WATER RESOURCES MANAGEMENT IN A TYPICAL CATCHMENT

BY

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Quotes

- *If there is good available water anywhere, there is no need for management of water resources (Dibal)*

- *Take away water from any community and there won't be peace anywhere (Dibal)*

INTRODUCTION

Water Resource

Water resource is the entire range of natural waters that occur on earth, regardless of their state (vapour, liquid or solid) and are potentially useful to humans.

Management

Management is a distinct process consisting of planning, organizing, actuating and controlling; followed to accomplish pre-determined objectives

Catchment

A catchment is a geographical area where precipitation collects and drains into an outlet such as a river, or lake. A catchment could both be small (local river) or large scale (large river)

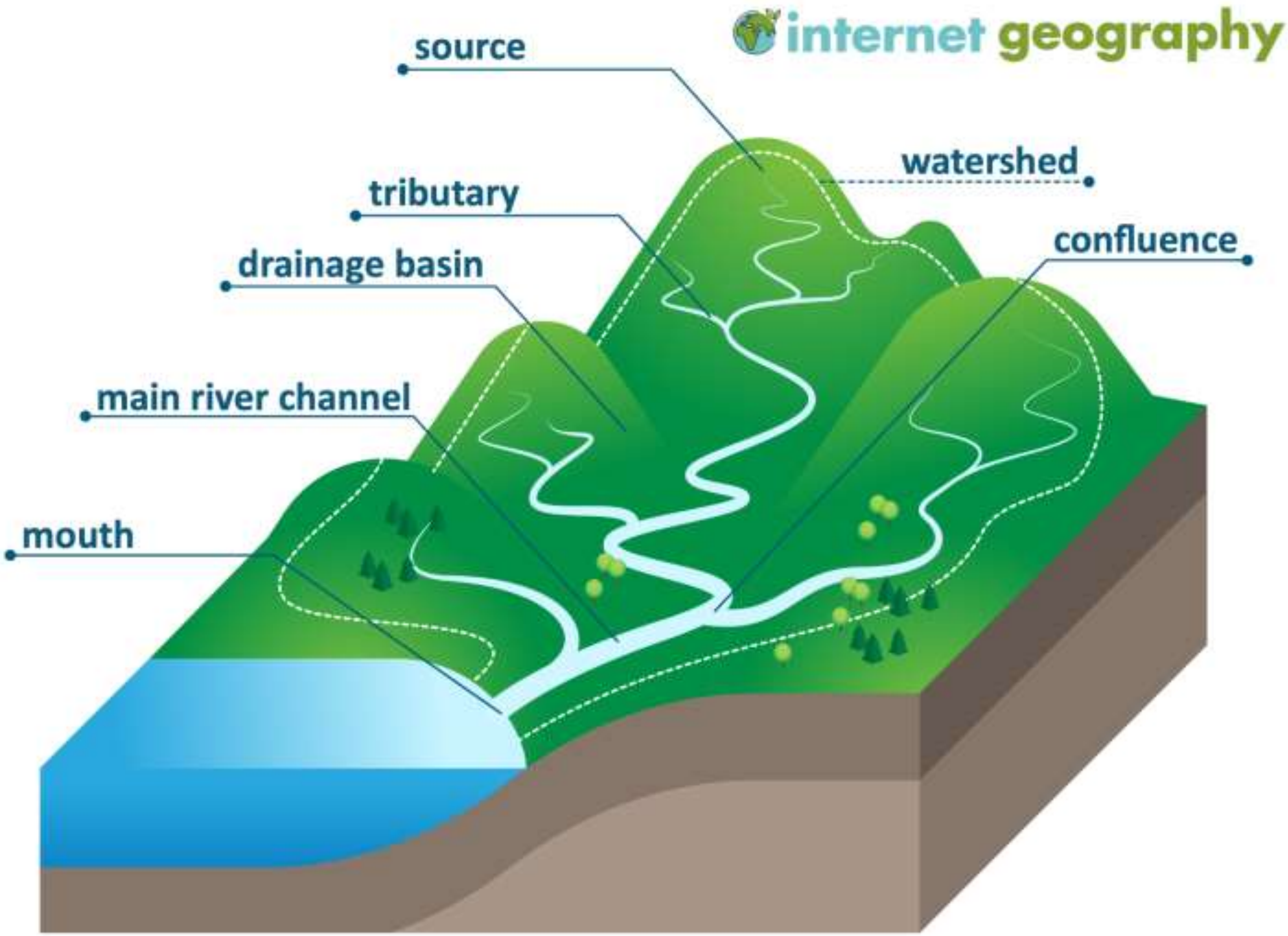


Fig 1: A typical catchment area

CHARACTERISTICS OF A TYPICAL CATCHMENT

- A typical catchment have the following characteristics
- 1. Size
- 2. Topography
- 3. Land use
- 4. Climate
- 5. Component of the Hydrological Cycle expressed as P = I + R + E
- Where P = precipitation
- I = infiltration
- R = surface runoff
- E = evapotranspiration

WATER RESOURCES IN A CATCHMENT

- 1. Surface (rivers, streams, lakes, ponds)
- 2. Groundwater (this could be developed in the form of hand-dug wells, hand pumps, and boreholes)
- 3. Rainwater Harvesting in some places

THE BIG QUESTION:

- Why is water not available?
- 1. Population growth
- 2. Climate change (rise in temperature, flooding, drought etc)
- 3. Competition.
- These have affected availability and quality of water and the eco-system all over the world.

WATER DEMAND AND ALLOCATION

- I. Domestic
- II. Agricultural (irrigation and livestock)
- III. Industrial
- IV. Recreational
- V. Mining

CRITICAL PARAMETERS IN THE MANAGEMENT OF WATER IN A TYPICAL CATCHMENT

- Location and geography of the catchment or river basin
- Drainage
- Relief
- Population and land use
- Geology
- Morphometry
- Aquifer characteristics
- Groundwater movement
- Stream flow and discharges

MORPHOMETRIC ANALYSIS OF THE CATCHMENT OR DRAINAGE BASIN

- a. Determine the stream number and order (Horton, 1945; Strahler, 1964
- b. The average length of the stream of each order
- c. The slope or gradient of the stream of each order
- d. The drainage basin area for the stream of each order
- The morphometric analysis of the catchment is defined by

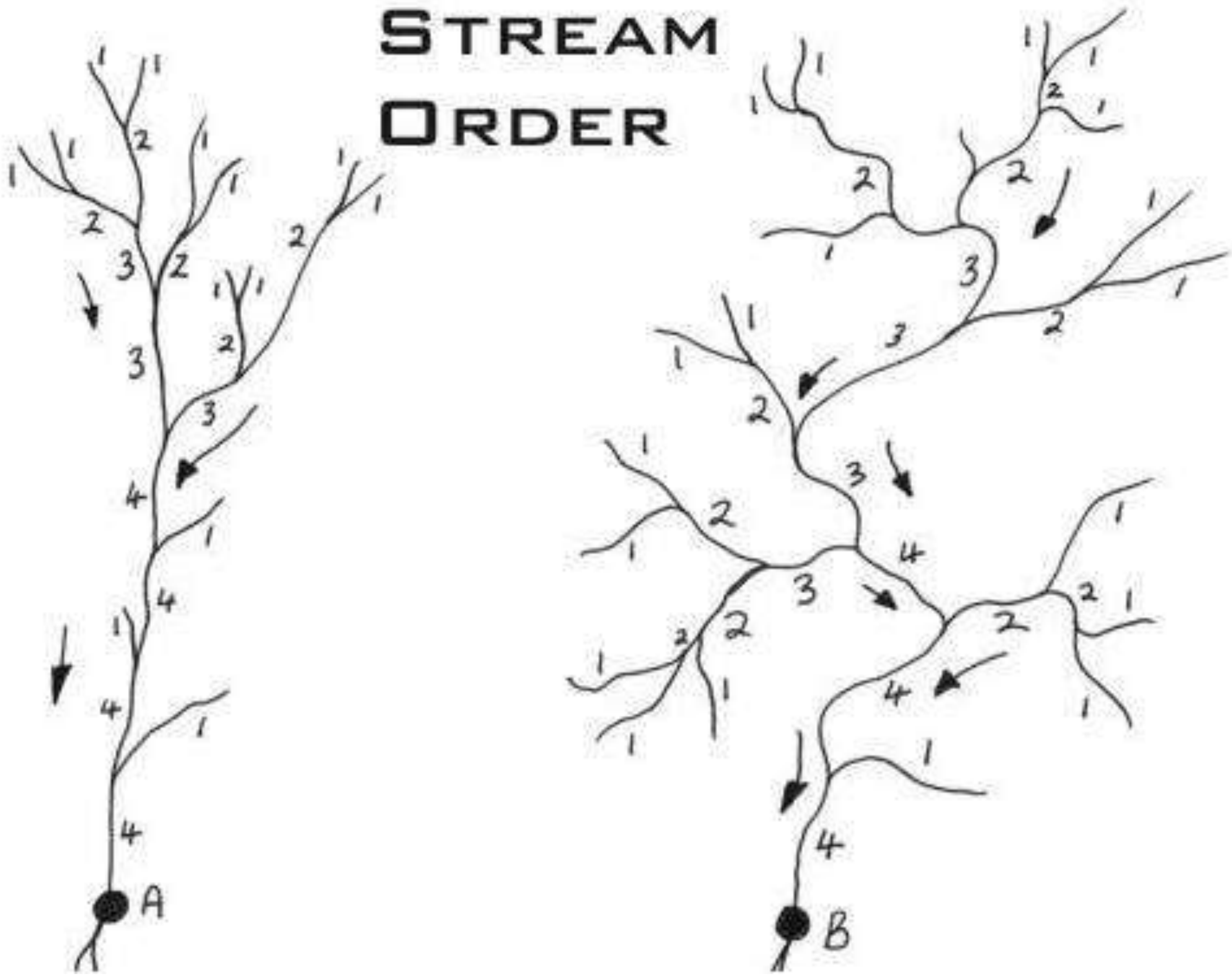
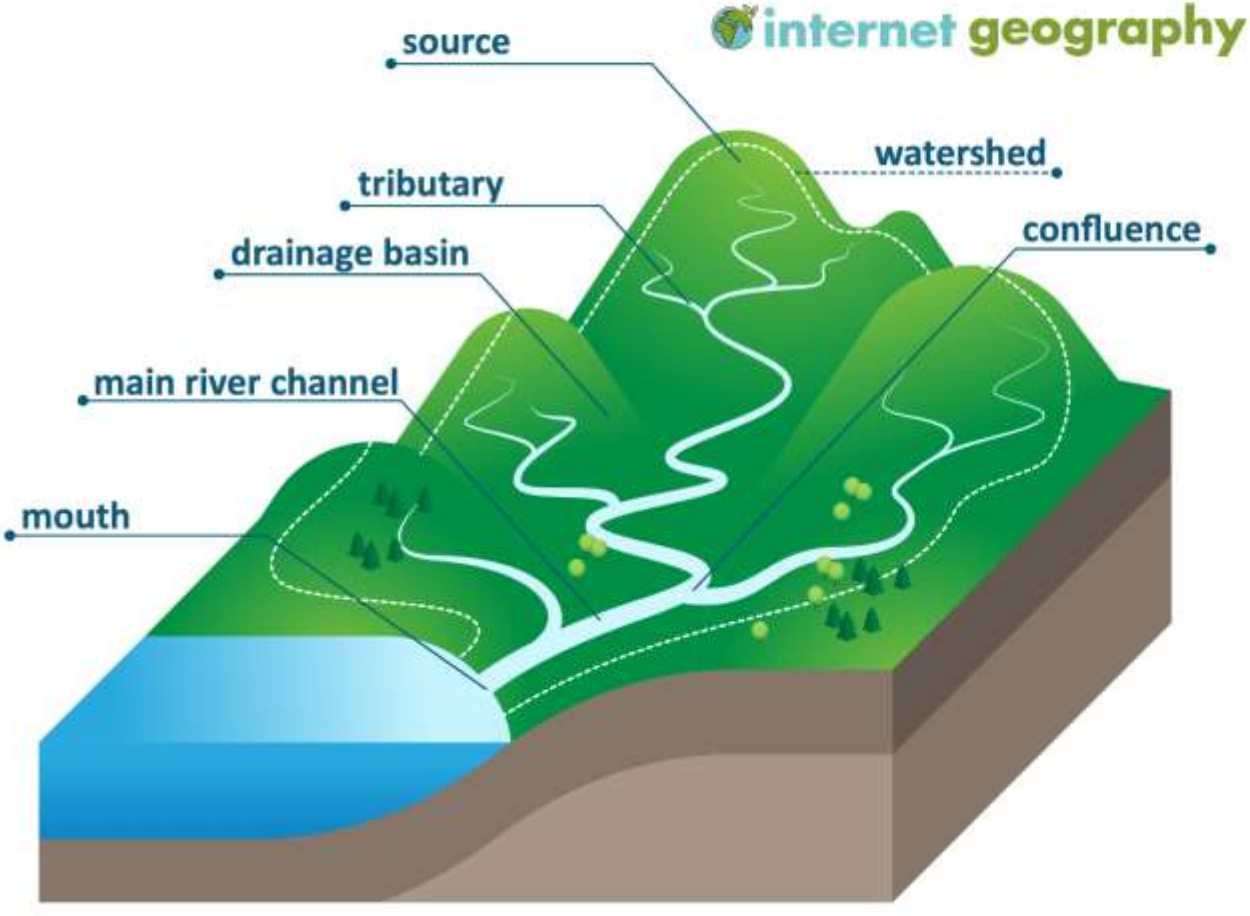


Fig 2: Stream order

- - Form of the basin
- - Shape of the basin
- - Circulatory ratio
- - Elongation


source
watershed
tributary
confluence
drainage basin
main river channel
mouth

AQUIFER CHARACTERISTICS

- The Aquifer Characteristics Are:
- Thickness of the aquifer
- Hydraulic conductivity
- Transmissivity
- Yield of the aquifer

GROUNDWATER MOVEMENT

- This is achieved by monitoring groundwater levels in open wells or boreholes over a period of time by measuring depth to water.

- Data obtained from such monitoring are used to plot groundwater flowlines from which the direction of groundwater flows is determined.

- Flow nets are then constructed.
- Compartments of flow tubes are determined according to areas

- In conjunction with pumping test data flow within tubes in areas can be used to determine flow over the area per day and up to a year

STREAM FLOW AND DISCHARGES

- Determination of river discharges (several methods such as;
- Weir/ stage stations/construction of artificial stream channels,
- measure of river velocity and cross sectional area
- Float velocity
- Measurement of velocity by dilution.

WATER BUDGET

- Available resources (surface and groundwater) are calculated based on the population and their water demand per head for various purposes.

- Critical to the World Bank in developing nations is the domestic and agricultural needs. This is not to say that other needs are not important

DETERMINATION OF QUALITY OF WATER

- Field Parameters (Physical)
- - Colour
- - Odour
- - Taste
- - Temperature,
- - pH
- - Total Dissolved Solids

  - Electrical Conductivity
- - Alkalinity ($CaCO_3$)
- - Dissolved Oxygen,
- - Eh (Oxidation Reduction Potential of Water)

LABORATORY ANALYSIS OF WATER SAMPLES:

1. Major cations (Na, K, Mg and Ca – Inductively Coupled Plasma Optical Emission Spectrophotometer or Atomic Absorption Spectrophotometer best methods)
2. The anions (HCO_3, Cl, SO_4 NO_3, F – Ion Chromatography best method for the analysis)
3. Trace elements (Al, Cd, Fe, Cr, Pb etc)
4. Microbiological content – Membrane filtration

MODELLING OF SOME PARAMETERS CRITICAL FOR WATER QUALITY

- Sodium Absorption Ratio
- Salinity Hazard
- Magnesium Hazard
- Exchangeble Sodium Ratio
- Residual Sodium Concentration
- Hardness
- Water Type

CASE STUDY OF WATER QUALITY FOR LANGTANG, PLATEAU STATE

- The catchment selected for the case study is Langtang in Plateau State.
- Langtang is located in the southern part of Plateau State.
- It has a population of 142,316 and projected population of 209,400 by 2022 (NPC, 2006)
- The drainage is dendritic.

- Three rivers drain the area, two of which has been impounded.
- The major rock types are Porphyritic biotite granite which underlain the area with intrusions of medium grained biotite granites, rhyolite, and trachyte.
- Sources of water are from rivers, streams, dam and hand dug wells and hand pumps.
- The aquifers are the river alluvium, weathered Overburden and fractured aquifer.
- It has temperature of 27 – 33^{O}C
- The terrain is flat in the east and hilly in the west, where the rivers and the streams originate.

Plate I: The Chalyat stream. Further away are the medium grained biotite granite Hills

Plate II: A typical opened hand dug well at Langtang. The well is over 50 years old, with a total depth of 15 m and depth to water of 10 meters.

Plate III: A river alluvium which serve as aquifer in the dry season

Plate IV: The Langtang Dam. The rhyolite hills at flank

Table 1: Microbiological Content of Water Sources in Langtang

Source of water	No of Samples	Range in Plate Count	Coliform Count (Cfu/ml)	Isolates
River	8	9 - 93	1 - 19	Proteus Spp. Staphylococcus Aureus. E. Coli and Baccilus Spp. E. coli is common in the rivers
Stream	8	39 - 69	22 - 42	E.coli, Staphylococcus aureus and Proteus Spp. E. coli common to all sources
Hand Dug well	4	6 - 51	3 - 29	Staphylococcus aureus, E. coli, Proteus Spp., Bacilus Spp and Salmonella Typhi. Staph. Aureus common in all sources
Hand Pump	1	75	71	E. coli
Dam	6	5 - 43	1 - 32	Staphylococcus aureus, E. coli, Baccilus Spp., Pseudomonas aeruginosa.
WHO/NSDWQ			0Cfu/ml/10Cfu/ml	

Field Parameters of Water Sources

Water source	No of sample	pH	Temp (^{O}C)	TDS (PPM)	EC (µs/cm)
River	8	7.03 – 7.74	20.60 – 34.40	41.00 - 47.00	82.00 – 84.00
Stream	8	7.10 – 7.57	27.56 – 35.80	51.00 – 78.00	120.00 – 156.00
Hand Dug well	4	7.36 – 7.51	31.80 - 32.50	65.00 – 239.00	130.0 – 478.00
Hand Pump	1	7.50	31.00	182.00	365.00
Dam	6	7.22 – 7.62	27.60 – 32.50	42.00 – 80.00	84.00 – 160.00
WHO/NSDWQ		6.0 – 8.0	Ambient	500 - 1000	

Chemical Prameters (Anions – ppm) of Waters in some of the Sources

Water source	No of sample	Cl	SO_4	NO_3	Alkalinity
River	8	15.00-20.00	1.00-91.25	5.85-18.00	80.00-100.00
Stream	8	15.00-20.00	5.80-22.56	9.00-27.00	120.00-140.00
Hand Dug well	4	15.00-55.00	3.76-15.20	9.00-67.00	180-260.00
Hand Pump	1				
Dam	6	9.00-15.00	2.00-19.00	9.00-27.00	100.00-120.00
WHO/NSDWQ		250	250	45	

Major Cations (ppm) in some water sources in Langtang.

Water source	No of sample		Na	Ca	Mg	K
River	River	3	8.09-12.83	3.97-18.84	0.62-3.46	1.23-2.84
Stream	Stream	1	13.35	13.70	2.73	1.03
Hand Dug well	Hand Dug well	1	16.64	22.00	4.68	1.02
Hand Pump	Hand Pump					
Dam	Dam	2	8.00-11.84	9.31-16.45	1.73-3.62	1.81-2.29
WHO/NSDWQ	WHO/NSDWQ		200	150 - 200		

Concentration of Trace Elements (ppm) in some water sources in Langtang

Water source	No of sample	Cd	Cr	Pb	Ni
River	4	0.51 – 0.52	0.02 – 0.05	BDL	0,12 – 0.14
Stream	6	0.06 – 0.35	0.01 – 0.05	BDL	0.01 – 0.09
Hand Dug well	1	0.43	0.06	BDL	0.14
Hand Pump	-	-	-	-	-
Dam	2				
WHO/NSDWQ		0.05	0.003	0.01	0.007

Requirements for Irrigation Waters in Langtang

Sample ID	Salinity Hazard	SAR	ESR	Magnesium Hazard	RSC
LGT 02 (River)	Low	0.007	0.456	23.2	0.00
LGT03 (River)	Low	0.008	0.648	23.9	0.07
LGT 04 (Hand Dug Well)	Low	0.008	0.488	26.0	0.01
LGT 05 (Stream)	Low	0.009	0.639	24.7	0.00
LGT 08 (Stream)	Low	0.007	0.465	29.9	0.00
LGT 18 (Dam)	Low	0.006	0.573	23.5	0.00
LGT 19 (Dam)	Low	0.007	0.460	26.6	0.08
LGT 26 (Hand Dug Well)	Low	0.100	1.412	20.5	0.00

MANAGING THE AVAILABLE WATER RESOURCES IN A CATCHMENT

- Adopt the concept of Integrated Water Resources Management which involves:
- 1. Stakeholders participation
- 2. Water Governance and Policy
- 3. Integration of social, economic and environmental considerations.
- Water Conservation and Efficiency
- 1. Practice efficient irrigation
- 2. Water saving technology
- 3. Create public awareness

Managing the available water resources in a catchment

- Water Efficiency
- In our demand for water for various purposes, water we should
- 1. re-use water
- 2. Harvest waters from rain
- 3. Be diligent to detect leakages underground

MANAGING THE AVAILABLE WATER RESOURCES IN A CATCHMENT

- Flood Management and Drought Mitigation Strategies.
- - This could be achieved through river channelization
- - Flood plain zoning
- - Build flood control structures.
- Drought could be mitigated through
- - Water storage facilities
- - Groundwater recharge
- - Planting of drought resistant plants

CONCLUSION

- *Everyday water is needed for various purposes, which is readily not available. The effect of climate change and population growth has compounded the problem. The World Bank spends billions of dollars in developing nations to provide these limited resources to communities to encourage healthy leaving and food sufficiency. There is therefore the need to practice efficient use of water to meet the need of the next generation*