Module 9

Lecture 2: Steps in watershed modelling

Steps in Watershed Modelling

1. Model Selection

❖Select model based on study objectives and watershed characteristics, availability of data and project budget

❖The selection of a model is very difficult and important decision, since the success of the analysis depends on the accuracy of the results

The selection of a model also depends upon time scale, hydrologic quantity aiming at and the processing speed of the computer at hand

(Bedient et al., 2008)

Steps in Watershed Modelling

Contd…

2. Input Data

- Obtain all necessary input data-

rainfall, infiltration, physiography, landuse, channel characteristics, streamflow, design floods and reservoir data.

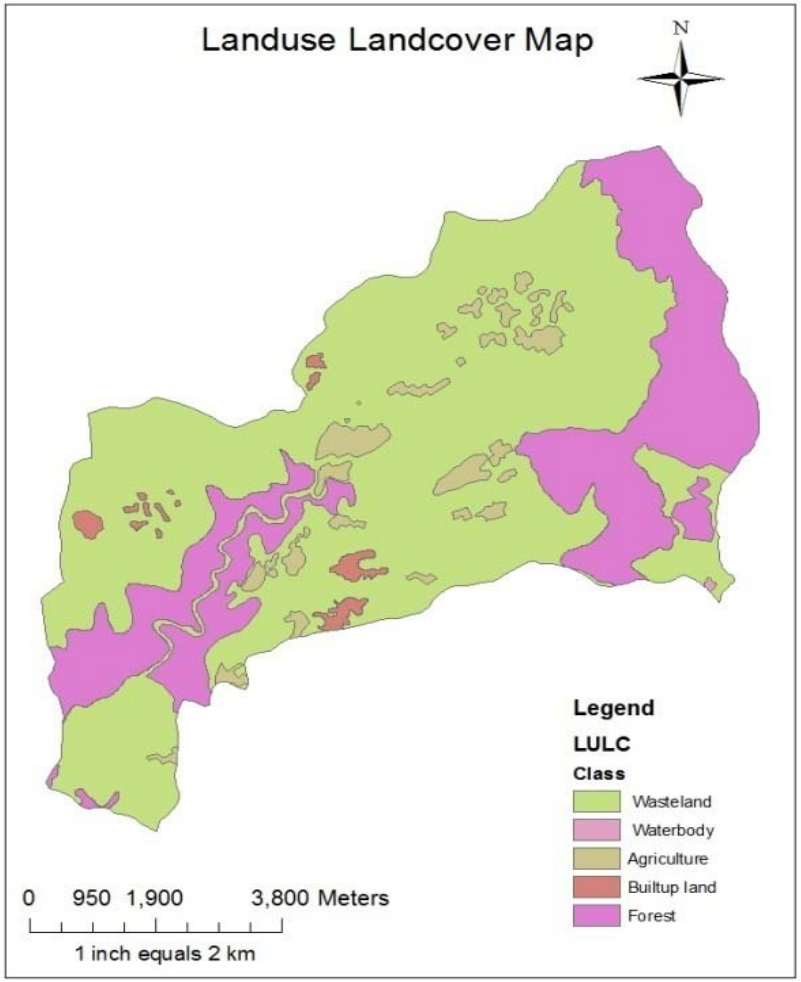
1. Agricultural Data:

- Vegetative cover,
- Land use,
- Treatment, and
- Fertilizer application

Steps in Watershed Modelling

Contd…

2. Input Data



Source: CSRE, IIT Bombay

Steps in Watershed Modelling

Contd…

2. Input Data

2. Hydrometeorologic Data:

- Rainfall,
- Snowfall,
- Temperature,
- Radiation,
- Humidity,
- Vapor pressure,
- Sunshine hours,
- Wind velocity, and
- Pan evaporation

Steps in Watershed Modelling

Contd…

2. Input Data

3. Pedologic Data:

- Soil type, texture, and structure
- Soil condition
- Soil particle size, diameter, porosity
- Soil moisture content and capillary pressure
- Steady-state infiltration,
- Saturated hydraulic conductivity, and
- Antecedent moisture content

Steps in Watershed Modelling

Contd…

2. Input Data

4. Geologic Data:

- Data on stratigraphy, lithology, and structural controls,
- Depth, and areal extent of aquifers.

- For confined aquifers, hydraulic conductivity, transmissivity, storativity, compressibility, and porosity are needed.

- For unconfined aquifers, data on specific yield, specific storage, hydraulic conductivity, porosity, water table, and recharge are needed.

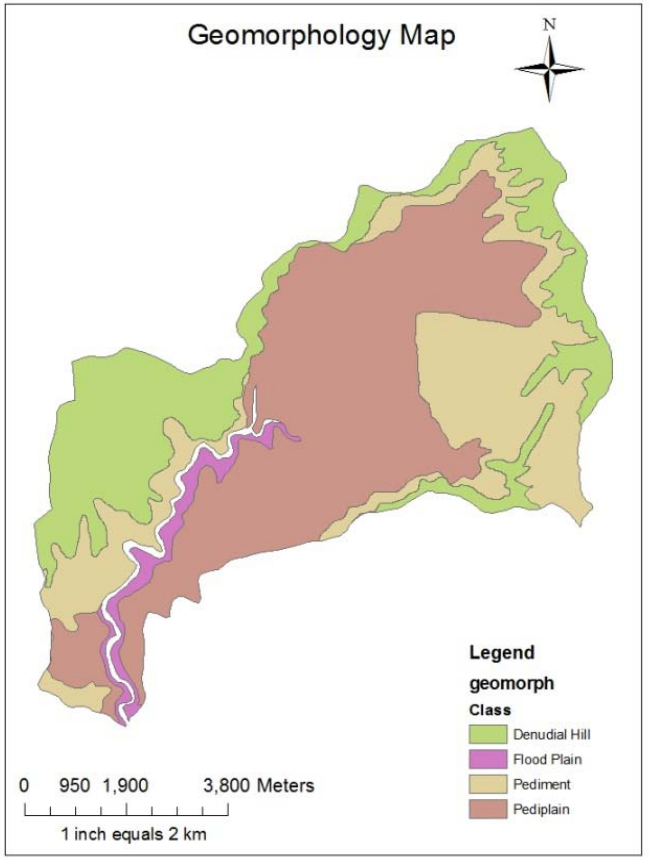
Steps in Watershed Modelling

Contd…

2. Input Data

5. Geomorphologic Data:

- Topographic maps showing:
  - elevation contours,
  - river networks,
  - drainage areas,
  - slopes and slope lengths, and
  - watershed area

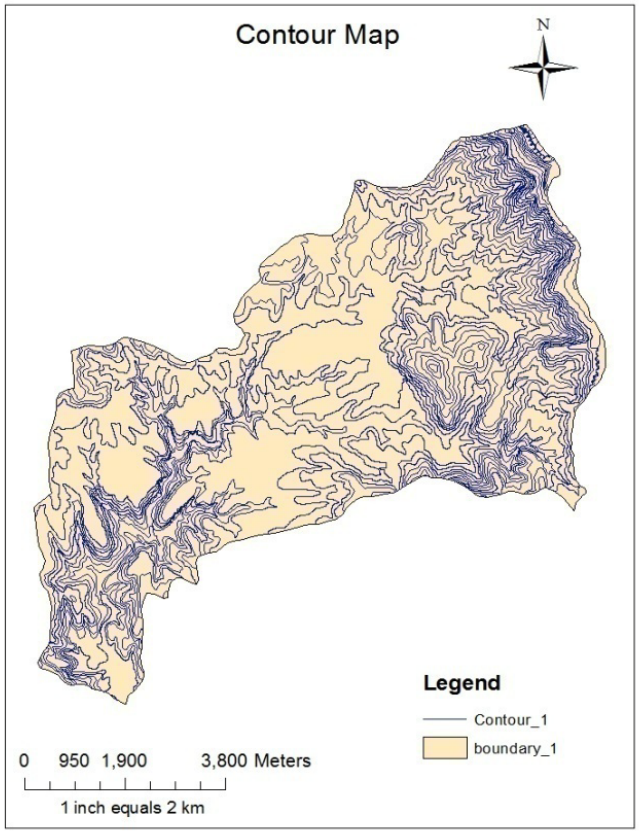


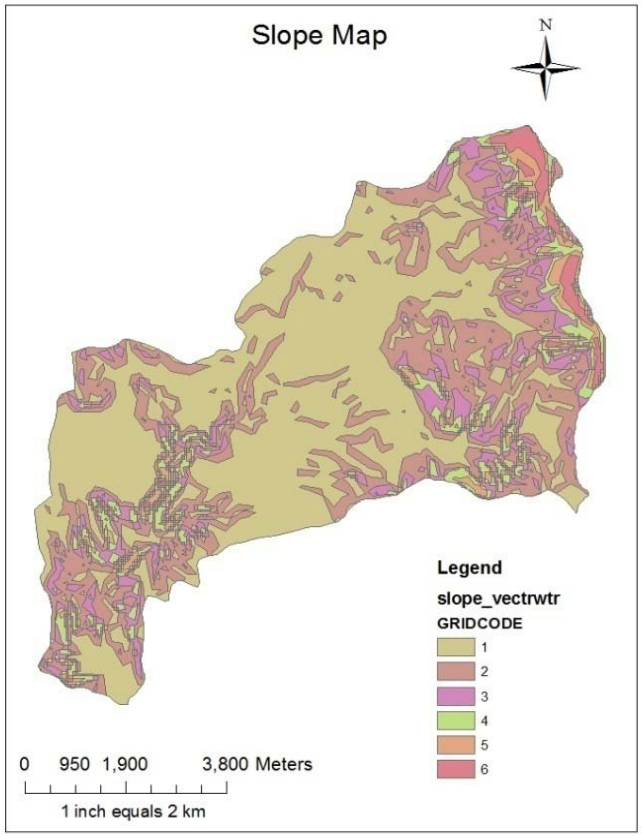
Source: CSRE, IIT Bombay

Steps in Watershed Modelling

Contd…

2. Input Data



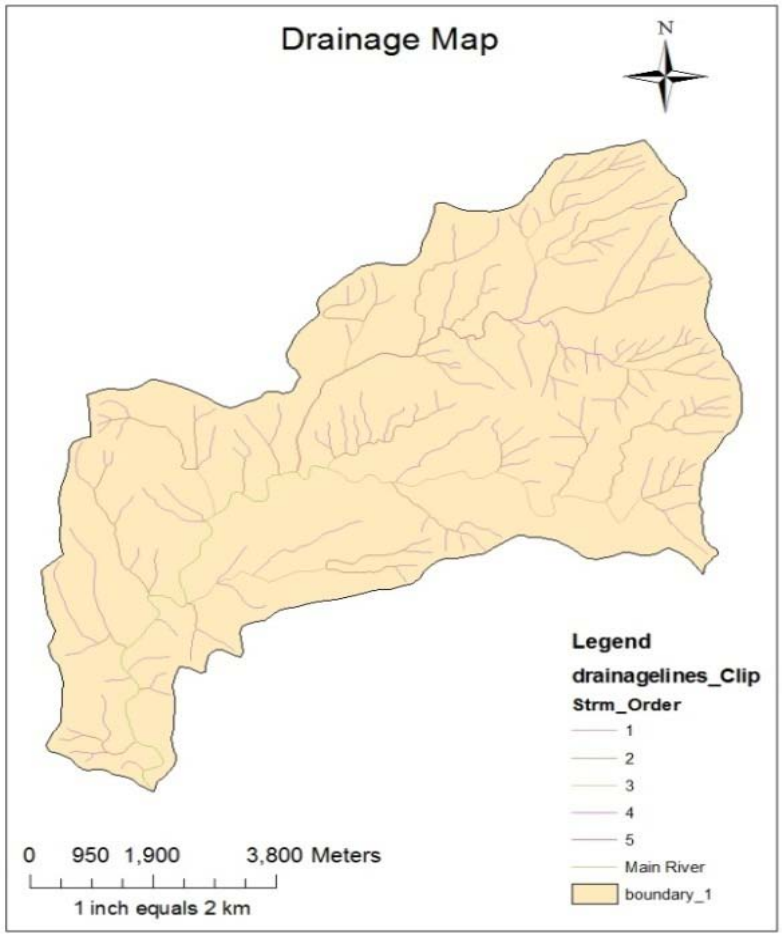


Source: CSRE, IIT Bombay

Steps in Watershed Modelling

Contd…

2. Input Data



Source: CSRE, IIT Bombay

Steps in Watershed Modelling

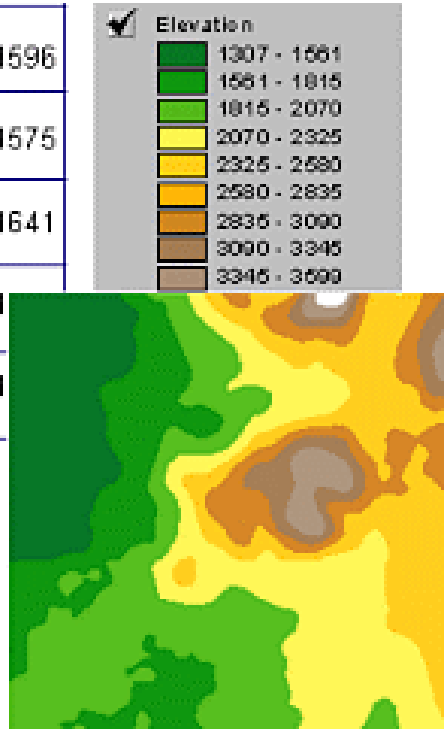
Contd…

2. Input Data

Digital Elevation Model (DEM)

- Digital file that stores the elevation of the land surface in a specified grid cell size (e.g., 30 meters)

1654	1606	1555	1546	1596
1686	1658	1597	1557	1575
1594	1618	1621	1648	1641
1562	1598	1586	1547	1
1473	1422	1430	1459	1

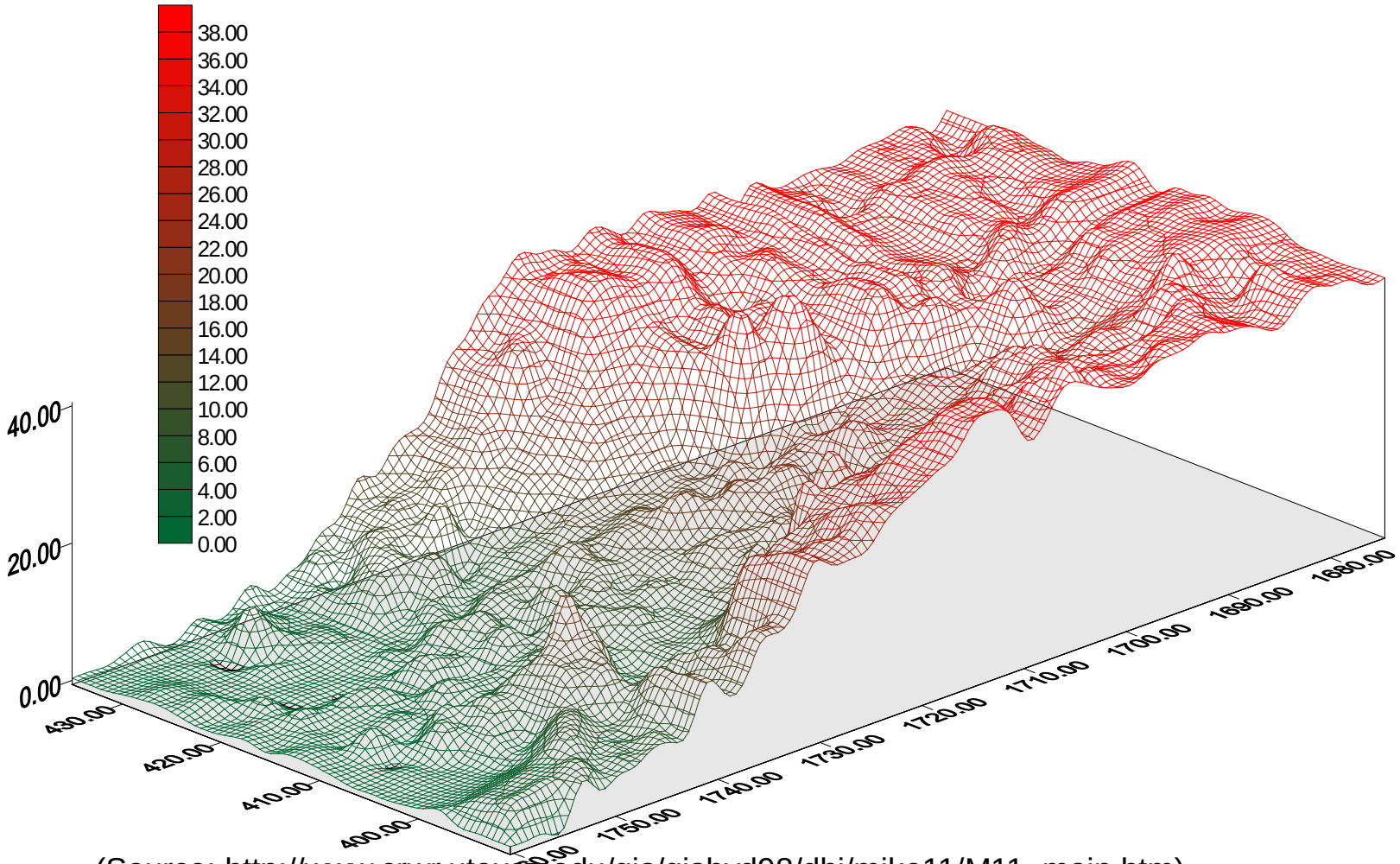


http://www.cabnr.unr.edu/saito/intmod/docs/tootle-hydrologic-modeling.ppt.

Steps in Watershed Modelling

Contd…

Digital Elevation Model (DEM)



(Source: http://www.crwr.utexas.edu/gis/gishyd98/dhi/mike11/M11_main.htm)

Steps in Watershed Modelling

Contd…

2. Input Data

6. Hydraulic Data:

- Roughness,
- Flow stage,
- River cross sections, and
- River morphology

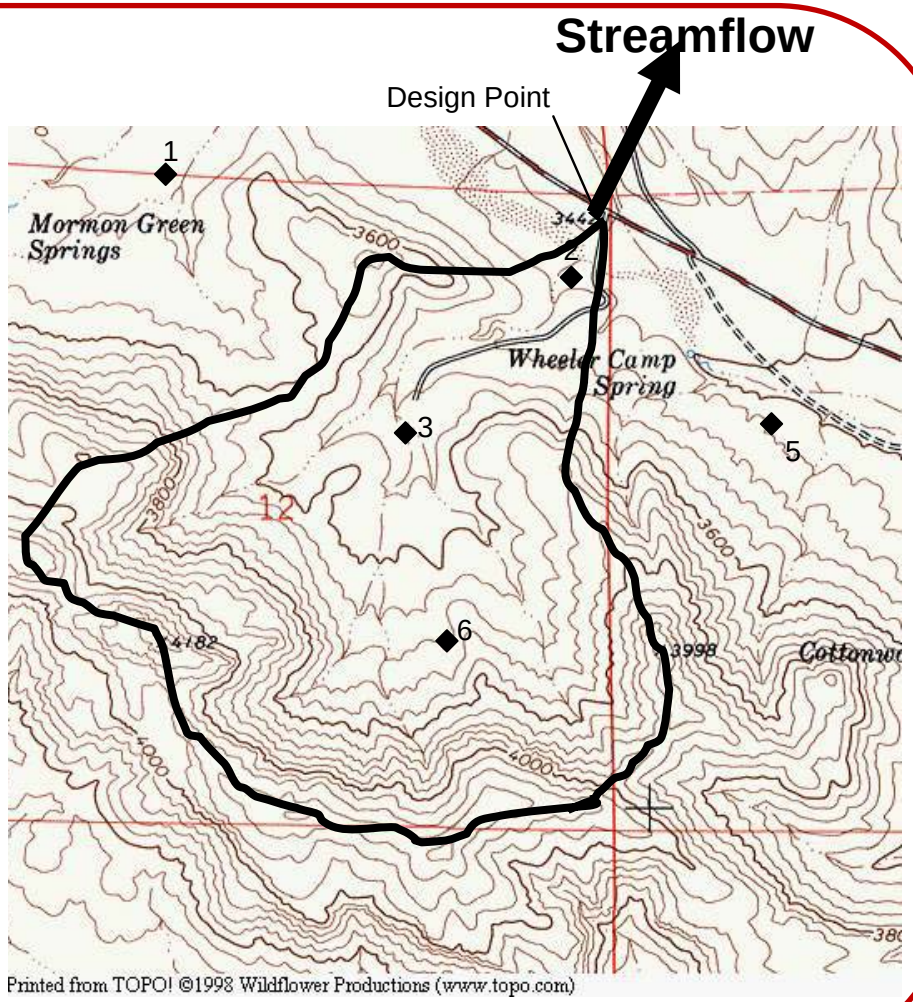
Steps in Watershed Modelling

Contd…

2. Input Data

7. Hydrologic Data:

- Flow depth,
- Streamflow discharge,
- Base flow,
- Interflow,
- Stream-aquifer interaction,
- Potential,
- Water table, and
- Drawdown



http://www.cabnr.unr.edu/saito/intmod/docs/tootle-hydrologic-modeling.ppt.

Steps in Watershed Modelling

Contd…

3. Evaluation & Refinement of Objectives

❖Evaluate and refine study objectives in terms of simulations to be performed under various watershed conditions.

4. Selection of Methodology

❖Choose methods for determining sub-basin hydrographs and channel routing

Steps in Watershed Modelling

Contd…

5. Calibration & Verification of Model

❖Model calibration involves selecting a measured set of input data (rainfall, channel routing, landuse and so on) and measured output hydrographs for model application.

❖Calibrate model using historical rainfall, streamflow and existing watershed conditions.

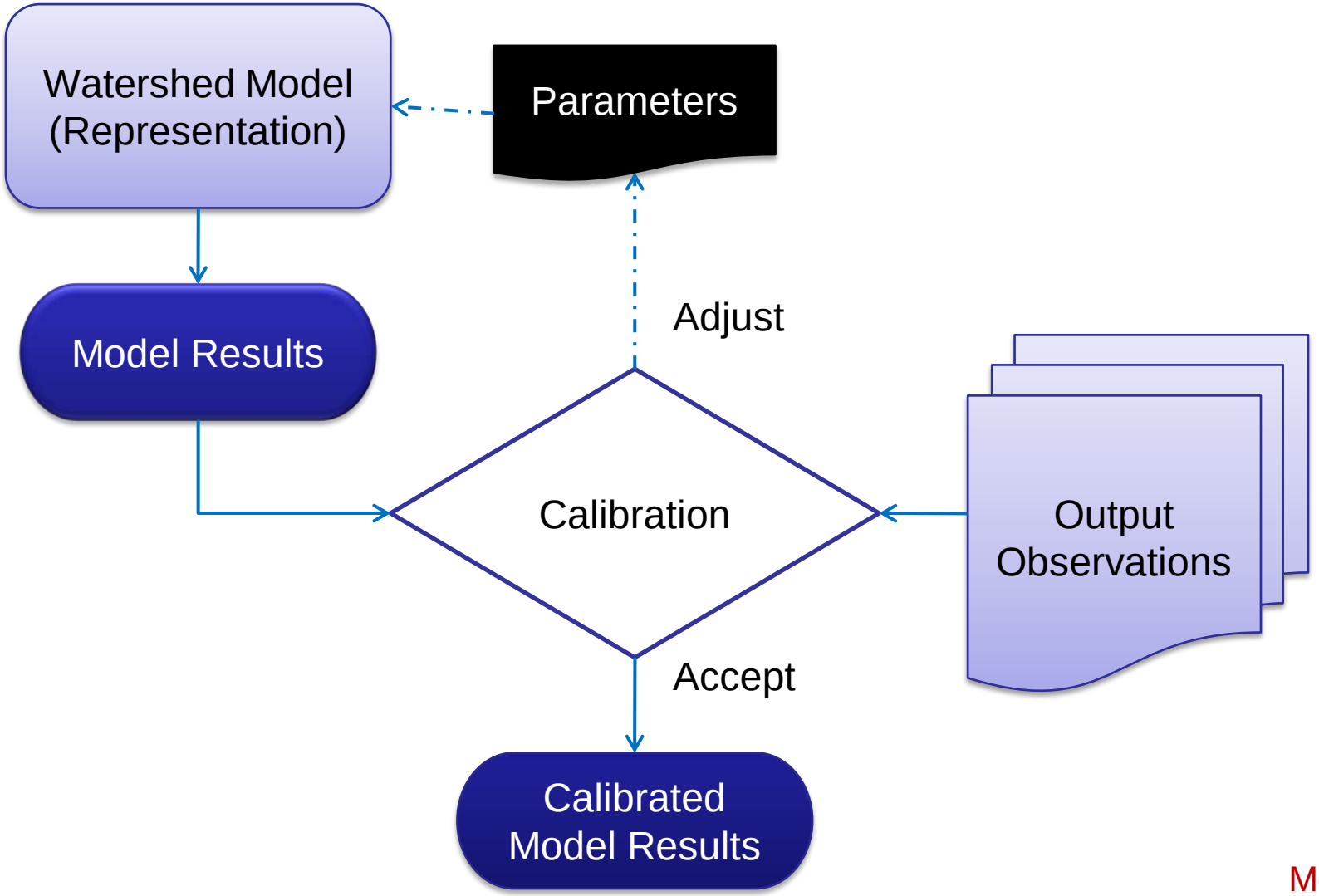
❖Verify model using other events under different conditions while maintaining same calibration parameters.

(Bedient et al., 2008)

Steps in Watershed Modelling

Contd…

Watershed Model Calibration



Steps in Watershed Modelling

Contd…

6. Simulations using Model

❖Perform model simulations using historical or design rainfall, various conditions of landuse and various control schemes for reservoirs, channels or diversions.

7. Sensitivity Analysis of Model

❖Perform sensitivity analysis on input rainfall, routing parameters and hydraulic parameters as required.

1) Precipitation
2) Soil parameters
   a) Hydraulic conductivity
   b) Soil water holding capacity
3) Evaporation (for continuous simulation)
4) Flow routing parameters (for event-based)

Steps in Watershed Modelling

Contd…

8. Model Validation

❖Evaluate usefulness of the model and comment on needed changes or modifications.

Uncertainties

- Precipitation
  - Extrapolation of point to other areas
  - Temporal resolution of data
- Soils information
  - Surveys are based on site visits and then extrapolated
- Routing parameters
  - Usually assigned based on empirical studies