematical data management, permanent preservation of highly compacted data and rapid data retrieval/dissemination.

HMGN further plans as an extended part of this study to implement the systems in line with the features as recommended from the study. For this implementation and establishment of the systems, further technical assistance services will be required under the Phase 2 of the Project.

4. Scope of Works

The scope of works shall include, but not be limited to, the following:

Phase 1: Study on System Development Plan

(1) Hydro-meteorological observation network system

- (a) Review of present conditions, especially present problems and constraints in existing network system from standpoints of gauges distribution, operating conditions of observation equipment, technical level of

observation staff, observation criteria, and operation and maintenance rules. The review study will include field reconnaissance in dry and wet seasons to acquire insitu information of observation sites,

- (b) Formulation of improvement and/or expansion plans incorporating the findings of the review above; namely, the plan shall propose (i) strategic installation of new observatories in due consideration of the objectives (river management, local flood dissemination, water resources development, etc.) and (ii) required rehabilitation of existing observatories. The plan shall be formulated for three time frames; (i) long term plan for a time span upto 2000, (ii) mid-term plan for a time span towards year 1995, and (iii) immediate implementation programme as an extended part of this project.
- (c) Selection of optimum observation method and equipment most suitable for observation objectives and gauge site conditions (accessibility, technical level of gauge readers available; etc.). The selection of type of equipment; manual, automatic or remote control type, shall be examined for each site.
- (d) Recommendation of organizational and institutional enhancement in relation with the new observation network, including staff training plan under this project.
- (e) Preparation of workshop service expansion plan required for achieving proper repair and maintenance of observation equipment/instrument, where the workshop is envisaged at DHM head office in Kathmandu and strategic local centers. The main workshop in Kathmandu will have a function of training center for personnel involved in the observatory work. The plan shall include the design of workshop facilities and the listing of shop tools/equipment to be procured.
- (f) Preparation of laboratory facilities; rehabilitation plan required for improving sediments analysis and developing water quality analysis system at DHM's head office in Kathmandu. Also plans for efficient sediment sample collection and analysis system, at field offices will be developed

(2) Hydro-Meteorological data management system

- (a) Review of methods/procedures and facilities presently employed by DHM for executing its hydro-meteorological data management work; namely, collection of original data from gauging sites, processing, storage and dissemination, including assessment of capacity of existing computer facilities,
- (b) Preparation of hydro-meteorological data base formats and forecast of data quantity to be handled in the new system and computational needs towards year 1995,
- (c) Planning of new system configuration in consideration of future system expansion. The following functions shall be taken into account:
 - decentralized processing of original data from gauge sites
 - data transmission and entry into a data base system in the DHM head office with data-stored diskette and, if practical, on telephone circuit line, and
 - data storage, retrieval and dissemination through the data base system

The study shall define the requirements of equipment installation and staff assignment, both at DHM head office and local centers.

(3) Preliminary Design and Tender Documents

As a part of immediate program proposed from the above studies, the DHM plans to implement the minimum required installations under an extended program of this Project. The implementation will include:

- (a) Supply and installation of facilities and equipment to be required for improvement and expansion of the observation network. DHM preliminarily foresees the installation of the following facility/equipment:

Improvement of the existing (15) synoptic cum field inspection stations at a minimum extent required to achieved the objective of the Project

- Installation of new gauges, comprising (30) rain gauges and (10) streamflow gauges
 - Rehabilitation of existing rain and streamflow gauges, estimated to be some (70) stations
- (b) Reinforcement of observation equipment workshop facilities in Kathmandu, including supply of tools and equipment
- (c) Rehabilitation of the existing chemical laboratory in Kathmandu to improve sediment analysis program and start water quality analysis for selected river basins; reinforcement of sediment analysis system at field offices
- (d) Provision of data management system facilities such as computer hardwares and data transmission equipment:
- A central system at the DHM head office in Kathmandu for handling the nationwide data
 - Local data processing and data transmitting systems, one set each at the (15) synoptic cum field inspection stations

For the procurement of the above works, the study shall produce the tender documents associated with preliminary design and cost estimate of the works.

On the basis of the design, estimate and documents so established, DHM will finalize the scope of system installations through discussion with the Technical Assistance Agency. the method of procurement of the works will also be discussed.

Phase 2: System Establishment and Guidance

- (1) Development of computer programs to be installed into the new management system for basic processing of original data, data base, data publishing, and system operation and maintenance
- (2) Assistance to DHM's supervision works on installation and testing of all equipment to be provided for the data management system

(3) Staff Training

The study team shall achieve a complete training of the DHM staff in aspects of operation and maintenance of the system. The training will cover:

- (a) On-site gauge observation technology including equipment operation, repair and maintenance
- (b) On-site data handling and transmission
- (c) Data processing, storage and management techniques related to the established data management system
- (d) Technology relevant to operation of equipment workshops including repair and maintenance of equipment
- (e) Transfer of computer softwares

The training shall be of such extent and depth that the DHM staff would have complete acquaintance with their assigned tasks. The operation and maintenance manuals, to be prepared by the study team and equipment suppliers, will be a main tool for this training.

Transfer of Technology

Other than the requirements in (3) above, the study team members shall use every opportunities for attaining the transfer of knowledges to DHM staff on various technical items relevant to the study, throughout the course of Phase 1 and Phase 2 studies. The transfer of knowledge will principally be attained by means of on-the-job-training.

5. Schedule of Works

The works will be conducted within thirty (30) months, as shown in Fig. 3: the first 15 months will be allotted to the Phase 1 study on system development plan and the latter 15 months for the Phase 2 works on the installation of the system.

6. Reports

The following reports shall be prepared within the period specified below:

(1) Phase 1

- (a) Inception Report : Within two (2) months after the commencement of the services

This report shall describe the initial findings based on the review of available information, and the detailed plan and methodology for the works.

- (b) Interim Report : Within eight (8) months after the commencement of the services

This report shall summarize the features of proposed observation network, observation method, and preliminary estimate the work quantities and cost, as well as the results of field reconnaissance survey.

- (c) Draft Final Report : Within thirteen (13) months after the commencement of the services

This report shall describe all the findings and conclusions of the Phase 1 study, including technical specification, work quantities and cost estimates.

- (d) Tender documents : Within thirteen (13) months after the commencement of the services

The documents shall be prepared for procurement of both observation network and data management systems. The documents will include the conditions of contract, specifications and bill of quantities, and other relevant information for the tenders.

- (e) Final Report (Phase 1): Within fifteen (15) months after the commencement of the services

This report shall be prepared as a final output of the Phase I study, to be duly revised and finalized on the basis of the DHM's comments on the aforesaid draft.

(2) Phase 2

(f) Operation and maintenance manuals on data observation and management works : Within twenty eight (28) months after the commencement of the services or at the end of system installation works

(g) Final Report (Phase 2): Within thirty (30) months after commencement of the services

These reports shall be prepared as the final outcomes of the Phase 2 activities.

7. Expertise Inputs

The following foreign engineers and experts will be required for performance of the works.

- Team leader (Hydro-meteorologist)
- Meteorologist
- Hydrologist
- Civil engineer
- Computer specialist/system design engineer
- Data base expert
- Telecommunications engineer
- Observation equipment expert
- Architect

8. Undertaking by HMGN

(1) To facilitate smooth and effective conduct of the works, HMGN shall take necessary measures including:

- (a) to secure the safety of the Consultant Team,
- (b) to permit the members of the Team to enter, leave and sojourn in Nepal for the duration of their assignment therein, and exempt from alien registration requirements and consular fees,

- (c) to exempt the member of the Team from taxes, duties and any other charges on equipment, machinery and other materials brought into Nepal for the conduct of the works,
 - (d) to exempt the member of the team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Team for their services in connection with the implementation of the works,
 - (e) to provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Nepal from Japan in connection with the implementation of the works,
 - (f) to secure permission for entry into private properties or restricted areas for the conduct of the works,
 - (g) to secure permission for the Team to take all information (including photograph) related to the works out of Nepal to Japan, and
 - (h) to provide medical services as needed, its expenses will be chargeable on the member of the Team.
- (2) HMGN shall bear claims, if any arises against members of the Team resulting from or occurring in the course of, implementation of the works, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team. This excludes personal and accidental insurance of the expatriate expert.
- (3) DHM shall act as counterpart agency of the Team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the works.
- (4) DHM shall, at its own expenses, provide the Team with the following; in cooperation with other organizations concerned:
- (a) Counterpart personnel,
 - (b) Available data and information concerned,
 - (c) Suitable office space with equipments in Kathmandu, and in provincial offices if necessary,
 - (d) Credential or identification cards, and
 - (f) Drivers and labourers.

附属資料 B Scope of Work (S/W)

SCOPE OF WORK
FOR
THE STUDY
ON
NATIONWIDE HYDRO-METEOROLOGICAL DATA
MANAGEMENT PROJECT
IN
THE KINGDOM OF NEPAL

AGREED UPON BETWEEN

MINISTRY OF WATER RESOURCES
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Kathmandu, September 11, 1990

H.M. Shrestha

Mr. H.M. SHRESTHA
CHIEF PROJECT COORDINATOR
MINISTRY OF WATER RESOURCES
HIS MAJESTY'S GOVERNMENT
OF NEPAL

白波瀬正道

Mr. MASAMICHI SHIRAHASE
LEADER
PRELIMINARY SURVEY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY

I. INTRODUCTION

In response to the request of His Majesty's Government of Nepal (hereinafter referred to as "HMGN"), the Government of Japan decided to implement the Study on Nationwide Hydro-Meteorological Data Management Project in the Kingdom of Nepal (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of HMGN.

The Ministry of Water Resources of Nepal (hereinafter referred to as "MWR") shall act as counterpart agency to the JICA Study Team and also as coordinating body in relation with other governmental and non-governmental organization concerned for the smooth implementation of the Study.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVE OF THE STUDY

The objectives of the Study are:


1. to formulate improvement and expansion plans for nationwide hydro-meteorological data management systems which comprise following systems;
 - a. hydro-meteorological observation network system
 - b. data management system
2. to effect technology transfer to Nepalese counterpart personnel in the course of the Study.

III. STUDY AREA

The Study area will cover the whole country of the Kingdom of Nepal.

IV. SCOPE OF THE STUDY

In order to achieve the above objectives, the Study shall cover the following;

HL 

1. Collection and review of available data and information related to the Study
 - a. socio-economic parameters
 - b. meteorology and hydrology
 - c. topography and geology including aerial photography
 - d. river basin condition including flood damage records
 - e. existing projects and plans for flood mitigation and drainage
 - f. existing projects and plans for regional and sectoral development
 - g. existing projects and plans for water resources development
 - h. existing projects and plans for watershed conservation and management
 - i. existing land use and future plan
 - j. existing condition of communication system and future plan
 - k. others

2. Review of existing systems; Hydro-meteorological observation network system and data management system.
 - a. hydro-meteorological observation network system, including field reconnaissance.
 - gauges distribution
 - operation conditions of observation equipment including workshop
 - observation staff
 - observation criteria
 - operation and maintenance rules
 - organization

 - b. hydro-meteorological data management system.
 - methods and procedures; collection of original data from gauging sites, processing, storage and dissemination
 - equipment and facilities including assessment of capacity of existing computer facilities

3. Formulation of improvement and expansion plans for hydro-meteorological observation network system and data management system.
 - a. formulation of long term programme
 - establishment of principles for long term programme
 - conceptual design of system
 - comparative study of alternatives
 - cost estimation
 - organization and institutional arrangement
 - selection of priority projects



- b. implementation of model system
 - identification of model system
 - detail design
 - installation of necessary equipment
 - monitoring and experiment
 - operation and maintenance plan
 - staff training by using model system

- c. formulation of immediate programme
 - preliminary design
 - cost estimation
 - implementation schedule
 - organization and institutional arrangement
 - project evaluation

V. STUDY SCHEDULE

The Study, in principle, shall be carried out in accordance with the tentative schedule shown in the attached Annex 1. The schedule is tentative and subject to be modified when both parties agree upon any necessity that arises during the course of the Study.

VI. REPORTS

JICA shall prepare and submit the following reports in English to HMGN.

1. Inception report
Thirty(30) copies within one(1) month after the commencement of the Study.

2. Progress Report(1)
Thirty(30) copies within three(3) months after the commencement of the Study.

3. Interim Report(1)
Thirty(30) copies within eight(8) months after the commencement of the Study.

4. Progress Report(2)
Thirty(30) copies within thirteen(13) months after the commencement of the Study.

5. Interim Report(2)
Thirty(30) copies within fifteen(15) months after the commencement of the Study.

6. Progress Report(3)
Thirty(30) copies within twenty one(21) months after the commencement of the Study.

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7. Draft Final Report

Thirty(30) copies within twenty five(25) months after the commencement of the Study. The HMGN will submit its comments on the report to JICA within thirty(30) days after receipt of the Draft Final Report.

8. Final Report

Fifty(50) copies within forty five(45) days after receipt of the comments on the Draft Final Report.

VII. UNDERTAKING OF HIS MAJESTY'S GOVERNMENT OF NEPAL

1. To facilitate smooth implementation of the Study, HMGN shall take necessary measures;

- 1) to secure the safety of the Japanese Study team,
- 2) to permit the members of Japanese Study team to enter, leave and sojourn in Nepal for the duration of their assignment therein, and exempt from alien registration requirements and consular fees.
- 3) to exempt the members of Japanese Study team from taxes, duties and any other charges on equipment, machinery and other materials brought into Nepal for the conduct of the Study,
- 4) to exempt the members of the Japanese Study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese Study Team for their services in connection with the implementation of the Study,
- 5) to provide necessary facilities to the Japanese Study team for remittance as well as utilization of the funds introduced into Nepal from Japan in connection with the implementation of the Study,
- 6) to secure permission for entry into all areas necessary for the conduct of the Study,
- 7) to secure permission for the Japanese Study team to take all data and documents(including photograph) related to the Study out of Nepal to Japan,
- 8) to provide medical services as needed, its expense will be chargeable on the member of the Japanese Study team.

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2. HMGN shall bear claims, if any arises against members of the Japanese Study team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese Study team.
3. MWR shall, at its own expense, provide the Japanese Study team with the following, in cooperation with other organizations concerned:
 - 1) Counterpart personnel
 - 2) Available data and information related with the Study
 - 3) Suitable office space with furniture in Kathmandu, and regional offices if necessary
 - 4) Credential or identification cards
 - 5) Arrangement of a helicopter with pilot

VIII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. to dispatch Study team at its own expense to Nepal,
2. to pursue technology transfer to the Nepalese counterpart personnel in the course of the Study,
3. to provide the equipment and machinery for the implementation of the Study, which will remain the property of the Government of Japan, unless otherwise agreed upon.

IX. CONSULTATION

JICA and MWR shall consult with each other in respect of any matter that may arise from or in connection with the Study.

File

[Signature]

TENTATIVE SCHEDULE

MONTH ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
STUDY IN NEPAL																												
STUDY IN JAPAN																												
REPORT	△																											
	IC/R	P/R(1)						IT/R(1)					P/R(2)		IT/R(2)						PR/R(3)				DF/R		F/R	

(REMARKS) IC/R : Inception Report P/R : Progress Report
 IT/R : Interim Report DF/R : Draft Final Report
 F/R : Final Report

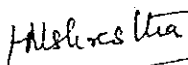
July

MINUTES OF MEETING
ON
SCOPE OF WORK
FOR
THE STUDY
ON
NATIONWIDE HYDRO-METEOROLOGICAL DATA
MANAGEMENT PROJECT
IN
THE KINGDOM OF NEPAL

AGREED UPON BETWEEN

MINISTRY OF WATER RESOURCES
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Kathmandu, September 11, 1990



Mr. H.M. SHRESTHA
CHIEF PROJECT COORDINATOR
MINISTRY OF WATER RESOURCES
HIS MAJESTY'S GOVERNMENT
OF NEPAL



Mr. MASAMICHI SHIRAHASE
LEADER
PRELIMINARY SURVEY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY

The Preliminary Survey Team (hereinafter referred to as "the Team") organized by Japan International Cooperation Agency (hereinafter referred to as "JICA"), and headed by Mr. Masamichi SHIRAHASE, visited the Kingdom of Nepal from September 5 to September 13, 1990 for the purpose of discussions and exchange of views on the Study on Nationwide Hydro-Meteorological Data Management Project in the Kingdom of Nepal (hereinafter referred to as "the Study").

The Team had a series of discussions with the concerned authorities of His Majesty's Government of Nepal (hereinafter referred to as "HMGN"), in particular with Ministry of Water Resources (hereinafter referred to as "MWR"), Department of Hydrology and Meteorology (hereinafter referred to as "DHM") and also conducted field survey. A list of participants is attached in Annex 1.

As a result of the discussions, both sides agreed on the Scope of Work for the Study.

The main items of mutual understanding in addition to the agreed Scope of Work are as follows;

1. Arrangement for the Study

- a. MWR shall be fully responsible to the implementation of the Study, and DHM shall act as executing agency.
- b. MWR shall make necessary arrangement so that data, information and views, provided by other agencies as well as DHM, shall be duly reflected to the Study.

2. Equipment

a. Vehicles

The team requested MWR to provide two (2) units of vehicles during the course of the Study. MWR, due to financial constraint and non-availability of vehicles, requested the Team to provide vehicles for the Study. The Team agreed to convey the above request to JICA for consideration.

b. Helicopter

Since the Nepal is mountainous country and the accessibility to the hydro-meteorological observation stations is very difficult, a helicopter plays important role for the smooth and effective implementation of the Study. The Team strongly requested MWR for the provision

July

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of a helicopter during the course of the Study. MWR explained that MWR, due to budgetary constraints, can not bear the hiring charges of helicopter, but will make necessary arrangement for its hire. MWR strongly requested the Team to bear necessary expense for hiring of helicopter. The Team agreed to the request.

c. Other equipment

MWR requested the Team to provide necessary study equipment and other materials for the successful conclusion of the Study. The Team agreed to convey the above request to JICA for consideration.

3. Counterpart

The Team requested MWR to assign to the JICA Study team the appropriate counterpart personnel and support staff such as typists, drivers, etc. MWR agreed to fulfill the request to the extent possible.

MWR requested that transfer of technology to the counterparts shall be done by both through on-the-job training in the course of the Study in Nepal and technical training in Japan. The Team agreed to convey the above request to JICA for consideration.

4. Others

HMGN requested the Team that due attention will be paid to water resources development and other water related projects while formulating the long term programme as well as immediate programme.

HMB

LIST OF PARTICIPANTSJICA Preliminary Survey Team

- 1.Mr. Masamichi Shirahase, Senior Officer for River information, River Planning Div., River Bureau, Ministry of Construction.
- 2.Mr. Junji Takayanagi, Deputy Director, Research and Information Div., Economic Affairs Bureau, Ministry of Construction
- 3.Mr. Noboru Jitsuhiro, Registered Consulting Engineer, Manager, Overseas Affairs div, Nikken Consultants Inc.
- 4.Mr. Kiyoshi Yoshimoto, Coordinator, Japan International Cooperation Agency

Embassy of Japan

- 1.Mr. kenzo Hiroki, Second Secretary

Ministry of Water Resources

- 1.Mr. Harsha Man Shrestha, Chief Project Coordinator
- 2.Mr. N. N. Vaidya, Senior Divisional Engineer

Water and Energy Commission

- 1.Dr. Hari Man Shrestha, Executive Director

Ministry of Finance

- 1.Mr. Ramesh Lal Shrestha, Section Officer

Department of Hydrology and Meteorology

- 1.Dr. S. P. Adhikary, Director General
- 2.Mr. Kiran Shankar, Chief Hydrologist
- 3.Mr. Adarsha P. Pokhrel, Senior Hydrologist

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附属資料 D 面談者リスト

1. 水資源 (MINISTRY OF WATER RESOURCES)

- MR. B. K. PRADHAN SECRETARY
- MR. H. J. MALLA ADDITIONAL SECRETARY
- MR. H. M. SHRESTHA CHIEF PROJECT COORDINATOR
- MR. V. S. SHRESTHA SUPERINTENDING ENGINEER
- MR. N. N. VAIDAYA SENIOR DIVISIONAL ENGINEER

2. 水・エネルギー委員会事務局 (WATER AND ENERGY COMMISSION SECRETARIAT)

- DR. C. K. SHARMA EXECUTIVE SECRETARY
- DR. H. M. SHRESTHA EXECUTIVE DIRECTOR

3. 大蔵省 (MINISTRY OF FINANCE)

- MR. R. L. SHRESTHA SECTION OFFICER

4. 水文・気象局 (DEPARTMENT OF HYDROLOGY AND METEOROLOGY)

- DR. S. P. ADHIKARY DIRECTOR GENERAL
- MR. KIRAN SHANKAR CHIEF HYDROLOGIST
- MR. A. P. POKHREL SENIOR HYDROLOGIST
- MR. P. B. SHRESTHA SENIOR CLIMATOLOGIST
- MR. L. M. ACHARYA CHIEF METEOROLOGIST
- MR. M. B. BASNET SENIOR METEOROLOGIST
- MR. B. K. BAIDAYA SENIOR METEOROLOGIST
- MR. K. P. SHARMA DIVISIONAL HYDROLOGIST
- MR. N. A. SHRETHA CHIEF, OKALDUNGA SYNOPTIC CUM STATION
- MR. Y. M. MISHRA HEAD, REGIONAL OFFICE, DHARAN
- MR. SHAKYA MANI CHIEF, POKHARA REGIONAL OFFICE, METEOROLOGIST
- MR. KANSAKAR SUNIL ENGINEER HYDROLOGIST, POKHARA REGIONAL OFFICE
- MR. R. S. KANSAKAR ENGINEER, WEATHER FORECASTING DIVISION

5. ネパール電力庁(NEPAL ELECTRIC AUTHORITY)

- DR. N. K. KAPALI DIRECTOR

6. 日本国大使館

- 有地 一昭 特命全権大使
- 西名 孝雄 参事官
- 廣木 謙三 二等書記官

7. JICAネパール事務所

- 熊野 秀一 所長
- 大山 雅民 所員

附属資料 E 質問書及び調査結果

調査団は、ANNEX E.1 に示す質問書を提出し、全体会議及び担当部局での個別事情聴取により、文書或いは口頭によるネパール政府の回答を得た。ネパール政府の回答を ANNEX E.2 にとりまとめる。

QUESTIONNAIRE
FOR THE STUDY
ON NATIONWIDE HYDRO-METEOROLOGICAL
DATA MANAGEMENT PROJECT

1. GENERAL

1.1 Basic Information

- a. Organizational setup of the Government
- b. Names of offices/sections in charge of;
 - foreign loan and technical aid,
 - meteorological observation and data management, and
 - hydrological observation and data management.
- c. Current national development plan and strategy

1.2 Sources of Data and Information

- a. Governmental publication
- b. National and regional statistics
- c. National and regional development plan
- d. Hydro-meteorological observation and data management
- e. Water resources development
- f. Flood control and river improvement
- g. Flood forecasting
- h. Other river administrative activities

1.3 Administration of Existing Observation and Data Management Systems

- a. Governmental and private agencies/organizations related to the observation and data management
- b. Organizational setup including central and regional offices of the organization: organization, number of staff, etc.
- c. Kinds of data, functions and purposes of respective organizations
- d. Cooperation and coordination among the organizations
- e. Laws and regulations related to the hydro-meteorological observation and data management
- f. Budgetary arrangement and amount of annual budget for the observation and data management during past 10 years

g. Fiscal year and hydrological year of the Nepal

1.4 Plan for Improvement and Expansion of System

- a. Needs of improvement and expansion of systems in relation with the existing, ongoing and future projects
- b. Expansion plan for the real time data communication system
- c. Existing improvement and expansion schemes and priority of implementation
- d. Possible sources of fund for the implementation

1.5 Clarification of Original Draft TOR by the HMGN

- a. Second line from the bottom in the 1st page: contents of "water policies"
- b. Fifteenth line from the top in the 2nd page: concept of "proper river management program"
- c. Thirteenth line from the top in the 4th page: basis of target years, 2000 for long term plan and 1995 for mid-term plan
- d. Item 4,(3),(a) in the 5th page: basis of quantity of stations proposed for new installation and rehabilitation
- e. Advantages of processing data locally

1.6. Others Matters to be Clarified

- a. Influence to the countries located in the lower reaches such as India and Bangladesh
- b. Kinds of data included in the project
- c. Necessity of water quality analysis and its necessary test items
- d. Purpose of sediment investigation and its necessary study items
- e. Result of study "Development of Operation of Hydrology" by UNDP

1.7 Implementation of JICA Study

- a. Agency or organization of the Nepal which will take charge of the Study
- b. Location of the office to be provided for the JICA Study Team
- c. Site Conditions and Access
 - Transportation
 - Communication
 - Security and other matters to be considered

2. BRIEF INFORMATION OF NEPAL

- a. Topography and geography
- b. Climate and weather
- c. Characteristics of precipitation
- d. Socio-economic parameters/statistics
- e. Major economic activities

3. BACKGROUND INFORMATION

3.1 Basin Development

- a. Existing land use and plan
- b. Existing urban development and plan
- c. Existing farm land development and plan
- d. Existing industrial land development and plan
- e. Strategy and schedule for future basin development

3.2 Water Resources Development

- a. Existing water use and facilities
- b. Existing water quality problems
- c. Existing water resources development plan
- d. Strategy and schedule for future development

3.3 Flood Control and River Improvement

- a. Existing river conditions
- b. Past floods and other river-related disasters
- c. Existing river-improvement/flood-control projects and plan
- d. Strategy and schedule for future improvement

3.4 Flood Forecasting

- a. Existing flood forecasting system and plan
- b. Strategy and schedule for future system

3.5 Other River Administrative Activities

- a. Existing administrative activities
- b. Strategy for future administrative activities

4. EXISTING OBSERVATION AND MANAGEMENT SYSTEMS

4.1 Availability of Data

- a. Number of existing stations by types and operating conditions
- b. Location of observation stations with location map
- c. Major dimensions of stations: type of equipment, manual or automatic, year of installation, operating conditions, etc.
- d. Period of available records for each station

4.2 Observation System

- a. Availability of observation manual/regulation
- b. Deployment of observers
- c. Method of observation: observer, time and frequency of observation, etc.
- d. Supply of consumables such as spare parts, recording paper, ink, battery, etc.
- e. Skill of observers and training program for them
- f. Existing laboratories and facilities for water quality test
- g. Conditions of the existing workshop for hydro-meteorological observation equipment
- h. Existing conditions and problems of the real time data communication system
- i. Other problems regarding the observation system

4.3 Data Management System

- a. Availability of manual for data management
- b. Method of gathering, processing, compiling and offering data: flow of data, equipment and facilities, formats, etc.
- c. Processing and compiling conditions of the existing data
- d. Other problems regarding the data management system

4.4 Others

- a. Functions of central and local stations and problems
- b. Appropriateness of distribution and density of stations

1.

1.1

- a) Cabinet - Ministry - Department — *K. M.*
- b) - Foreign Aid and Coordination Division
Ministry of Finance
Incharge - Dr. T. N. Pant,
- Department of Hydrology and Meteorology (DHM)
Incharge - Dr. S. P. Adhikary
- c) The implementation of the next five year development plan will start in the coming fiscal year.

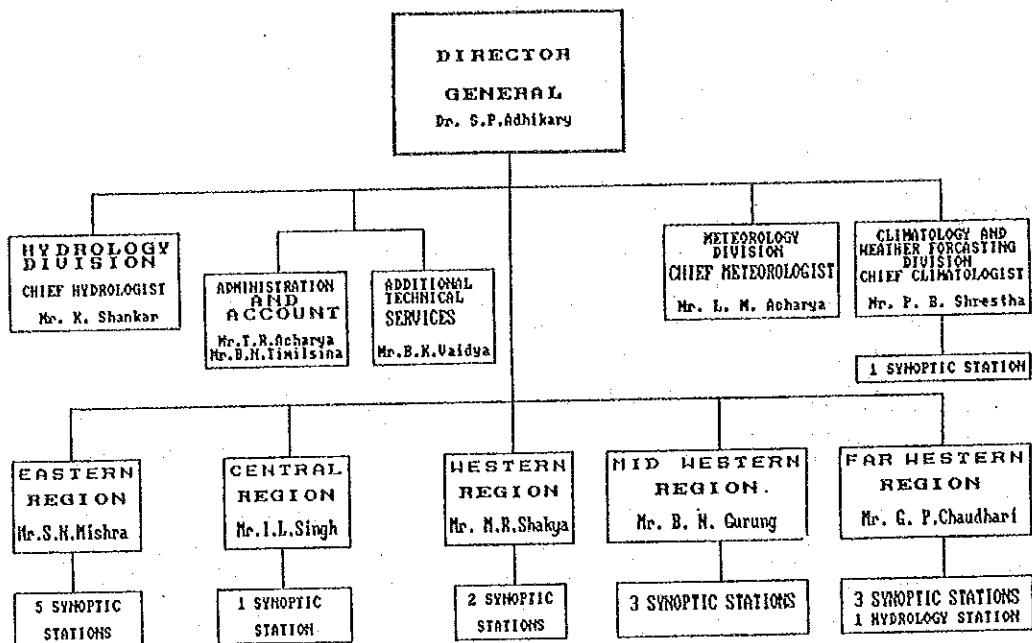
1.2

- a) Government publications are made by the respective Ministries and Departments.
- b) Statistical yearbook is published every two year by the Statistical Bureau of Nepal covering the national and regional statistics.
- c) National Planning Commission
- d) DHM is the sole organization responsible for the hydrological and meteorological data management in the country.
- e) Ministry of Water Resources (MWR), Department of Irrigation (DOI), Water and Energy Commission (WEC) and Nepal Electricity Authority (NEA) are the sources of data and information on water resources development.
- f) DOI is the source of data and information on flood control and river improvement works.
- g) DHM is the source of information on flood forecasting activities.
- h) *Dept. of Soil Conservation and Watershed Management*
MWR and WEC are the sources of information on other river administration activities.

1.3

- a) DHM is the sole organization related to the observation and data management. The other organizations eg, NEA and DOI may collect some data for certain duration for their specific needs.
- b) See the available organization chart of DHM
- c) Hydrological and meteorological data *including sediment data*
- d) Any data collected by the agencies are generally sent to the DHM.
DHM makes the data available to the individual users, agencies and organizations.
- e) DHM formulates the laws and regulations related to the hydrometeorological observation and data management based on the standard practices under the general guidance of the MWR.

HIS MAJESTY'S GOVERNMENT OF NEPAL
 MINISTRY OF WATER RESOURCES
 DEPARTMENT OF HYDROLOGY AND METEOROLOGY
ORGANISATIONAL CHART



Summary of staffs:

1. Gazetted class I	4 nos.
2. Gazetted class II	30 nos.
3. Gazetted class III	48 nos.
4. Non Gazetted	257 nos.
5. Peons, Chaukidars	57 nos.
	396 nos.

- f) See the table made available
- g) Fiscal year : starts and ends in mid-July
- Water Year : Same as Gregorian calendar year

1.4

- a) Needs : - Upgrading of the existing stations
- Establishment and operation of at least the minimum network density for the proper assessment of water resources, weather and climate
- Data management for timely processing and smooth information flow
- Upgrading and expansion of the existing system for flood forecasting activities
- b) Plans have been formulated for flood forecasting in the major river basins.
- c) Priorities are the improvement in operation of the existing data collection and management system and initiation of flood forecasting system in Nepal. Some infrastructural works in the field of flood forecasting are being carried out in collaboration with the Government of India.
- d) His Majesty's Government of Nepal, Bilateral and International

1.5

- a) Collection, processing and preparation of hydrological and meteorological data as per the requirements of different projects designed to support national water resources development programme. Literature on it is available in WECS.
- b) The term includes flood control, flood forecasting, sediment studies river water control and other similar aspects related to the river for its utilization and control.
- c) Nepal's basic needs programme is formulated for a period of 2000 A.D. According to this concept the long term plan is for a period of upto 2000 A.D. which means a 10 year-plan. Hence, 1995 a period of 5 years is termed as a midterm plan.
- d) At present 15 synoptic stations are in operation in Nepal. So this is the basis for synoptic station numbers.

As per the regional hydrological analysis conception, it is felt that at least 30 more rain gauges and 10 more stream flow gauges are to be added in the present network.

It is estimated that about 70 rain and stream flow gauges need rehabilitation at present.

- e) Local technical personnel are better aware of the station situation.

1.6

- a) As India and Bangladesh are the lower riparians of the rivers in Nepal, the data management system of Nepal can be directly beneficial to these countries as it is essential to use the data of the head water region for water management as well as flow forecasting.
- b) Hydrological and Meteorological data
- c) Necessity of water quality analysis for the monitoring of water quality of the rivers exposed to the excessive agricultural, industrial, tourist and urbanization activities. Test items may differ in different rivers depending on their source of pollution.
- d) For the assessment of sediment yield of different basins in Nepal. Study items could be : sediment concentration, Suspended sediment transport, bed load transport and sediment size analysis.
- e) - Developed and installed computerized data base system
- Established workshop for the maintainance of hydrological equipment
- Upgraded the data processing system
- Provided local and overseas trainings
- contributed in regional hydrological studies

1.7

- a) Department of Hydrology and Meteorology
- b) Kathmandu
- c) As per the following Table

Hydrometric Stations

Number of Stations

Accessibility	Hydrometric Stations			Meteorological Stations				
	Regular(Q)	Partial(H)	Total	Aero/synop	Agro. Met	Climate	Precipitation	
1) Within .5 hour walking distance from nearest road head	19	14	33	11	18	34	56	119
2) Within .5 day walking distance from nearest road head	5	11	16	x	1	3	7	11
3) Within 1 day walking distance from nearest road head	4	16	20	1	x	2	1	4
4) More than 1 day walking distance from nearest road head	15	48	63	10	4	6	5	25
TOTAL	(43)	(89)	(132)	(22)	(23)	(45)	(69)	(159)
Within 1 day walking distance from nearest air port (only the places with no motorable road).	6	3	9					

2.

- a) - Lies between 80 and 88 E and 27 and 30 N
 - Area : 147,181 sq km
 - Elevation range from 100 to over 8000 m
 - Extreme climatic contrast from south to north with tropical climate of the Ganges plain to arctic desert of the highest regions
 - The country is divided by nature from south to north as the Terai (plain areas) and mountains. The mountains from south to north can again be divided as the Siwalik hills, The Mahabharat, the midlands, the Himalayas, the inner Himalayas and the Tibetan mountains
- b) Monsoonal climate with wet summer monsoon and dry winter monsoon.
- c) About 80 % of annual precipitation occurs during the summer monsoon. Some precipitation in winter occurs under the influence of the western disturbances.
- d) Per capita GNP = \$170

e) Agriculture

3.

3.1 Contact MWR, DOI, Department of Survey and Ministry of Housing and physical Planning.

3.2 " " " " " "

3.3 " " " " " "

3.4

a) No flood forecasting system is in operation. It is only at planning stage.

b) Flood forecasting system with Indian Government collaboration in near future.

3.5 Contact MWR

4.

4.1

a) Regular streamflow stations = 43
River Stage stations with partial discharge measurements (excluding discharge stations) = 79
Aeronautical/Synoptic meteorology stations = 22
Agrometeorological stations = 23
Climatological stations = 45
Precipitation Stations = 69

About 90 % of stations are fully operational

b) Location map - made available

c) List of stations with required information - see the available table

d) See the list of the stations

4.2

a) No. manual on hydrological observation. On meteorology - "Nepal Meteorological Service, Manual of observations" June 1978.

b) One observer at each station deployed under part time daily wages basis

c) Observer : manual observation by observer supported by mechanical automatic recorders at some stations.

Time and frequency :

Water level readings - 0800, 1200, 1700 (3/day)

Precipitation - 0845, (1745) (1 or 2/day)

Climatic observation - " " " "

Synoptic - 0545, 0845, 1145, 1445, 1745 (5/day)

Discharge - program made on annual basis

d) Consumables are supplied through regional offices during the field visits by the technicians.

e) Skill of the observers is fair to very good. Observers are

trained by technicians at site. No planned training activities for part time observers.

- f) No water quality test laboratory exists in the department.
- g) There are two separate workshop rooms, one for hydrology and one for meteorology with reasonable facilities.
- h) Real time data communication system available only in 15 meteorological synoptic stations where data is transmitted to Kathmandu via (voice) wireless.
- i) Other problems regarding the observations are : poor equipment facilities at the station , remoteness of most of the sites, lack of instrument calibration facilities, insufficient field visits from the regional and central offices etc.

4.3

- a) Manual on primary processing of hydrological data in the computer is available.
- b) Data observed by the observers are either collected by the technician or are sent by post to the Regional Offices. These data are entered in the computer and are sent to the Kathmandu for final processing.
- c) Monthly means and extreme values of river discharge, rainfall, air temperature, humidity are being compiled.

4.4

- a) Central office in Kathmandu acts as the main controlling point for all the regional offices. Regional offices control the stations in their region.
- b) Number of stations in the existing network is not enough.

Budget allocation

In Nepali Rs.

<u>Fiscal Year</u>	<u>Hydrology</u>	<u>Meteorology</u>
1981 - 82	58,45,000	42,00,000
82 - 83	61,85,000	43,10,000
83 - 84	63,25,000	43,88,000
84 - 85	85,65,000	40,37,000
85 - 86	88,00,000	64,00,000
86 - 87	1,19,90,000	34,71,200
87 - 88	1,04,96,000	49,82,120
88 - 89	1,00,00,000	52,51,788
89 - 90	90,22,000	53,38,933
90 - 91	73,00,000	43,65,000

附属資料 F

調査関連資料の賦存状況等

(1) ネパール国の概要

ネパール国の自然、社会、経済等の概要に関する資料は、大学教官、政府官吏により著作、編集された書物が一般に市販されている。

(2) 経済・統計資料

政府から1989年版Statistical Year Book (National Planning Commission Secretariat) 及び1989-90年版Economic Survey (Ministry of Finance) が刊行されており、これらが最新資料である。これらの刊行物は一般に市販されており、その主な内容は次のとおりである。

1) Statistical Year Book of Nepal (1989)

- 地域と人口
- 食糧と農業
- 森林、気候、観光
- 健康、家族計画
- 運輸・通信
- 教育
- 通貨・金融、貿易、財政、国家経済勘定、物価
- 工業
- 水、電力、かんがい
- 国際比較

2) Economic Survey (1989-1990)

- 経済活動の現状
- 国家歳入、消費、貯蓄
- 農業
- 工業、公共事業、観光
- エネルギー、林業
- 運輸・通信
- 貿易及び国際収支
- 通貨供給、金融、財政制度

- 公共投資
- 物価及び供給の状態
- ソーシャルサービス

一方、Nepal Rastra Bankは年報としてEconomic Report (1987/88が最新版)及び速報としてMonthly Report : Main Economic Indicatorsを発行している。年報と月報の記載項目は概ね同じで、年報の主な内容は次のとおりである。

- 経済概観
- 国家収入及び生産
- 通貨・金融
- 財政
- 物価
- 対外貿易及び支払
- 統計資料

(3) 地図、航空写真及び地質図等

(3-1) 地形図

ネパール全土にわたる下記縮尺の地形図が、Topographical Survey Branch, H. M. G. Survey Departmentで印刷、出版されており、一般に市販されている。

- 1/500,000 (1985年)
- 1/250,000
- 1/125,000
- 1/50,000 (1960年代編集)

これらのうち、1/50,000地形図は青焼単色仕上げである。Index MapをANNEX F.1に示す。1/50,000地形図の青焼原図はTopographical Survey Branchにあり、青焼を直接依頼(有料)することもできるが、原図の一部が欠損している。

(3-2) 航空写真

概ね15,000ftより低地のネパール全土をカバーする航空写真(1/10,000~1/50,000)がTopographical Survey Branchで入手可能である。航空写真の賦存状況図をANNEX F.2に示す。ANNEX F.2に示す以外の航空写真もあるが、エベレスト山頂付近、カトマンズ市付近等、局部的なものである。

航空写真の入手にあたっては、Ministry of Water ResourcesあるいはDepartment of Hydrology and Meteorology等の政府機関を通じて購入しなければならない。

(3-3) 地質図

ネパール全土の地質図として、下記の2種があり、いずれも一般に市販されている。

— Geological Map of Nepal

縮尺：1/1,000,000

発行：Department of Mines and Geology,
Ministry of Industry, 1982

— Geological Map

縮尺：1/125,000

印刷・発行：Topographical Survey Branch,
H.M.G. Survey Department, 1982

上記のほかにネパール東部、中部、西部毎の地質図の製作出版準備が進められている模様であるが、詳細は不明である。

(3-4) 行政図

行政区、人口等を取りまとめたものとして次の地図があり、いずれも一般に市販されている。

— Nepal : Administrative, Physiographic, and Relief (1987) ;

1/2,000,000 ; Topographical Survey Branch, Survey Department

— Central Service Map : 1989 ; Ministry of Works and Transport, Department of Roads, Supervision Bridge Division ; District毎に1枚仕上げになっており、現在Nepalの80%程度のDistrictsが完成している。

(4) 開発関連資料

国家の中長期的な開発計画は、National Planning Commission Secretariatが担当しているが、本年春の政変後、暫定政権状態にあり、現在、単年度計画で施行されている。近く公布される憲法の制定を待って、中長期計画の策定に入るとのことである。

水資源開発関連の計画は、主にMinistry of Water Resourcesが担当しているが、Ministry of Housing and Physical Planning及びMinistry of Forestry and Soil Conservationもそれぞれの関連する分野を担当している。

これらのうち、かんがい開発に関しては、UNDPが実施したマスタープランがある。水力発電に関しては、流域毎のPotential Project図をWater and Energy Commission Secretariat (WECS) が作成しているが、マスタープランは策定されていないとのことである。他の分野に関しては、本調査期間中に、マスタープラン等の広域かつ中長期的な計画の存在を確認できなかった。

(5) 水文・気象資料

(5-1) 水文・気象資料整備事業計画

水文・気象資料の整備に関する事業計画資料は、水文・気象局が保有しているが、事業に直接関連する観測所の計画については、事業主体が計画資料を保有している。しかし、事業関連の観測所の場合であっても、DHMはその計画、設置に参画している。

(5-2) 水文資料

水位、流量等の資料は、Hydrology Div.,DHMが管理している。1985年までの資料は、電算処理済みで、提供可能な状態になっているが、1986年以降の資料は、未整理あるいはカトマンズへ未回収であり、提供できる状態になっていないとのことである。

水文資料はインド等との国際問題があり、現在一般公開（市販等）されていない。資料の整理が遅れていること、流量観測精度が低いこと（流速計が調達後未調整であること等による）等のため水資源開発計画検討への利用に問題がある。

さらに、洪水時記録についても、定時観測（標準1日3回）のため洪水最大水位を必ずしも観測できないこと、洪水時に接近できない観測所があること、自記水位記録があってもデジタルタイザー（DHM1台所有）が故障しており、読み取り作業が進んでいないこと等により、資料は極めて少ないとのことである。

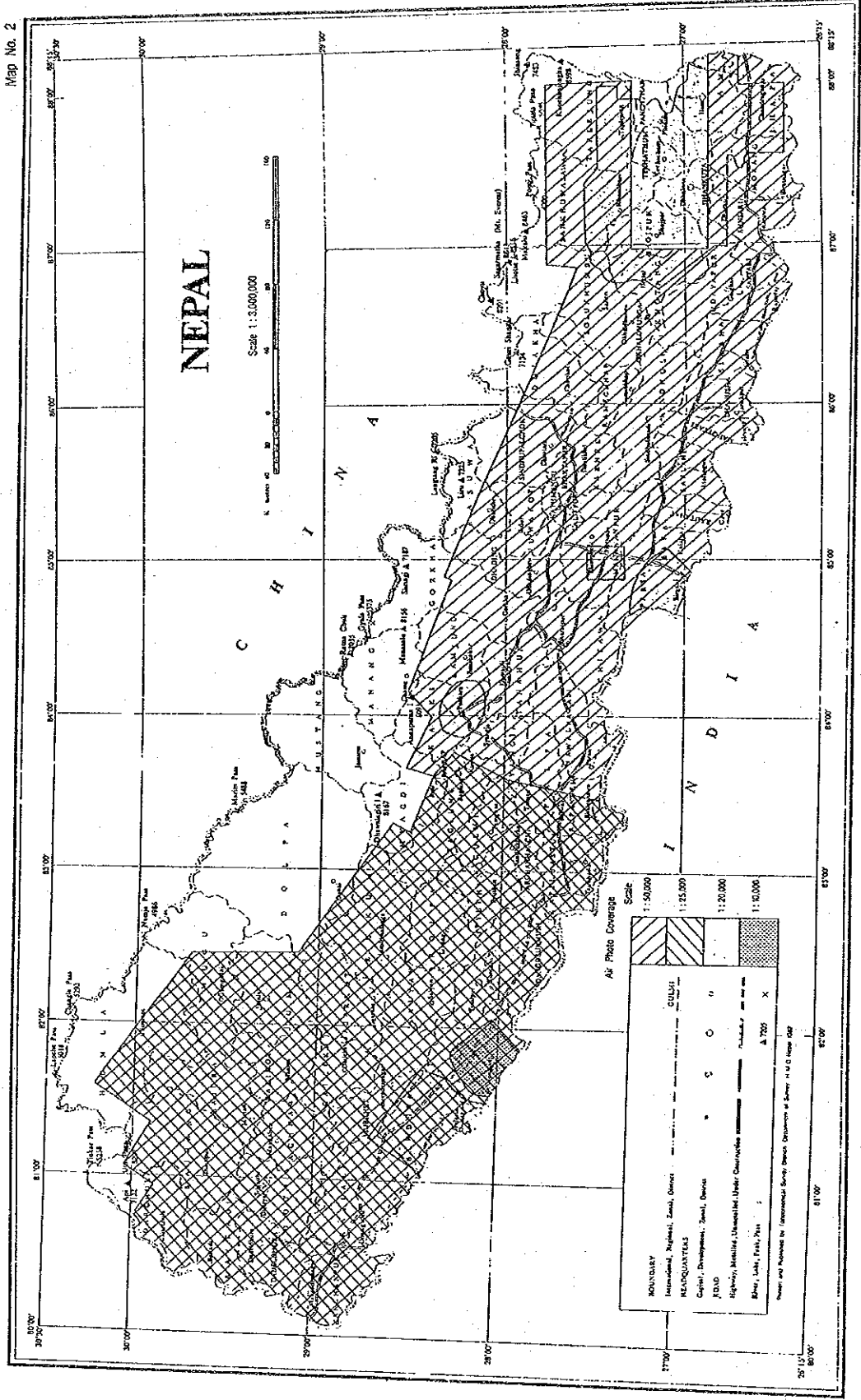
(5-3) 気象資料

気象資料はMeteorology Div.,DHMが管理している。1986年までの資料は市販されており主要書店で購入できる。同部職員によると1988年までの資料が電算処理済みで、提供可能な状態であるとのことである。

(5-4) 観測所設置費資料

水資源省が実施する水文・気象観測所の設置は、水文・気象局が実施しており、機器を除く土木工事費の積算資料を持っている。

Map No. 2



附属資料 G

収集資料リスト

本格調査の基本となる事項の検討及び事前調査報告書の作成に必要な資料を中心に、ANNEX G.1に示す資料を収集した。

これらの資料は、カトマンズ市内の主要書店及び地図店で購入したもの及びネパール国政府より供与あるいは複写用に貸与されたものである。供与あるいは複写用に貸与された資料は、統計資料及び個人的に所有している報告書あるいはファイル資料がほとんどである。

個人所有の報告書及びファイル資料は、紛失あるいは、公式化されていないことを理由に、必ずしも収集が容易でない。しかし、これらの資料の中にこそ、事情を知る情報があると思われるので、本格調査の実施にあたっては、今回の収集資料を事前に十分検討し、重複した資料の要求を避けるとともに、既収集資料を足掛かりに、さらに詳細な資料・情報を収集することが必要となるろう。

附属資料 G 収集資料リスト

収集資料リスト(1)

番号	資料の名称	発行年	発行機関	収集数量	収集方法
A.	ネパールの概要				
A 1.	Nepal in Map: Prepared by S.H. Shrestha	1988	Educational Enterprise Pvt. Ltd.	1冊	購入
A 2.	Nepal-Nature's Paradise: Edited by T.C. Majupuria	1984-85	White Lotus Co., Ltd.	1冊	購入
B.	経済・統計資料				
B 1.	Statistical Year Book of Nepal 1989	1989	National Planning Commission Secretariat, Central Bureau of Statistics	1冊	供与 (DHW)
B 2.	Economic Survey: Fiscal Year 1989-90	1990	Ministry of Finance	1冊	供与 (DHW)
B 3.	Statistical Pocket Book: Nepal 1990	1990	National Planning Commission Secret.	1冊	購入
B 4.	National Urban Consumer Price Index	1990	Nepal Rastra Bank, Research Dept. Price Div.	1部	複写
B 5.	Economic Report: 1987/88	1988	Nepal Rastra Bank	1冊	複写
B 6.	Main Economic Indicators: Monthly Report: Dec. 1989	1989	Nepal Rastra Bank	1冊	複写
C.	地図/地質図				
C 1.	Nepal: Administrative, Physiographic, and Relief: 1/2,000,000; 全土各1枚計3枚構成	1987	Topographical Survey Branch, Survey Dept.	2組	購入
C 2.	Nepal: Landcover Indications Directed from Landsat imagery: 1/500,000; 全土2枚組	1981	Nepal Remote Sensing Centre, Dept. of Soil Conservation and Watershed Management, Min. of FSC	1組	購入
C 3.	Nepal Navigation Chart (International Notam Office): 1/1,000,000; 全土1枚	1987	Tribhuvan International Airport Office, Aeronautical Information Service Section: Printed by TSB	1枚	供与 (TSB)
C 4.	Geological Map of Nepal: 1/1,000,000; 全土1枚	1982	Ministry of Industry, Dept. of Mines and Geology	1枚	購入
C 5.	Nepal: 1/500,000 地形図: Eastern, Central, Western sheetsの計3枚構成	1985	Topographical Survey Branch, Survey Dept.	1組	購入
C 6.	Nepal Map Sheet Layout 1:50,000 Scale	1988	Topographical Survey Branch, Survey Dept.	1枚	供与 (TSB)
C 7.	Nepal Air Photo Coverage	1982	Topographical Survey Branch, Survey Dept.	1枚	供与 (TSB)
D.	開発関連資料				
D 1.	Development Atlas of Nepal (National, Regional, Zonal and District): Statistical Profile	1988	Centre for Research Team	1冊	購入
D 2.	Master Plan for Irrigation Development in Nepal, Cycle 2: Planning and Design Strengthening Project, UNDP; Canadian International Water and Energy Consultants - Main Report - Volume 1~4(目次のみ) - Map Volume	1990	Dept. of Irrigation, MWR	1冊 1部 1冊 1部	複写 複写 複写 (WECS) 複写 (WECS)
D 3.	Nepal水資源開発プロジェクト位置図: 貯水池、水力発電、灌漑	不明	Water and Energy Commission Secretariat	各1部	供与 (WECS)
D 4.	WECSハンフレット: 4種	-	Water and Energy Commission Secretariat	各1部	供与 (WECS)

ANNEX G.1

収集資料リスト(2)

番号	資料の名称	発行年	発行機関	収集数量	収集方法
E.	水文・気象資料				
E 1.	Hydrological Network and Hydrometric Problem in Nepal: by Kiran Shankar	1989	Dept. of Hydrology and Meteorology, Regional Workshop on Hydrology of Mountainous Areas	1部	供与(DHM)
E 2.	Climatological Records of Nepal - 1983-1984, Vol. I - 1976-1984, Vol. II, Supplemental Data - 1985-1986	1986 1986 1988	Dept. of Hydrology and Meteorology, MWR	1冊 1冊 1冊	購入 購入 購入
E 3.	Agrometeorological/Climatological Observation, Note Book	1990	Western Resion Office, DHM	1冊	供与(DHM)
E 4.	Nepal Meteorological Service Manual of Observation (目次のみ); Prepared by WMO Advisers	1978	Dept. of Hydrology and Meteorology	1部	複写
E 5.	Snow and Glacier Hydrology Project, Year Book for 1987 - 1989	1990	Dept. of Hydrology and Meteorology, MWR	1冊	複写(DHM)
E 6.	Report of Nepal-Bangladesh Joint Study Team on Flood Mitigation Measures and Multipurpose Use of Water Resources, Final Draft	1989	不明	1冊	複写
E 7.	User's Manual: Hydrological Data Base: UNDP/WMO Project, Development of Operational Hydrology Services	1987	Dept. of Hydrology and Meteorology, MWR	1冊	複写(DHM)
E 8.	Water Resources Data: Staff Gauge Reading (記録用紙)	1989	Hydrology Div., Dept. of Hydrology and Meteorology, MWR	1枚	供与(DHM)
E 9.	Hydrometric Stations in Nepal (水位観測所一覧表/配置図)	-	Dept. of Hydrology and Meteorology, MWR	1枚	供与(DHM)
E 10.	Mean Monthly and Yearly Discharges/Extreme Discharges; Karnali, Narayani, Bagmati, Santa Kosi rivers (各河川1観測所)	-	Dept. of Hydrology and Meteorology, MWR	1部	複写(DHM)
E 11.	Meteorological Station Records (Type-wise) (気象観測所一覧表/配置図)	-	Dept. of Hydrology and Meteorology, MWR	1部	供与(DHM)
E 12.	水文観測所設置工事資料	-	Dept. of Hydrology and Meteorology, MWR	1式	供与(DHM)
E 13.	その他水文観測所関連資料	-	Hydrology Div., DHM, MWR	1式	供与(DHM)
E 14.	その他気象観測所関連資料	-	Meteorology Div., DHM, MWR	1式	供与(DHM)

水文・気象観測データ

1. 気象観測記録様式見本
2. 水文観測記録様式見本
3. 月平均・年平均及び最大・最小流量

सूचना

यो पुस्तिका श्री ५ को सरकारको सम्पत्ती हो र अधिकार प्राप्त व्यक्तिहरूले सबकल 'छाट्टा' रेकर्ड गर्नको निमित्त मात्र प्रयोग गर्नु पर्दछ ।

यो पुस्तिका कहीं कुनै महानुभावले भेट्टाउनु भएमा निम्न लिखित ठेगानामा पठाई दिनु हुन अनुरोध गरिन्छ ।

H. M. G. of Nepal Department of Hydrology & Meteorology

Western Regional Office
Pokhara

Agrometeorological / Climatological Observations

NOTE BOOK

जलवायु विज्ञान विभाग

पश्चिमांचल क्षेत्रीय कार्यालय

रत्नपुरी, पोखरा

Station Name:

Month:

Station No:

Year:

CL-026

Revised June, 1990

DATE:		MONTH:		YEAR:	
थने		महिना		वर्ष	
Observation Time (NST) सबतोकल समय (ने. ए.प. स.)		0845	1145	1445	1745
Dry bulb (°C) शुष्क बल तापक्रम					
Wet bulb (°C) आद्र बल तापक्रम					
Temperature	Maximum (°C) अधिकतम तापक्रम		X	X	
	Minimum (°C) न्यूनतम तापक्रम		X	X	
	Max after Setting सेटपछिको प्र.		X	X	X
	Min after Setting सेटपछिको भु.		X	X	
	Dew Point (°C) जित बिन्दु तापक्रम				
	Rele. Humidity (%) सापेक्षित आद्रता				
Grass Mini	Temperature (°C) घास भु. ता		X	X	X
	Af. Setting (°C) सेटपछिको घा. भु.	X	X	X	
Soil Temperature	0 cm depth (°C) भू. ता 0 से.मी.				
	5 cm depth (°C) भू. ता ५ से.मी.				
	10cm depth (°C) भू. ता. १० से.मी.				
	20 cm depth (°C) भू.ता. २० से.मी.				
	30 cm depth (°C) भू.ता ३० से.मी.				
	50 cm depth (°C) भू.ता ५० से.मी.				
Wind	Anemometer read एनको रिक्रड				
	Mean Speed वायुको औसत गति ()				
	Direction degree वायुको दिशा(दि)				
Precipitation (mm) वर्षा (मी.मी.)			X	X	
Dew amount (mm) जित (मी.मी.)					

Observation Time (NST) सबतोकल समय (ने. ए.प. स.)		0845	1145	1445	1745
Eva. Gauge Read मापिपङ्करण रिड (...)			X	X	
Eva. Adj Read मापिपङ्करण समायोजनमा ()			X	X	
Miscellaneous Meteors (✓)	Rain वर्षा (✓ चिह्न लगाउने)		X	X	
	Drizzle सिमसिमे वर्षा (")				
	Shower घुसलवारे वर्षा (")				
	Lighting बिजुली चम्केको (")				
	Thunder गेष गर्जेको (")				
	Haze तुषारो लागेको (")				
	Fog कुहियो परेको (")				
	Forst तुषारो परेको (")				
	Hail प्रतिना परेको (")				
	Freezing Rain फ्रीजिने वर्षा (")				
Snow depth (cm) हिउँको गहिराई (से.मी.)			X	X	X

Remarks:
कैफियत

Observer's Signature
प्रबन्धनको सही

HYDROLOGY DIVISION

STAFF GAUGE READING

River Name: _____
 Location: _____
 Station No: _____

तिथि : २०४६ / ३०११
 Date : 1989 / April-May

DATE	TIME		READING		TIME		READING		TIME		READING		TEMP °C	REMARKS
	hr	min	m	cm	hr	min	m	cm	hr	min	m	cm		
१	११	३												
२	११	४												
३	११	५												
४	११	६												
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HMG NEPAL
 MINISTRY OF WATER RESOURCES
 Department of Hydrology & Meteorology
HYDROLOGY DIVISION
 P. O. Box No. 3526, Babar Mahal, Kathmandu.

WATER RESOURCES DATA

RIVER NAME: _____ STATION No: _____
 LOCATION: _____
 GAUGE READER: _____
 ADDRESS: _____

Station name: Chisapani
 River: Karnali River
 Station no.: 280

MEAN MONTHLY AND YEARLY DISCHARGES [in cumec]

Year:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1962	496	471	506	561	741	1720	2900	5710	3990	1460	691	469	1650
1963	357	299	363	450	725	1530	3550	5600	3430	1090	630	453	1550
1964	355	293	273	389	468	982	3440	3930	3440	1210	623	458	1330
1965	366	342	360	482	569	1100	2010	2480	1650	718	478	346	913
1966	263	274	261	294	526	1070	2390	4380	1960	741	466	353	1090
1967	280	241	234	287	388	821	2670	4530	2590	960	550	417	1170
1968	371	335	369	402	656	1580	3480	4300	2110	1050	581	419	1310
1969	367	319	326	405	791	1330	2710	4120	3640	1350	677	463	1380
1970	379	333	319	420	573	1410	3840	4080	2300	1240	662	474	1350
1971	385	351	383	536	609	2790	4120	5090	3530	1390	810	557	1720
1972	435	428	414	438	818	1050	2760	2950	2860	1010	623	442	1190
1973	389	357	430	611	967	2140	2670	3890	3220	2800	899	559	1590
1974	442	379	347	450	532	898	2280	3880	2120	1090	607	448	1130
1975	393	378	389	579	891	3050	3650	4340	3690	1500	740	525	1680
1976	407	372	346	438	731	1140	2150	3330	2570	910	553	405	1120
1977	337	310	272	315	529	952	3440	4190	2460	1030	616	451	1250
1978	377	364	457	561	1090	1730	3490	5440	2730	1110	628	479	1550
1979	372	385	355	496	893	1240	2610	2880	1130	625	402	331	983
1980	285	241	292	400	670	1260	3700	4810	2520	984	552	398	1350
1981	341	303	326	436	718	1060	3490	4270	2150	1260	675	457	1300
1982	377	354	510	625	881	1650	2720	4510	2630	935	564	401	1350
1983	345	297	283	460	811	1080	2070	3070	5540	3210	815	479	1540
1984	376	356	334	340	771	1710	3190	2890	2810	815	468	351	1210
1985	298	254	242	297	450	773	3010	4100	3270	2740	975	563	1420
Average:	367	335	350	445	700	1420	3010	4120	2850	1300	637	446	1340

Station name: Narayan Chat
 River: Narayani
 Station no.: 450

Date: 17 Aug. 1988

MEAN MONTHLY AND YEARLY DISCHARGES [in cumec]

Year:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1963	462	351	290	408	699	1690	3760	5160	3720	1700	1070	820	1690
1964	453	377	310	413	444	1180	4060	4610	3570	1760	987	638	1560
1965	472	323	268	470	642	1520	3130	4610	2820	1310	954	592	1440
1966	369	313	245	285	615	1330	3490	5330	3380	1320	852	583	1520
1967	431	328	309	422	578	1400	3800	4060	2990	1390	806	541	1430
1968	407	308	320	366	636	1920	4470	4180	3150	2820	1040	670	1700
1969	315	250	245	262	380	1000	2890	4060	3530	1200	569	341	1270
1970	249	208	187	257	374	1610	5150	5420	2540	1320	604	360	1540
1971	263	213	205	309	479	2720	4270	4930	2690	1730	862	427	1600
1972	315	257	231	236	546	1280	4880	4100	2810	1170	664	377	1410
1973	295	241	254	351	608	2090	2960	4770	4070	3430	988	545	1730
1974	404	317	281	368	492	1110	4110	6420	2990	1480	800	521	1620
1975	430	386	328	402	638	3340	5040	4500	4940	1840	905	566	1950
1977	374	336	314	594	808	1500	4520	8530	2850	1120	695	434	1860
1978	349	295	304	422	1040	2470	5840	5840	2990	1590	711	425	1870
1979	303	262	218	283	435	977	3600	5070	2430	1130	571	395	1320
1980	273	223	222	281	435	1610	4740	5340	4060	1270	529	382	1630
1981	286	240	221	345	567	1350	4700	5400	3400	1440	708	418	1600
1982	325	298	325	437	514	1620	3490	4860	3300	1070	602	382	1440
1983	283	235	221	230	505	863	3170	4130	4490	1930	823	457	1450
1984	344	255	229	238	669	1820	5740	4190	4660	1240	639	424	1710
1985	320	271	278	289	397	1070	4780	3910	3890	1840	894	515	1550
Average:	351	286	264	348	568	1610	4210	4970	3420	1600	790	492	1590

Station name: Narayan Chat
 River: Narayani
 Station no.: 450

Date: 17 Aug. 1988

EXTREME DISCHARGES

MAXIMUM INSTANTANEOUS			MINIMUM INSTANTANEOUS		
Discharge (cumec)	Gauge height (meters)	Date	Discharge (cumec)	Gauge height (meters)	Date
7970	7.22	8 Aug. 1963	267	0.47	16 Mar. 1963
8400	7.40	4 Aug. 1964	273	0.48	24 Mar. 1964
7940	7.12	12 Aug. 1965	217	0.38	15 Mar. 1965
9480	8.10	24 Aug. 1966	180	0.37	13 Apr. 1966
8790	7.70	10 July 1967	239	0.42	12 Mar. 1967
10200	8.44	5 Oct. 1968	200	0.35	6 Mar. 1968
7270	6.10	26 July 1969	212	0.52	4 Apr. 1969
12900	7.73	16 July 1970	163	0.30	5 Apr. 1970
9760	6.90	8 Aug. 1971	191	0.43	19 Mar. 1971
13800	7.95	28 July 1972	207	0.50	7 Apr. 1972
12800	7.71	5 Oct. 1973	200	0.47	6 Mar. 1973
25700	10.12	5 Aug. 1974	249	0.66	10 Mar. 1974
15100	8.24	3 Aug. 1975	289	0.80	20 Mar. 1975
15500	8.32	29 Aug. 1977	301	0.84	22 Feb. 1977
12400	7.62	16 June 1978	262	0.71	9 Mar. 1978
10600	7.15	21 Aug. 1979	198	0.46	25 Mar. 1979
12800	7.70	6 Sep. 1980	193	0.44	19 Mar. 1980
13300	7.82	31 July 1981	196	0.45	15 Mar. 1981
10900	7.21	13 Sep. 1982	259	0.70	26 Feb. 1982
15400	8.30	17 July 1983	200	0.47	13 Apr. 1983
14100	8.00	8 Sep. 1984	191	0.43	14 Apr. 1984
15400	8.30	17 July 1985	200	0.47	13 Apr. 1985

Station name: Karmaiya - Mangalpur
 River: Bagmati River
 Station no.: 590

Date: 28 Apr. 1987

EXTREME DISCHARGES

MAXIMUM INSTANTANEOUS		MINIMUM INSTANTANEOUS	
Discharge (cumec)	Gauge height (meters)	Discharge (cumec)	Gauge height (meters)
1780	5.15	4.90	0.58
1380	4.40	9.00	0.60
2810	6.80	8.48	0.64
2680	6.62	5.60	0.98
2770	4.85	8.00	0.61
2220	4.90	10.5	1.18
1590	4.15	9.70	1.15
2880	4.70	10.5	1.00
3240	4.90	8.56	0.78
3760	5.15	13.0	0.70
9000	7.00	11.8	0.87
1990	4.13	8.00	0.25
1580	3.80	13.3	0.81
7150	6.45	13.2	0.81
8650	6.90	14.0	1.05
1550	3.75	9.00	0.90

Station name: Karmaiya - Mangalpur
 River: Bagmati River
 Station no.: 590

Date: 28 Apr. 1987

MEAN MONTHLY AND YEARLY DISCHARGES (in cumec)

Year:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1965	8.71	7.41	11.5	23.4	25.6	244	670	655	289	49.4	61.1	25.0	174
1966	18.4	14.1	14.8	11.6	17.7	59.2	489	562	295	36.5	27.4	15.6	131
1967	18.2	13.4	16.8	12.5	16.0	111	522	458	401	141	32.9	20.8	149
1968	16.8	13.9	17.4	14.5	20.2	202	631	514	350	417	79.9	20.3	193
1969	9.60	10.3	14.0	10.3	10.8	206	498	631	482	145	35.9	22.2	174
1970	17.9	16.2	12.8	17.7	37.5	243	635	602	283	112	19.6	13.8	169
1971	12.8	12.5	12.3	20.2	94.0	806	429	569	238	111	45.5	26.9	199
1972	21.1	17.5	13.3	12.6	19.1	88.4	542	234	317	62.5	42.0	26.2	117
1973	20.6	17.5	18.6	10.5	26.3	176	512	383	459	172	58.7	30.9	158
1974	21.8	17.7	15.0	16.0	22.4	57.6	639	895	762	124	63.5	40.6	225
1975	30.5	26.7	18.6	17.1	39.9	190	662	412	318	149	68.1	23.4	164
1976	12.5	12.8	10.4	11.3	30.0	412	242	371	118	68.2	54.1	30.2	115
1977	18.0	17.8	15.6	17.1	22.8	48.6	267	426	143	103	47.8	35.3	97.8
1978	25.6	17.7	15.9	26.6	73.9	319	858	416	375	274	90.7	46.9	213
1979	29.9	37.4	23.8	23.1	17.4	47.2	487	562	237	87.5	38.0	25.6	136
1980	17.0	9.10	17.5	16.6	23.9	124	429	384	220	83.5	33.5	22.6	116
Average:	18.7	16.4	15.5	16.7	31.1	208	532	505	330	133	49.9	26.7	158

Station name: Chatara-Kothu
 River: Sapta Kosi
 Station no.: 695

Date: 29 Nov. 1987

MEAN MONTHLY AND YEARLY DISCHARGES (in cumec)

Year:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1977	362	305	296	490	757	1280	3460	4730	2730	1700	894	549	1480
1978	393	316	334	462	1080	2570	4250	4600	2730	1560	836	542	1650
1979	385	336	288	370	605	1180	3890	4450	2680	1370	706	517	1410
1980	359	312	338	434	659	1960	5020	5850	4550	1450	838	521	1870
1981	404	388	368	564	704	1630	5040	5940	3780	1560	875	481	1820
1982	358	338	357	491	634	1580	3170	3080	2270	1270	599	442	1220
1983	300	247	265	328	732	1330	3600	3380	3680	1480	806	499	1400
1984	373	292	291	347	620	1640	4310	3320	4860	1140	553	455	1530
1985	339	303	328	328	555	1740	4230	3700	3820	1630	943	494	1540
Average:	364	315	318	424	705	1660	4110	4340	3460	1460	795	501	1550

Station name: Chatara-Kothu
 River: Sapta Kosi
 Station no.: 695

Date: 29 Nov. 1987

EXTREME DISCHARGES

MAXIMUM INSTANTANEOUS			MINIMUM INSTANTANEOUS		
Discharge (cumec)	Gauge height (meters)	Date	Discharge (cumec)	Gauge height (meters)	Date
7380	6.54	26 Aug. 1977	260	0.97	22 Mar. 1977
7470	6.58	28 July 1978	286	1.04	9 Mar. 1978
8720	7.11	24 July 1979	271	0.58	30 Mar. 1979
23600	11.50	25 June 1980	292	0.74	9 Feb. 1980
5550	5.66	19 July 1982	286	1.04	15 Mar. 1981
6740	6.25	4 July 1983	292	0.74	27 Feb. 1982
12100	8.35	17 Sep. 1984	230	0.55	25 Feb. 1983
9200	7.30	5 Sep. 1985	248	0.61	9 Apr. 1984
			263	1.42	7 Apr. 1985

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