Catastrophe Modeling

ASI, Mumbai, Dec 19 , 2013

CAT Modeling

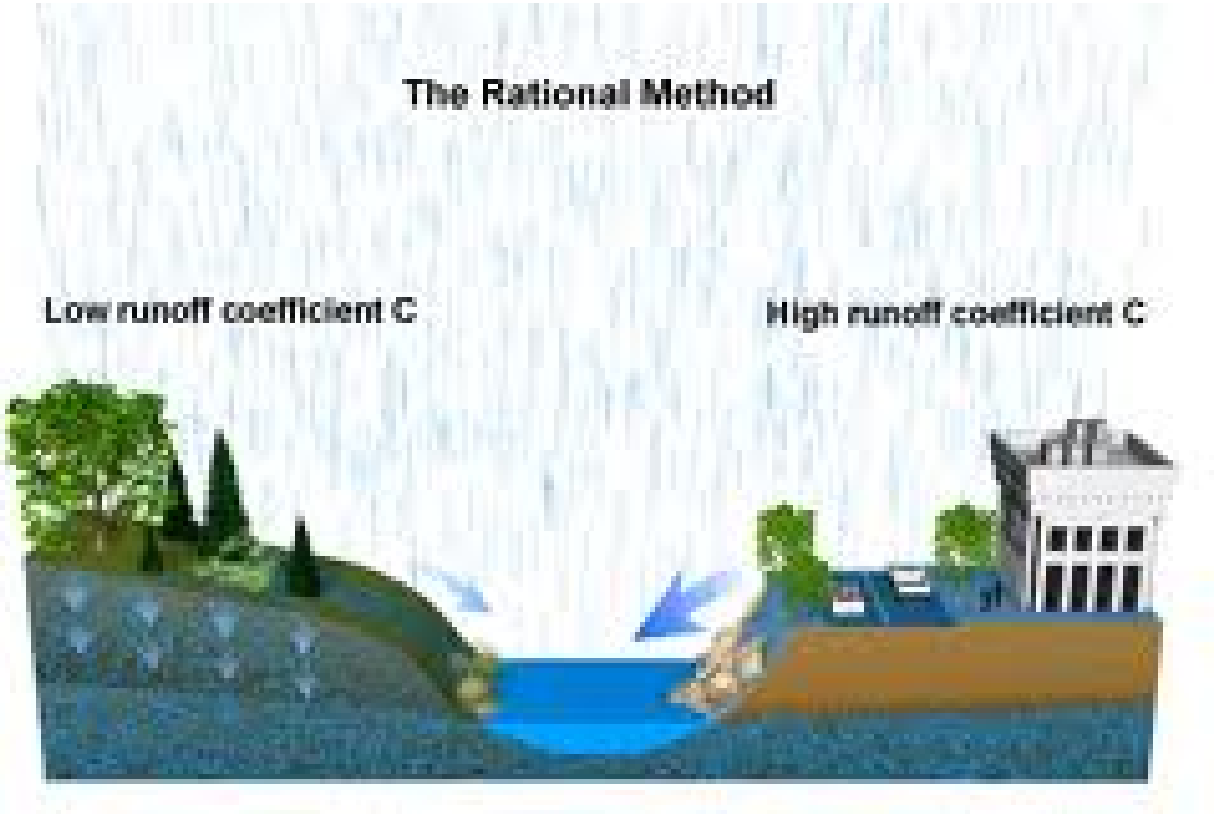
- Flood
- Cyclones
- Earthquake
- Drought

CAT Modeling

- Advanced Simulations
- Heuristics, Guidelines
- Statistical

Flood Modeling

- The Rational Method
- Peak Discharge (Q) = Runoff Coefficient (C)*Rainfall Intensity(I)*Drainage Area(A)
  - A should not be greater than 300 acres
  - C depends on slope and imperviousness of surface
  - C also depends on Intensity of Rainfall
  - Rainfall intensity is assumed to be constant for the time of concentration



Contd..(Run Off coeff)

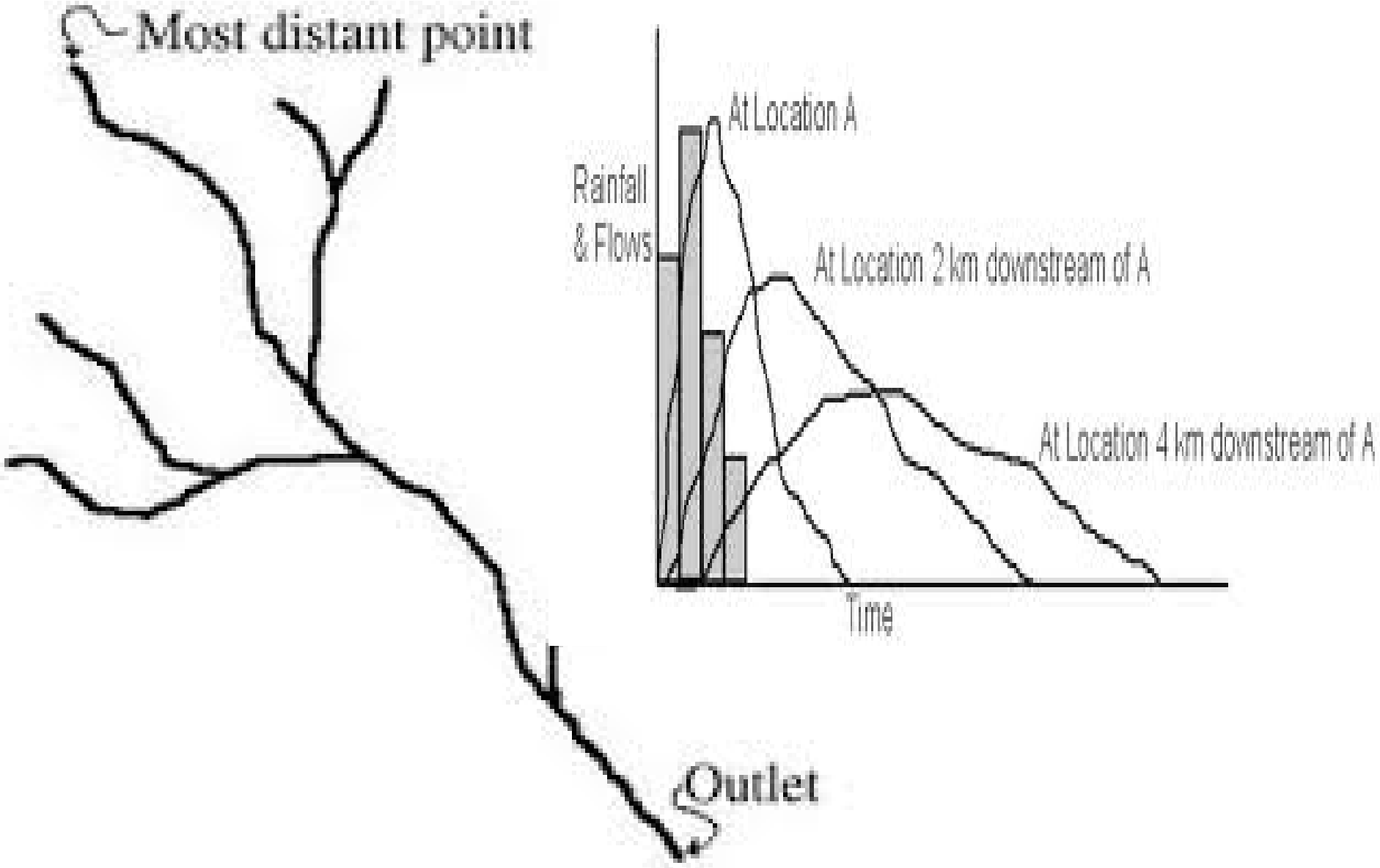
Type of Surface	Flat	Rolling	Hilly
Pavement	0.9	0.9	0.9
Lawns	0.17	0.22	0.35
Grass Shoulders	0.25	025	0.25
Forests	0.1	0.15	0.2

Contd…

- Time of Concentration (Tc)
  - Time it takes the run off water to reach from the most distant point in the watershed to the reference point downstream
  - Tc depends on the nature of the path and the water flow
    - Overland Sheet flow
    - Shallow concentration flow
    - Open Channel and Pipe flow

Contd..

- Junctions
  - Need to estimate the Tc of all the tributaries upstream to the reference junction point
  - Order the tributaries in terms of the respective Tc
  - Compare the total discharges into the junction based at different times of concentration
  - Only a portion of the tributary with the longer time of concentration will contribute. Use the ratio of times of concentration for this purpose

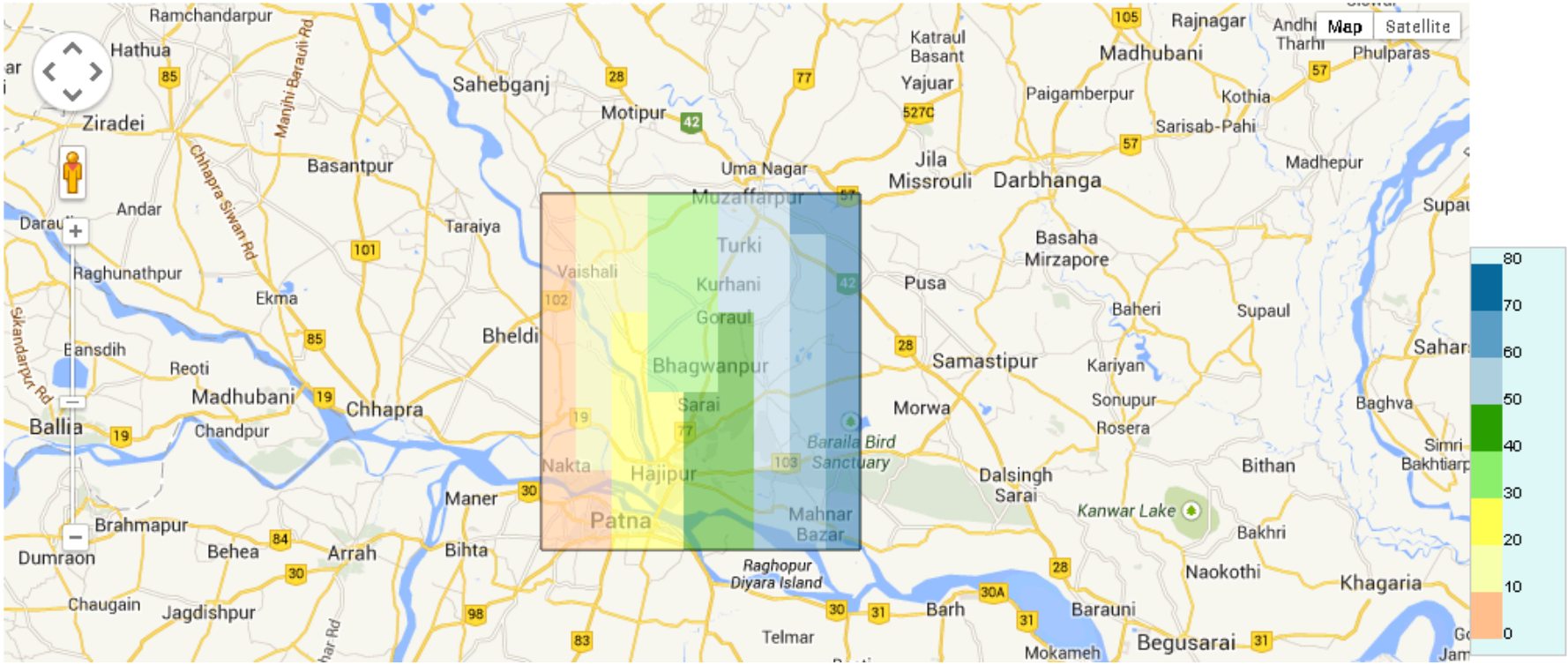

Most distant point
Outlet
Rainfall & Flows
At Location A
At Location 2 km downstream of A
At Location 4 km downstream of A
Time

Flood Maps -

States	Bihar	**Map Type**	WaterAccum
District	VAISHALI	**Date From**	08/01/2013
Location	Banthu	**Date To**	08/31/2013

24.086 seconds; Part 2 - 24.084; Part 3 - 0.001;

Submit



Cyclones

- Obtain Wind Forecasts (Speed and Direction) using
  - Captive WRF models
  - Other sources
- Use this wind-speed to calculate wind-load
- Analyze impact of windload on Structures

Wind Load Calculation

- The first procedure, called the Static Procedure, is appropriate for most cases, including the design of the structure of most low- and medium-rise buildings as well as the cladding of all buildings. The structure or element to be designed in these cases is relatively rigid, Detailed knowledge of the dynamic properties of the structures or elements is not required and dynamic actions of the wind can be represented by equivalent static loads.

- The second procedure, called the Dynamic Procedure, is intended for determining the overall wind effects, including amplified resonant response, primarily for tall buildings and slender structures but not for cladding and secondary structural members. Its format is the same as that of the Static Procedure except that the gust effect. factor and the exposure factor are determined

  differently. Cg is derived from a series of calculations

Wind Load Calculation

- Exposure (factor) (Ce)
  - Height of the building (h) ,h for the windward face is the actual height of that point above ground, h far the leeward face is half the height of the building, and
  - Roughness of the upwind side
    - Anemometric
    - NBC and other guidelines
      - ***E.g. Ce = 0.4*(h/32)^0.72 for highly rough areas***
  - Altitude of the Surface
    - Formula available for adjustment in the exposure due to altitude and slope. Buildings on a hill or escarpment with a maximum slope greater than 1 in 10, particularly near a crest, may be subject to significantly higher wind speeds than buildings on level ground. The exposure factor at height z above the surrounding ground elevation is equal to that over open level terrain multiplied by a factor (1 + AS(Z))~wh ere AS(z) is the "speed-up factor" for the mean wind speed

Wind Load Calculation

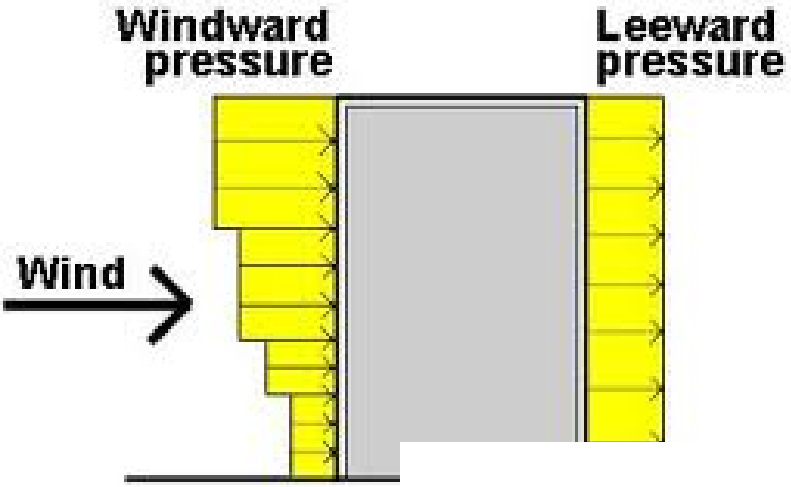
- Gust factor (Cg)
  - are defined as the ratio of the maximum effect of the loading to the mean effect of the load
  - random fluctuating wind forces caused by turbulence in the approaching wind and acting for short durations over all or part of the structure
  - fluctuating forces induced by the wake of the structure itself, additional inertial forces arising from motion of the structure itself as it responds to the fluctuating wind forces, and additional aerodynamic forces due to alterations in the airflow around the structure caused by its motions (aero-elastic effects
  - Quasi static – Background effect
  - Resonance effect

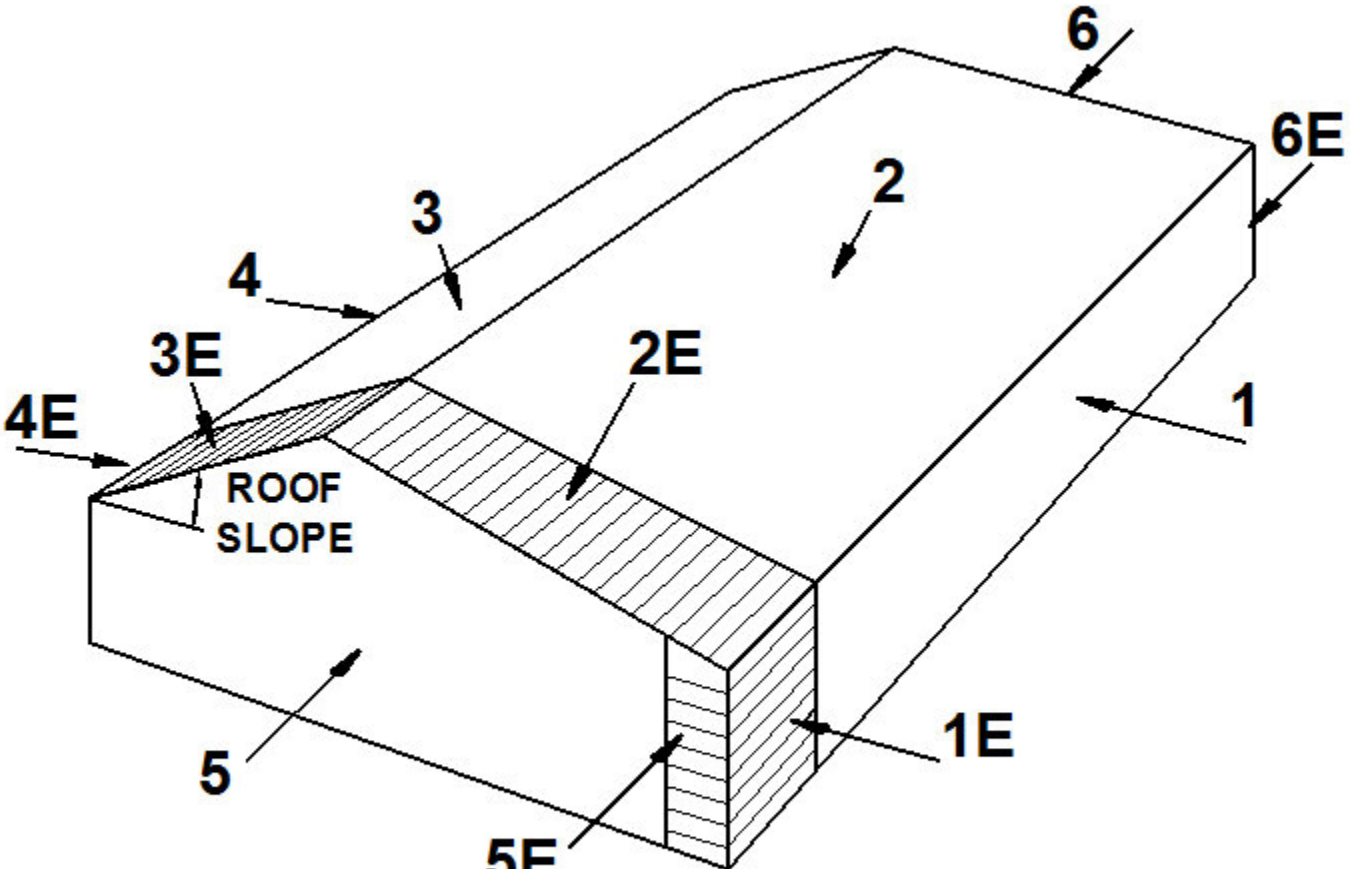
Wind Load Calculation

- Pressure Coefficient
  - Pressure coefficients are the non-dimensional ratios of actual wind-induced pressures on a building surface to the velocity pressure of the wind at the reference height. They account for the effects of aerodynamic shape of the building, orientation of the surface with respect to the wind flow, and profile of the wind velocity,
  - Pressure coefficients are usually determined from wind-tunnel experiments on small-scale models, although measurements are occasionally made on full-scale buildings. It is very important to simulate the natural velocity profile and turbulence in the wind tunnel

Structural Impact Analysis

- Structural Members and Frames
- Interior Walls and Partitions
- Protected Membrane Roofs


Windward pressure
Leeward pressure
Wind


6
6E
2
3
4
3E
2E
4E
1
ROOF SLOPE
5
1E
5E

Statistical Estimates

- Presently
  - One in 30 years or 97% VAR for temperature
  - For excess rain or drought for some cases we can go to 1 in 100 years based on actual data
  - For other events/or higher VAR analysis we have to rely on
    - Extreme loss models
      - Double Exponential/Gumbel (Used in Climatology for max or min rain, temp)
      - Other Parametric distributions
      - Monte-carlo if no closed form parametric solutions fit

- For 250 year events - Understand the extreme loss patterns from other markets and apply to Indian Weather (produce some kind of adjusted distribution)

Thank You