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Ministry of Higher Education and Scientific
Research University of Technology
Building and Construction Engineering
Department

The Water Balance To Four Dams on The Tigris River

Scientific Project Submitted to the Department Of
(Building and construction)
University of Technology

In Partail Fulfillment of The Requirement
For The Degree of Bachlor
of Scienc In WaterResources and Dams Engineering

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2010

بسم الله الرحمن الرحيم

ولقد اتينا داود وسليمان علما وقالا
الحمد لله الذي فضلنا على كثير من
عباده المؤمنين

صدق الله العلي العظيم

النمل ((١٥))

Dedication

TO
My Dear Father

My Dear Mother

And My Whole Family
With All My Deep
Respect and Love

ALI JAMAL
ZAINAB ALAA

ACKNAWLEDSMENT

We are adduced to .Dr.Hasan .A My gratitude and appreciation for supervision continuous guidance efforts and interest throughout the work that contributed to its completion ....

We express my sincere thanks to Dr.Mahmood.S for the useful discussion and help in preparing the project calculation..........

would like to express my very deep We respect and sincere appreciation to my family ,my father ,my mother ,my friend for their continued moral support encouragement and prayer ....

Above all , my great thanks to " ALLAH" for his mercy and blesses.......

ALI JAMAL
ZAINAB ALAA

LIST OF CONTENTS

ABSTRUCT:-

Water balance calculations help to determine if drainage area is large enough or if it has the right characteristics to support a permanent pool of water during average or extreme conditions.

Water balance can also be used to help establish planting zones in a wetland design.

The natural water resource have already been developed by the second half of the century, which necessitated construction of large regulating reservoirs is control the annual flow which is admitting surplus water in the winter-spring periods and releasing it in the low water periods of summer and autumn.

This project contains the water balance calculations to four dams on the rivers Tigris by taken the inflow discharge(m^3/sec) and we calculated the storage by subtract the outflow from inflow and add the rainfall to storage after that subtract the evaporation from the storage to obtain the water balance to the four dams.

CHAPTER ONE

INTRODUCTION

1-1 INTRODUCTION:-

Water balance calculations help to determine if a drainage area is large enough or if it has the right characteristics to support a permanent pool of water during average or extreme conditions. A water balance calculation should be completed for wet detention basins (storm water ponds) and constructed storm water wetland design. The details of a rigorous water balance are beyond the scope of this manual.

However, a simplified procedure is described to provide an estimate of permanent pool viability and point to the need for more rigorous analysis. Water balance can also be used to help a establish planting zones in a wetland design.

The natural water resource have already been developed the second half of this century, which necessitated construction of large regulating reservoirs such as, Dokan, Derbendi-Khan, Al Mosel, Qadisiya, Adhaim, Hemreen, Habbaniya and Therthar.

The main aim of these reservoirs is to control the annual flow which is admitting surplus water in the winter – spring periods and releasing it in the low water periods of summer and autumn.

Due to the construction of additional reservoirs and the increase of the irrigation projects in Turkey and Syria, additional water is required, which, in the long run, reduces the water inflow to the territory of Iraq. For this purpose both the qualitative and quantitative assessment of natural water resource are required. In this investigation emphasis will be placed in quantitative aspect, the qualitative will be limited to provision minimum sanitary discharge.

Reservoirs provide a number of related benefits the following is a typical example of immerse benefits that could be utilized totally or partially, namely, human consumption, agricultural, domestic, and industrial uses recreation, hydro-electric power generation, water quality improvements, flood control, fish and navigation.

Various objectives may have an influential effect on the benefits of operation due to the methods of release, storage; demand send other constraints which minimize the difficulties that may be faces during operation.

It is customary to analysis a multiple stage process which has a non-linear objective function based on storage and release as primary factors.

Many techniques of optimization has been used to find the optimal operation such as linear, non-linear, and dynamic programming. The most widely used technique is dynamic programming due to their to deal with discrete dynamic models and no limitation on the types of equation governing the system, constraints, or cost function the successive approximation discrete differential dynamic programming is used to reduce the computer time and memory requirements. The discrete differential dynamic programming is an iterative technique in which the recursive equation of dynamic programming is used to search an optimal operation for this study.

1-2 OBJECTIVE OF PROJECT:.

The objective of this project is to study the water balance of four Dams in north of Iraq which lies on Tigris river. The water balance is carried out For 10 years period Beginning from (1985) and up to (2003).

CHAPTER TWO

LITERATURE REVIEW

LITERATURE REVIEW :-

There are Many Researcher Studied The Water Balance Systems and some of Them are Explained as Follows :-

Heermann (1974):-

Assumed that effective rainfall is equal to the total rainfall occurring less surface runoff. However, any effective rainfall, which exceeds the available to be lost by drainage from the root zone.

Doorenbos (1975):-

Stated that effective rainfall is only a portion of total rainfall. Part of the rain may be lost by surface runoff, deep percolation below the root zone, or by evaporation of the rain intercepted by the plant's foliage.

Smith (1992):-

Defined effective rainfall as that part of rainfall, which is effectively used by the crop after rainfall losses due to surface runoff and deep per collation have been accounted.

Effective rainfall is the rainfall ultimately used to determine the irrigation requirements of the concerned crop.

Smith (1993):-

Defined effective rainfall as that part of the precipitation, which is effectively used for evapotranspiration by the crop.

Phocaides (2001):-

Defined effective rainfall, in irrigation practice, as that portion of the total precipitation, which is retained by the soil so that it is available for use for crop production.

Owen – Joyce and Raymond (1996):-

Description the mass balance equation in the Colorado river as

$$Qds = Qus + Qrf + P + Tr - E - ET - \Delta Sa - Qsb$$

Where :-

Qds= flow at the downstream boundary.

Qus= flow of the upstream boundary.

Qrf= return flow to the river (from outside the region).

P=precipitation (on open water surface).

Tr= tributary inflow (local runoff).

E= evaporation from open water surface.

ET= evapotranspiration.

ΔSa= change in aquifer storage.

Qsb= flow to sub-basin.

- Note that there was no surface storage capacity at or below morlos Dam.

Total inflow, for the region as a whole or a particular sub-system, can be described as:-

$$If = Qus + Qrf + P + Tr$$

Total outflow can be described as:

$$Of = Qds + E + ET + Qsb + \Delta Sa$$

CHAPTER THREE

Hydrological Data

Hydrological Data:-

3-1 Location

The republic of Iraq is situated in the Middle East between the latitudes 29° N and 37° N and longitudes 39° E and 99° E. it is bounded on the north by turkey, on the east by Iran, on the south by Saudi Arabia and Kuwait, on the southeast by the Arabian Gulf, and on the west by Syria and Jordan.

The total area of Iraq is 434.920 square k: lometers and population of the country is around 25 million persons.

3-2 Physiographical Regions

Iraq is divided into the following five physiographical regions:-

1- The mountainous region:

-The northern and north eastern parts of the country Zagros - Taurus mountain chains that form the boundaries of irage with turkey and Iran.

2- The foot hills:

These are lying southwest of the Zagros- Taurus Mountain in the form of a belt of foothills.

3- The Jazira (upper Mesopotamia):

This region consists of the upper parts of the extensive region lying between the Tigris and Euphrates Rivers south of the foothills and extends south-wards from the Iraqi-Syrian frontier as far as Baghdad.

4- The plains:

This region covers the lands in the neighborhood of the Euphrates (south of hit) and Tigris (south of ballad).

5- The desert region: This region lies to the south and the south west of the Euphrates where true desert conditions are encountered and extends up to Syrian, Jordanian, Saudi Arabian and Kuwaiti border

3-3 Soils

The soil of Iraq is sedimentary, especially in the central and southern parts.

3-4 Climate and rainfall

The climate of Iraqi is semi-tropical, arid and continental with dry hot summers and dry cold winter. The two main seasons are hot weather (May to October) and cold weather (November to April).

Rainfall is insufficient in the plains of Iraq and rainfalls mostly in the months of November to April. Average annual rainfall in the northeast is 800 mm and in the middle and south around 150 mm.

The precipitation in the foothills and the mountain varies from 406 mm to 182 mm, much of it falling as snow collecting on the mountains and melting in the spring, and causing floods, which occure in late spring.

3-5 Water Resources:-

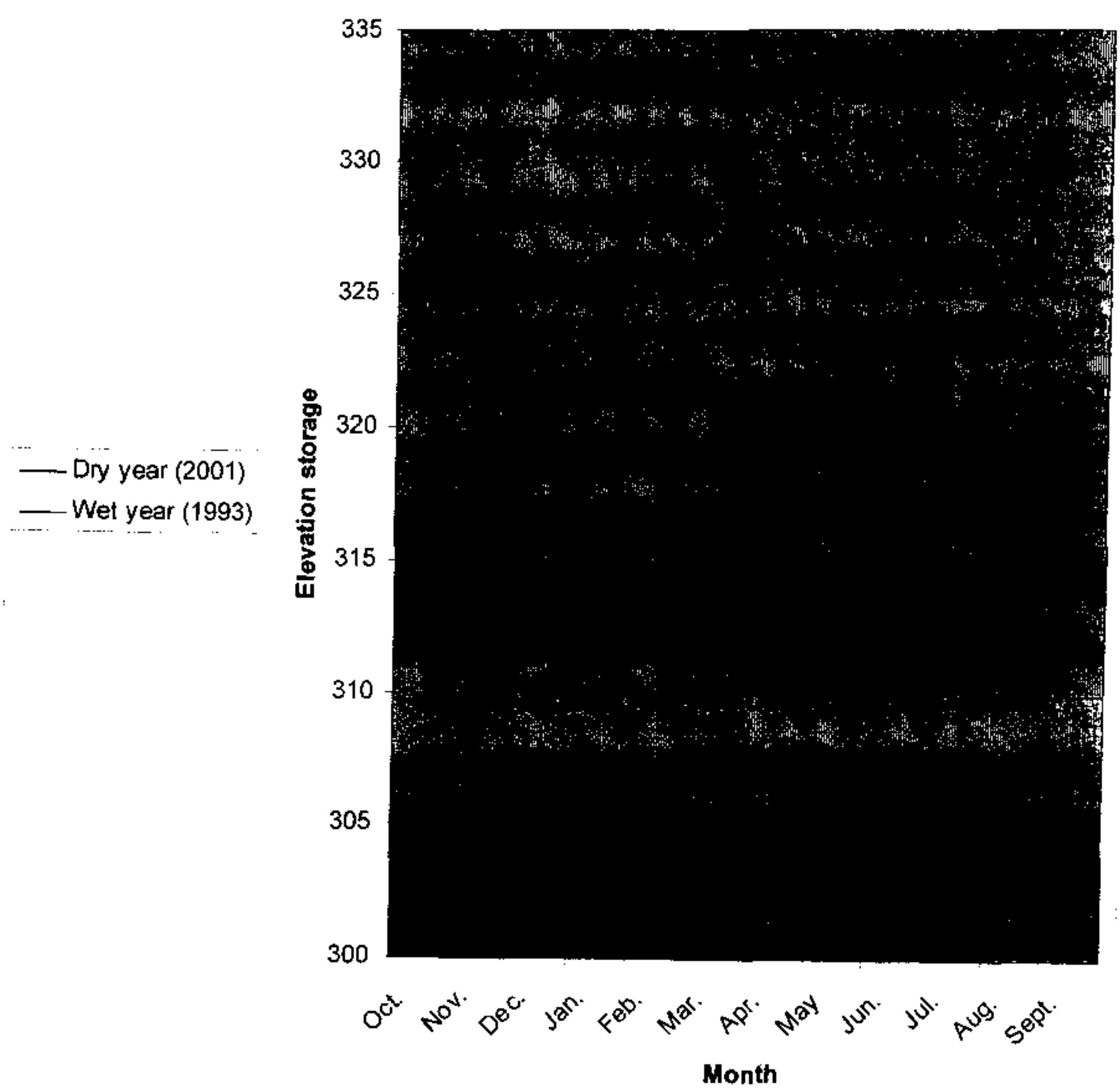
The main sources of water in Iraq are the rivers Tigris and Euphrates.

The average inflow for the main water resources of the country are estimated in table (3-1):-

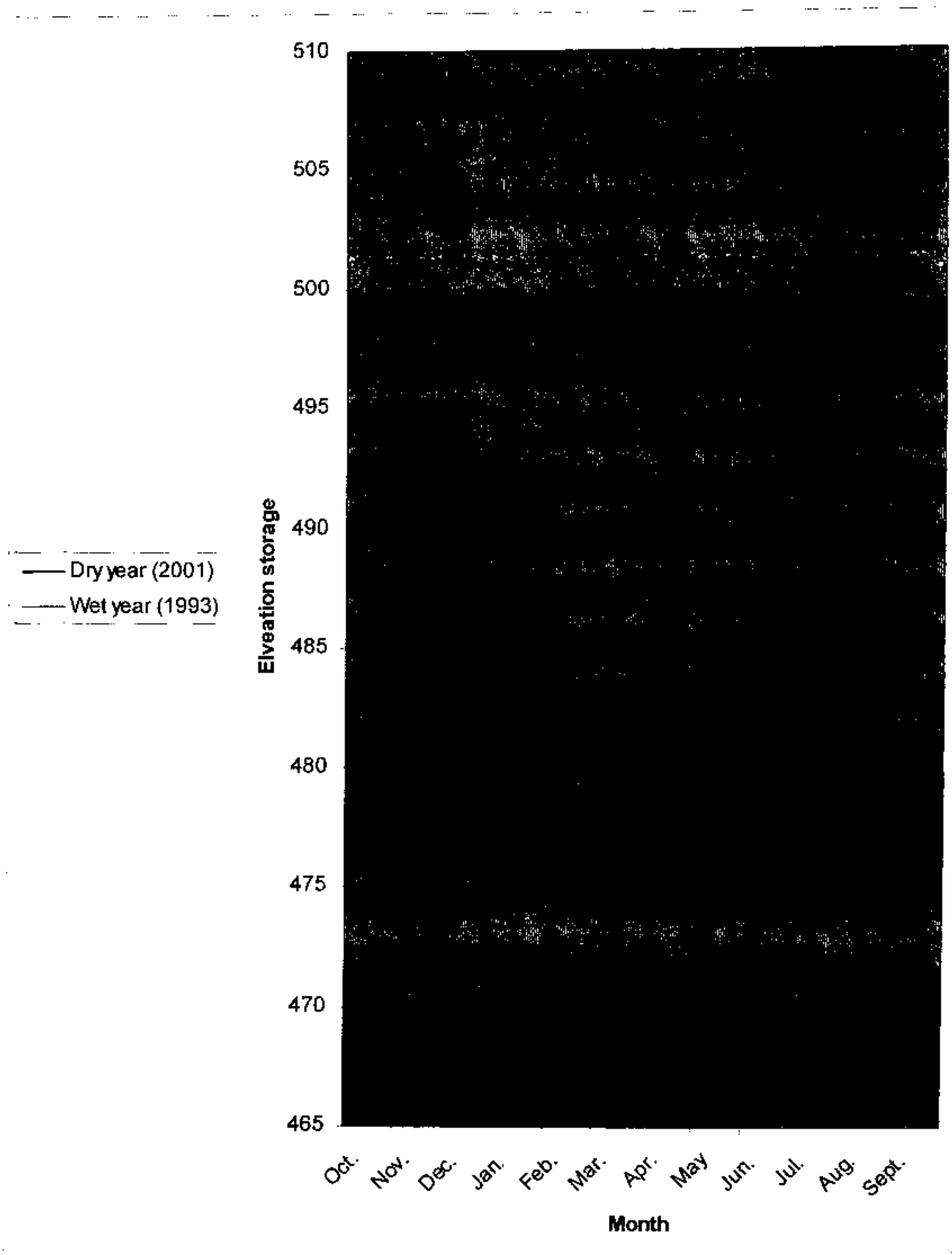
Table (3-1) :Average inflow of water resources for Duration (1990 – 2001)

Source and Location	Quantity (billion m^3)
Tigris river at Feish-Khabur	20.90
Greater-zab River at Eski-Kalak + Al-Khazer River	14.30
Lesser-zab River u/s Dokan Dam	7.10
Adhaim River at Enjana	0.70
Diyala ULS Derbendi-KanDam	5.85
Euphrates at tussaiba (1976-1989)	27.40
Euphrates at hussaiba (1994-2001)	21.30

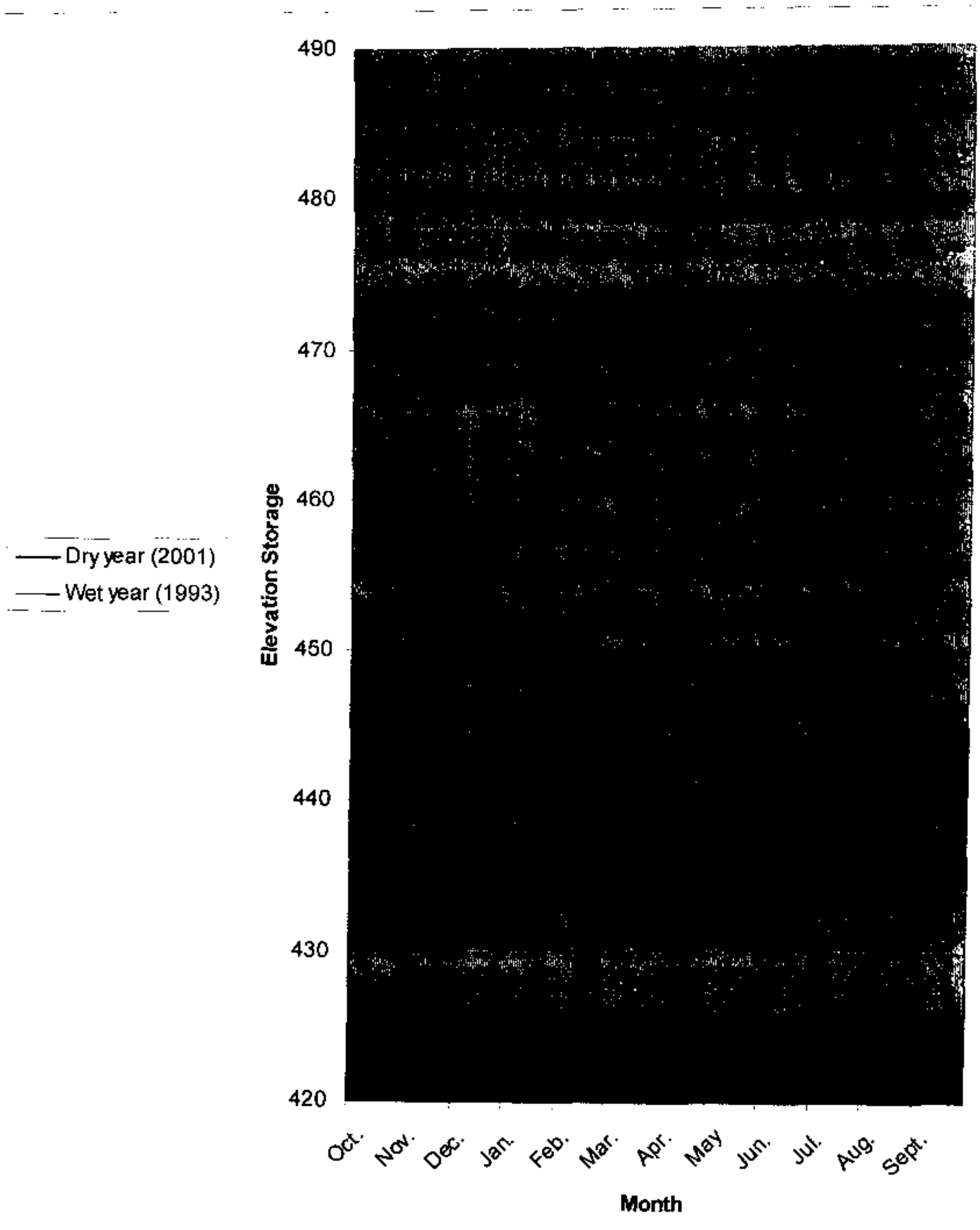
3-6 Hydrograph of dry and wet year for:-



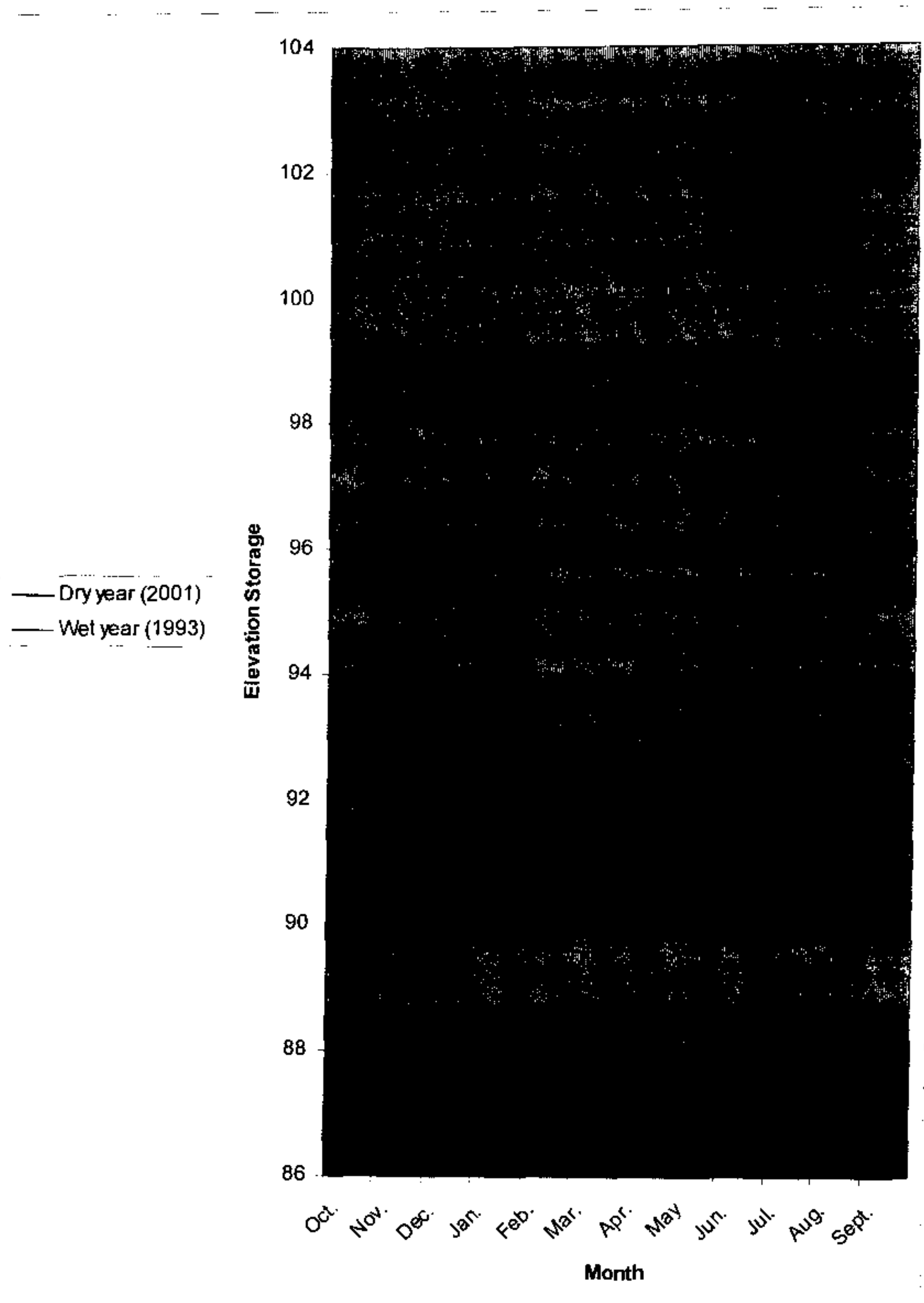
Fig(3-1) Main Reservoirs Storage Levels For Mosul Dam



Fig(3-2) Main Reservoirs Storage Levels For Dokan Dam



Fig(3-3) Main Reservoirs Storage Levels For Darbandi-khan Dam



Fig(3-4) Main Reservoirs Storage Levels For Hemrin Dam

3-7: Basic Equations:-

-Water balance is defined as the change in volume of the permanent pool resulting from the total inflow minus the total outflow (actual or potential).

$$\Delta v = \sum inflow - \sum outflow$$

Where:-

Δv= change in the permanent pool

$\sum inflow$ = Sum of all inflows over a period of time.

$\sum out\ flow$ = sum of all out flow over a period time, including losses to infiltration and evaporation.

The inflows consist of rainfall (P), runoff (R), and base flow (Bf) into the pond.

The outflow consist of infiltration (I), evaporation (E), evapotranspiration (Et) and surface overflow (O) out of the pond or wetland these changes are reflected in Equation (2),

$$\Delta v = [P + R + Bf] - [I + E + Et + O] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

3-7-1: Rainfall (P)

Monthly values are commonly used for calculation of values over aseason Rainfall is direct amount falling on the surface of the time period being studied itistorical monthly rainfall totals are available for most all locations in lowa in various formats for anumber of gauge stations.

3-7-2: Run off (R)

Runoff is equivalent to the rainfall for the period times the efficiency of the watershed which is equal to the ratio of runoff to rainfall. In tiea of gauge information, Q/P can be estimated one of several ways; the best method would be to perform long. Term simulation modeling using rainfall records and a watershed model two other methods have been proposed.

The ratio of runoff to rainfall volume for a particular storm can be determined using Equation (3)

It is assumed that if the average storm that produces runoff has a similar ratio, then the RV value can serve as the ratio of rainfall to runoff. Not all storms produce runoff in an urban setting.

$$Q=0.9\ P\ RV \quad \text{.................................. Equation (3)}$$

Where :-

P = precipitation

Q = runoff volume

RV = volumetric runoff coefficient for the watershed most storm water ponds wetlands have little, if any base flow, as they are rarely placed across perennial streams. If so placed base flow must be estimated from observation or through theoretical estimates methods of estimation and base flow separation can be found in most hydrology textbooks.

3-7-3: Infiltration (I)

Infiltration is a very complex subject and cannot be covered in detail here. More detailed information is included including data on nominal infiltration rates and soil water capacity the amount of Infiltration depends on soils, water tube depth, rock layers surface disturbance, the presence or absence of a line in the pond, and other factors, the Infiltration rate is governed by the Darcy equation as:

$$I = AK_hG_h \dots\dots equatioin\ (4)$$

Where :-

I = Infiltration

A = cross – section area through which the water Infiltrates.

K_h= saturated hydraulic conductivity or Infiltration rate (ft/day)

G_h= can be set equal to 1.0 for pond bottoms and 0.5 for pond sides steeper than about 4:1 infiltration rate can be established through testing. Through not always accurately.

3-7-4: Evaporation (E)

Evaporation is from an open take water surface evaporation rates are dependent on differences in vapor pressure, which in turn depend on temperature, wind, atmospheric pressure, water purity shape and depth of the pond. It is estimated or measured in a number of ways, which can be found in most hydrology textbooks.

3-7-5: Evapotranspiration (Et)

Evapotranspiration consists of the combination of evaporation and transpiration by plants. The estimation of ET for crops in lowa is well. Documented and has become standard practice However, for wetlands the estimating methods are not documented nor are there consistent studies to assist the designer in estimating the demand wetland plants would put on water volumes. Estimating ET only becomes important when wetlands are being designed and emergent vegetation covers significant portion of the pond surface. In these cases, conservative estimates of lake evaporation should be compared to crop-based ET estimates, and a decision mode crop-based ET estimate can be obtained from typical hydrology textbooks

3-7-6: Over flow (O)

Over flow is considered as excess runoff. In water balance design, over flow is either not considered, since the concert is for average values of precipitation; or is considered lost for all volumes above the maximum pond storage obviously, for long – term simulations of rainfall runoff. Large storms would play an important part in pond design.

CHAPTER FOUR

RESULTS

RESULTS :-

4-1: Mosul Dam:-

- Coordinate $N36.63^{\circ} E\ 42.82^{\circ}$
- $A\ 100\ m$ height, height –zoned earth embankment
- $A\ 10\ m$ width, 3.6m length crest leveled at $343.2\ (M.O.S.L)$
- Max reservoir level $338.00\ (m.o.s.l)$
- Normal operation level $300.00\ (m.o.s.l)$
- Min. storage at max reservoir level$13.14 * 10^9 (m^3)$
- Normal storage at normal operation level $11.11 * 10^9 m^3$
- Dead storage $2.95 * 10^9 m^3$

4-1-1: Spillway:-

- S radial (tainter) gated concrete – lined chute with aski – jump section for energy dissipation, each $13.3 * 13.3\ m$
- Spill way sill level $317.5\ (m.o.s.l)$
- Max designed discharge at max reservoir level$13000\ (m^3/s)$
- Fnse - plugged spillway has $400m$ length at the max reservoir level with a discharge of $4000 (m^3/s)$

4-1-2: Power House:-

- 4 Francis turbine generator units each $187.5\ MW$
- 4 Francis vertical turbine can provide $3420\ Million\ KWh$
- Power intake gates $7.0 * 10.5\ (M)$

4-1-3: Bottom Outlets:-

Two Bottom outlets located at the left of the power station, hydraulically operated and radial (tainter gates controlled the outlets with a combined discharge of 2600 (m^3/sec)

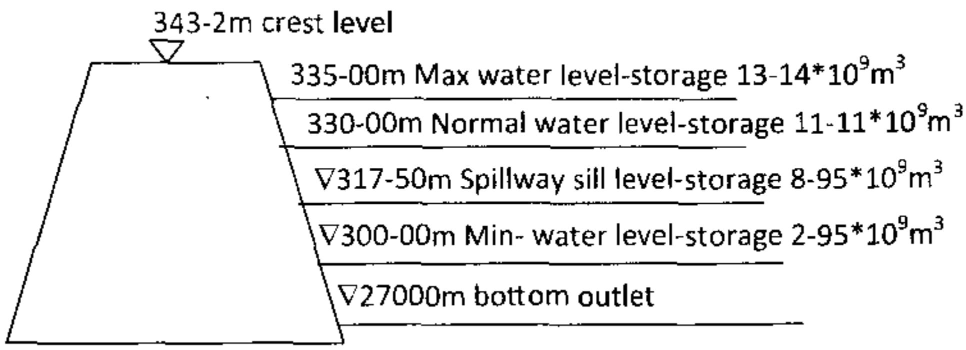


Fig (4-1) : Elevations of MOSUL DAM

4-1-4: Discharge Data :-

The data which are collected for AL-Mosul Dam contains the inflows and outflows.
The figures (4-2)(4-3) shown the variation of inflow and outflow discharge with months during the period from (1985) to (2003):-

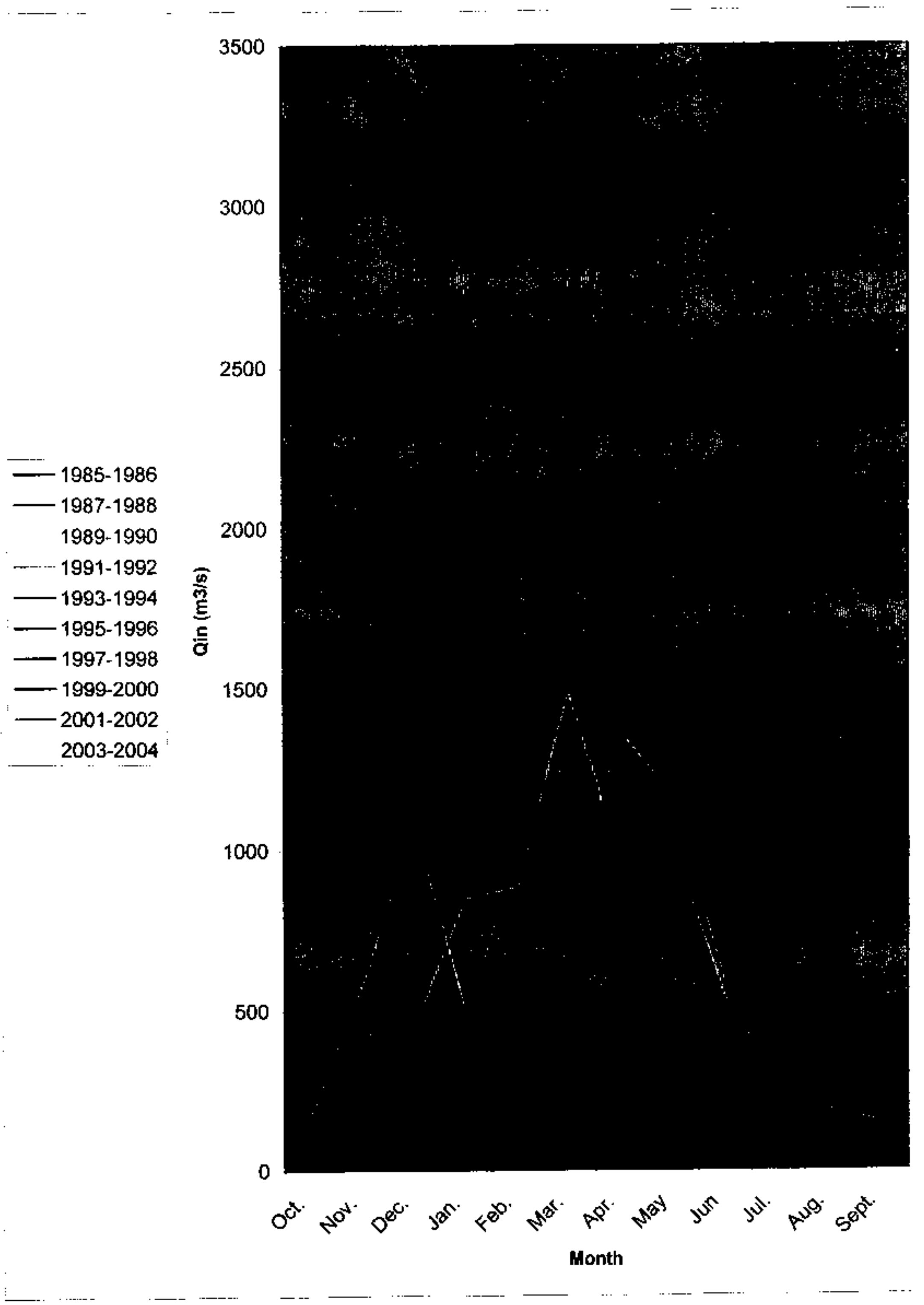


Fig (4-2): Qin Mosul Dam

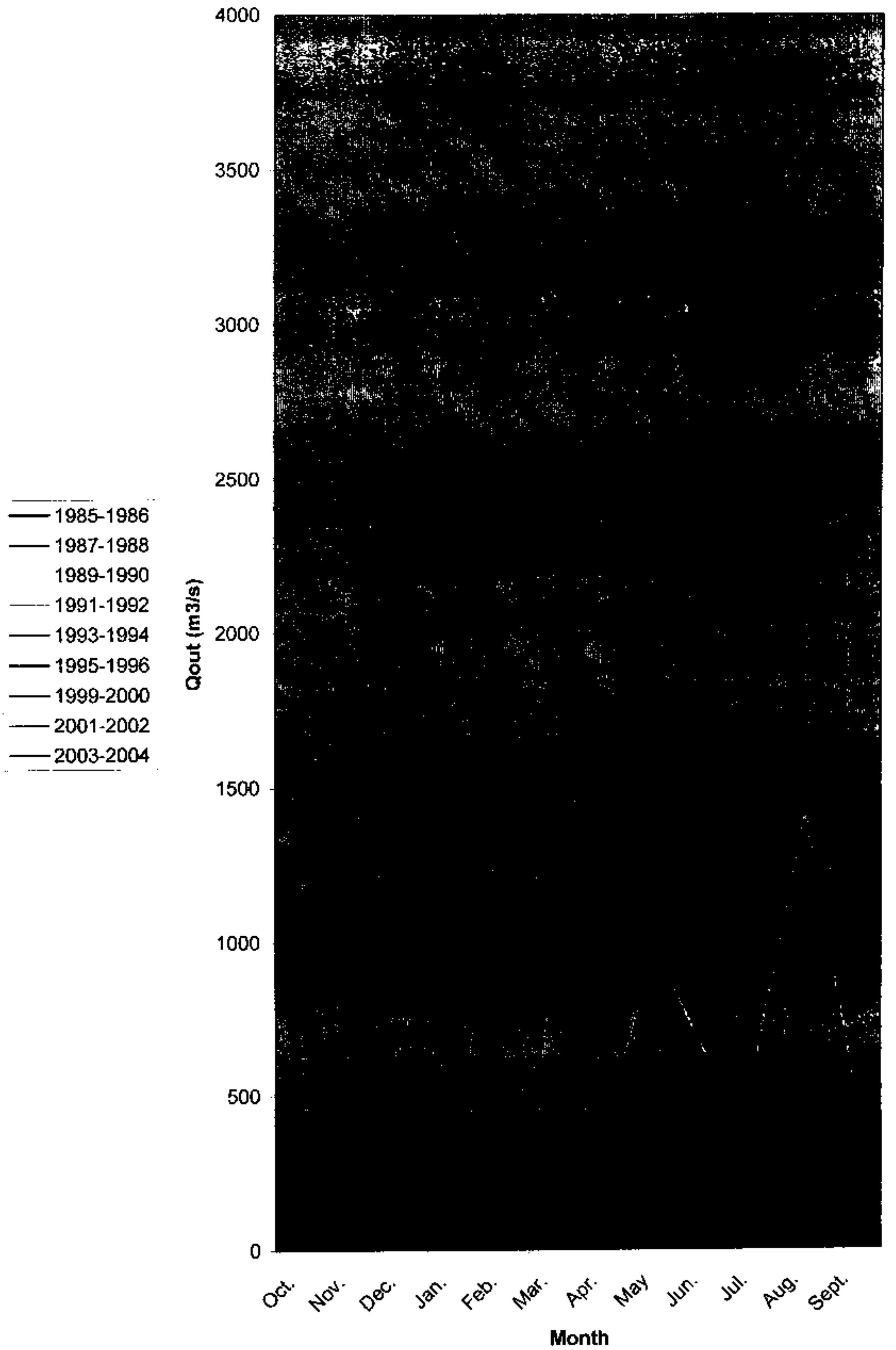


Fig (4-3) Qout Mosul Dam

4-2-2: Power House:-

- Five vertical shafts each related 110 MW
- Min reservoir level for energy production 480 (m.o.s.l)

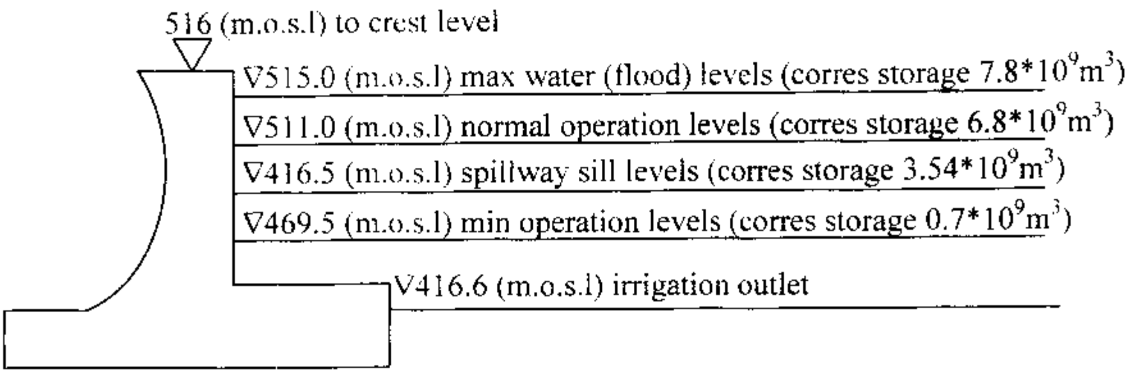


Fig (4-4) Elevation of DOKAN DAM

4-2-3: Discharge Data :-

The data which are collected for Dokan Dam contains the inflows and outflows.

The figures (4-5)(4-6) shown the variation of inflow and outflow discharge with months during the period from (1985) to (2003):-

4-3: DERBENDI – KHAN DAM:-

- Coordinate N35.11^0 E45.7^0
- A 128m height , height , high – Zoned earth embankment
- A 17 m width , 535 m length crest leveled at 495 (m.o.s.l)
- Max reservoir level 493.50 (m.o.s.l)
- Normal operation level at 485.00 (m.o.s.l)
- Min operation level 434.00 (m.o.s.l)
- Max storage at max reservoir level 3.80 * 10^9(m^3)
- Normal storage at normal operation level 3*10^9(m^3)
- Dead storage 0.47 *10^9 (m^3)

4-3-1: Spillway :-

- Three radial (tainter) gated concrete lined spillway terminate in ask:- jump and plunge pool , each 15.00 * 15.00 (m)
- Spillway sill level 470.00 (m.o.s.l)
- Max designed discharge at max Reservoir level 11400 (m^3/ sec)
- Diversion tunnels diameter 6.00(m)

4-3-2: Power House:-

- There turbine units , each 80.0 MW
- Three irrigation outlets with a designed discharge of 3175 (m^3 / sec)

4-3-3: Bottom Outlets :-

- Three concrete –lined outlets each have a diameter of 4.28(m)
- Total designed outflow at the normal operation level 450 (m^3/ sec)

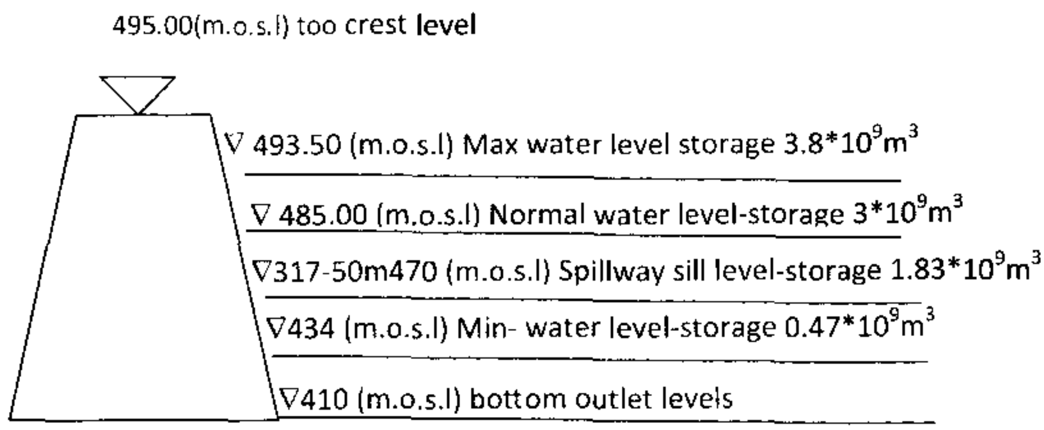


Fig (4-7) Elevation of DERBENDI-KHAN Dam

4-3-4: Discharge Data :-

The data which are collected for DERBENDI-KHAN Dam contains the inflows and outflows.

The figures (4-8)(4-9) shown the variation of inflow and outflow discharge with months during the period from (1985) to (2003):-

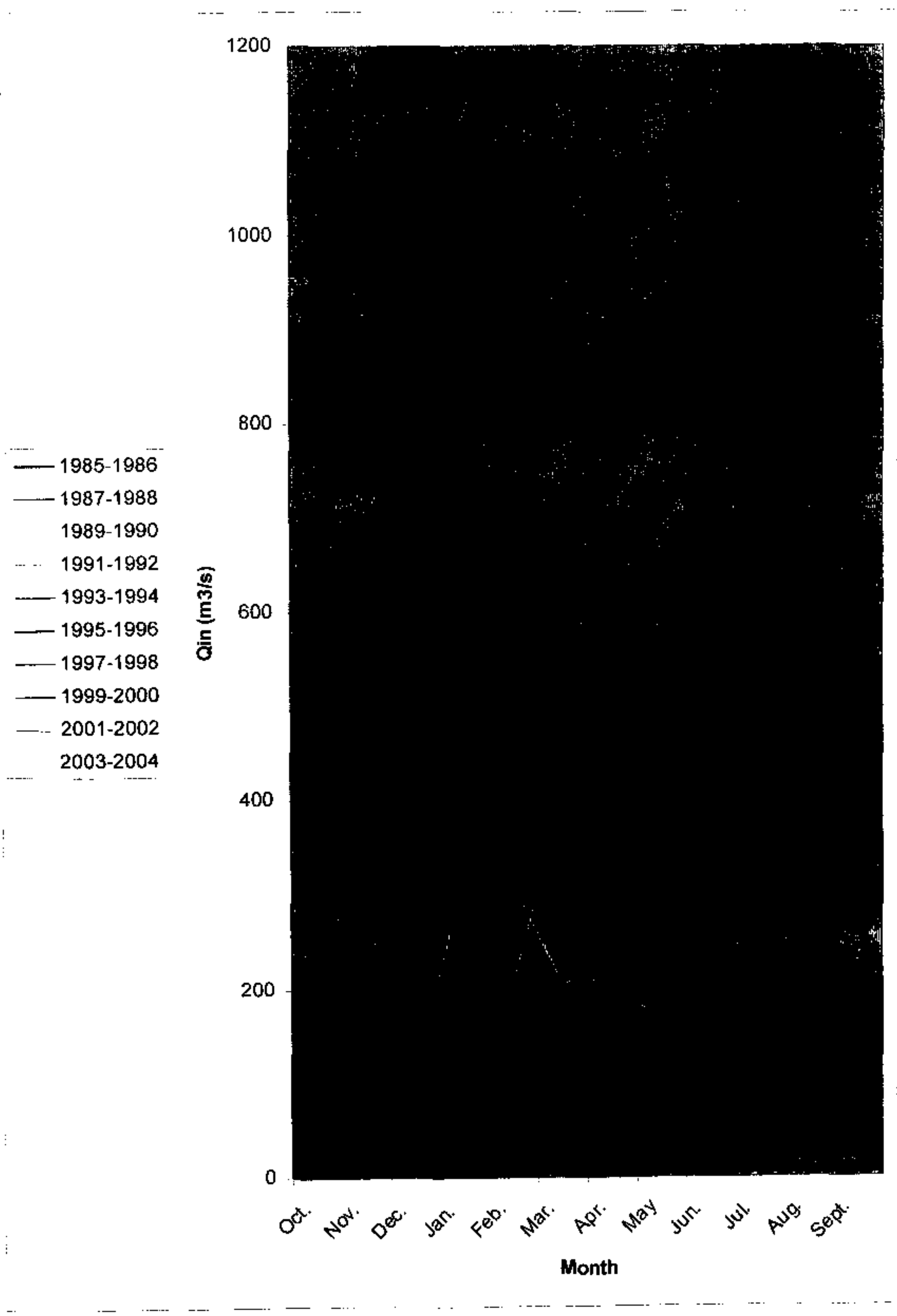


Fig (4-8) Qin For Derbendi-Khan Dam

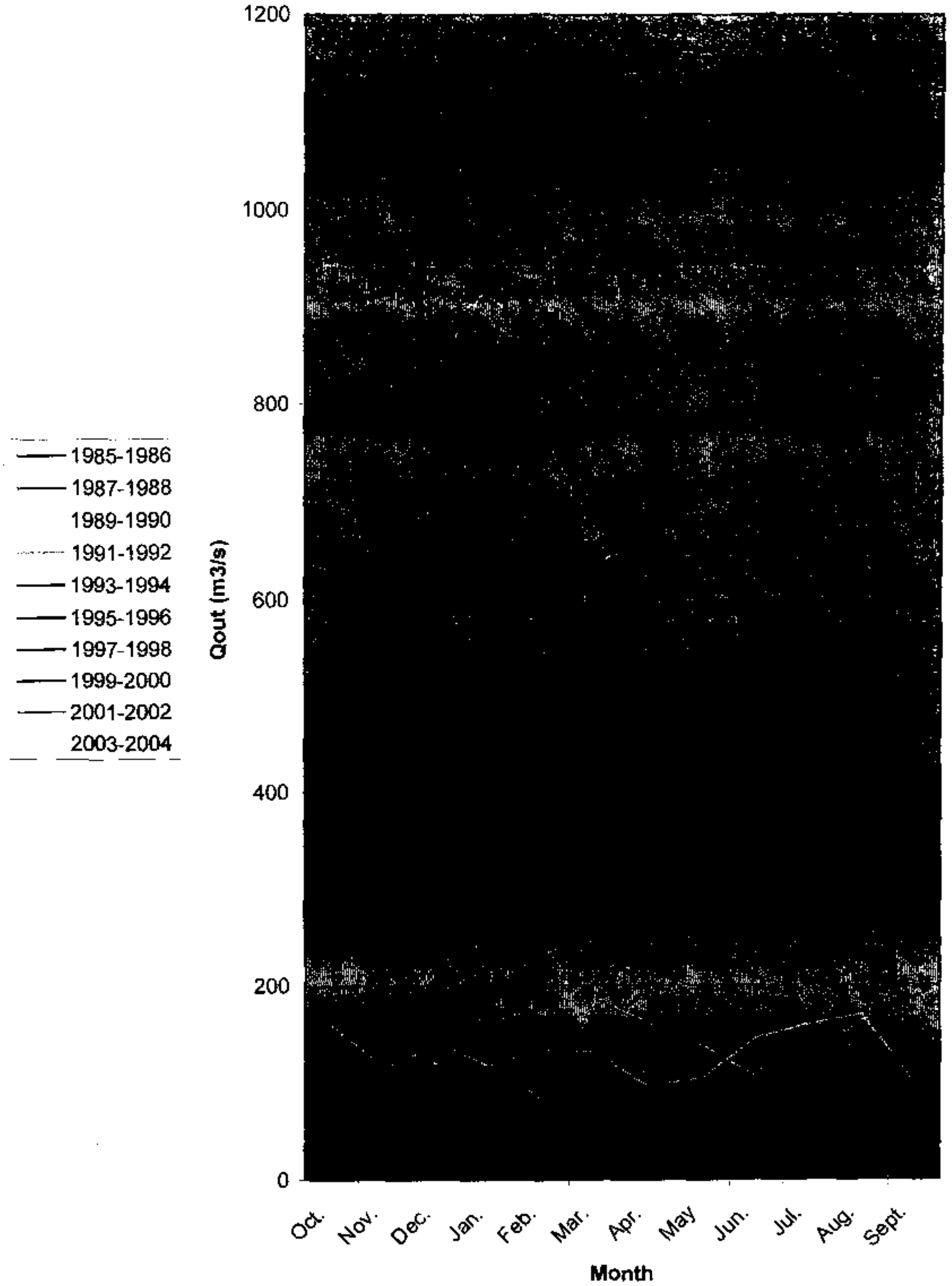


Fig (4-9) Qout For Derbendi-Khan Dam

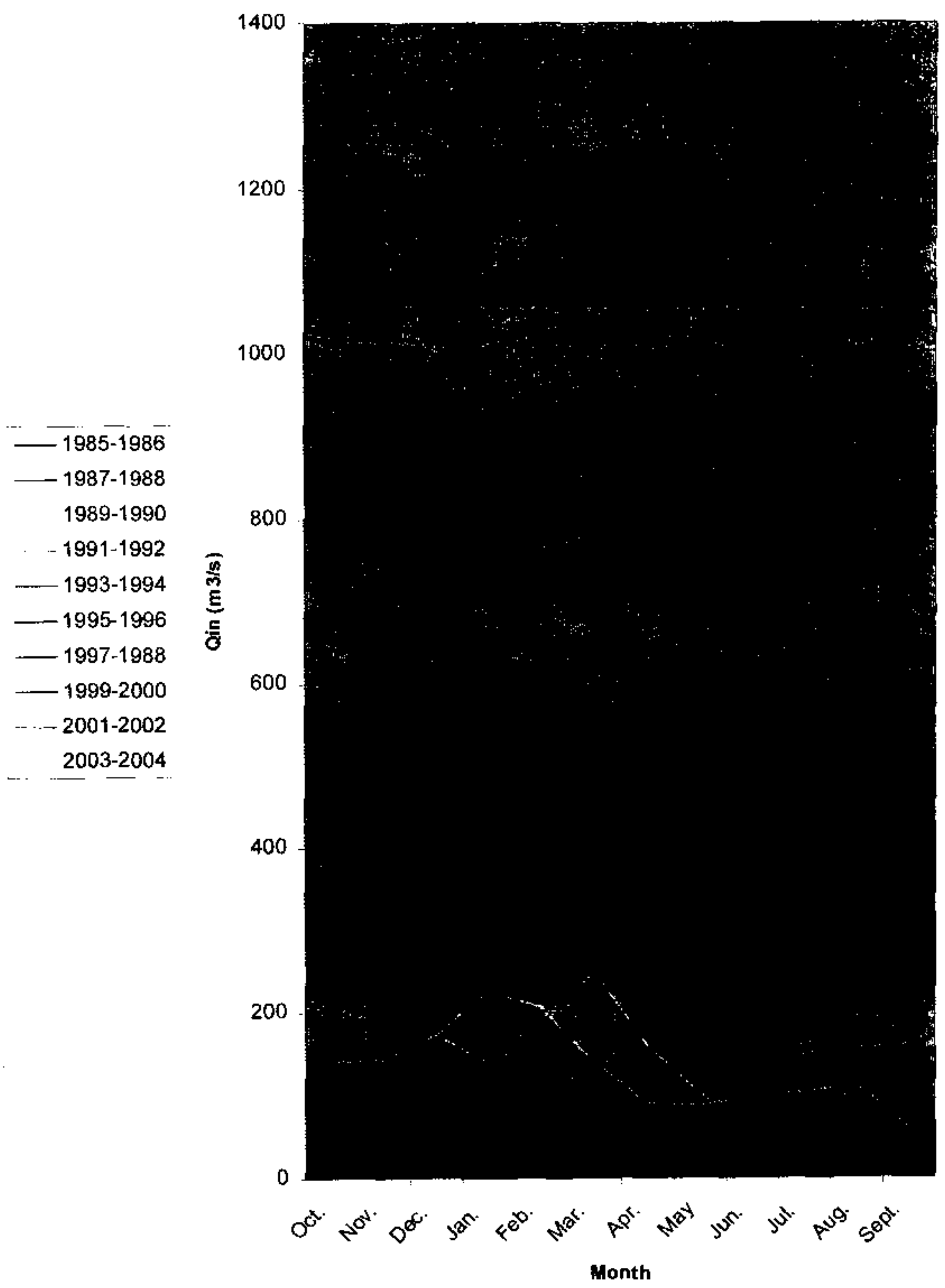


Fig (4-10) Qin For Hemrin Dam

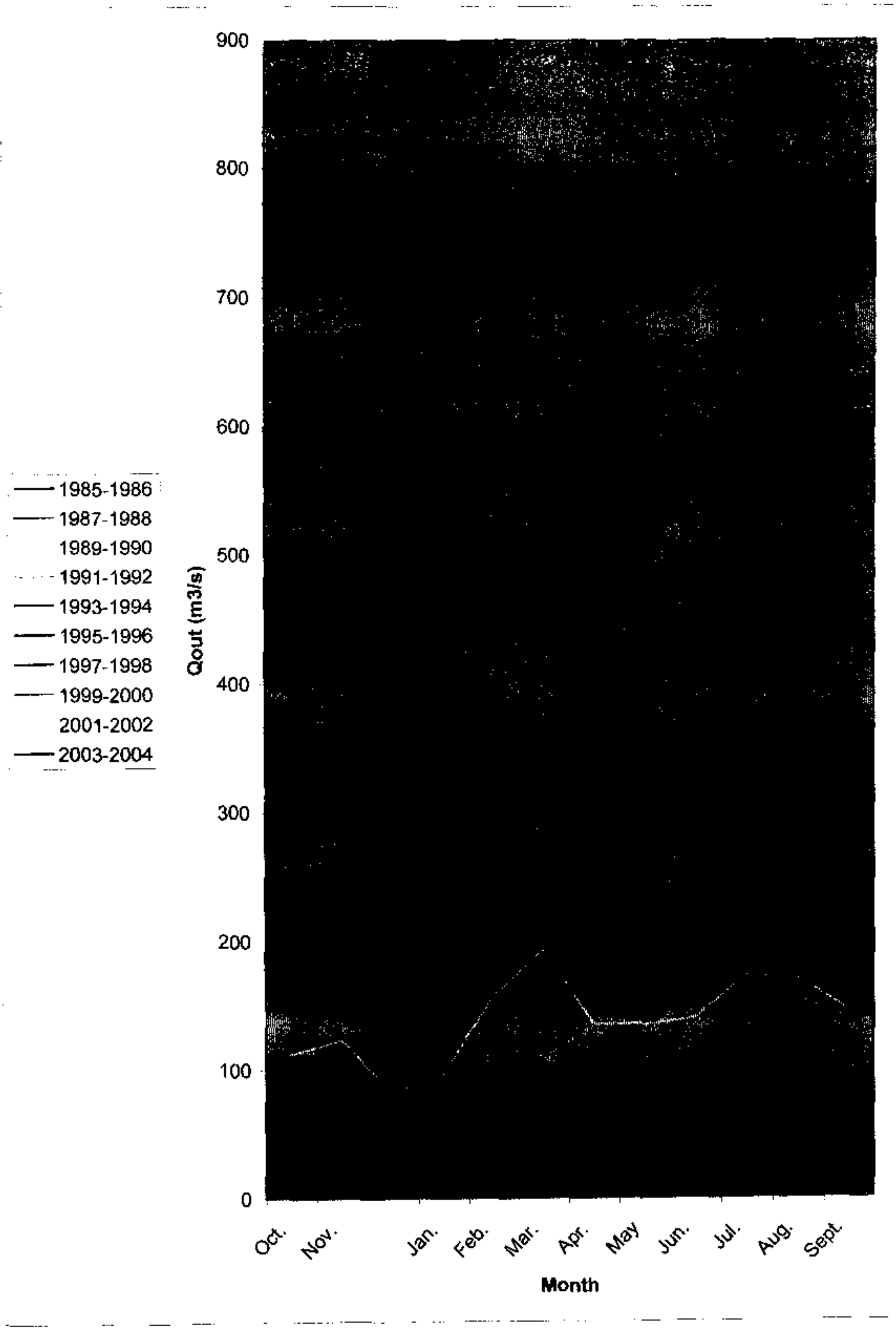


Fig (4-11) Qout For Hemrin Dam

4-5:-Rain fall(P mm)

The rainfall data which are collected for this project contain the average monthly rainfall on the reservoirs of the dams .

Because of the limited variation in intensity and duration of rainfall in the area of four dams which are included in this study, the average values are taken for these dams as shown in fig (4-12)below

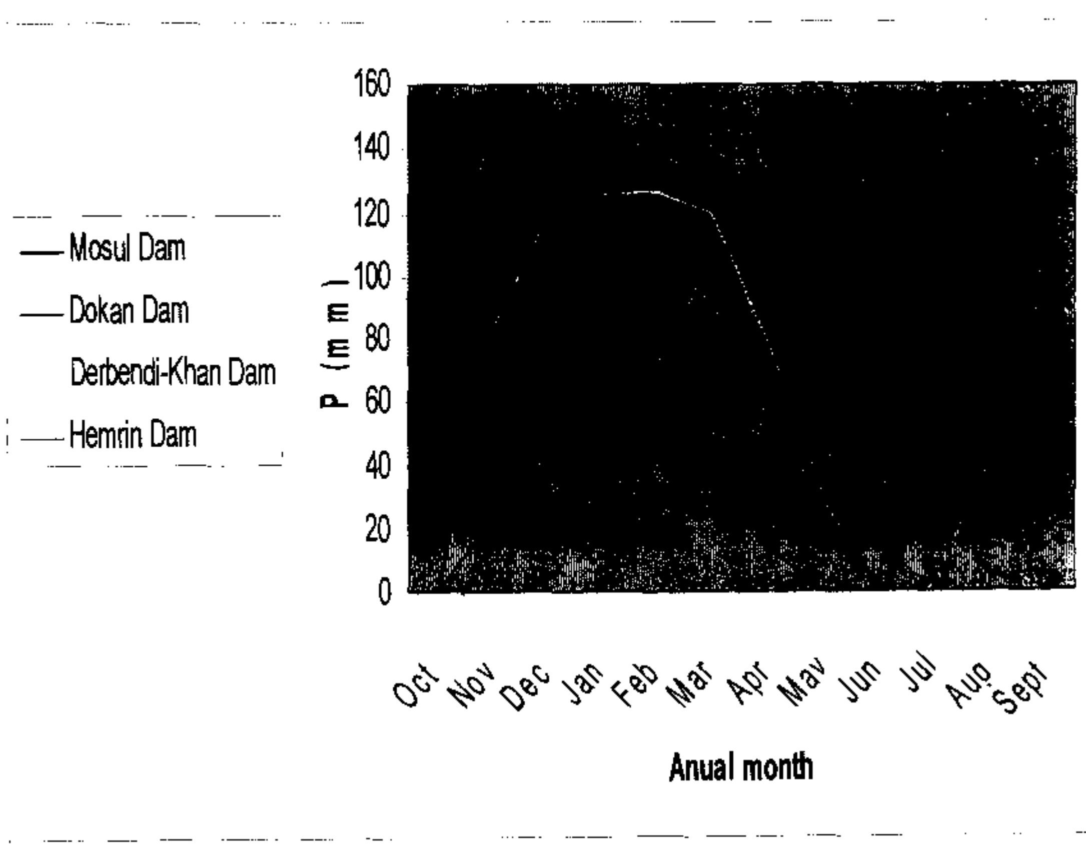


Fig (4-12) Rainfall (P mm)

4-6 Evaporation (ETo mm):-

The evaporation data which are collected for this project contain the average monthly evaporation on the reservoirs of the dams .

Because of the limited variation in intensity and duration of rainfall in the area of four dams which are included in this study, the average values are taken for these dams as shown in fig (4-13)below :-

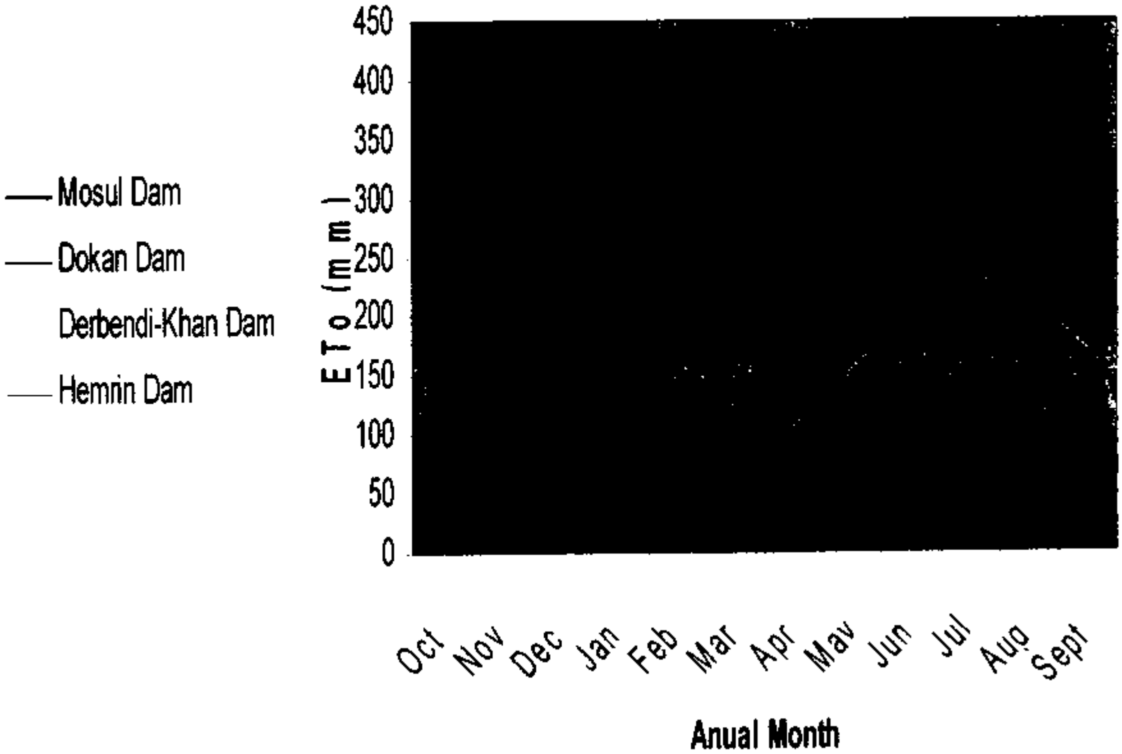


Fig (4-13) for Evaporation (ETo mm)

CHAPTER FIFE

DISCUSSION

DISCUSSION :-

The water balance which we done it was on the four dams which lies on Tigris river the data which was taken are the monthly rainfall and evaporation which are available in water resources office so that the water balance equation which was used is:-

DS = (Qin – Qout)+ VP – VETo

DS = chance storage (m3).

(Qin – Qout) = DV1 (Inflow and Outflow) (m3).

VP = volume rainfall (m3).

VETo = volume evaporation (m3).

The values of (P and ETo)which are collected are in (mm) ,and from the relation between the elevation of water and the area for each reservoir The areas are estimated and the volumes of water are calculated .

The results contains the variations in storage in the dams which are included in this study (DS m3) and these results are shown :-

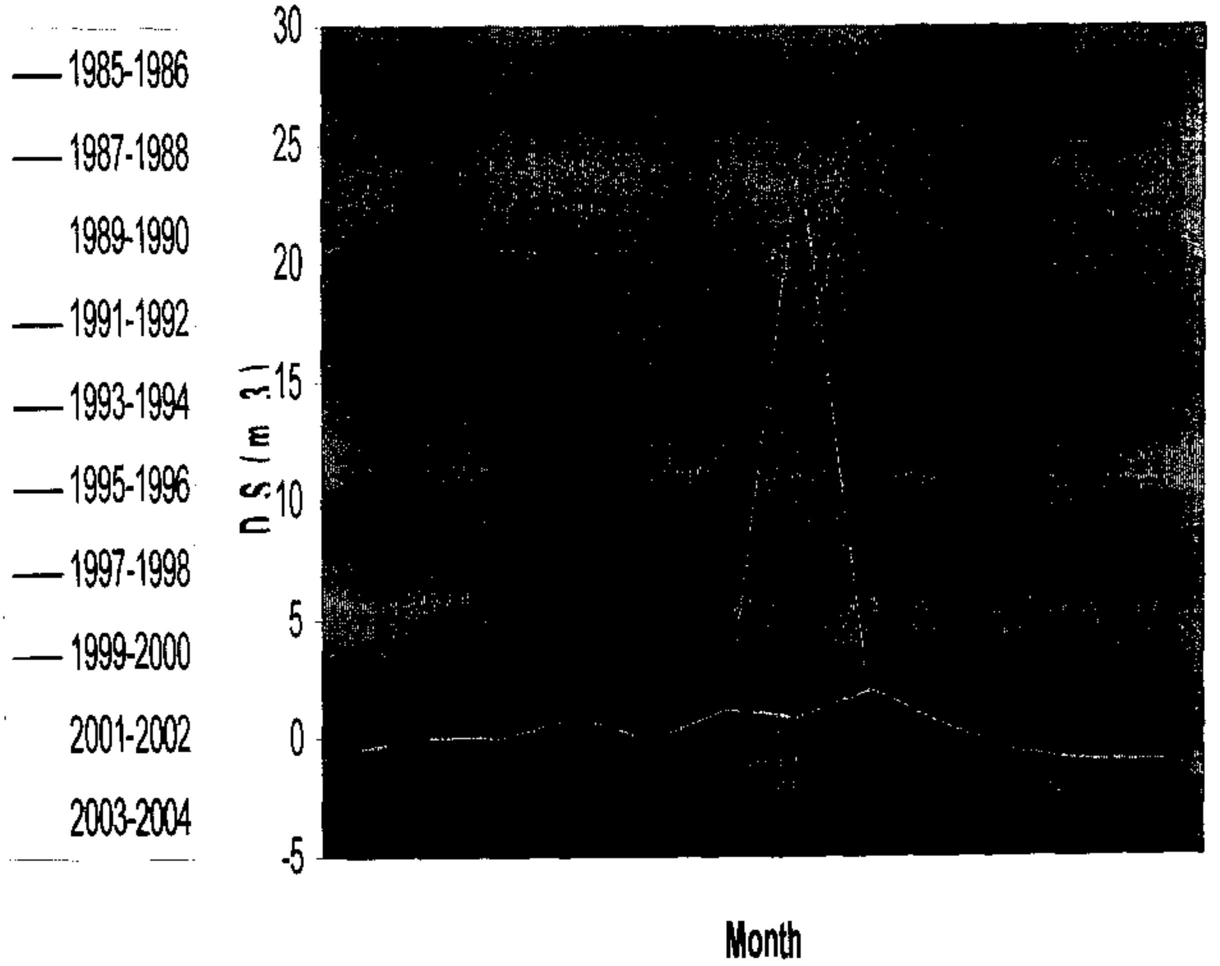


Fig (5-1) DS (m3) for Mosul Dam

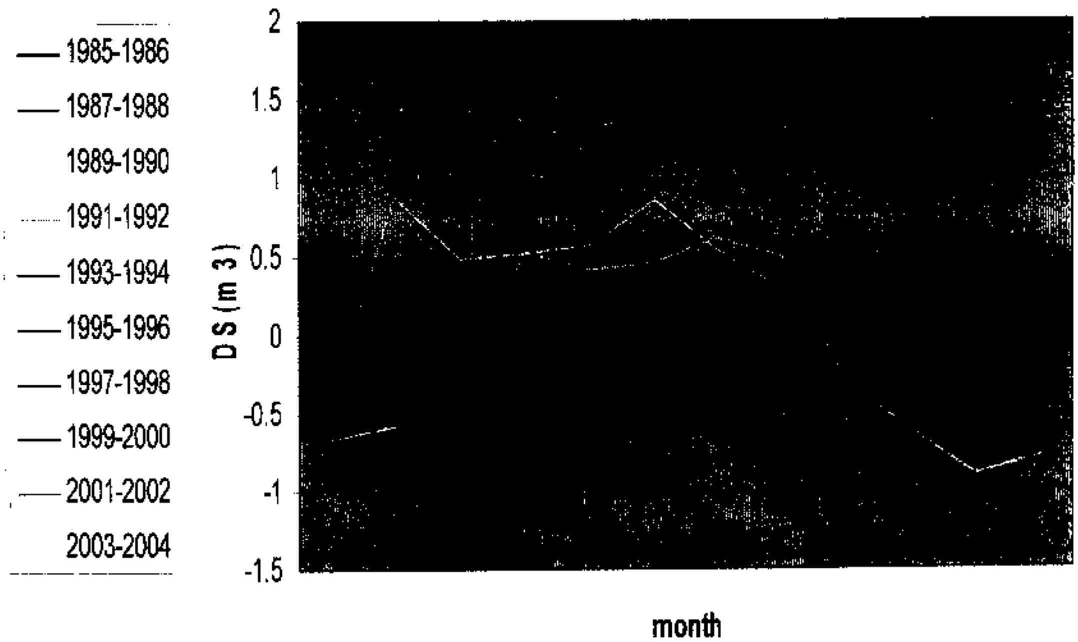


Fig (5-2) DS (m3) for Dokan Dam

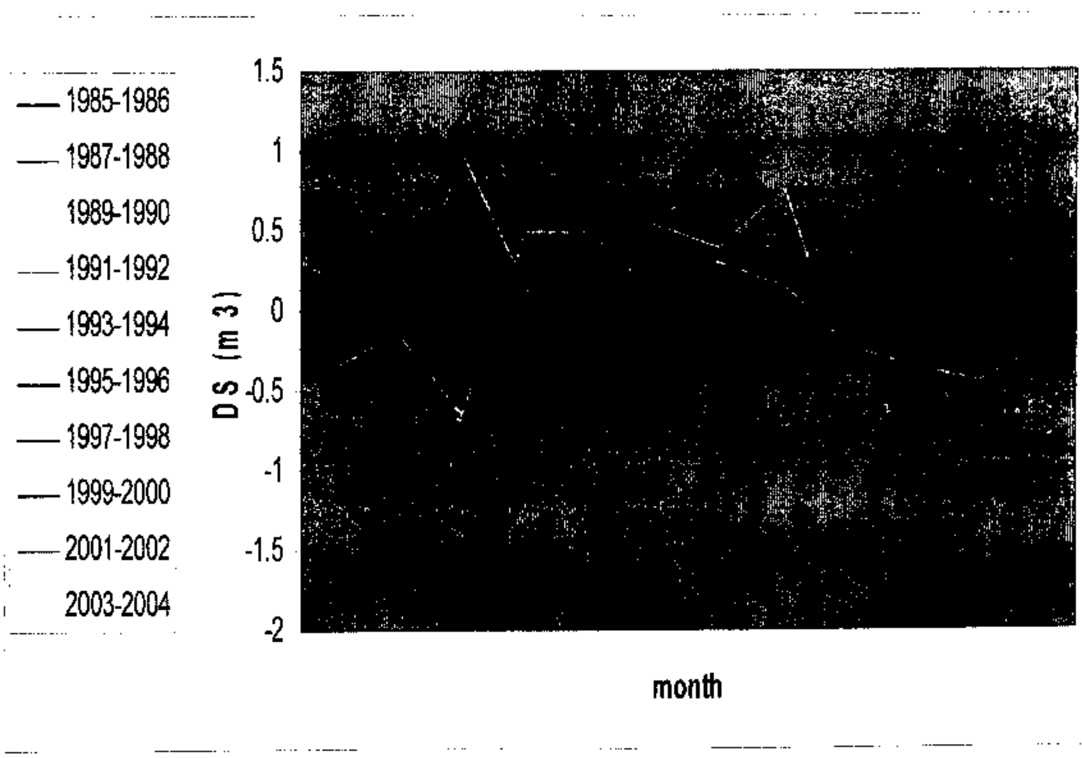


Fig (5-3) DS (m3) for Darbandi -khan Dam

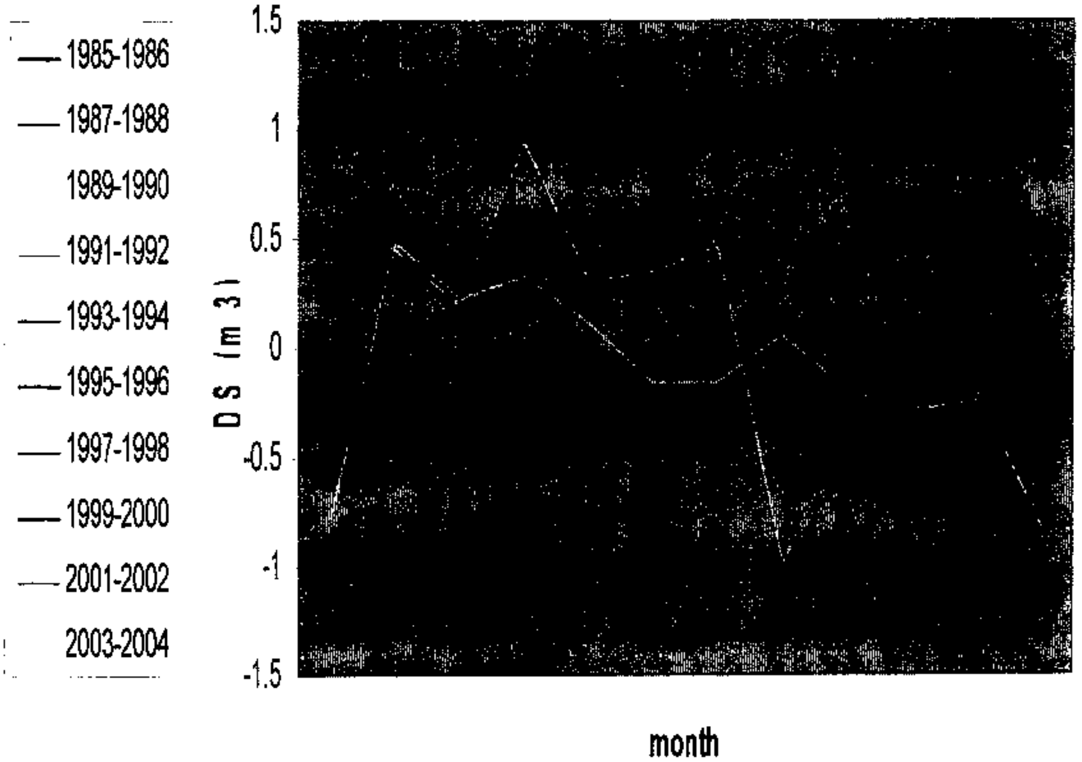


Fig (5-4) DS (m3) for Hemrin Dam

DISPUTATION OF FIGERS :-

-In compressive of the results for year by year ,The results of Mosul Dam head been showed increasing in the dam storage for (1989-1990) at April month , but there is a decrease in the level at (1989-1990) and (1987 -1988) at Aug. and sept. month of the year .....

But at others year's during all the year months the results show different values , with increasing and decreasing and specific months ......

-And The results of Dokan Dam show approximate of years increasing and decreasing....

Head been showed increasing in the dam storage for (1997-1998)

Between Mar. and Apr. months ..and increasing in the dam storage for(1987-1988) at Feb. month ...

But there is a decrease in the level at (1987-1988) at Aug. and sept. month of the year .....

-The results of Darbandi-Khan Dam head been showed increasing in the dam storage for (1995-1996) at April month and (1991-1992) at Dce. Month

but there is a decrease in the level at (1995-1996) at Nov. month of the year .....

-The results of Hemren Dam head been showed increasing in the dam storage for (1987-1988) at April month and (1995-1996) at Dce. Month and (1989-1990) at Mar. month of small difference at level to increasing .....

but there is a decrease in the level at (2001-2002) at September month of the year and (1989 - 1990) at May month of year .....

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