FLOOD ESTIMATION

INTRODUCTION

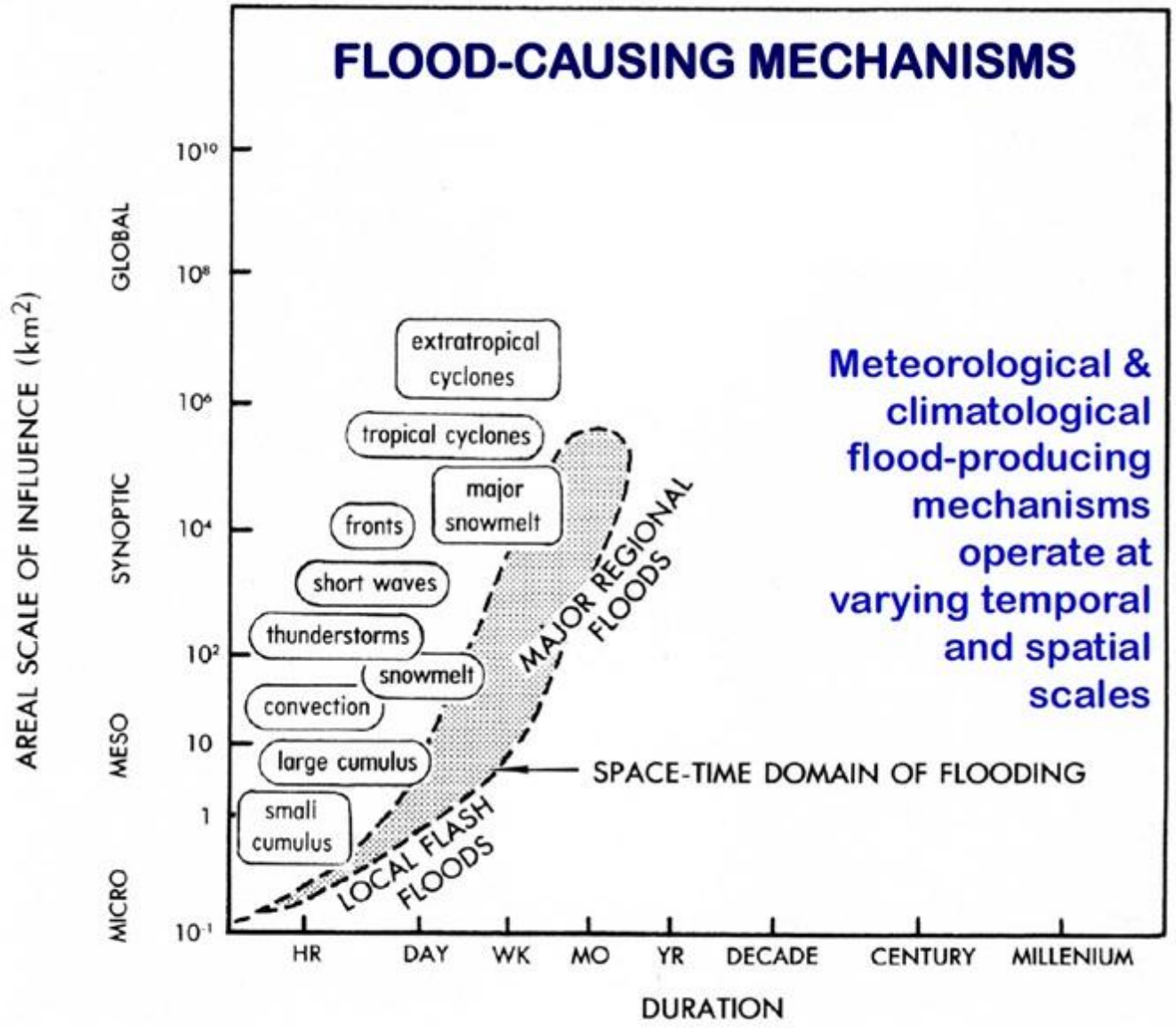
- A FLOOD IS RELATIVELY HIGH FLOW THAT OVERTOPS THE NATURAL OR ARTIFICIAL BANKS IN ANY REACH OF A SYSTEM.

- FLOOD PLAIN IS DESIRABLE LOCATION FOR HUMAN LIVELIHOOD AND HIS ACTIVITIES, IT IS IMPORTANT THAT FLOODS BE CONTROLLED SO THAT DAMAGE DOES NOT EXCEED AN ACCEPTABLE AMOUNT

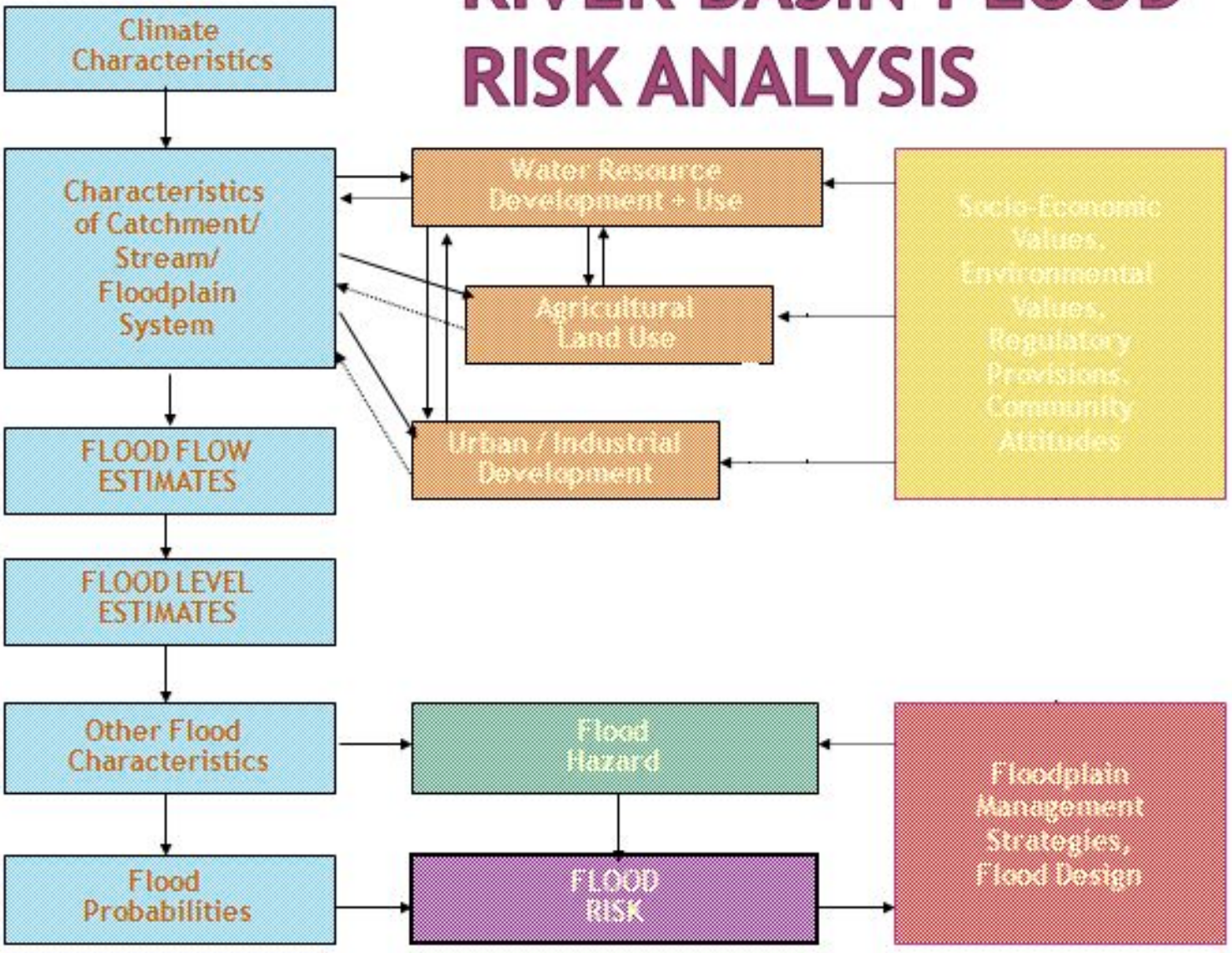
- DESIGN OF WATER RESOURCES STRUCTURE SUCH AS SPILLWAYS, DIVERSION WORK, BRIDGES, CULVERT ETC. OFTEN REQUIRE THE DESIGN AT A CERTAIN LOCATION IN ORDER TO ESTIMATE THE SIZE AND COST OF THOSE STRUCTURE.

NEED OF FLOOD ESTIMATION

- TO DESIGN THE WATER RESOURCE STRUCTURE SUCH AS DAM, SPILLWAYS, DIVERSION WORKS, BRIDGE ETC.
- TO DETERMINE THE MAXIMUM DISCHARGE AND MAXIMUM POTENTIAL.
- ESTIMATE COST AND SIZE OF STRUCTURE.

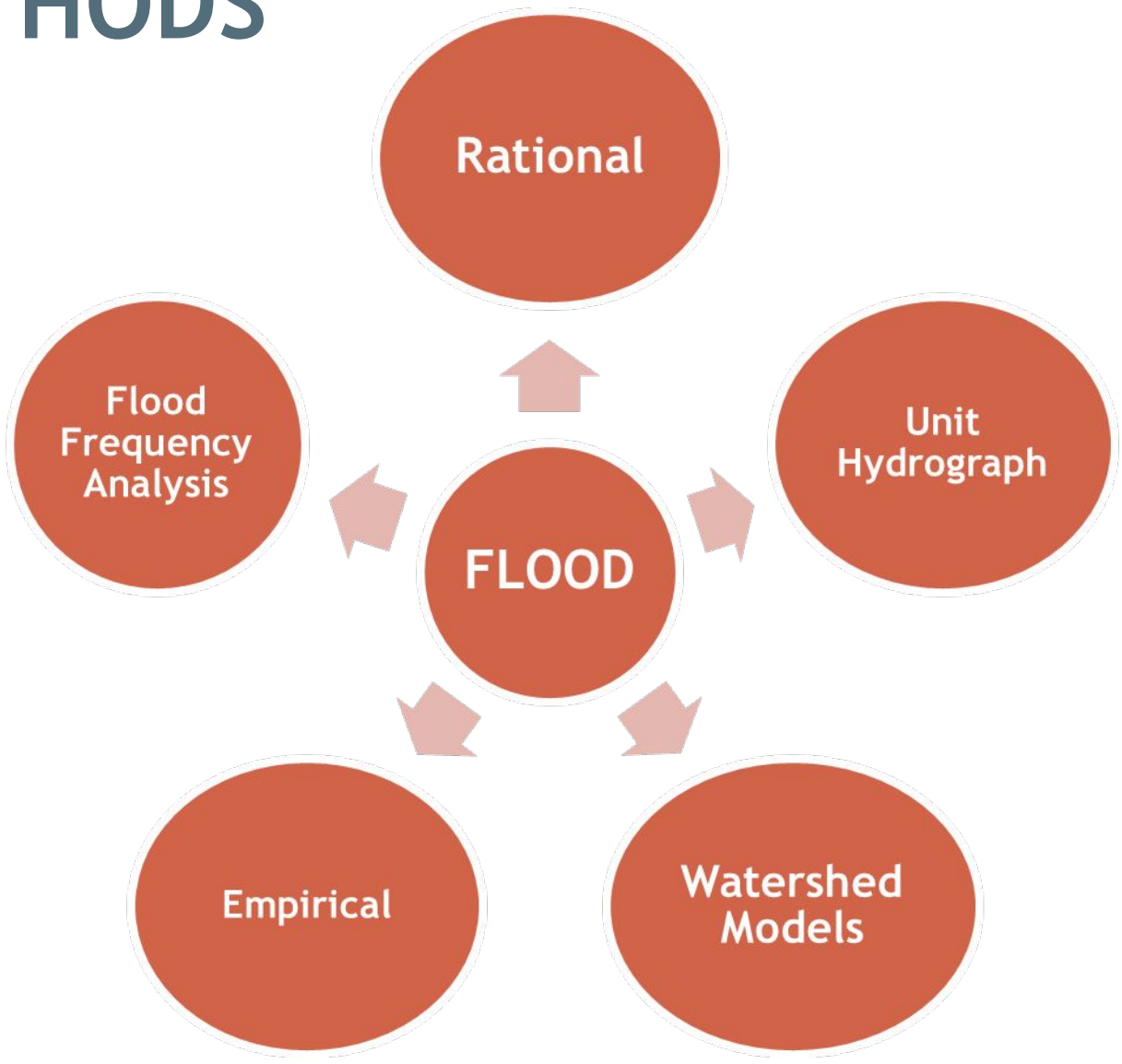

FLOOD-CAUSING MECHANISMS
AREAL SCALE OF INFLUENCE (km²)
GLOBAL
SYNOPTIC
MESO
MICRO
10¹⁰
10⁸
10⁶
10⁴
10²
10
1
10⁻¹
extratropical cyclones
tropical cyclones
major snowmelt
fronts
short waves
thunderstorms
snowmelt
convection
large cumulus
small cumulus
MAJOR REGIONAL FLOODS
LOCAL FLASH FLOODS
SPACE-TIME DOMAIN OF FLOODING
HR
DAY
WK
MO
YR
DECADE
CENTURY
MILLENIUM
DURATION
Meteorological & climatological flood-producing mechanisms operate at varying temporal and spatial scales

RIVER BASIN FLOOD RISK ANALYSIS



TYPES OF FLOOD

METHODS


Rational
Unit Hydrograph
Watershed Models
Empirical
Flood Frequency Analysis
FLOOD

EMPIRICAL METHOD

- IT SHOULD BE EMPLOYED ONLY WHEN THERE IS INSUFFICIENT AVAILABLE HYDROLOGIC INFORMATION FOR PERFORMING THE DETAILED AND PRECISE ANALYSIS.

- THE VARIOUS EMPIRICAL FORMULAE COMMONLY USED IN INDIA ARE

  (a) DICKEN'S FORMULA

  (b) RYVE'S FORMULA

  (c) MODIFIED REGIONAL FLOOD FORMULAE

(A)DICKEN'S FORMULA

- DICKEN (1885) MADE THE FIRST ATTEMPT IN INDIA TO DERIEVE A GENERAL FORMULA FOR DETERMINING THE MAXIMUM FLOOD ON THE BASIS OF STUDIES CONDUCTED FOR DETERMINING THE RELATION BETWEEN DISCHARGE RATE TO DRAINAGE AREA.

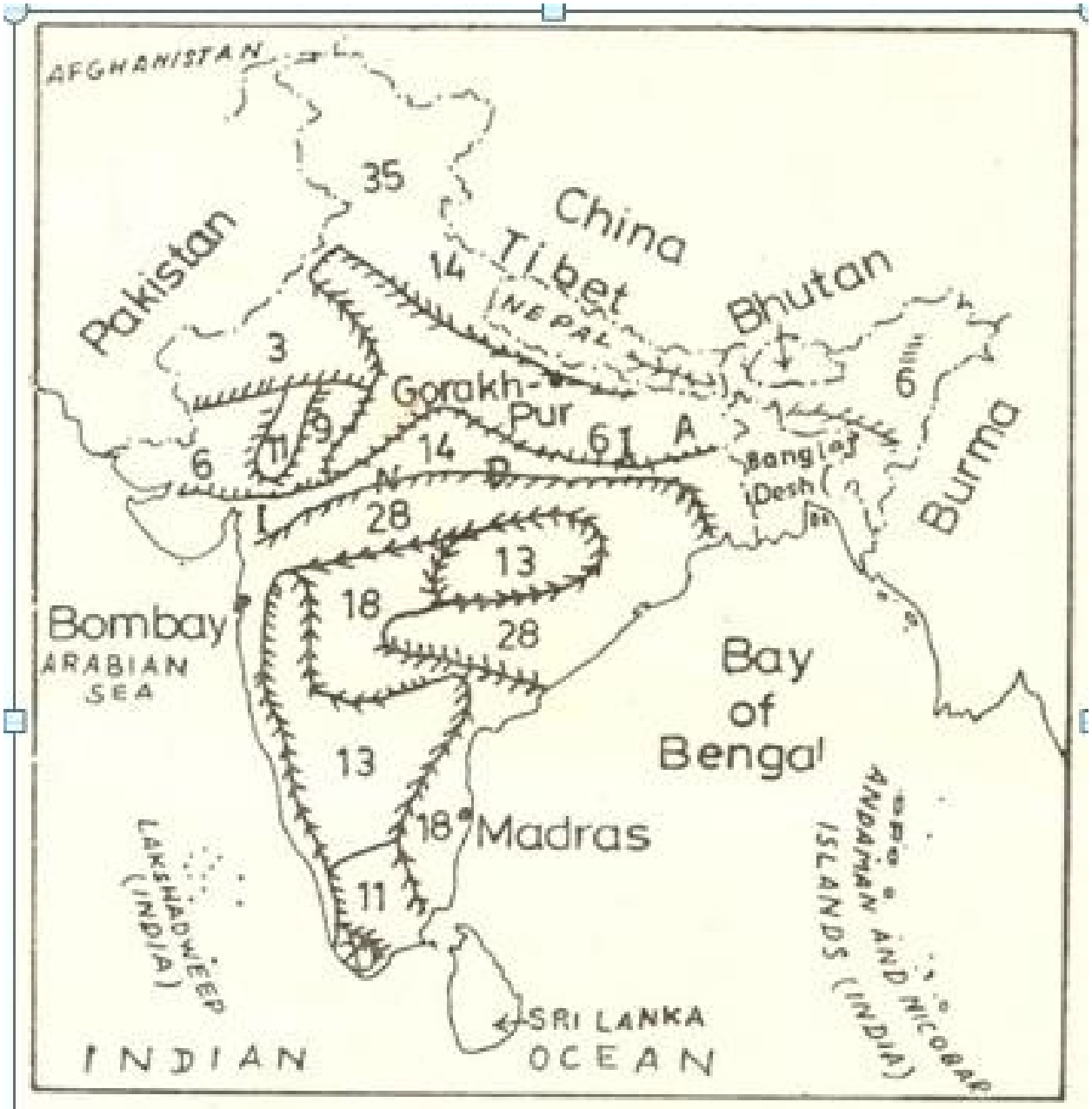
- $Q=C\ A^{(3/4)}$

  where,

  Q=PEAK FLOW RATE

  C,(3/4)=REGRESSION CONSTANT

  A=AREA OF DRAINAGE(km2)



Dicken's Constant C for Different Parts of India.

(B)RYVE'S FORMULA

- RYVE'S MODIFIED DICKEN'S FORMULA TO SUIT SOUTH INDIAN CONDITIONS FOR AREAS WITHIN 25 km FROM THE COAST, BETWEEN 25 TO 175 km FROM THE COAST, AND FOR LIMITED AREAS NEAR THE HILL

- $Q=C\ A^{2/3}$

- THE VALUE OF CONSTANT VARIES WIDELY BEING 6.8 IN FLAT TRACTS ALONG THE COAST AND ABOUT 42.4 IN THE WESTERN GHAT REGION.

(C) MODIFIED REGIONAL FLOOD FORMULAE

- KUMAR ET AL. (1999) DEVELOPED A METHODOLOGY WHICH MODIFY THE FORM OF THE EMPIRICAL FORMULA.

- $Q_T = C_T A^b$

  C_T = REGIONAL PARAMETERS

  Q_T =FLOOD OF T-YEAR RETURN PERIOD

  A=CACHMENT AREA

  b = TO BE ESTIMATED FOR REGION USING REGRESSION.

RATIONAL FORMULA

- IT IS MOST WIDELY USED FOR THE ANALYSIS OF RUNOFF RESPONSE FROM SMALL CATCHMENT

- THIS METHOD TAKE INTO ACCOUNT THE FOLLOWING HYDROLOGICAL CHRACTERISTICS OR PROCESSES

  (a) RAINFALL INTENSITY

  (b) RAINFALL DURATION

  (c) RAINFALL FREQUENCY

  (d) CATCHMENT AREA

  (e) HYDROLOGIC ABSTRACTIONS

  (f) RUNOFF CONCENTRATION

  (g) RUNOFF DIFFUSION

- THE REQUIREMENT OF THE RATIONAL METHOD IS THAT THE CACHMENT BE SMALL . FOLLOWING STEPS ARE INVOLVED IN THIS METHOD

i. DETERMINE THE TIME OF CONCENTRATION

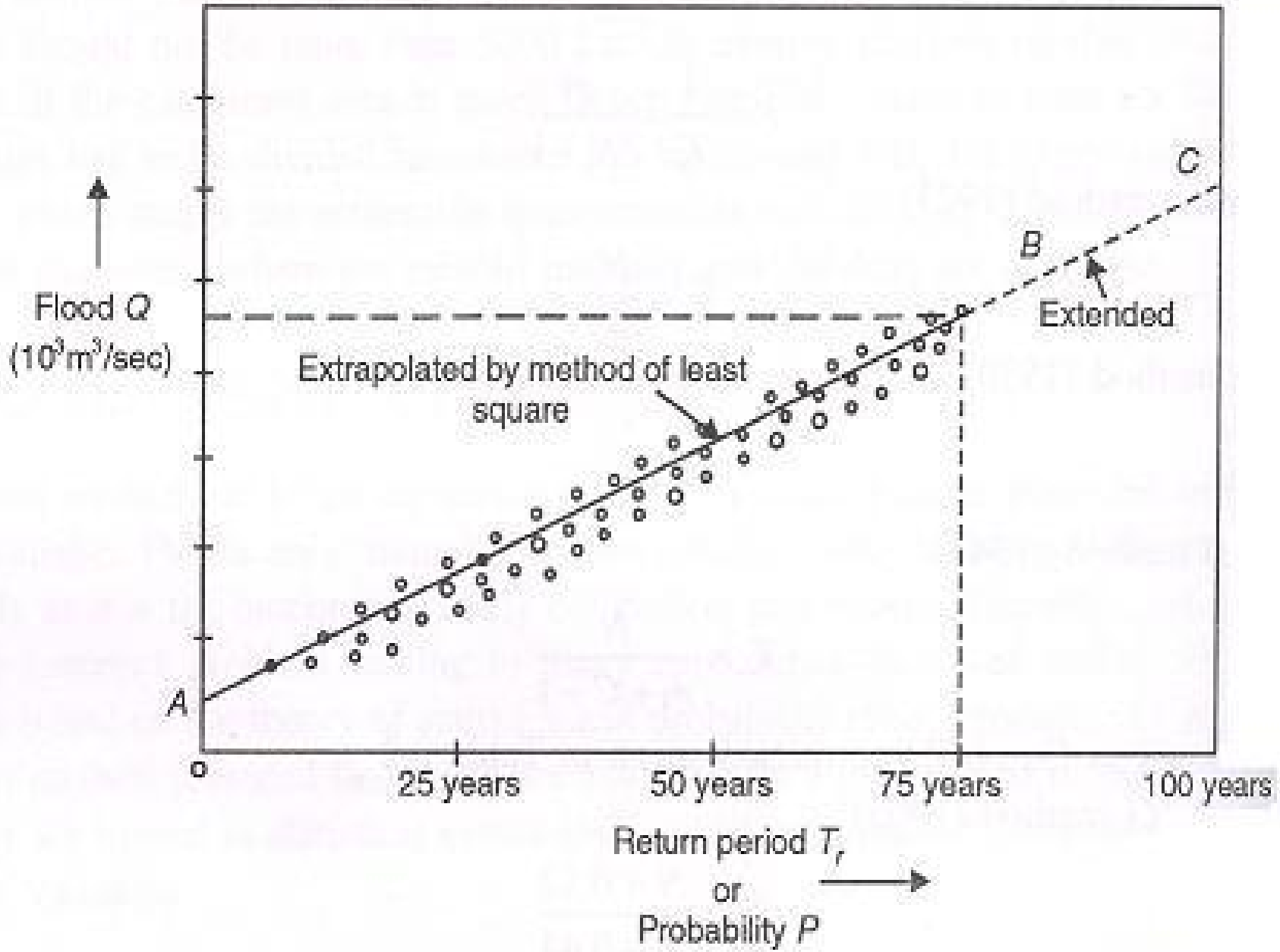
ii. OBTAIN THE RAINFALL INTENSITY FOR THE DESIRED DURATION AND FREQUENCY FROM THE APPROPRIATE INTENSITY-DURATION-FREQUENCY CURVE.

iii. RUNOFF COEFFICIENT DEPENDS ON THE CONDITION.

$$Qp = C\ I\ A$$

FLOOD FREQUENCY ANALYSIS

- FLOOD FREQUENCY DENOTES THE LIKELIHOOD OF FLOOD BEING EQUALLED OR EXCEEDED.
- THE RETURN PERIOD (Tr)OF ALL FLOODS ($Q_1, Q_2, \ldots\ldots Q_N$) ARE CALCULATED.
- THE CURVE BETWEEN Q V/S Tr IS PLOTTED .
- THE CURVE CAN BE USED TO DETERMINE THE RETURN PERIOD FOR THE CORRESPONDING MAGNITUDE OF FLOOD.



Plot of flood Q against return period T_r or probability P.

UNIT HYDROGRAPH APPROACH

- UNIT HYDRO GRAPH WAS PROPOSED BY L.K. SHERMAN.

- UNIT HYDROGRAPH IS DEFINED AS THE HYDROGRAPH OF SURFACE RUNOFF OF A CACHMENT AREA RESULTING FROM UNIT DEPTH OF RAINFALL EXCESS.

- UNIT HYDROGRAPH IS A LINEAR MODEL OF THE CACHMENT .

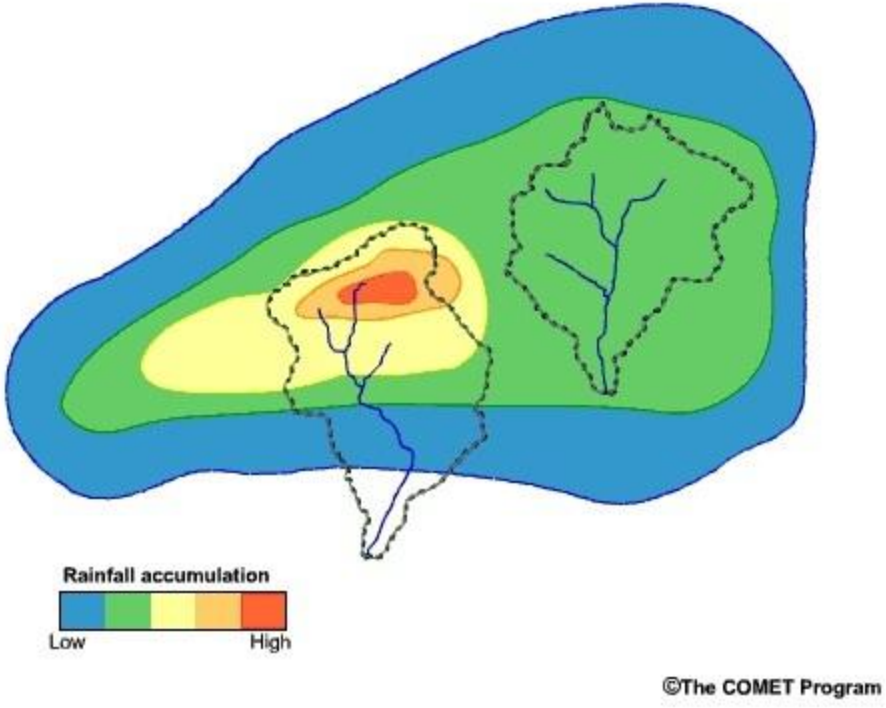
- ASSUMPTIONS IN UNIT HYDROGRAPH METHOD

  (i) RAINFALL IS OF UNIFORM INTENSITY WITHIN ITS SPECIFIED DURATION.

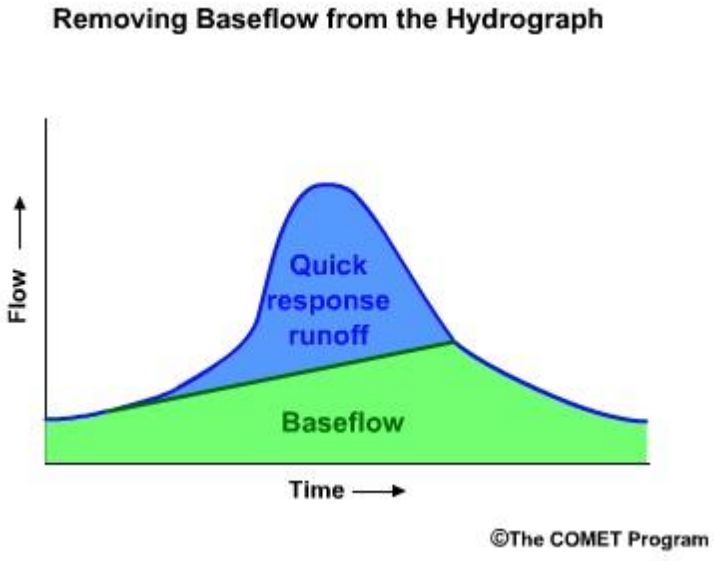
  (ii)THE EFFECTIVE RAINFALL IS UNIFORMLY DISTRIBUTED THROUGHOUT THE AREA OF DRAINAGE BASIN.

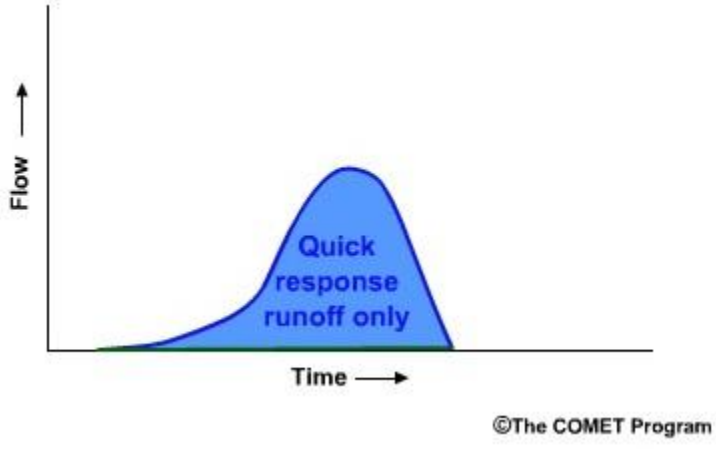
STEPS REQUIRED TO DERIEVE UNIT HYDRO GRAPH

- **Step 1: Select Appropriate Precipitation Event**

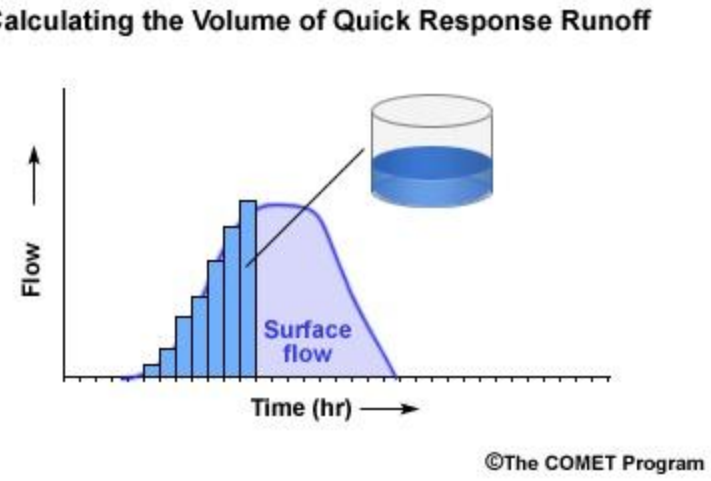


- **Step 2: Remove Baseflow Contribution**

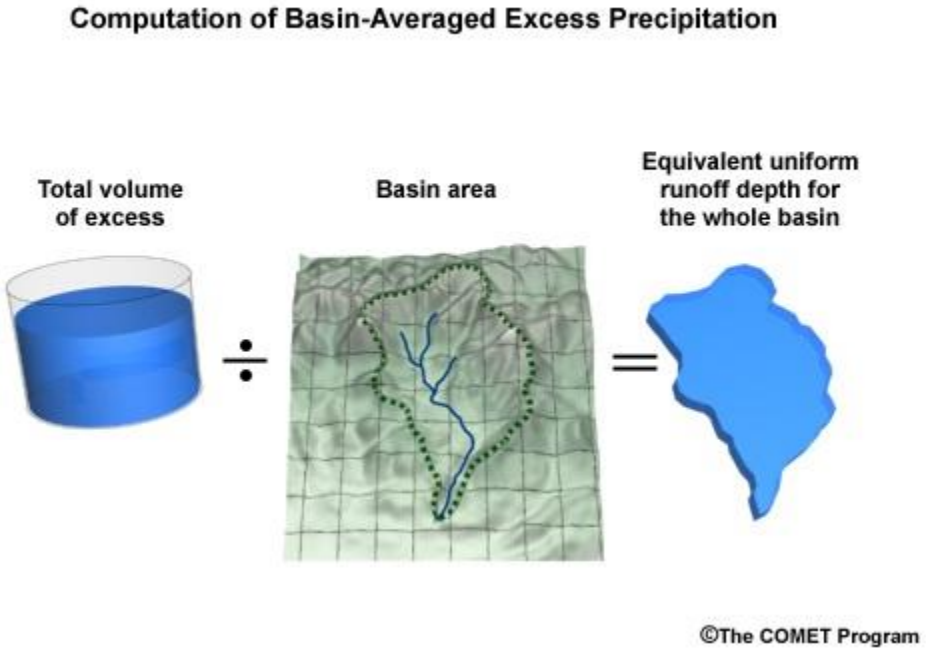




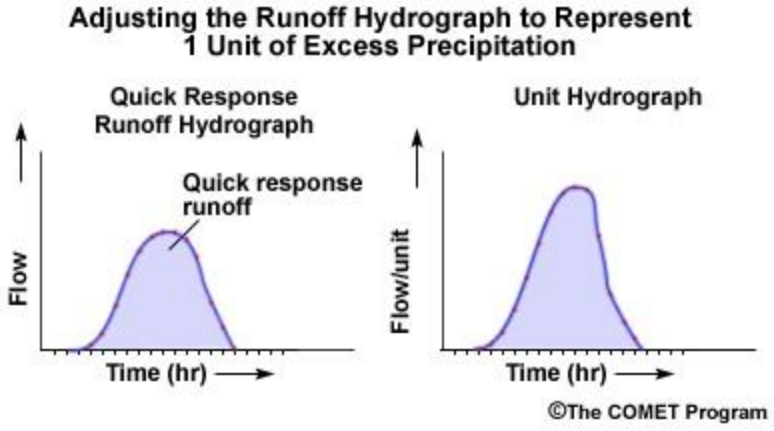
- **Step 3: Calculate Volume of Quick-Response Runoff**



- **Step 4: Determine Excess Precipitation Depth for the Basin**



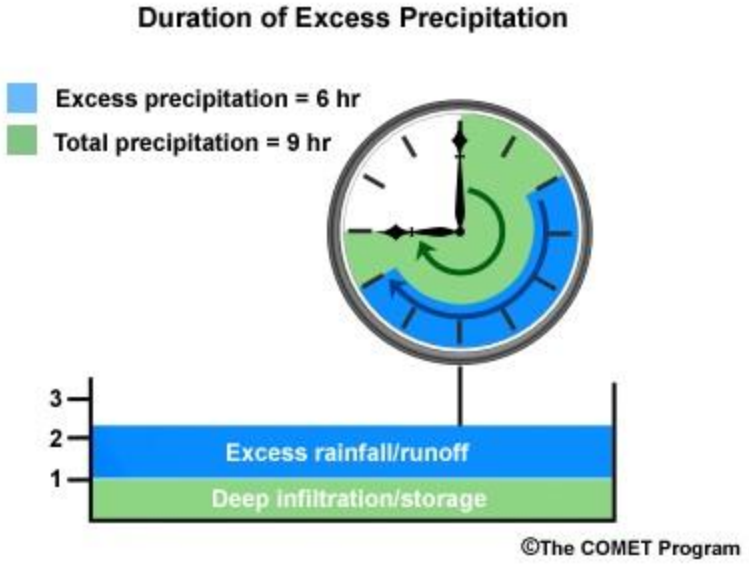
- **Step 5: Adjust The Quick-Response Hydrograph to Represent 1 Unit of Excess**

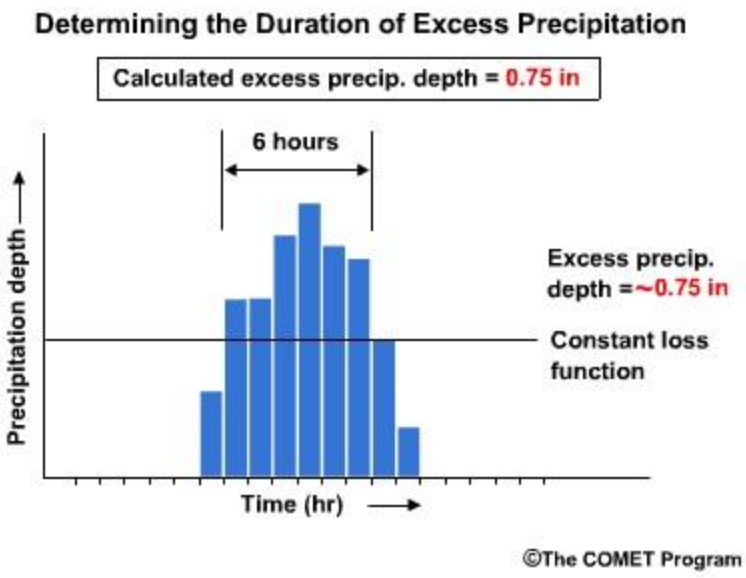


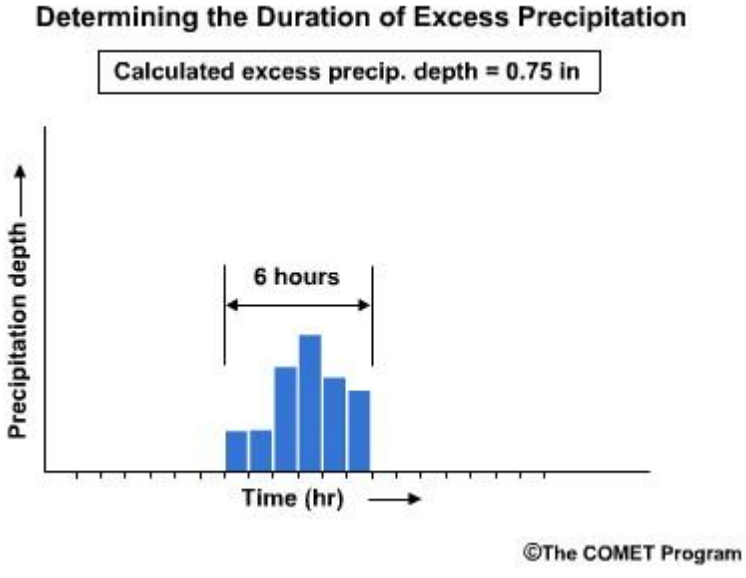
$$\frac{\text{Hydrograph Unit}}{\text{Excess Precip.}} = \text{Adjustment factor}$$

suppose, $\frac{1 \text{ in}}{0.75 \text{ in}} = 1.33$

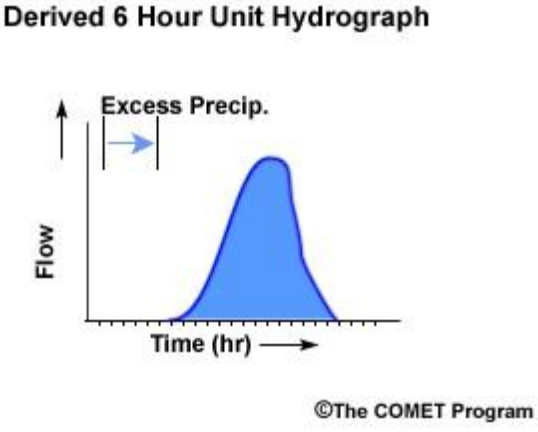
- **Step 6: Determine Duration**







- **Final Unit Hydrograph**



WATERSHED MODELS

- WITH THE ADVENT OF HIGH SPEED DIGITAL COMPUTERS WATERSHED MODELS HAS BEEN DEVELOPED BY MANY INVESTIGATORS.

- SOME INTERACTIVE SOFTWARE PACKAGES HAVE BEEN DEVELOPED BY NATIONAL INSTITUTE OF HYDROLOGY FOR UNIT HYDROGRAPH DERIVATION AND FLOOD ESTIMATION.

UHPACKI (Unit Hydrograph Applications for Flood Estimation Package)

FLPACK(Flood Estimation for Large Catchments)

SRA (Software for Reservoir Analysis)

References

- **Global flood risk - Upmanu Lall.** Columbia Water Center, IRI.
- www.nih.ernet.in
- http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Water%20Resource%20Engg/pdf/m1l01.pdf
- ENGINEERING HYDROLOGY, BY K SUBRAMANYA, TATA MCGRAW-HILL THIRD EDITION.
- GLOBAL FLOOD RISK - UPMANU LALL. COLUMBIA WATER CENTER, IRI.
- HYDROLOGY , BY- MADAN MOHAN DAS AND MIMI DAS SAIKIA, 2009 PHI LEARNING PRIVATE LIMITED, NEW DELHI
- APPLIED HYDROLOGY , BY K N MUTREJA,1986, TATA Mc GRAW HILL PUBLISHING COMPANY LIMITED, NEW DELHI

THANK YOU