(In case of the D-2 plan, above function will be owned by the branch offices.)

2) Data processing, storing and forwarding to the Central Office

3) Development of discharge rating curves and conversion of water level to discharge

4) Monitoring and evaluation system

5) Basic analysis of hydrological features

6) Dissemination of qualified data

(2) Work at Central Office

1) Data collection from Regional Offices

2) Data processing and storing

3) Hydrological analysis including observation network design

4) Data dissemination

5) Training of trainers and Regional Office's staff for technical and managerial improvement and preparation of manuals

6) Monitoring and evaluation system

7) Data quality improvement

8) Routine dialogue with data users on data quality and further requirements

The general data flow and roles of Regional and Central Offices for the Model System were determined by studying those for the Long Term Programme preliminarily.

6.4 System Design

6.4.1 The Way to Improve Present Problems

Since the data flow was similar to the present, data flow of the approach to design the Model System was to improve the problems for the present Data Management System.

The problems for the present system were studied in the Section 5.2.1 and the priority items to be improved were found as below:

1) collect data quickly,

2) duplicate data correctly, quickly and comfortably at Regional Office,

3) process data correctly and quickly at Regional Office,

4) process rating curve and table correctly, quickly and comfortably at Regional Office,

5) check data correctly, quickly and comfortably at Regional Office,

6) send data to Central Office quickly and comfortably,

7) enter data quickly and economically,

8) store hydrological data correctly and quickly at Central Office, and

9) How to check hydrological data correctly, quickly and comfortably.

The ways to improve above problems in the Long-Term Programme was supposed preliminary as follows:

(1) Collect data at the Regional Offices quickly and send processed and original data to the Central Office quickly and comfortably

There are several ways to collect data such as by mail, manpower, wireless and public line. Among these ways, the most suitable one was chosen as follows:

1) From observation station to Regional Offices or Branch Offices

The postal service will be the most suitable way to collect data, because that way will not need to be maintained and the postal charge is very cheap. It is only 7 NRs per one register mail. In case of other ways, there will be some basic problems. It will be very hard to collect all data by manpower in the remote and mountain area whole of Nepal. The way of public line will not be also realistic especially in the mountain area, network in Nepal of the condition of public line. Although the way of wireless will be good to collect data quickly, it will not be necessary to collect real time data. That way will need to maintain wireless machine and train observers. The electricity will be also problem for wireless machine.

At present, the data are collected by mail. One of the problems of this system is that more than 40% of data can not be collected within one month and the data are sent for more than two months at once. But almost of data were collected within three months. For data book publishing within next observation year, this late will not be so big problems. If necessary, the data will be able to be collected on the way of inspection. But in case that the station will be far from post office, it will be very hard to go and the way of wireless seems to be useful. In the Long-Term Programme, the number of meteorological stations will be increased about two times of present one. Especially in the mountain and remote area, it will be more difficult to

collect data by mail because of lack of post offices and traffic. For this remote area, the way of wireless or manpower was studied in the Model System.

In case of sediment and water quality sample, they will be collected by manpower.

2) From Regional Offices to Central Office

After data processing at the Regional Offices, the original data and processed data will be sent to the Central Office once a year.

If the data are the original ones, they will be sent by mail because it is hard to bring by manpower. In case that the data are the processed one, they will be sent by public line.

(2) Duplicate correctly, quickly and comfortably at Regional Offices

If the computer will be installed at each Regional Offices, the data will be entered directly from original form into the compute at Regional Offices and sent them to the Central Office by on line. All data processing work will be completed at the Regional Office. The original data will be duplicated by photo copy machine. It will not be then necessary to duplicate data manually.

(3) Process data correctly, quickly and comfortably, process rating curve and table correctly, quickly and comfortably, and check data correctly, quickly and comfortably.

By using computer, the data will be processed correctly, quickly and comfortably. If the data logger system will be used, the data will be entered directly from ram card into computer in the Long-Term Programme.

The manual for data processing will be necessary in the Long-Term Programme. To get the reliable data, the data checking will be carried out systematically using this manual. In this manual, the way to process and check data will be mentioned with check list for monitoring data quality. Also the organization and the functions of each sections for data processing will be mentioned to clear responsibility for data processing. The annual data processing schedule will be made and attached at the manual for monitoring the processing condition with the data processing monitoring form.

After the publication of the year book, the staffs for data processing at Regional Offices will be trained at the training center to be established newly to master the way to check data

quality and correct data processing method using the error samples found in the data checking at Central Office.

(4) Enter data quickly and economically

Using the data logger system, the data will be entered directly from ram card into computer. In case of continuous record on chart, digitizer will be used. If the data will be recorded by manual, the computer programme for easy data entry will be developed.

(5) Store hydrological data correctly and quickly

There will be three types of data that the DHM will store. Those are original records, output lists and processed data:

1) Original records

At present, original data are stored at the Central Office. But there are some problems. Sometimes original records were lost because some users brought them and never returned. Some recording forms were eaten by insects. There are not enough cupboards to store. It is difficult to store because of different shapes of data forms such as recording chart, notebook, card and sheet form.

Considering above conditions, the optical disk system will be suitable to store original records in the Long-Term Programme. The original records will be duplicated into optical disk like a photocopy machine. The original data will be stored temporarily at the Temporal Reference Room until the data book will be published. After publishing, the original data will be sent to Permanent Store House planned in the Long Term Programme with the optical disk. After ten years, the original record will be thrown away and the optical disk will be kept forever.

2) Output lists

The output lists will be stored in the cupboards at the output reference room installed in the Long-Term Programme at the Central Office.

3) Process data

The processed data will be stored in the data base. This data base will be newly designed and programmed. The data stored in the data base will be made back up by optical disk.

Making back up for original data and processed data, they will be stored safety. Using machinery such as optical disk and computer, they will be stored quickly.

After entering the data into the data base, the DHM will disseminate them to the users. The following ways of data dissemination will be ready:

1) publishing yearly data book,
2) duplication of computer output,
3) duplicating data in floppy disk, and
4) on-line using public network.

But the service of on line will be served only at the Central Office. Because the user will be able to get data from the Central Office by public network and security problems for computer at the Regional Offices will be worry.

Besides the above improvement items, following analysis will be recommended to improve data quality and to grasp hydrological features in Nepal:

1) Basic hydrological analysis such as making of hydrograph.
2) Analysis such as comparison of hydrological features to near gauging records, comparison of hydrographs of same rivers and comparison of run-off rates.

Data quality improvement way should be examined in the Hydrological and Climatological Division. To examine, study of observation network, equipment, check methods and so on will be necessary. Dialogue with data users will be conducted under the management of the Hydrological and Climatological Divisions.

6.4.2 General Idea for the Model System

Referring the idea to improve present problems, the general idea for the Model System was created as follows.

The main work components of the Model Data Management System could be arranged as five components, 1) data collection, 2) data processing at the Regional Office 3) data transfer, 4) data processing at the Central Office, 5) data storing, and 6) data dissemination. These components were supported by the activities of management, supply of consumables, maintenance, and training as follows:

(1) Data Collection Method at Regional Office

In the Model System, two methods of data collection from gauging stations to the Regional Offices were applied, one was common collect system and the other was special collect system.

The common collect system consisted of the following methods:

1) Precipitation and water level records observed by ordinary/staff gauges were sent by mail or wireless facility once a month. The wireless facility was set at Kathmandu, Pokhara and Tatopani to collect data and monitor data collection activity.
2) Precipitation and water level records on chart by recording gauges were collected by the staff of the Regional Office every three month during trip of inspection.
3) Precipitation and water level records observed and stored in the data loggers at Pamdur and Kalleri were collected by taking ram card from the data logger by the staff of the Regional Office once a month.
4) Discharge measurement records were brought by the staff of the Regional Office after measurements.
5) Suspended sediment samples was carried by staff of the Regional Office or bottle runners once a month.

The special collect system was adopted in case that data do not reach at the Regional Office within one month, of which the procedure are:

1) Issuance of request letter to observers to urge them to send data, and
2) Data collection by the staff of the Regional Office on the way to station inspection.

All the above data and sample were registered just after arrival at the Regional Office on monitoring sheets shown in the General Manual of Model Data Management.

(2) Data Processing Method at Regional Office

The data processing activity in the Model System consisted of sediment analysis, data entry and data processing.

The suspended sediment sample was analyzed at the existing laboratory of each Regional Offices. The value of suspended sediment concentration and problem on the analysis were obtained.

The collected data were entered into computer installed at each Regional Offices within one month after data arrival according to the following manners and using check list attached in the General Manual of Model Data Management:

1) Continuous precipitation and water level record charts were duplicated by hand with carbon papers for future reference at the Regional Office. On the other hand, hourly values were read form the chart and entered into computer through key board.

2) Continuous precipitation and water level records stored in the data loggers were transferred to the computer from ram cards directly.

3) Precipitation and water level records observed by ordinary/staff gauges, discharge measurement records and suspended sediment concentration values are entered into the computer by key board.

Verification of the above entered data was made by inspiration checking and checking by totalling. The inspiration checking was conducted by the experienced staffs such as the Regional Chief, Hydrologist or Meteorologist. The checking by totalling was carried out by the staff of the Processing/Observation Unit. The data error was corrected at the Regional Office.

The data processing work was carried out by using newly introduced computers, in which daily precipitation, water level, discharge and suspended sediment transportation values were calculated with quality checking during the period form April to December, 1992:

1) The precipitation data were processed and the total, average, maximum, minimum and the other values are computed.

2) The water level data were processed by the UNDP/WMO software and the average, maximum, minimum and the other values are computed. Hydrographs of the daily mean water level were also made by using the computer and printer in order to verify data quality and find extraordinary values.

3) The discharge measurement records were processed and rating tables were developed.

4) Daily mean discharge values were estimated form the water level records and rating tables. Using the above discharge values, the suspended sediment amount was computed.

The above mentioned processed values were examined by the experienced staff such as the Regional Chief, Hydrologist or Meteorologist.

(3) Data Transfer form Regional Office to Central Office

The input and processed data which were duplicated to floppy disks in the Regional Offices were sent to the Central Office by the staff of the Regional Offices. The original record books and charts were also carried to the Central Office by the staff.

(4) Data Processing at Central Office

The data transferred to the Central Office from the Regional Offices were checked, corrected and registered into the data base at the Central Office in the following manner:

1) The overall checking including checking of discharge rating curves was made by the staff of the Data Checking Section.

2) In case some obvious mistakes or considerably unbelievable figures and their reasons were found in the data, they were corrected by the Data Checking Section.

3) The data were registered to the data base and output. The corrected data were informed to the Regional Offices.

(5) Data Storing at Central Office

In the Model System, the data are stored in the Central Office as follows:

1) The original record such as notebooks, sheets and charts were kept in the present store house.

2) The computer output lists were kept in the present Computer Unit.

3) The data entered into the computers and processed were stored in the data base. All the above data were also duplicated to newly installed optical disk in December 1992 for the purpose of backup.

(6) Data Dissemination at Central Office

The data were offered by floppy disks or computer output lists.

The general data flow for the Model System was as shown in Fig. 6.2 and the process flow was as shown in Fig. 6.3.

In order to operate the Model System more systematically, the tentative organization was set up. This organization consists of Sections and Units in the Central Office, Regional Offices, and the Study Team. In the Central Office, four (4) section, Negotiation Section, Central Management Section, Data Checking Section and Data Entry Section was

established. At each Regional Offices, Processing Unit and Observation Unit were set up under the control of the Regional Chief as shown in Fig. 6.4.

The Central Management Section performs management works such as making of data processing schedule, monitoring on data processing, evaluation works, supplying consumable and maintaining computer facilities. The outline of roles for each section and unit are as shown in Table 6.1. Through monitoring works in the Model System, the effectiveness of branch office will be examined.

6.5 Structure of the System

In the Model System, personal computer sets were installed for data processing at each Regional Offices, and for analysis and temporal data base at the Central Office. Present hydrological and meteorological data base software and necessary software were transferred into these computers. These computers will work for data processing and data base after the Model System at each DHM offices. These computers were chosen considering the following conditions:

(1) Compatibility

The DHM has hydrological data base system installed by UNDP/WMO Project. This system consists of IBM or IBM compatible machines. The newly installed computer should also consist of IBM or IBM compatible machine considering compatibility.

(2) Computer for Central Office

To chose the computer facilities at the Central Office, following items must be considered:

1) The memory size of had disk must be more than 110 MB. Because this computer was used as main data base instead of present computer of IBM PC-AT, after this Model System.
2) The computer must be maintained by DHM staffs
3) There must be computer shops which can maintain them in Nepal.
4) The IBM PC machine is the old model at present. Considering the supply of spare parts, IBM PS/2 machine, common model at present, should be installed.
5) IBM PS/2 model has already installed at the Central Office for meteorological data base system. The DHM has experience to operate and maintain that model.

6) The new machine had better to have the expansion ability, especially, for network such as Local Area Network (LAN), considering the Long-Term Programme.

(2) Computer for Regional Offices

The new computer for the Regional Offices must be satisfied with following items:

1) The memory size of hard disk should be more than 30 MB.

2) The computer must be compatible with the computer installed at the Central Office in this System.

3) The computer set must have 10 keys key pad to enter data easily.

4) The computer should be laptop computer because of lack of office space at the Regional Offices and easy transportation from the Regional Office to Kathmandu to repair.

5) The machine must be able to use the present DHM software.

Considering above basic policy, the system for the Model System consisted of six laptop computers at the Regional Offices and one desktop computer at the Central Office as shown in Fig. 6.5 The list of equipment for the Model System was as shown in Table 6.2

6.6 Implementation Schedule

The Data Management System for the Model System was installed on March, 1992 and operated from April to December, 1992 as follows:

(1) Installation

The necessary equipment for the model data management system was chosen based on above basic policy in 1991 and they were supplied in 1992. After checking for these equipment, the necessary software was installed into computer. It was necessary to revise the data base software developed by UNDP/WMO Project to apply the black and white monitor for lap top computer. Then the computer for the Central Office was installed at the computer room. The computer for the Regional Office was brought and installed at the Regional Offices by the staffs of DHM with the Study Team after introduction training at the Central Office.

(2) Basic policy of operation

This Model System was operated following the basic policy:

1) The operating term was from April to December, 1992.

2) This system was mainly operated by the staffs of the DHM, because actual Data Management System in the Long-Term Programme had to be operated by themselves, one of the purposes of the Model System was to find the problems of the plan for it and transfer of technology.

3) The Study Team monitored this system and instruct the staffs to examine the suitable data collection, data processing and management ways.

4) After the Model System, the facilities such as computer was undertaken to the DHM and used for ordinary works of data processing.

(3) Training

The Study Team transferred technology to the staffs mainly by on-the-job training method in the Model System. But the following intensive training, divided three courses, were held in the monitoring term to operate the System.

1) First training

To introduce the Model System, the first training was held about for one week at the Central Office in the second field investigation term, on March 1992.

2) Second training

To instruct how to operate computer and software, the second training was held at the Central Office on June 1992 in the Third field investigation term about the ten days.

The Study Team arrived at each Regional Office to investigate the condition and advice to the staffs about for one month, in March and June, 1992.

3) Third training

The Study Team introduced how to check and process data using the data processed at the Regional Offices.

6.7 Operation of the System

6.7.1 Data Collection

The eighty five hydrometric and precipitation stations were chosen as object stations for the Model Data Management System. Since that number of object stations were too small to analyze present condition of data collection, especially in the northern part of Nepal, that condition of all meteorological and hydro-metrical stations operated by the DHM in 1991 and 1992 were investigated based on register for data collection recorded by each Regional Offices as shown in Table 6.3 and 6.4.

Almost of records observed in 1991 have already arrived at the Regional Offices before October 1992. It showed that observed record can be collected within one year by the present data collection way and management. In case of records observed in 1992, most of records have arrived at each Regional Offices within three months. But the condition of data collection within three months was different with each Regional Offices.

To analyze that condition more in detail, the Western and the Mid-Western Regions were investigate more, because the data when data arrived at these Regional Offices could be supposed from their registers as shown in Tables 6.3 and 6.4. But the actual date could not be investigated from these registers, because the staff who had responsibilities to record these date was sometimes in the field to observe or inspect stations when the record arrived at. The date on register just shows the tendency of data collection condition.

Before analyzing the arrival date on register, the characteristics of the object Regions such as transportation, topographical condition and so forth must be investigated to get the surrounding conditions:

(1) Characteristics in Western Region

In the Western Region, there are many famous sight seeing points and the network of transportation and communication is well developed comparing to other four Development Regions as follows:

1) In the southern part of the Western Region, the east-west highway runs through Terai Plan. In the middle of the Western Region, the highway runs between Kathmandu and Pokhara. These two highways are connected to each other by the north-south highways between Butwal-Pokhara. In the northern part, the road between Pokhara

and Baglung is under construction and it can be used between Beni and Pokhara at present. In the norther part of the Western Region, trekking ways are well developed also because of sight seeing places such as Annapurna and Dhawalagiri Himal Range.

2) In the northern part of the Western Region, high mountain area, the condition of communication is not good. The density of post office in that area is small, especially in the northern part of the Himalaya Mountain Range as shown in Fig. 3.2.

(2) Characteristics of Mid-Western Region

The Mid-Western Region is the biggest region in Nepal. The land area is 42,378 km^2 and it accounts for almost 30% of all Nepal. The population density is almost 46 persons per 1 km^2 and it is smallest in Nepal. Almost of the Mid-Western Region is covered with mountains.

The network of road and communication in the Mid-Western Region is very poor. Only in the southern part, the east-west highway runs. There is no gravelled road in the middle and northern part. In the Mid-Western Region, the trail way is the main road. The density of post office is also poor. That in Karnali Zone is 281 km^2 per one post office. In the northern part, there is no telephone services.

In this condition, Mid-Western and Western Region collected data by mail, staffs and observers. The register for data collection showed how long did it take to collect data as shown in Table 6.5. Averagely, it took 33 days to collect hydrological data observed in the Western Region in 1991. In case of meteorological data, it took 43 days. Comparing to each months, the condition of data collection did not depend on season.

In the Mid-Western Region, it took 48 days to collect hydrological data. In case of meteorological data, it took 52 days. The condition of data collection in Mid-Western Region does not also depend on season.

These facts show that the data can be collected averagely within two months by the present data collection way. The difference of necessary days to collect data between the Mid-Western Region and the Western Region was about ten days and it depended on the distances between station and post office. Even if the station is in remote and mountain area, the data can be collected easily if the station is near from post office.

For example, in Mid-Western Region, the data observed at meteorological station of which index number was 0303 arrived at Regional Office averagely within one month, even if it

was in the mountain area as shown in Fig. 4.13. In case of the stations of 0304, 0305 and 0308 in the mountain area, the data arrived at Regional Office about within 40 days. It did not take so much days to arrive, because these stations were near from post offices.

The Table 6.5 was made by arranging collected date in the view point that how many days were necessary to collect data averagely for each stations. In case that the same information was arranged in the view point that how many months were necessary to collect data, the result was shown in Table 6.6.

The 58% of data arrived at the Regional Office within one month, 78% were collected within two months and 86% reached within three months. Although average necessary days to collect data were about 40 days, more than 50% of data arrived at the Regional Offices within one month. It indicated that there were some stations that did not send data so long. Referring the register for data collection in the Mid-Western Region, there were many stations that did not send data for more than two months.

The reason why these stations did not send data every months was not only distance between stations and post offices. The stations that sent data for more than five months at the same time are listed in Table 6.7. Almost of these stations are near from post office and in plain area as shown in Fig. 4.12 and 4.13. To collect data correctly, it is important that the staff check what data have not arrived at and collect them on the way to inspection with guidance for observers to send data every month, when the staffs go to field.

The actual condition how to collect data in the Western Region is as shown in Table 6.8. The 64% of data were collected by mail. The 19% of data were by staffs. Remaining 17% of data were brought by observers in 1991 and 1992.

In the Model System, the observed data sent from Samargau and Yaragau to the Regional Office by post were lost on the way. There are two types of post offices in Nepal. One is the post office that serves register mail and another is that has not such register mail service. Especially in the northern part of Nepal, in mountain area, almost of post offices have not such register mail service. The mail from remote area is sent by post offices staff with relay ways on foot. Sometimes no register mail is lost on the way to relay. But it is seldom to loose register mail.

The data observed at the stations especially far from post office that serve register mail should be collected by staffs on the way to inspection. Each Regional Office should

investigate the condition of data collection by monitoring of register and arrange to send staffs to the stations that the condition of postal services is not good.

The wireless way was also attempted in the Kali Gandaki River Basin and Jamuni River Basin. The condition of this communication way depended on the time to communicate. In the morning and evening, that condition was not so bad with relatively clear voice. But in the day time, it was impossible to communicate due to heavy noise. The way of wireless will not be good manner for data collection, because the office hour is from ten o'clock in the morning to five o'clock in the evening.

The urgent information was sent from Tatopani and Chyuntaha, in the Model System operation term. At Tatopani, flood washed away the sensor for the pressure water level gauge and observer came to Western Regional Office on foot to inform that condition. At Chyuntaha, the flow was shifted to opposite side of water level gauge and the water level record was missed for about ten days. This information was sent by telegram to the DHM.

From the investigation as above, the tendency for data collection and the recommendations for the Long Term Programme were found as follows:

1) The condition of data collection does not depend on season.
2) More than 85% of data collected within three months with present data collection way. This condition is not dependent on the Development Region comparing to the Western Region and the Mid-Western Region.
3) The condition of data collection within three months is influenced by development region referring to the Tables 6.3 and 6.4. The condition seems to depend on the distance of post office.
4) The serious problem for data collection was that some of observer did not send data for more than five months even if they lived in plain area or near from post office.
5) To prevent such condition as 4), the DHM should guide observers to send data every month with perseverance.
6) To guide observers, Regional Office should clear the condition of data collection recording the receiving date on register.
7) Referring that register, Regional Office should monitor the condition of data collection regularly and arrange to collect data that have not arrived on time on the way to inspection or discharge measurement.

8) In the mountain area where post office does not serve register mail, especially in the northern part, the Regional Office should arrange suitable route programme to collect data regularly on the way to inspection and discharge measurement.

9) If the observer sends data every month, the DHM had better to pay the certain prize to collect data regularly.

10) The wireless system is not effective for original data collection.

6.7.2 Data Processing

(1) Operation of Computer

One laptop computer TOSHIBA T3100 SX was installed at each Regional Offices in Dhangadhi, Surkhet, Pokhara, Kathmandu, Dharan and Dhankuta and one desktop computer IBM PS/2 was installed at the Central Office in Kathmandu for the Model System. The computers at the Regional Offices were for data processing. That at the Central Office worked as main data base.

Before installing these computers, the DHM had IBM or IBM compatible computers as follows:

1) one IBM compatible computer at Mid-Western Regional Office in Surkhet.
(That was broken and transferred to Central Office.)

2) one IBM PC XT computer at Western Regional Office in Pokhara.
(That was broken in October 1992 and sent to Central Office.)

3) one IBM PC XT computer at Eastern Regional Office in Dharan.
(That was broken and sent to Central Office.)

4) six IBM and IBM compatible computers at the Central Office in Kathmandu as follows:
   - one IBM PC AT for main hydrological data base
   - one IBM PC XT for hydrological data entry
   - one IBM PC PS/2 model 80 for meteorological data base
   - two IBM PS/2 model 30 without hard disk for meteorological data entry
   - one IBM Compatible computer for multi purpose

1) Condition of Eastern Regional Office

At the Eastern Regional Office in Dharan, there was one computer IBM PC-XT without hard disk installed by UNDP/WMO Project. The purpose of that computer

was for data entry. All the necessary software was stored in floppy disk and entered data were also stored in it. But that computer was damaged and sent to Central Office.

In 1992, new computer was installed at Dharan for the Model System. This computer has hard disk and data base software was installed in it. One hydrological assistant engineer who did not have experience for computer before attended training at the Central Office and trained at the Eastern Regional Office in Dharan. This trainee can operate minimum function of data base software to process data. But it was often necessary for him to be helped to operate MS-DOS by GDS staff dispatched at the Eastern Regional Office in 1992.

There is meteorological office in Dhankuta. New computer was installed for the Model System in 1992 there also. Comparing to hydrological data, the procedure for processing of precipitation data was easier and they could operate software for processing of precipitation. Although it was first time to operate computer for them, they could operate the data base software easily.

2) Condition of Central Regional Office

The Central Regional Office is in the same building with the Central Office in Kathmandu. The Central Office has staffs who have much experience to operate computer and necessary software to process data and develop software with Basic Language. The Central Regional Office also has the staffs who can operate computer and software with the Central Office staffs. There was no worry about operating of computer.

In the Model System, one computer was installed at the Central Regional Office for data processing in 1992. But the power supply unit for that computer was troubled. In Kathmandu it was impossible to get such spare parts and that computer was sent to Singapore for repairing. The computer at the Central Office was also used by the Central Regional Office instead of that computer.

3) Condition of Western Regional Office

At the Western Region, there was computer IBM PC-XT, before new computer for the Model System was installed. At first, that computer did not have hard disk and was used for only data entry with floppy disk. The GDS installed hard disk in it with revised data base software from main data base software at the Central Office by the DHM staff.

There were two staffs for data entry at the Western Region. One was for meteorological data entry, another was for hydrological data entry. They could operate data base software by MS-DOS. One engineer was transferred from Kathmandu in 1992, he was trained for data base software, MS-DOS and Basic Language programming in Kathmandu by GDS. These staffs could operate computer and necessary software for data processing. There was no big problem at the Western Regional Office for operation.

Laptop computer was installed for the Model System not to prevent ordinary data processing work at the Western Regional Office. After installation, the previous computer IBM PC-XT for regional data base was broken and sent to the Central Office for repair. Then the newly installed computer was used not only for Model System but also ordinary data processing work.

4) Condition of Mid-Western Regional Office

Once, there was a computer at the Mid-Western, Western and Eastern Regional Offices. At the Mid-Western Region, IBM compatible computer was installed with software for data entry without hard disk. That software was stored into 5.25" floppy disk and entered data was stored into the same floppy disk. That computer was broken and sent to Central Office. When new computer was installed for the Model System in 1992, it was first time for them to operate such computer with hard disk and software including data processing function such as converting from water level to discharge value.

In 1992, two newly employed senior engineers were transferred into the Mid-Western Region. They had experience to use main frame computer once in university. One of them had good knowledge about MS-DOS also. After training for the Model System, they operated the computer and software very well. They brought some software for graphics and drew rating curve on logarithmic scale grid by themselves. One technician could also operate data base software because he learned that at the Central Office once and was transferred to the Mid-Western Regional Office in 1991. There was no worry to operate computer in the Mid-Western Region.

5) Condition of Far-Western Regional Office

At the Far Western Regional Office, one computer was installed for the Model System in 1992. It was the first time for the Far Western Regional Office to operate computer. One meteorologist and one senior hydrological assistant attended the

training for computer in Kathmandu and operated data base software at the Far Western Regional Office.

In November 1992, the error about MS-DOS operation occurred. The staff at the Far Western Regional Office carried that computer to Kathmandu to solve that problem and it was solved. Although there was no problem for ordinary operation of computer, it was very difficult to solve such unexpected trouble about MS-DOS. To train such beginners, it is important to stay with them until they meet such unexpected trouble and guide how to solve them.

At each Regional Offices, new computer was installed for the Model System in 1992 as above and following suggestion were got:

1) It is possible to instruct beginners to operate application software within one week for each software, if trainees have interest for that software.

2) Trainer must stay with beginner to solve unexpected trouble and guide them how to deal with trouble so long.

3) To train every staffs in computer effectively, we should train young engineers well at Kathmandu and send back them to each office. If those engineers guide other staffs at each offices, every staff can operate easily and economically.

4) Even if necessary manuals were disseminated to offices, they were seldom to be used. We should instruct directly.

(2) Condition of Data Entry

Since hydrology data book up to 1984 has been published, the condition of data entry for hydrological data from 1985 to 1992 was investigated as below:

1) In case of staff gauge reading record up to 1991

The condition of data entry for staff gauge reading record observed at existing stations is as shown in Table 6.9. Since the computer installed at the Central Regional Office was broken and sent to dealer for repairing, the data for the Central Regional Office were entered by the computer at the Central Office. The time for data entry was limited with that computer and much data remained without entry, despite the Central Regional Office had well trained staffs for it.

At the Eastern Region, much data remained, because it was first time for them to operate data base software and they were not familiar with that. Also all staffs for data entry had ordinary work such as inspection of gauge, discharge measurement and arrangement of data and the time for data entry was limited.

The Far Western Regional Office and the Mid-Western Regional Office entered almost of data up to 1990.

In case of the Western Regional Office, the condition of data entry was good. Because, the Western Regional Office had much experience for operating computer and software. Some staffs were nominated for data entry and had the responsibility for them. They recorded the data entry condition on register and checked one by one if the data had been entered.

In the Model System, forty six priority hydrometric stations were chosen as object stations. The condition of data entry for these stations are as as shown in Table 6.10. About fifty percent (50%) of data observed manually from 1985 to 1991 have been entered completely into computer. One hundred and forty seven (147) year data have remained without processing at present. It took less than ten minutes to enter one month and station data. It indicated that it would taken seventeen thousands six hundred and forty minutes to enter these remaining data into computer. If these data will be entered with three existing computer for five hours in one day at the Central Office, all of these remaining data for priority stations will be entered within one month. If these data will be entered at the Regional Offices, it will take less than one month.

The condition of data entry was investigated in the first field investigation in Nepal. At that moment, a lot of staff gauge records had not been entered after 1985 as shown in Table 4.15. But the DHM decided that they tried to publish data book at the end of 1992 and every staff related with data processing work intended to process data. At least, fifty percent of data had been already entered at present.

At the Western Regional Office, staffs for data entry entered data with responsibility and the condition of data entry was good.

These facts indicated that if the responsibility and the object for data entry were clear, data could be entered on schedule. Before 1991, the deadline of publishing of data book was not clear and the staffs for data entry entered data as they liked without assignment for responsibility. That was why much data remained in store house without entry in the Central Office.

2) In case of staff gauge reading record recorded by the newly installed gauge for the Model System

In the model basins, four stations were installed at Tatopani, Kalleri, Setibeni and Chyuntaha. Some of staff gauge records observed at these stations have arrived at the Regional Offices. But almost of these record had not been entered yet.

To enter these data, new stations must be registered into main data base at the Central Office at first. But this procedure was late and it had been impossible to enter data into computer without register. On October 1992, the new stations were registered and data began to be entered.

3) In case of automatical recorder recorded up to 1991

Much data recorded on chart from 1985 to 1991 remained at store house without arrangement and processing. Before 1991, they were stored at store house in Kathmandu, and sent them back to each Regional Offices in 1991 to process there. Some of the Regional Offices began to process the charts and faced following problems.

They were too old to investigate the cause of error, correct and adjust them in these days. The reason why these charts remained without processing were as follows:

a) Because of Sedimentation

Almost of rivers in Nepal have much sedimentation in flow. The float for measurement of water level in the well does not work in the rainy season because of sedimentation and the line on the chart for water level draw flat line even if in flood term.

b) Because of Adjustment

Almost of automatical water level gauge is long-term type recorder. When the staffs go to inspect or take discharge measurement, those records are collected and brought to the Regional Offices three or four times per one year.

Sometimes the clock is stopped or late and the rope hanging on drum is slipped. Before data entry, the hourly record must be picked up from the chart with adjusting work for time correction and so forth. It is not so comfortable work, especially for the long-term record.

c) Because of Much Record

Comparing to the manual record, much data must be entered into computer in case of automatical water level record.

d) Because of Procedure

The DHM calculates mean daily discharge from mean daily water level by computer. The daily water level can be calculated from hourly water level and also staff gauge reading record. Without automatical record, mean daily discharge can be estimated from staff gauge record.

e) Because of Arrangement

Once there was not clear who had the responsibility for the arrangement of hydrological data. When data were send from the Regional Offices in big sack, they were stored in the store house in same sack without arrangement.

f) Because of Time Lag

Although the manual data arrive within one month by mail, the charts recorded by automatical recorder are collected after several months by staffs. Almost of manual data have been already entered, when those charts arrive.

4) In case of automatical recorder newly installed for the Model System

In the Model Basins, four automatical water level were installed. The data recorded by these recorder had not been entered into computer because the DHM had concentrated all staffs for data processing on data book publication work.

5) In case of precipitation data

The condition for precipitation data entry is good comparing to hydrology data. The data book from 1987 to 1990 has been already published. Almost of manual record had been entered into computer when they arrived. The data observed by newly installed automatical recorder could not been entered because of quality of records.

The counter plans for automatical gauge data problems were got from the attempt in the Model System as follows:

1) Sedimentation Problem

This is the problem for observation. This problem should be solved for choosing good site or gauge that is not influenced by sedimentation.

2) Adjustment

Basically this problem is also for observation. At first good gauge must be chosen. Secondly, installed gauge must be maintained correctly. If the manual records are reliable, it is not so difficult to adjust. The DHM must check manual data carefully and instruct observers. The DHM should also train staffs how to adjust fast and correctly. Data logger system can solve some adjustment problems.

3) Much Record

Using machinery such as data logger, digitizer, image scanner and so on, data entry work can be carried out automatically. Sharing works to each other, the number for data entry can be decreased for one person.

4) Procedure

The software that makes monitoring summary to show which hourly water record have been entered should be developed and the DHM can check the condition of hourly water level record entry regularly.

The software must have functions to protect to calculate mean daily water level values from staff gauge reading instead of hourly water level record.

5) Arrangement

By clearing who has responsibility for data processing and storing, this problem can be solved.

6) Time Lag

Even if there is time lag for data collection, hourly water level must be entered into computer. The solution for this problem is same with procedure problem (see 4)).

(3) Condition of Daily Mean Water Level Calculation

The actual condition of daily mean water level calculation is shown in Table 6.9. This condition is depend on that of data entry, because the actual works for calculation are carried out by computer automatically as soon as data entry.

(4) Condition of Rating Curve Estimation

Before 1991, all the rating curve was estimated at the Central Office. In 1991, the DHM decided to transfer these works to each Regional Offices. Some of engineers who had the roles for estimation of the rating curve were young employed by the Nepalese Government in 1991 and transferred to the Regional Offices without enough experiences for such field. Some of the staffs at the Regional Offices were trained to make rating curve by foreigner in the developing project. But it was the first time for almost of the staffs to make rating curve.

The DHM made rating curve mainly by using the logarithmic paper plotted discharge measurement records. The DHM checked the accuracy by the difference between discharge values estimated by the rating curve and discharge measurement records.

The least square method to determine rating curve was introduced in the training. The adopted formula for the rating curve was the quadratic equation. Because it could be calculated easily and the number of discharge measurement in high flood was not enough to determine. If more than quadratic was applied in such condition, the values of discharge were sometimes estimated too much.

When the new computers were installed at each Regional Offices for the Model Systems, the DHM staffs installed application software to estimate the formulas for the rating curve by trial and error method and attempted it.

In the Model System, the four stations were newly installed in 1992. The number of discharge measurement record for these stations were too small to try to make rating curve as follows:

Station Name		Station Number	Number of Discharge Record
1.	Tatopani	403.5	1
2.	Kalleri	406	6
3.	Setibeni	410	2
4.	Chyuntaha	595	12

The actual condition of these records is as shown in Table 6.11, and Fig. 6.5. Referring the plots of discharge measurement records, it was impossible to make rating curve.

In case of existing priority stations, the DHM had tried to publish hydrology data book from 1985 to 1990. Almost of these rating curves had been estimated at each Regional Offices and brought to the Central Office. These curves were checked at the Central Office by one senior staff. The total number for these priority stations was forty six including one closed station in 1991.

Monitoring the condition of estimation of rating curve at each Regional Offices, the following problems were found:

1) Lack of number of discharge measurement

It was difficult to draw rating curve because of lack of discharge measurement records.

The number of discharge measurement record observed at priority stations and stored in data base on November 1992 was as shown in Table 6.12. Even if the priority stations, the average number for that is four times per year. That number was depends on the budget for porter.

Actually, some of discharge measurement records observed in 1991 and 1990 had not been entered into computer yet. Considering these conditions, that number was also too small to draw reliable curve, especially for Nepalese river.

The rivers in Nepal have steep slope and much sedimentation. The rating curve for these rivers changed so much because of changing the shape of river bed. To determine the application term for these rating curve with such condition, enough number of discharge measurement record is necessary.

Even if the application term was decided, the number was not enough to draw rating curve correctly, too.

2) Lack of cross section survey

There were only one or two cross sections for each stations from the beginning of observation. There were also stations that have not surveied cross section. It was difficult to determine the application term for the rating curve without cross section.

Since it is very difficult to measure the discharge while maximum flood occurs, the rating curves made by discharge measurement records ordinarily have to be extended to calculate flood record. Without cross sections, the slope area method can not be used to extend.

This slope area method is also useful for check discharge measurement record in high flood range. Without cross section, it can not be applied to check the rating curve in high flood range.

(5) Condition of Rating Table Estimation

It is easy to estimate rating table after rating curve has been determined. The actual condition of rating table entry for the priority stations are as shown in Table 6.13. About 50% of rating curve have been estimated.

At present, DHM enters rating table by point. But some of users use software to enter it by formula. The DHM also had better to develop the software that can be entered by formula.

(6) Condition of Daily Mean Discharge Calculation

The condition of daily discharge calculation is shown in Table 6.9. This work is carried out by computer automatically. If the mean daily water level and rating table are recorded into computer, daily mean discharge can be estimated easily and quickly.

(7) Condition of Sediment Transportation Calculation

This work is also carried out by computer automatically. The condition of sediment concentration data entry is as shown in Table 6.14. Sediment transportation can not be estimated without daily mean discharge and sediment concentration record. The condition of sediment transportation is not good as shown in Table 6.15.

6.7.3 Data Checking

The procedures for data checking consisted of four phases in the Model Data Management System; inspiration checking, total checking, data processing checking, and overall checking.

As soon as the data arrived at the Regional Offices, they were checked by the Inspiration Checking. Inspiration Checking is the checking way that experienced staffs check data referring the original data carefully.

After the Inspiration checking, they were checked if they were entered into computer correctly by the Total Checking. The entered data were checked comparing with the monthly values calculated manually and by computer. If there is the difference between them, it indicates that there are data entry errors.

The entered data were checked during data processing by the Data Processing Checking. It checked data graphically by computer or manually.

Finally the processed data were checked by the overall checking. The overall checking checked data comparing with the data observed at near stations to each other.

The outline of the procedure for these checking way was instructed by the training with the Manual distributed on March 1992.

The condition of data checking in the Model System was as follows:

(1) Inspiration Checking

The DHM usually checks data by this checking way at present. The space for signature who checks data by this way is printed on each recording form of the DHM. If the experienced staffs check data by this way carefully, errors can be found correctly.

But this data checking way is boring work. Almost of the staffs did not check carefully and it was seldom to find errors by it in the Model System. To motivate to check more carefully, the result by this data checking method must be evaluated fairly and the staffs who find data error must be prized.

(2) Total Checking

This checking way is useful to find data entry error correctly and easily. In the Model System, this checking way was not used so much. Because it was not necessary to calculate total values manually to process data instead of computer.

But this method is the most reliable one and useful to find data entry error. To carry out this method, the area for total values calculated manually and signature for checked staffs should be created on the recording form and the training to guide to carry out it correctly is also necessary.

(3) Data Processing Checking

1) Hydrological data

The entered data were checked graphically by computer drawing hydrograph. This method is useful to find error easily referring the shape of hydrograph.

To apply this method, the idea to revise the software to make hydrograph was recommended by the user in the Model System to check more comfortably as follows:

a) The observation values should be displayed with graph,
b) The function to expansion and reduction are necessary,

c) The function to choose the object term for hydrograph is necessary,

d) The multi display function is useful for easy operation,

e) The mouse is useful for easy operation also.

This checking way was useful for data checking. Sometimes it indicated that observer did not observe three times a day. By plotting manual record on the chart recorded by automatical recorder, it became clearly.

2) Precipitation data

For precipitation data observed by manual gauge, this checking way by hyetograph was not so useful. Instead of this method, it was more useful to check data by comparing the precipitation data observed at near gauges to each other. But it was useful to check continuous value.

3) Discharge measurement data

In the training for the Model System, the checking method was instructed by gauge height and water area graph, by gauge height and discharge graph, by gauge height and velocity graph, and by gauge height and river width graph.

If the shape of river bed has not changed, the value of water area, velocity, discharge and river width depend on water level. Dotting these values of discharge measurement record on the section paper, these dots should be draw smooth curve. Using this relation, the discharge measurement record can be checked.

But this method was difficult to apply in the Model System, because the number of discharge measurement was too small to draw the curve. Some of staffs tried to check by this way but it was not useful, because the shape of river bed changed rapidly. To get reliable data, the number of discharge measurement must be increased.

(4) Overall Checking

The Model System was planned that the Central Office carried out the overall checking. But the Regional Offices Chiefs recommended to carry it out by themselves because the Regional Offices must process data completely there. It is useful to process data completely at the Regional Offices, because the responsibility for data quality becomes very clear and it is easier to investigate the cause of error. In the Long Term Programme, overall checking should be carried out at the place where data will be processed.

The main items for overall checking are, by correlation factor for precipitation data by correlation factor, by correlation factor, by comparing of hydrograph between at the up stream and lower part, and by run-off coefficient for water level and discharge data.

These checking items were applied for the records observed in 1990 in the Model Basins, because the term of record observed by newly installed gage was too short to apply overall checking. The results of this checking were as follows:

1) Precipitation

If the correlation factors were estimated by monthly data, they showed good relation between near gauges. In case of daily data, almost of the value of correlation factor were less than 0.5 in Kaligandaki Basin and 0.6 in Jamuni Basin in the monsoon season in 1990. These results indicated that it was a little bit difficult to use this method for data checking directly. Instead of this method, it is easy to find error by comparing with observed data directly to each other.

The checking by isohyetal map was also applied and found that it was useful to check generally.

2) Water Level

By comparing to water level hydrograph between at the up stream and the lower part, the tendency of the flow at the object station could be grasped and it was useful to check data.

3) Discharge

The discharge hydrograph was useful for data checking. In the Kaligandaki River Basin, the runoff coefficient was also estimated roughly from 1980 to 1990. Those values of runoff coefficient were nearly one. Considering to the condition of land use in the Kaligandaki River Basin, that value was so much and it indicates the observation network should be reviewed. This method was useful not only for data checking but also evaluation of observation network.

6.7.4 Data Management

Model Data Management System was designed to be managed by two main parts. One was the Central management Section in the Central Office and another was the Regional Office Chiefs. The Central Management Section was installed temporarily to manage the Model Data Management System as shown in Fig. 6.4. The Regional Chiefs were existing post.

The main roles of the Central Management Section were: 1) progress control on data processing, and 2) quality control on data. The progress control aimed to monitor if the data were collected and each data processing phase were completed within the fixed deadline. The quality control aimed to monitor if the data were checked correctly by the checking lists attached with the Manual for Data Management.

The Regional Chief managed all activities at the Regional Office including the data processing. Almost of management work for the chiefs in the Model System was same with the present works. But the deadline and the reporting to the Central Management Section by the monitoring form and the check list were newly attached works for them.

All of the necessary information for management were mentioned in the Manual for Data Management and those manuals were distributed to every Regional Chiefs and related staffs for management work at the Central Office.

In 1992, the DHM decided that they would try to publish data book up to 1990 within 1992. That term was overlapped with the term for the Model System. Although the object data for the Model System were the record observed in 1992, all the staffs related with data processing work had to be hurry to process data observed up to 1990.

Since the main purpose of the Model Data Management System was to attempt if the data were processed completely at each Regional Offices with computer and it did not depend on the observation year, the object observed year to monitor about data processing condition at existing gauges was changed from 1985 to 1990 instead of 1992. This determination conforms to the basic policy also that the Model System should be operated without disturbance for present DHM works.

Because of the changing of the object observation year, the schedule on the data processing for the Model Data Management System was not fitted to actual data processing works. That schedule had to follow the DHM ordinary work. The precipitation data had been processed at the Central Office instead of the Regional Offices and published. Because almost of the data up to 1991 had been already stored there.

With these conditions, the Model Data Management System had been operated from April, 1992. The management work for this system was not work well because of as follows:

1) All of staffs for data management works were related to publishing work for data book up to 1990. That was the first priority work for the DHM.

2) All the data were processed by present data processing procedures instead of that for the Model System because of the data publishing. The data checking way and monitoring materials such as monitoring form and report to the Central Management Section were not applied.

3) The data processing schedule was changed because of the changing of object observation year and it was impossible to follow the original schedule for the Model System.

4) The training for data processing was held for three times in March, June, and December 1992 to operate this System. Two trainees from each Regional Offices attended the training. But the number of staffs for data processing at the Regional Offices were more than that and these staffs who did not attend the training did not know well about the procedure on the data management work for the Model System.

5) The data checking lists attached to the manual for data management had too much checking items to fill in it.

6) The roles of organization for the Model Data Management System were not same with the present one for the DHM. For example, the meteorological data in the Central Office were collected and stored by the Acquisition Unit instead for the Central Management Section. The management works such as quality control and progress control for hydrological data were carried out by Checking Unit at present beside the Central Management Section in the Model System. Since the all of management works were carried out by the present organization for the data book publication, the temporal organization for the Model System did not work.

Referring the ordinary management work for publication, the following things were revealed.

(1) The condition of arrangement for information and data at the Central Office was not satisfied.

The information about the stations were stored as station inventories made by UNDP/WMO project for each station sites at the Central Office. Those information on the inventories had not been updated by the DHM and they were sometimes too old to use. Moreover, some of those inventories had been lost. Such information about the stations were also stored on data base at the Central Office. These informations were old, too.

The information about data processing condition had not been arranged and it was difficult to grasp the actual condition at the Central Office. These information were important to manage data processing work.

The DHM had the fixed inspection form for stations. These forms were made and sent to the Central Office and stored without arrangement.

To solve these problems, the DHM installed Network Unit at the Central Office in 1992 and had been tried to arrange the information about stations. These informations are basic for data management works and should be arranged, stored with fixed rule and updated regularly.

(2) The form for management should be made simple.

In the Model System, the monitoring forms for data collection and data checking were distributed to each Regional Offices. But they did not used them for management work. One of the reason was that those forms were too complicated to be used. Those forms should be designed to fill in by tick mark to maintain the management system easily. For data checking, the checking item should be attached on the recording form.

(3) The condition of original hydrological data storing was not good.

Meteorological original data were stored in the store room by permanent staffs who had responsibility to collect and stored data after those information were recorded on register. In case of hydrological data, they were stored into different store room without arranging. Sometimes the Central Office requested to the Regional Office to send same data that had been already sent to the Central Office before, because these data could not be found or loosed at the Central Office.

(4) The quality of data could not be controlled without manual.

Almost of the DHM staffs were trained by the on-the-job training way such as irrigation and hydropower project, USAID, UNDP/WMO Project, Snow and Glacier Project and so on Since each staff learned data processing such ways, they processed data following their experiences and the quality of processed data were not uniform in the DHM.

The data disseminated by the DHM are official data in Nepal. The quality of these data should be satisfied with certain standard. To get the such reliable data, the DHM should determine the standard and make manual how to process and check data. Without standard and manual, it is difficult to control the data quality.

(5) There was no regulation about data management and the responsibility for it was not clear.

The data Checking Unit in the Other Technical Service carries out the almost data management works. It monitored the data processing condition and data quality. But the responsibilities for data collection, storing, dissemination were not clear in Other Technical Services. The DHM should make the regulations about data management and clear the place of the responsibilities for main works to work more systematically.

Even if observation error was found in data processing works, this experience was not used to guide the observers to observe more correctly. Comparing to the manual gauge and automatical chart, the following problems were found.

1) Even if such observer did not observe at correct time, he recorded the fixed time.

2) Even if observer did not observe, he made the data and recorded the recording form.

If such errors are found, the DHM staffs must guide observers to observe correctly explaining the importance of those records for developing in Nepal. Before going to the site, the staffs must check the error conditions found in the data processing works.

(6) There was no evaluation unit for observation and data processing.

Data could be processed by computer easily without data checking if the quality of data was not evaluated. By evaluating of the observer and data processing conditions, observer and staffs for data processing will try to observe or process more carefully.

(7) The schedule for data processing must be determined before the data processing.

The DHM had not published hydrological data book officially after 1984 and decided to publish data book observed up to 1990 by the end of 1992.

The half of data processing work for the data observed from 1985 to 1990 was completed on November 1992 for about one year. It showed us that the DHM could process data and publish book with in next observation year by themselves if the deadline was clear. The Regional Chief can manage to necessary activity for data processing by the deadline. The most important point for data management is to set the deadline and make schedule to complete it.

6.8 Training

The training in the Model System was held at the Central Office for three times and at each Regional Office when the Study Team visited there.

The main purposes for these trainings were; 1) to instruct how to operate the Model System, 2) to transfer technology, and 3) to study the suitable training for the DHM.

To accomplish above object, four main training items; 1) introduction of the Model System, 2) how to operate computer newly installed computer and software, 3) how to process data following the manual, and 4) basic knowledge about data processing were instructed in these training.

Two trainees were chosen for each training from each Regional Offices and the Central Office. Their class in the DHM was from technician level to engineer level.

The outline of each training was as follows:

(1) First Training

The first training at Kathmandu was held from March 15 to March 23, 1992 to guide mainly how to process data following the manual for the data management made for the Model System and observe by newly installed gauges. The basic knowledge about computer and data base software was also introduced in this training.

(2) Second Training

The second training at Kathmandu was held from June 3 to June 12, 1992 to instruct how to operate necessary software such as data base software, Lotus 1-2-3, MS-DOS, and Vaccine programme and observe.

At each Regional Offices, the training for data processing and operation of computer and software was held when the Study Team visited there.

(3) Third Training

The third training at Kathmandu was held from December 6 to December 14, 1992 to instruct how to process and check data with revised manual for the data management referring the result of monitoring works.

The schedule for these training was shown in Table 6.16, 6.17 and 6.18.

6.9 Recommendation for the Long Term Programme and the Immediate Programme

(1) Data Collection Way

1) About 60% of the manual data have arrived at the Regional Offices within one month by mail. This data collection way will be useful.

2) The DHM should guide observer to send data every month on the way to inspection.

3) To guide observers, Regional Office should monitor the condition of data collection regularly and arrange to collect data that have not arrived on time.

4) In the mountain area where post office does not serve register mail, the DHM should arrange suitable route programme to collect data.

5) The DHM had better evaluate observer about data sending and prize them.

6) The wireless system is not effective for data collection

(2) Operation of Computer

1) It is important for beginners to make chance to operate computer in the training to get interested in data processing with computer.

2) To train staffs in operation of software, one week is necessary for ordinary operation of each software.

3) To train every staffs in computer effectively, we should train young engineers well at Kathmandu and send back them to each offices to train other staffs.

4) Easy operation is the most important to maintain system.

5) The software should be developed with free-maintenance.

(3) For Data Entry

1) One of the problems for the hourly water level data entry is adjustment. The DHM should train staffs how to adjust fast and correctly.

2) To enter hourly water level data easily and correctly, they should be entered by machinery way such as data logger, digitizer, image scanner and so on.

3) The software that makes monitoring summary to show which record have been entered should be developed.

4) The software must have functions to protect to calculate mean daily water level values from staff gauge reading instead of hourly water level record.

5) The responsibility for data processing and storing must be clear.

(4) For Estimation of Rating Curve

1) The DHM should take discharge measurement record as much as reliable rating curve can be drawn.

2) The DHM should survey cross section more at the gauging station.

3) The software that help to make rating curve easily should be developed.

(5) For Rating Table Estimation

1) The rating table should be entered not only by point value but also by the formula.

2) The rating table had better to be expressed by formula and estimated by software to save time and evaluate by statistical method.

(6) For Data Processing

1) The data processing should be carried out by computer to prevent careless error and save time.

(7) Data Checking

1) To motive to check more carefully, the result must be evaluated fairly and the staffs who find data error well must be prized.

2) To carry out total checking, the area for total values should be created on the recording form.

3) The data should be checked graphically by computer drawing hydrograph with the system as follows:
   a) The observation values should be displayed with graph,
   b) The function to expansion and reduction are necessary,
   c) The function to choose the object term for hydrograph is necessary,
   d) The multi display function is useful for easy operation, and

e) The mouse is useful for easy operation also.

4) Precipitation data should be checked by comparing to the precipitation data observed at near gauges to each other.

5) The discharge measurement data should be checked by following method.
   a) By gauge height and water height graph
   b) By gauge height and discharge graph
   c) By gauge height and velocity graph
   d) By gauge height and river width graph

6) The Regional Office should carry out overall checking.

7) The precipitation data should be checked by isohyetal map.

8) The discharge and water level should be checked by hydrograph.

9) The runoff coefficient should be estimated to check discharge and precipitation data and observation network.

10) The data checking work had better to be carried out by computer automatically to prevent careless mistake and save time because the data checking work is boring.

(8) Management

1) The data and information should be arranged and stored with the fixed rule.

2) The monitoring forms should be designed as simple as possible. If possible these forms should be made automatically by computer.

3) To store data safely, the unit for data storing should be installed to clear the responsibility.

4) The DHM should determine the standard for data quality and make manual how to process and check data.

5) The DHM should make the regulations about data management and clear the place of the responsibilities to work more systematically.

6) Before going to the site, the staffs must check the error conditions found in the data processing work and instruct observer how to observe correctly on the way to inspection.

7) The system for the evaluation on the observer and data processing condition should be planned.

8) The schedule for data processing and deadline should be determined for management.

9) The permanent section for data management should be installed to manage the system.

(9) Training

1) The data processing procedure should be trained well to process data correctly and keep data quality.

2) The DHM tried to combine meteorology and hydrology unit at the Regional Offices. To combine each units, the training for each field should be serve to related staffs.

3) Almost of data checking work was carried out by engineers. The technician also had better check data to observe more correctly and guide observer with more suitable way. In the training of the Model System, some of technician who has the sense for check data were found.

4) The actual data and error should be used in the training to prevent reappearance error and guide what is the actual problems.

(10) Others

1) In the Model System, the Central Office checked data and instruct the Regional Offices what was the error and how to correct it. But it was difficult to instruct well because of lack of communication way. The on-line between the Regional Offices and the Central Office will be useful to instruct correctly by mail function and transfer of data rapidly and correctly.

2) The DHM had better to pay allowance to the staffs for maintain of software. It is difficult to find staffs for maintenance of software, because it is hard work and staffs prefer to go to field to get field allowance.

7. THE LONG TERM PROGRAMME

7.1 Basic Policy for the Long Term Programme

The Long Term Programme is the programme presenting improvement and reinforcement plans of the existing hydro-meteorological observation and data management systems in the DHM to be implemented until the year of 2005.

Observation items in the Long Term Programme are precipitation, river water level, discharge, sediment load and water quality, all of which are fundamental and essential to disclose hydrological features of the whole Nepal and to plan and design water resources development projects.

The data management system will not include for the real-time rainfall and water level data during floods for flood control purpose.

The data management system will process observed hydrological and precipitation data to disseminate them to optional users. The object works for this system are 1) data collection works, 2) data processing works, 3) data storing works, 4) data dissemination works, 5) instruction works to operate this system, and 6) management works

The ideal system will satisfy with all of the requirements; 1) correctness, 2) fastness, 3) easy operation, and 4) economy. If the ideal data management system exists actually, every body can get the correct processed data freely and automatically as soon as observation. But it is impossible to make such system at present and the priority of them must be determined to plan system. Among four requests mentioned as above, correctness is the first priority item for the Data Management System. Because inaccuracy data are no use for any purposes.

The correctness for data management in the DHM is explained concretely as below:

1) Data are disseminated after they are fully checked.
2) Everybody can reappear the same result from the original data.
3) The data are processed following the same data processing procedure and the procedure must be opened to users.
4) Simple works are carried out by computer to prevent careless mistake.
5) Data are processed according to annual schedule correctly.

Since data should be processed as soon as possible because of effective data checking and user's needs, the second priority item is fastness. But it takes much time to process data correctly. Therefore data will be served to users within the next observation year to prevent backlogs.

Next priority item is the easy operation, because easy operation is important to maintain the system. Easy operation will be realized with following ways:

1) Simple works are carried out by machinery.

2) All procedures are indicated by computer without manual and special training.

The last priority item is the economy. Because other three items are basic requirements to process and maintain system and they must be realized according to the object of this System. Since there are many ways to satisfy with these basic requirements correctness, fastness and easy operation also, the most economical way will be chosen by comparing to them in the designing stage.

The data management system must be planned also to satisfied with recommendations found in the Model System as shown in section 6.9.

7.2 Basic Structure

7.2.1 Structure of Sub-System

The object works for the Data Management System studied in the section 4.2 can be classified into two parts, data arrangement work and, management work. These two parts works can be considered independent system itself as follows:

(1) Data Arrangement System

The object of this system is to disseminate processed and original data and information about observed data and stations to user.

This system will also consist of four sub-systems such as Dada Collection System, Data Processing System, Data Storing System and Data Dissemination System.

The Data Collection System will collect observed data and information about stations and brings them to the processing place after registration. The Data Processing System will process them. The Storing System will store processed data, information and also original data. The Data Dissemination System will disseminate stored data and information according to user's requests.

(2) Management System

The Management System will assist the Data Arrangement System in working well and correctly. Usually, management work deals with administration and accounting works. But this Management System does not include these works.

This system will consist of five main sub-systems such as Training System, Data Quality Research System, Progress Control System, Quality Control System and Evaluation System. The Progress Control System will make annual schedule and control progress of data collection and processing. The Training System will train the DHM staffs and observers on observation and data processing. The Data Quality Research System will research the network of observation from the result on data processing and recommend more reliable observation network. The Quality Control System will monitor the condition of data checking, study on cause of error, making counter plan and instruct. The Evaluation System will evaluate the condition of observation and data management works and report the results to use for training and improvement of system to get more reliable data.

The outline of basic structure of Data Management System is shown in Fig. 2.5 and the outline of data flow and procedure for Data Arrangement System is shown in Fig. 7.1.

7.2.2 Organization

At present, the DHM consists of three main parts. Those are the Central Office at Kathmandu, the Regional Offices for each development regions and the synoptic and hydrology stations in Nepal. The synoptic and hydrology stations observe meteorology and hydrology phenomenon. Each Regional Offices observe, collect and process data and manage the meteorology and hydrology stations. The Central Office manages each Regional Offices and checks, stores and disseminates data.

The DHM has studied most suitable organization and its roles to manage hydrology and meteorology data and the present organization has been formulated as below. Before 1991, the Central Office processed, stored, disseminated and managed data. Each Regional

Offices managed stations, observed collected and processed data manually without making rating curve work beside the Western Regional Office at Pokhara. From 1991, the DHM transferred all data processing roles from the Central Office to each Regional Offices because of much backlogs at the Central Office. In 1992, the DHM established the Training Unit for training, Data Checking Unit for data checking and Network Unit for disseminate and arrange information about station and data. Although the suitable data flow was studied when the Model System was designed as section 6.3, the most suitable data processing mode should be restudied, referring the above historical organization of the DHM and the results of the Model System before planning the Long Term Programme in detail.

There are two main data processing modes. One is the centralized data processing mode and another is the decentralized mode. The centralized data processing mode is the system that the Central Office collects all data and processes them by itself. Since every resources such as manpower and computer system can be concentrated at one place, data can be processed efficiently. The decentralized data processing mode is the system that data are processed at each Regional Offices without concentration. This mode can decentralize the functions, load and accident.

Before, almost of the systems were designed as centralized data processing mode because of maintenance of computer and cost performance. At present, the decentralized data processing mode has been also applied, because of economical efficiency, high performance of personal computer with almost same ability as old general purpose computers has been supplied and the development of communication network. It is impossible to decide generally which is the better processing mode. The processing mode for data management should be studied with concrete conditions.

To make the concrete models for the study on data processing mode, three models were chosen as the basic organization for the DHM as follows.

1) The DHM will consist of only the Central Office.
2) The DHM will consist of the Central Office and the Regional Offices under the Central Office.
3) The DHM will consist of the Central Office, the Regional Offices under the Central Office and the Branch Offices under the Regional Offices.

The seven alternative models were made by distributing the functions of data collection, entry, processing and management to these three basic organizations, as follows:

Case 1 The DHM will consist of only the Central Office. The Central Office will collect, enter, process and manage data.

Case 2 The DHM will consist of the Central Office and the Regional Offices. The Regional Offices will only collect data and send them to the Central Office without any processing.

Case 3 The DHM will consist of the Central Office and Regional Offices. The Regional Offices will collect and enter data into computer and send them to the Central Office.

Case 4 The DHM will consist of the Central Office and Regional Offices. The Regional Office will collect, enter, process and send them to the Central Office. The Central Office will manage data.

Case 5 The DHM will consist of the Central Office, Regional Offices and Branch Offices. The Branch Offices will collect and send data to the Regional Offices. The Regional Offices will collect, enter, and send data to the Central Office. The Central Office will process and manage data.

Case 6 The DHM will consist of the Central Office, Regional Offices and Branch Offices. The Branch Offices will collect and send data to the Regional Offices. The Regional Offices will collect, enter, process and send data to the Central Office. The Central Office will manage data.

Case 7 The DHM will consist of the Central Office, Regional Offices and Branch Offices. The Branch Offices will collect, enter and send data to the Regional Offices. The Regional Offices will collect, enter, process and send data to the Central Office. Central Office will manage data.

To evaluate above cases concretely, the suitable places for the Regional Offices and Branch Offices must be determined at first. At present, the DHM has Regional Offices in each development regions. The distribution of these offices has the following inconvenient points:

1) The river basins are sometimes divided into more than two development regions. In this case it is impossible to carry out overall checking and get the whole basin condition by one Regional Office without transfer of data.

2) At present, some Regional Offices are located in remote places that the traffic condition is not good and it is not so easy to go to inspect all belonging stations.

To solve these problems as above, the suitable places for establishment of the Regional Offices were studied based on the following points:

1) The stations belonging to one river basin should be managed by the same Regional Office.

2) The place of the Regional Office should be decided according to traffic conditions.

All river basins in Nepal can be divided into seventeen basic units as shown in Table 7.1. It will not be so effective to establish one office for each river basins, because of access in the basins. For example there is no covered road in Karnali River Basin, especially in the northern part. If the office will be established in the middle of this basin, it will be difficult to maintain all stations in the Karnali River Basin from one place. To inspect stations in the basin, Nepalgunj will be the most suitable place to establish the office even if it will be out of Karnali River Basin because of traffic condition. From Nepalgunj, the network of airplane covers the basin and it is the center of bus services.

If the office will be established in Nepalgunj, it will be able to maintain stations not only in Karnali River Basin but also South Border River Group No.1, No.2, No.3, Mahakali River, Babai River and Rapti River Basins using the east and west highway. At present the east-west high way is not completed between Nepalgunj and Dhangadhi. But near future it will be completed.

For the Narayani River Basin, Pokhara will be the most suitable place to maintain stations in the basin because Pokhara is in the middle of the basin and the traffic condition is good. There is air port in Pokhara and covered road runs to the south and east. The Chinese road from Pokhara to Baglung is now constructed and it will be useful to access the northern part.

In case of Bagmati River, Kathmandu will be the suitable place because of access. The stations in South Border River Group No.4 and No.5 will be maintained from Kathmandu easily using east and west highway.

For Kosi River Basin, Biratnagar will be the most suitable place for establishment of office because of network of airplane and road. The office in Biratnagar will be able to maintain stations in Kamala River, Kankai River and South Border River Group No.6, 7 and 8, too.

In this way as above, the four places Nepalgunj, Pokhara, Kathmandu and Biratnagar were selected for the office place according to the river basins and access. Since the area for each offices will divide development regions according to the river basins, these offices under the Central Office will be called the Basin Office instead of the Regional Office.

In case of branch offices, the site of branch office was studied based on the following main points:

1) The Branch Office should be installed near from hydrology gauging stations because of discharge measurement.
2) If the automatical gauge will be troubled, staff must be able to arrive at that place from Branch Offices as soon as possible to prevent to loss data. The Branch Office should be installed especially near the automatical gauges.
3) The Branch Office should be installed at the place where telephone service and house for rent are available.
4) The synoptic station should be studied also as the Branch Office to save manpower and running cost.
5) The Branch Office should be installed especially in the northern part of Nepal, because staffs will be able to collect data from observers who will live far from post offices except for postal service.

Under the Nepalgunj Basin Office, five Branch Offices will be established at Bangga, Chainpur, Simikot, Jumla and Musikot. Although Bangga is in the southern part of Nepal, there are some important stations near from Bangga for Karnali Multipurpose Project. Chainpur is in the northern part of Nepal and district headquarter. Simikot is also district headquarter in the northern part of Nepal and has airport. Jumla is the zonal headquarter in the northern part of Nepal. There is also airport and one synoptic station at Jumla. Musikot is the district headquarter and mountain area in the middle part of Nepal.

Under the Pokhara Basin Office, one Branch Office will be established at Jomson. Pokhara locates in the center part of the object river basin area. In the southern and middle part in this basin area, the network of highway is developed well. But in the northern part of this area, there is Himaraya Mountain Range and one Branch Office will be necessary at Jomson. Jomson is the district headquarter and has one airport.

Under the Kathmandu Basin Office, one Branch Office will be established at Simara. Kathmandu is in the northern part of the object basin area. From Kathmandu, the condition of access to the southern part is not good because of Siwalik mountain range. The condition of data collection in the Central Region has not been good at present as shown in Table 6.4. Because of these conditions, one Branch Office will be necessary in the southern part. The condition of traffic in the southern part is good at present, because of east and west highway. At Simara, there is one airport and aeronautical station. To save resources such as manpower and office facility. One Branch Office will be established at Simara.

Under the Biretnagar Basin Office, three Basin Offices will be established at Okaldhunga, Khadbari and Taplejun. These places are the district headquarter and in the northern part of Nepal. At Okhaldhumga and Taplejun, synoptic stations are located.

The location for each Branch Offices were chosen at Bangga, Chainpul, Simikot, Jumla, Musikot, Jomson, Simara, Okhaldhumga, Khandbari and Taplejun as shown in Table 7.2 from above studies. Based on these general idea for the Basin Office and Branch Office, the most suitable case was chosen as follows.

Since the disseminated data by the DHM will be used as the basic data for planning and designing of the developing project in Nepal, the Data Management System for the DHM should be planned based on the following basic concepts:

1) The System will prevent to miss data and disseminate long term data.

2) The System must disseminate liable data.

To prevent data missing, emergency information such as about damaged or trouble gauges should be collected as soon as possible. The DHM should also carry out suitable counter plan for those emergency information to make trust between observers. In case that the DHM will consist of only the Central Office without any Basin Offices or Branch Offices, it will be difficult to cope with such emergency information rapidly because of access, especially in the northern part and monsoon season. The road is sometimes closed because of land slide and the airplane is sometimes cancelled. Even if the airplane will be available, it will be difficult to get the ticket soon.

In the Long-Term Programme, the DHM will operate 110 hydrologic stations and 417 precipitation stations. It will be difficult to manage such big number of stations by the Central Office only because of the condition of traffic and communication. Before, the

DHM processed data by the Central Office only. In 1991 the DHM transferred the roles of data processing from the Central Office to the Regional Offices because of much backlog. Considering these conditions, the plan of case 1 that the DHM will consist of only the Central Office will not be suitable for the Data Management System.

In case that the DHM will consist of the Central Office and the Basin Office without branch offices were studied as follows.

If the Basic Office will be established under the Central Office, the average number of stations in charge of each Basin Offices will be one hundred and eighteen as shown in Table 7.3. If the Far-Western Basin Office at Nepalgunj will manage one hundred and ninety six stations in charge of its area, it will be difficult to manage all stations by that office only because of topographic and traffic conditions. If five Branch Offices will be established under the Basin Office, that condition will be improved. Because the average number of stations to be managed by it will become forty one. It shows the effect of the Branch Office.

Actual effects for access by establishing Branch Office are supposed as follows. The condition of access from offices to the stations will depend on the distance between the stations and the office or the end of road that vehicle will be able to go along. The DHM staff can walk 15km per/day officially and the necessary walking days to reach at the site can be estimated by the walking speed and the distance between the station and the end point of the road. The end point of road was determined by assuming that the under construction and seasonal road will be available whole season in 2005.

The condition of access to the farthest stations from present Regional Offices is as shown in Table 7.4. It will take more than seventeen days to go to farthest rainfall stations and twelve days to the farthest hydrologic stations by walk. Especially, the condition in the Mid-Western Region is not good. These conditions will be same with the case of Basin Office without Branch Office in the Long-Term Programme. In case of Branch Office case, it will be supposed as shown in Table 7.5. Even if the farthest station, it will take eight days by walk. Staff will be able to arrive at any hydrologic stations within one week. It indicates that the Branch Office will be useful to cope with urgent incident.

If the Basin Office will be established without Branch Office, it will not be so easy to cope with the emergency cases, especially in the northern part of Nepal. If the Branch Offices will be established in the Northern part, it will become easier to cope with emergency case because of access. The Branch Office will be also useful for discharge measurement in the

high flood. In these ways as above, the necessity for the branch office place was cleared to cope with urgent incident.

To get reliable data, observed data had better to be entered and processed at the same place near from each observing station. If they will be processed at the same place, the responsibility for data processing and checking will be clear. If they will be processed near from stations, it will be easy to investigate the cause of errors and guide observers to prevent error.

If observed data will be able to be processed at Branch Office, it will be ideal. But it will be difficult, because the electricity condition will not be so good in remote area for data processing by computer, especially in dry season. The resources such as well trained staffs who will be able to check data will be limited to distribute them to each Branch Offices. To process data correctly by well trained staff, they should be processed at the Basin Offices. Actually the DHM has tried to publish data book observed from 1987 to 1990 up to the end of 1992 and almost of data have been already processed by each Regional Offices. The young staffs had abilities to operate computer studying the result of training. Some of them had enough knowledge about OS and application software and are much interest in computer. It shows that they will be able to maintain computer system for data processing by themselves.

In this way, the case 6 was chosen as the most suitable mode for the DHM as shown in Table 7.6.

7.3 Sub-System

7.3.1 Data Collection System

(1) Outline of System

1)	Object	:	collection of observed data and information about stations correctly and sending of them to the Data Processing System
2)	Input	:	• observed data • information about stations
3)	Output	:	data and information sent to Data Processing System
4)	Function	:	• collection of data • registration on inventory • sending of data and information to Data Processing System • information of emergency item to Management system

(2) Basic Policy for this System

The first priority item for planning of the system is correctness. The correctness for Data Collection System is that data are collected within the deadline without loss and damages. Since it is not so easy to realize such system completely referring to the present data collection condition in Nepal, the following ways should be provided:

1) Before sending of data, duplicated data should remain at station for backup.

2) If data do not arrive within specific term, request way to observers and special collection way should be provided.

To collect data correctly, following ways are also useful beside the above ones:

1) The register for data collection should be ready for to monitor the data collection conditions.

2) The DHM should evaluate observers and guide to send data within the specified term.

3) If observers send data within the specified term, the DHM had better pay a certain allowance for motivation.

4) The wireless system is not useful for original data collection from stations to the Regional Offices.

To cope with emergency cases such as damage of stations due to flood, emergency communication way between observers and staffs should be provided.

Easy data collection ways should be also studied to maintain systems.

(3) Outline of Procedure

The outline of procedure for Data Collection System is as shown in Fig. 7.1 as follows:

1) collection of data and information
2) report of emergency information to Management System
3) registration of data and information
4) sending of data to the Data Processing System

(4) Material to be Collected

There are two types of materials to be collected. One is observed data and another is information about stations. The observed data will be precipitation, water level, discharge, cross section survey results, samples such as suspended sediment, river bed material and water quality. The information about stations will be reports on station inspection form or emergency information. There are two types of observation records. One is observed records by the DHM staffs such as cross section survey results and discharge. The another is those observed by part-time observers without the DHM staffs such as precipitation and water level as shown in Fig. 7.2.

(5) Collection Way

Since there are many kinds of data to be collected as shown in Table 7.7, the data collection way should be determined considering characteristics of observation style as below.

Five data collection ways; 1) mail, 2) staff, 3) wireless, 4) telemeter, and 5) telephone ways were studied for this system. Comparing to these ways as shown in Table 7.8, the suitable ways for data collection were chosen as follows:

The way to send precipitation and water level record from site to the DHM office depends on observation equipments such as manual gauge and automatical gauge. Basically the records observed by manual gauge are transferred by mail at present. In the Long Term Programme, the records will be also collected by mail. Referring the result of monitoring in the Model System, this way was useful to collect data, if the DHM managed it well. To

manage this system effectively, the Progress Control System and the Evaluation System are designed in the Management System. In case that the post office is located far from stations, they are to be transferred by manpower. If the data are to be recorded on chart by automatical gauge, staffs will carry them. In case of data logger system, the staff will also bring by themselves.

It will take more than one week to arrive at the DHM office by the above ways. The data recorded at the basic stations, especially in the big three river systems such as Karnali River, Narayani River and Kosi River, should be collected and processed as fast as possible to check and get more reliable data, because they are the representative stations with accurate observation located downstream of the basin and the base point for water resources development planning. To prevent observation trouble and data missing, experienced engineers should monitor and check the above three basic stations every day. If some troubles happen at the basic stations, the DHM should get that condition and solve them as soon as possible. For these purposes, the telemetering systems are planned at the above three basic stations as shown in Fig. 7.3.

The data observed by the DHM staffs such as 1) discharge measurement record, 2) cross section survey result, and 3) report on station inspection are collected by themselves.

Since there are no ways to transfer samples beside man power, staffs transfer; 1) suspended sediment bottle, 2) river bed material, and 3) water quality sample from the site to the Laboratory.

When the emergency information must be transferred urgently, observers should give call or telegraph to the Basin Office or Branch Office.

(6) Register

To monitor the condition of data collection effectively, the information such as collected date and collection way should be recorded on the register and the summary for data collection condition should be made automatically by computer to save time and get reliable and latest information.

To satisfy such functions, following items are required:

1) The information of data collection condition is to be recorded in computer.

2) The software to show the latest condition of data collection is necessary to monitor.

3) The software to search the stations in which condition of data collection is not good is necessary to evaluate stations.

4) The collected date and way should be registered on register to evaluate.

If data collected by branch offices, collected date and way are to be registered on paper and entered at the Basin Offices.

(7) Data Transfer

The data are to be transferred to the Data Processing System from the Data Collection system by staffs. In case that they are collected by branch offices, they are also to be transferred by staffs to the Basin Offices at first.

(8) Emergency Information

In case of emergency information, observers will send them by telephone or telegram. They should be transferred to the Management System urgently and counter plans to prevent data loss and reoccurrence of error are to be made.

7.3.2 Data Processing System

(1) Outline of System

1)	Object	:	processing of collected data into the figures as user's need
2)	Input	:	collected data and information
3)	Output	:	collected and processed data and information
4)	Function	:	• entry of data • checking of data • processing of data • preparation of data book • laboratory test

(2) Basic Policy for this System

The hydrological and meteorological data disseminated by the DHM is the official data in Nepal, they must be disseminated to users as fast as possible with the style that user requires after full data checking. The information such as error report, observation

condition, data processing procedure, adjustment way and original data must be clear to show the quality of data for users especially for developing project purposes.

Basically, the quality of data depends on the quality of observation. If the observation is carried out correctly and the necessary data and information are collected, it is easy to process data. Actually it is not so easy to observe correctly because of surrounding condition on observation and the data must be checked carefully to disseminate reliable data. If the errors are found earlier, it is easier and more effective to investigate the error cause, correct data and prevent to miss data. On the basis as above, the data will be checked in the every steps by 1) preliminary data checking, 2) data entry checking, 3) data processing checking, 4) overall checking, and 5) final checking.

To prevent careless mistake and save manpower, data should be processed by computer.

The manual for data processing is necessary to uniform the procedure for data processing and save manpower.

The Data Processing System must also satisfied with the recommendation that found in the Model System.

(3) Outline of Procedure

The outline of procedure for data processing is as shown in Fig. 7.1 as follows:

1) laboratory test
2) primary data checking before data entry
3) entry of data and information into computer
4) checking of entered data if data entry error or observation error occur
5) processing of data into the figures as user's requirement
6) checking of processed data
7) overall checking
8) forwarding of data and information to the Central Office
9) final checking (carry out by the Quality Control System)
10) preparation of data book
11) transferring of data and information to the Storing System

(4) Laboratory Test

The samples of suspended sediment, river bed material and water quality must be analyzed before entering into computer. There are two places for analysis. One is at laboratory and another is at sample site. Sieve analysis and some of water quality analysis are to be carried out at site. Others are to be carried out at laboratory. All procedure will be mentioned in the manual and well trained staff will analyze at the site or laboratory.

(5) Primary Data Checking

The Primary Data Checking will check data before data entry. The actual checking items in the Primary Data Checking will be 1) if code number of station is filled in correctly, 2) if observation date is filled in correctly, 3) if name of station is filled in correctly, 4) if the data are not strange, and 5) all items on the form is filled in.

The code number, observation date and name of station will be checked at first. Referring mail pad, they will be checked and corrected easily. The storage value on the form will be checked by the experienced staffs, referring the recorded value. Before entering data, the form should be also checked whether necessary data and information are to be filled in it. If they will not be filled in correctly, it will have to be investigated, and corrected. The confusing data will have to be also investigated before data entry.

(6) Data Entry

The data entry method was studied with the two basic policies, automatical data entry and easy operation.

Since data entry work is monotony and boring, this work should be carried out automatically by computer to prevent to make data entry mistakes. Easy operation is also important concept to design data entry system.

The continuous precipitation and water level records are recorded by automatical gauges on chart. The data logger records data in the ram card and transfer them to computer through card reader. The telemeter system sends data automatically with analog or digital sign from stations. After analysis, the data of sediment and water quality are to be recorded on paper form. Other collected data and information are to be recorded on the paper form when observed or inspected.

Since the most suitable data entry way is depend on the recording style, it should be determined by studying the characteristics of recording style as follows.

1) Paper Form

Since there is no suitable way to enter data recorded on paper form besides keyboard, these data are to be entered by keyboard. If this way is not preferable, observation method should be changed. But new technology for data entry such as voice pattern recognition way and hand writing way for data entry are developing now. If these ways will become practical ones, these ways must be studied in the future to enter data correctly and quickly.

2) Chart

At present, data recorded on chart by automatical gauge are duplicated on the paper form and entered into computer by key board. It takes much time to enter and adjust time. In the Long-Term Programme, these data should be entered by machinery to save manpower and prevent mistake. At present, the digitizer is the most suitable way to enter data from chart easily and this way is to be recommended in the Long Term Programme. But in the future, it will become possible to enter chart itself directly by machinery such as image scanner. This way also should be studied if it will be practical in the future.

3) Ram Card

This way is the most suitable way to enter data easily and correctly at present. The observed data can be transferred to ram card from data logger system and entered them into computer through card reader automatically and quickly.

4) Analog or Digital Sign

This way is also good way to enter data easily and correctly. Observed data are transferred and entered automatically soon after observation. But this way is not economical comparing with the other ways. This way is applied to three basic stations to get the most reliable data as studied in the Data Collection System.

The suitable data entry way for each observation items can be determined depending on data recording style as above and the results were as shown in Table 7.9.

(7) Data Entry Checking

Data must be checked fully before processing. If data entry error can be found before processing, it becomes easy to correct error and saves time for further processing work. Since data checking work is not so comfortable work, it should be carried out by computer as much as possible as follows:

1) After data entry, monitoring checking will be carried out. Monitoring checking is the checking way to find error comparing to the output and original data.

2) Entry data will be checked by computer automatically whether the data observed in the same day will have been already entered.

3) Entered data will be checked by computer automatically whether the format will fit the specified form.

4) The observation date will be checked by computer automatically whether that date will exist actually.

5) Limit checking that checks whether the entered data will be in the upper and lower limit should be also carried out by computer automatically.

6) Entered data will be checked by total checking that will check data by comparing with total value calculated by manually and computer.

(8) Data Processing

Almost of data processing works are simple works such as duplication and calculation. These simple works should be carried out by computer to prevent to make careless mistakes. The computer system for data processing should be designed to be operated easily as follows:

1) It will be operated without knowledge about computer such as operation system.

2) It will have help functions to operate without operation manual.

The procedure for data processing can be classified with three levels. The first processing level is that entered data are to be arranged and stored into computer without other data. The second processing level is that entered data are to be processed with other data. The outline of procedure in the second data processing level is as follows:

1) First, rating tables are to be made from discharge measurement record referring cross section and hydrograph.

2) Secondly, discharge values are to be estimated from the rating table and water level.

3) Finally, sediment transportation values are to be estimated from the discharge and sediment concentration.

Almost of data processing works are completed up to this second data processing level. In the last processing level, data books are to be published. Outline of these procedures is summarized as shown in Fig. 2.6 with each processing level.

Almost of above data processing works are to be carried out with computer besides making rating curve. To make rating curve, experienced staffs must judge the applied range and period for rating curve by considering the condition of site and discharge measurement record and check shape with his experience carefully. But the computer will be able to help to make materials that will be useful to make rating curve easily.

In the future, computer will be able to make rating curve by itself automaticaly with fifth generation software such as expert system. Unfortunately, that software is under developing and not practical level. If they will become practicable level, they should be studied for the Long-Term Programme.

(9) Checking of Processed Data

After data processing, the processed data should be checked as early as possible in each processing steps. Since it takes much time to check data only by manpower and the checking works are boring one, computer should help to check data. The checking work must be carried out following manual and check form must be filled in to keep data quality at each offices.

1) First Processing Level

a) Precipitation

Precipitation data are to be checked with hyetograph made by computer. If they are observed by automatical gauge, the data observed by manual gauge must be also used to check them.

b) Water level record

Water level records are to be checked with hydrograph made by computer. If they are observed by automatical gauge, the data observed by manual gauge must be used to check them.

c) Discharge measurement record

Discharge measurement records should be checked as follows:

i) plotting the discharge measurement records on the rating curve

ii) drawing the height - area curve and comparing with historical one

iii) drawing the height - velocity curve and comparing with historical one

iv) estimating discharge value by slope area method, especially law flow and high flow range

v) comparing water level observed by manual gauge

d) Suspended sediment concentration

Suspended sediment concentration values are to be checked with hydrograph drawn by computer.

e) Particle size

Particle size records are to be checked by historical ones.

f) Riverbed material

Riverbed material data are to be checked comparing with historical ones.

g) Water quality

Water quality data are to be checked by graph drawn by computer.

1) Second Processing Level

a) Rating curve

Rating curve is to be checked as follows:

i) comparing with historical rating curve

ii) dotting the discharge measurement record

iii) comparing with estimated rating curve by slope area method, especially in the low flow and high flow range

iv) checking applied term by comparing with historical cross sections, height - area curve and water level record observed in low flow-term.

b) Rating table

Rating table is to be checked by statistics way to fit the discharge measurement records. Discharge measurement records are also to be used to check the applied range.

c) Discharge

Discharge values are to be checked by hydrograph.

d) Sediment transportation

Sediment transportation records are to be checked by hydrograph.

(10) Overall Checking

After the checking of processed data, data are to be checked comparing with other data observed at near gauges as follows:

1) Precipitation

Precipitation data are to be checked by comparing with near gauges. Isohyetal map is also to be used to find error.

2) Water level

Water level records are to be checked as follows:

a) comparing with shapes of upper or down stream hydrograph

b) comparing with precipitation record observed at near gauges

3) Discharge

Discharge values are to be checked comparing with previous run-off coefficient. They are also to be checked by correlation factor.

Experienced staff will check data in these ways. The computer will provide materials such as hydrograph, isohyetal map and so on to help them.

(11) Bringing of Data and Information to the Central Office

Since the original and processed data and information are to be stored at the Central Office finally, they are to be transferred from the Basin Office to the Central Office. The original data and information are brought by staffs. The processed data are to be transferred from the Basin Office's computer to the Central Office on line because:

1) Since data are to be entered in the Basin Office computer at first, it is easy to transfer them to the Central Office computer on line.

2) If they are to be carried out by off line way, many works such as duplication, transferring, making of covering letter, registering of transferred data, processed data entry and so on must be carried out manually.

3) In case that the errors are to be found and data must be corrected, it is easy to correct and check data at the same time correctly. It will be important to disseminate same data at the Basic Office and at the Central Office.

(12) Final Check

Before publishing of data book, processed data will be checked again finally. The final data checking will be carried out by the Quality Control System.

(13) Making of Data Book

Since the duplication work will make careless mistakes, the original copy for the data book should be output by computer directly from data base.

This system will make three kinds of data books such as precipitation data book, discharge data book and sediment, riverbed material and water quality data book and the data items to be referred in each data book as shown in Table 7.10.

(14) Bringing of Data and Information to Storing System

There are two kinds of data brought to the Storing System. One is processed data registered in computer. Another is original data. The processed data should be transferred to the Storing System on line automatically to prevent to be lost and to cut down procedure of transportation. The original data are to be transferred to the Storing System by manpower.

(15) Dealing with Error

Data are to be checked following manual at any stages by well trained staffs. After data checking, checking staffs must fill in the checking forms as soon as possible. That checking forms must be designed as simple as possible. When they will find errors, they will have to deal with errors as follows.

When errors will occur, the report on error condition and detail correction work will have to be recorded in the computer and these informations should be referred in any time by everybody to serve reliable data. The Quality Control System will also study the error condition by those informations, make counter plan and instruct Basin Office how to correct and prevent error. The staff will investigate the cause of error and correct them if possible. But if the cause is not obvious, they must not correct error and put indication on the recording form as follows.

1) Data Entry Error and Processing Error

Since the cause of data entry and processing errors are obvious, staff must correct them as soon as possible without report.

2) Observation Error

When observation errors are to be found, the experienced staffs must investigate the cause of errors and correct them if possible. In case that the cause of errors is not obvious, they should report the condition to the Quality Control System and must not correct them by themselves. In any case, the staffs must make report about the error condition and enter it into computer.

3) Error by damaged station

As soon as possible, staffs must go to repair station and inform to the Quality Control System. The staff make report and enter the report into computer.

4) Other Error

If the cause of error is obvious, staff must correct them. In case that it is not clear, staff must not correct them by themselves. In any case, staff must make report and enter the report into computer.

7.3.3 Data Storing System

(1) Outline of System

1)	Object	:	storage of data and information safely
2)	Input	:	collected and processed data and information
3)	Output	:	• duplicated data and information • needless data and information
4)	Function	:	• registration of data and information • storage of data and information • duplication of data and information • abandonment of needless data and information

(2) Outline of Procedure

The outline of procedure for Storing System is as shown in Fig. 7.1 and as follows:

1) Check the data and information if they are necessary
2) Register data and information for storage
3) Store data and information
4) Duplicate data and information
5) check term for storage and throw away useless data and information if the term is over.

(3) Check of Data and Information

The data to be stored are as shown in Table 7.11. If other data will be transferred, they will be refused to be stored. The only necessary data and information will be stored.

(4) Registration

When the data for storage transferred to the Data Storing System, they will be registered on computer with identified number to search easily. If the data are original ones, the identified number is to be put on them.

(5) Storing

The Storing System will store original and processed data once a year after processing. Original data are to be stored in the store room. The processed data are to be stored in the data base. Output lists are also to be stored in the Data Dissemination Unit and store room to refer easily. For safety, back up data for original and processed data are to be stored in optical disk in the store room. Nobody will be able to bring stored data from store room to outside. If they will be necessary to take data out of the store room, duplicated ones will be served.

(6) Duplication

If the Dissemination System will request stored data, they will be duplicated and submitted to the Dissemination system.

(7) Check of Term

The Storing System will check the storing term as shown in Table 7.11 periodically. If the storing term will be over, those data or information will be thrown away.

7.3.4 Data Dissemination System

1) Outline of System

1)	Object	:	dissemination of necessary data
2)	Input	:	• request of users • information of users • duplicated data for dissemination from the Storing System
3)	Output	:	• request for data to the Storing System • duplicated data • refusal of request • data book
4)	Function	:	• checking of user for safety • data searching • data arranging • data dissemination • publishing of data book

5) Dissemination Method : • data book
• on line
• floppy disk
• duplication by photo copy

(2) Basic Policy

Since the DHM's budget is provided by Nepalese taxes, the processed data must be disseminated to every body widely. But the data disseminated by the DHM will be official data in Nepal and they will be disseminated after fully data checking.

The use of meteorological and hydrological data is variety such as developing project, industry, academic purposes and so forth. To cope with such variety users, the DHM must be ready for variety data dissemination ways such as 1) data book, 2) on line, 3) floppy disk, and 4) duplication of photo copy.

1) data book

To disseminate data widely and easily, the data book is the most suitable way. Basically, the data will be served to users by this way.

2) on line

Although the on line way is very useful to get data quickly and easily, it is sometimes dangerous for data base. This way must be applied for only government organ without personal users for security of data file.

3) floppy disk

Since the floppy disk way is useful to disseminate data for analysis purpose, the DHM should serve data by this way. The floppy disk for data dissemination must be supplied by the DHM to protect infection of virus with charge.

4) duplication by photo copy

Basically, the data should be disseminated by data book. If the user prefers duplication by photo copy, the DHM should offer data with charge.

Although the DHM must disseminate data to every body, the minimum cost for the dissemination of data such as floppy disk, paper, ink ribbon, photo copy and so forth should charge to users to maintain this system if the user use data for private purpose.

(3) Outline of Procedure

The outline of procedure for the Dissemination System is as shown in Fig. 7.1 and as follows:

1) In case that data are to be disseminated on line, the user must register their information at first for security of data.
2) Determine dissemination way
3) Search required data
4) If the required data have not been stored by the Storing System, the level of emergency is to be investigated. If the required data will be urgent one, the Dissemination System will arrange. In case that the need will not be urgent one, the Dissemination system will refuse the request.
5) If the data will have been stored already in the Data Storing System, the Dissemination System will request the Storing System to duplicate.
6) If the required data will arrive, they will be disseminated to users.

(4) Registration of User

Before dissemination of data on line, the user must be registered in advance for security of data. If data are to be disseminated off line, it is not necessary to be registered.

(5) Determination of Dissemination Way

If users will request data, requested dissemination way will be checked and the Dissemination System will check and decide suitable way as follows:

1) If the users will access to data base directly on line without register, this System will refuse to connect.
2) If the user will access to data base directly on line after registration, this system will serve registered data.
3) If users will request to duplicate published data by photo copy after publishing object data book, this System will recommend to buy data book or serve duplicated data with charge.

4) If the user will request to duplicate published data on floppy disk, they will be disseminated with charge.

5) In case that the user will request to duplicate unpublished data, this system will judge whether they will be necessary urgently. If the necessity will be recognized, this System will offer them by duplication of output list or floppy disk. If the user registered on computer, the data will be disseminate also on line.

(6) Searching

If the dissemination way will be decided, the System will check if the required data will be already stored by inventory.

(7) Investigation of Emergency

If the required data will not be stored yet, data will not be offered usually. But the requirement will be urgent, the System should offer data even if they will be under processing. In the urgent case, it will check the level of data processing by computer at first. Then it will arrange to serve data on line or off line.

(8) Arrangement

If the Data Storing System will already store required data, the Dissemination System will request them to duplicate to Storing System.

(9) Dissemination

If the Dissemination System request data to the Storing System, the Storing System will duplicate and transfer them to the Dissemination System. After receiving the required data, the Dissemination System will offer them to users.

(10) Network

Since the DHM must process data with limited term, the data entered into computer will be required from different places at once to process, check and manage them. To share the stored data as above, the computer at the Central Office and Basin Offices should be connected to each other by on line system. At the Central Office, local area network (LAN) will be installed to connect. In case of each offices, the public line will be used to connect with each other by global area network.

7.3.5 Data Quality Research System

(1) Outline of System

1)	Object	:	research of data quality by analysis on meteorological and hydrological characteristics and recommend more reliable observation network, observation method and data processing procedure including data checking
2)	Input	:	processed data
3)	Output	:	recommendations on more reliable observation network, observation way and data processing procedure including data checking
4)	Function	:	analysis of characteristics of hydrology and meteorology revising of manual

(2) Basic Policy

The Data Quality Research System will analyze meteorological and hydrological characteristics in Nepal to check the observation network and data quality whether the data observed and processed by the DHM will be useful and reliable. The main analysis items will be precipitation, runoff, sedimentation and water quality.

(3) Precipitation

Although the observed precipitation data are point precipitation, the precipitation data required for developing project are area mean value. The network of observation must be designed to catch the mean value from the observed point data.

To judge the reliability on the observation network, following items are analysis using actual observed data in Nepal.

1) average precipitation over area by Thiessen and Isophyetal method
2) depth - area duration

(4) Runoff

For developing project, amount of discharge is the basic factor to design. To estimate reliable discharge data at the project site, reliable runoff model must be developed in each River Basins.

To get such model, the DHM had better study following items.

1) runoff cycle

2) low flow analysis

3) high flow analysis

(5) Sedimentation

Almost of land is covered with mountain area and the river has much sedimentation in Nepal. This sedimentation is the big problems for developing water resources. To analysis of sediment, the DHM had better study; 1) sediment rating curve, and 2) sediment yield of a catchment.

(6) Water Quality

The observation network for water quality in Nepal will be introduced newly in the Long-Term Programme and it will be evaluated in this Data Quality Research System.

To evaluate it systematically, the long term observed value for water quality will be necessary and they will be analyzed comparing with surrounding conditions such as temperature, land use, amount of precipitation and so forth.

(7) Report

The recommendation on more reliable observation network, observation method and data processing method will be summarized in annual report and submitted to the Evaluation System.

7.3.6 Training System

(1) Training System

1)	Object	:	training of staffs to process and observe data according to the fixed manual on annual schedule correctly
2)	Input	:	Evaluation report made by Evaluation System and trainee.
3)	Output	:	trained staffs
4)	Function	:	• training of staffs

• study on training menu

(2) Basic Policy

The Training System will serve training to the DHM staffs for observation and data processing to observe and process data correctly. The training will consist of two parts. One will be regular training that will train the basic knowledge and technique for observation and data processing including data checking technique. Another will be the special training that will train the staffs nominated by the Evaluation System as trainees.

(3) Regular Training

The regular training will train the DHM staffs about the observation, data processing, analysis and management. The training menu will be ready for according to the classes as follows.

1) For newly employed staffs

The newly employed staffs will be trained about outline of the roles and organization of the DHM, observation and data processing to introduce their work.

2) For field assistant staffs

The training on observation will be held for the field assistant staffs. In this training, the observation way adopted by the DHM will be trained. The maintenance technique of station including automatical gauges and cable way will be also trained.

3) For junior staffs such as junior hydro-meteorological assistant

This training will be held to observe correctly including the site inspection work and enter data into computer.

4) For senior staffs such as seminar hydro-meteorological assistant

The target of this training will be to train staff on data processing by computer. Especially the technique of computer operation and how to determine rating table will be the main items. The water quality will be also trained on.

5) For engineer staffs such as hydrologist and meteorologist

In this training, how to check data correctly, plan observation network and analyze data will be trained mainly.

When the staffs will get their promotion, they must complete necessary training for their new grade as above before actual working.

These training will be held mainly at the training center in Kathmandu except for practice of observation and high level technique on analysis. The practice of observation will be held in the field. The high technique on analysis will be trained by attending seminar or on the job training of developing project.

The main training items are as shown in Table 7.12.

(4) Special Training Menu

The Training System will serve the special training menu for the staffs nominated by Quality Control System. This special menus are to be made according to actual their poor works.

7.3.7 Progress Control System

(1) Outline of System

1) Object : control of the Data Arrangement System in order to disseminate data within next observation year

2) Input : information about data collection and processing condition

3) Output :
- instruction to collect or process data earlier
- report on data collection and processing condition

4) Function :
- collection of information about data collection and processing condition
- checking of the condition of data collection and processing
- instruction to collect or process data earlier
- preparation of annual schedule

(2) Basic Policy

It is necessary to make annual schedule and monitor the data processing condition to manage the system. The Progress Control System must make the schedule for data processing in advance and monitor the condition of each processing level. The material to show the condition of data collection and processing will be made by computer automatically. The main monitoring item in this system are 1) data collection, 2) data entry, 3) determination of rating table at the Basin Offices, 4) estimation of discharge at the Basin Offices, 5) estimation of sediment transportation at the Basin Offices, 6) final data checking at the Control Office, 7) registration of data into the data base at the Central Office, 8) data storing at the Central Office and 9) data book publication.

(1) Collection of Information

The Progress Control System will make monitoring report about data collection and processing conditions by computer referring the registered data file automatically every month. These reports will be recorded in temporary file and printed at each Basin Office, the Central Office and the MWR every month. These temporary files are to be deleted when evaluation works are completed. These reports are to be made also at each Branch Offices manually and transferred to the Central Office on line from the Basin Office.

(2) Check of Condition

The Progress Control System will check the progress condition by monitoring report once a month. The main checking items are described in the basic policy as above.

(3) Control

If the progress on data processing will not be satisfied, the Progress Control System will guide related staffs and office to complete earlier. In case that the schedule for data processing will not be suitable, it will be studied again and changed if necessary.

(4) Report

The summary to show the condition of data collection and data processing will be made and reported to the Evaluation System once a year. If the condition of data collection or processing will not be satisfied, the cause and the counter plan will have to be mentioned in the summary.

7.3.8 Quality Control System

(1) Outline of System

1)	Object	:	improvement of data quality
2)	Input	:	• processed data • check list • error report
3)	Output	:	• instruction of checking and correction method to the related staffs • making of counter plan for prevention of error • improvement of check list • improvement of data checking way • report about the condition of data checking and error
4)	Function	:	• checking of data finally • study on useful check way • update of check list • guide of Basin Offices on data checking and error correction method • preparation of report about condition of data checking and error • revising of manual

(2) Final Data Checking

To disseminate more reliable data, the Central Office will have to check processed data transferred from Basin Offices at last by 1) isohyetal map, 2) rating curve, and 3) hydrograph.

Computer should make above materials automatically from the data files to prevent mistakes, save time and manpower. If the errors are to be found, these data are to be transferred to the Basin Offices from the Central Office on line with messages that shows what is the problems. After correction of error, they will be transferred to the Central Office again on line.

(3) Study on Useful Check Way

Before studying useful check way, the actual condition about errors must be investigated carefully. The Quality Control System will investigate error conditions by the results of

final data checking, error reports and check lists. Error reports and check lists are to be transported from each Basin Office and stored into computer at the Central Office every month. The Quality Control System will make report on results of final data checking by itself also. Studying the conditions of error, the useful data checking way and counter plans to prevent error are to be developed.

(4) Update of Check List

The Quality Control System will update check list if necessary from the result of data checking.

(5) Guidance of Data Checking Method

If error will be found by the final data checking, the Quality Control System will guide Basin Offices how to correct data and check data correctly by on the job training way.

(6) Update of Processing Manual

If the necessity to update manual will be found by data checking, the Quality Control System will study the suitable improving plan. If the suitable plan will be found, the manual will be updated.

(7) Report

The Quality Control System will submit report on the result of data checking and error conditions to the Evaluation System every year.

7.3.9 Evaluation System

(1) Outline of System

1) Object : improvement of the system totally by evaluation of the system conditions from the outsider's view points

2) Input :
- report on data quality, data processing and recommendations on observation network and method and data processing procedures condition
- observed and processed data
- requests from users

3) Output :
- report on recommendation to improvement existing system
- report on result of evaluation

4) Function : • evaluation of present condition about data quality, data processing activities, observation network and observation way

(2) Evaluation Item

The Evaluation System will evaluate following points:

1) If data are observed and processed correctly according to the manual.

2) If every work is completed on schedule.

3) If observation network is able to catch proper value.

4) If observation method is suitable.

5) If data processing way is suitable.

6) If training is effective.

(3) Evaluation Material

The Evaluation System will evaluate all the Systems by 1) report on data quality made by the Quality Control system, 2) report on progress condition made by the Progress Control System, 3) report on analysis carried out by the Data Quality Research System, 4) observed data, 5) processed data, 6) dialog with users, and 7) inspection report on stations.

(4) Evaluation on Data Quality

The Evaluation System will evaluate the data quality mainly from the error condition reported by the Quality Control System and the dialog with user. After evaluation, the Evaluation System will prize 1) the Basin Office that will process data most correctly, 2) staffs who will find much error, 3) observers who will observe extreme value, and 4) observers who prevent to miss data.

The Evaluation System will also advise the persons or Basin Offices that will process data inaccurately. This System will inform these conditions to the Training System. The Training System will train these persons to process data correctly.

(5) Evaluation on Progress

The Evaluation System will evaluate the progress condition reported by the Progress Control System mainly about following points:

1) If observer will send data correctly.

2) If the Basin Offices will collect data within deadline.

3) If the Basin Offices will process data on schedule.

4) If the Central Office will publish data book within the next observation year.

After evaluation, the Evaluation System will prize the best Basin Office and good observers. If observers will not send data within deadline so many times, the Evaluation System will advise Basin Office to guide them. In case that Basin Offices will not process data on schedule, the Evaluation System will guide them to process.

(6) Analysis

From the results of analysis carried out by the Data Research System, the reliability of meteorological and hydrological observation network is to be evaluated.

(7) Observation Way

The Evaluation System will evaluate present observation technique and study more reliable and suitable observation way.

(8) Data Processing Way

The Evaluation System will evaluate present data processing procedures including data checking way to process data more correctly and quickly.

(9) Dialogue with Users

The Evaluation System will make and send questionnaires to primary users to get their requires. This System will also accept the complain about the data qualities and observation network from users.

(10) Stations

From the station inspection form, the Evaluation System will evaluate the quality of stations. If the necessity of improvement of stations will be found, the Evaluation System will recommend to improve it.