Hazen

Stormwater: Too Simple?

Integrated Stormwater Management for Future Resiliency

CWEA Stormwater Committee – 2017 Fall Seminar
December 13, 2017

Proposal: All MS4 Phase 1 Permittees Must Develop a System-Wide H&H Model

Criteria and protocols exist for stormwater management design of individual facilities/developments.

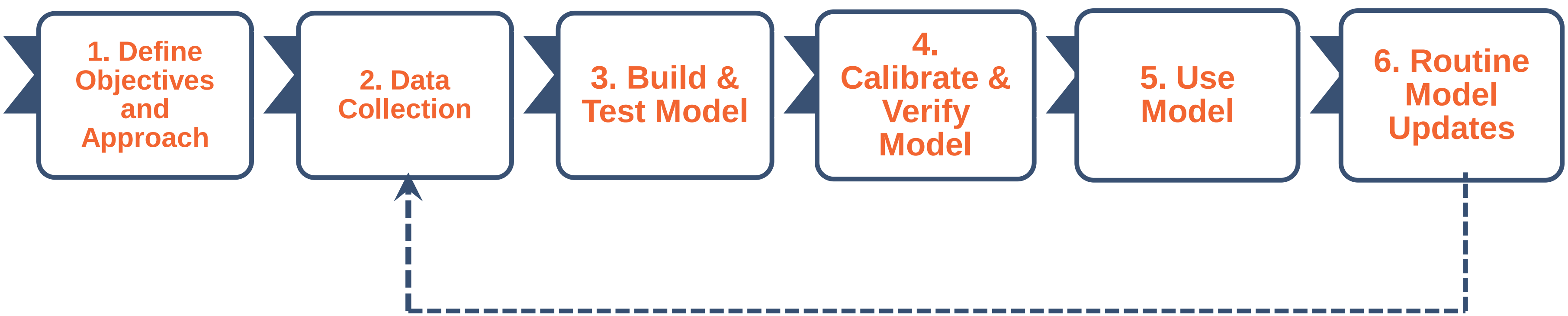
But, there is a need to evaluate the system holistically on a system-wide, watershed level.

Benefits of Integrated Watershed Developments

Key Decision-Support System

- Characterize Stormwater Quantity and Quality
  - Identify capacity limitations which create flooding
  - Evaluate Stormwater Management Strategies
  - Quantify Point and Non-Point Pollutant Loadings to receiving waters
- Optimize Stormwater Management Planning and Design
  - Quantification of Performance vs. Goals
- Optimize System Operation
- Evaluate New Development/Redevelopment

General Steps to H&H Model Development



Start Simple, Add Complexity Over Time

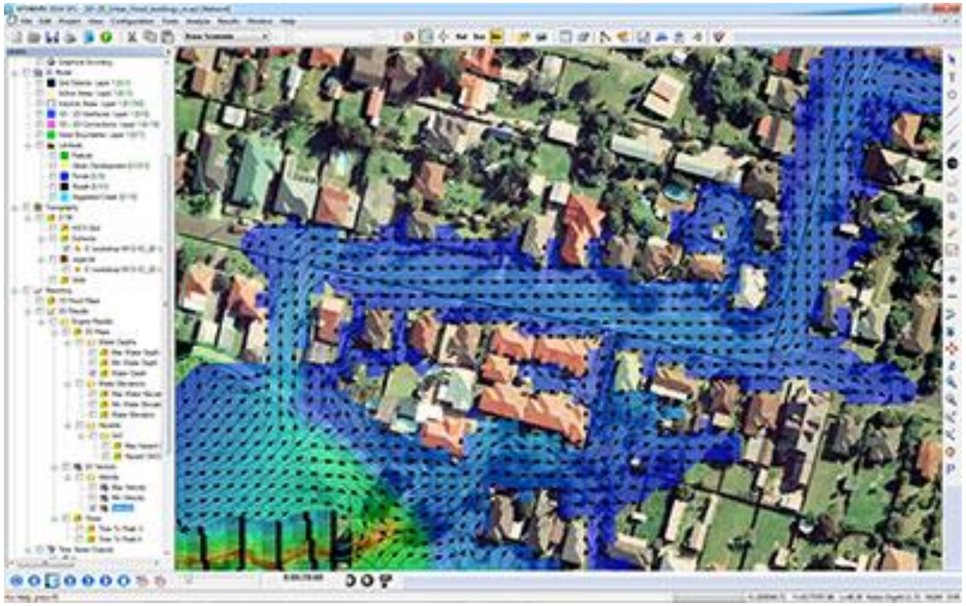
Near-Term Objectives

- Build & Populate Stormwater GIS
  - Record Drawings & Field Inspections
- Develop Storm Sewer System Model to determine Quantity
- Model Watershed Surface in known flood-prone areas

Start Simple, Add Complexity Over Time

Long-Term Objectives

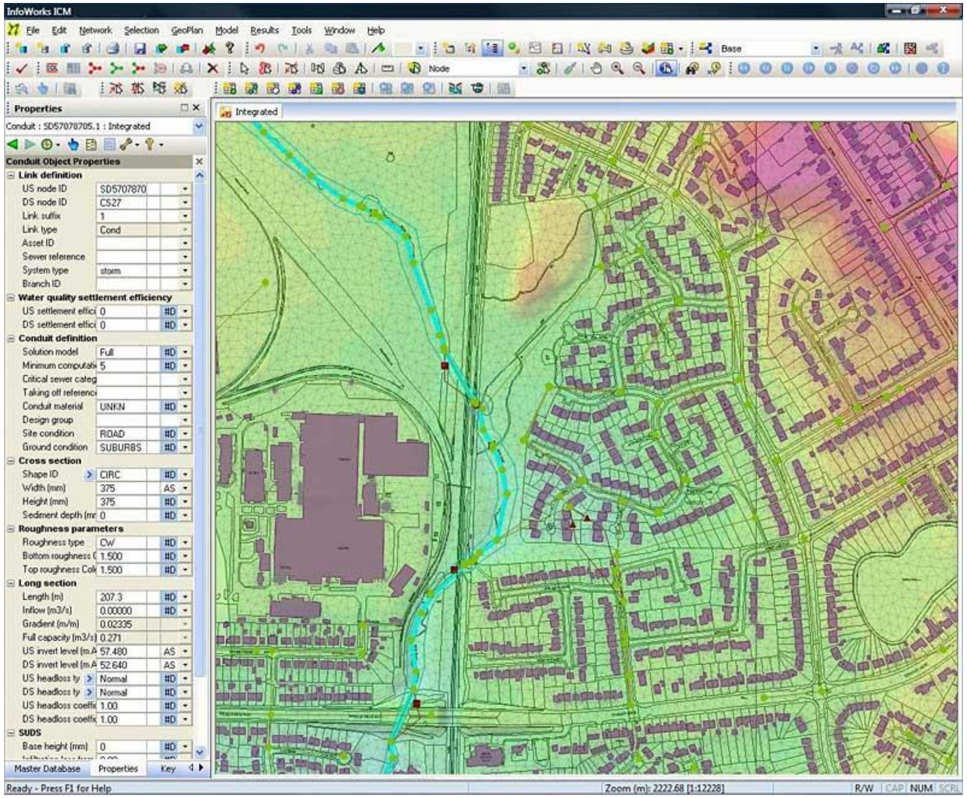
- Develop a model of the entire watershed
- Include Water Quality
  - Build-Up/Wash Off
  - Transport/Settling
  - EMCs for runoff



Innovyze, Broomfield, CO.

Components of 1D Hydraulic Model

- Inlets/CBs
- Outfalls/outlets
- Manholes
- BMPs
- Storm Drains
- Culverts
- Pump Stations
- Storage Facilities
- Channels/Watercourses



InfoWorks ICM™ by Innovyze

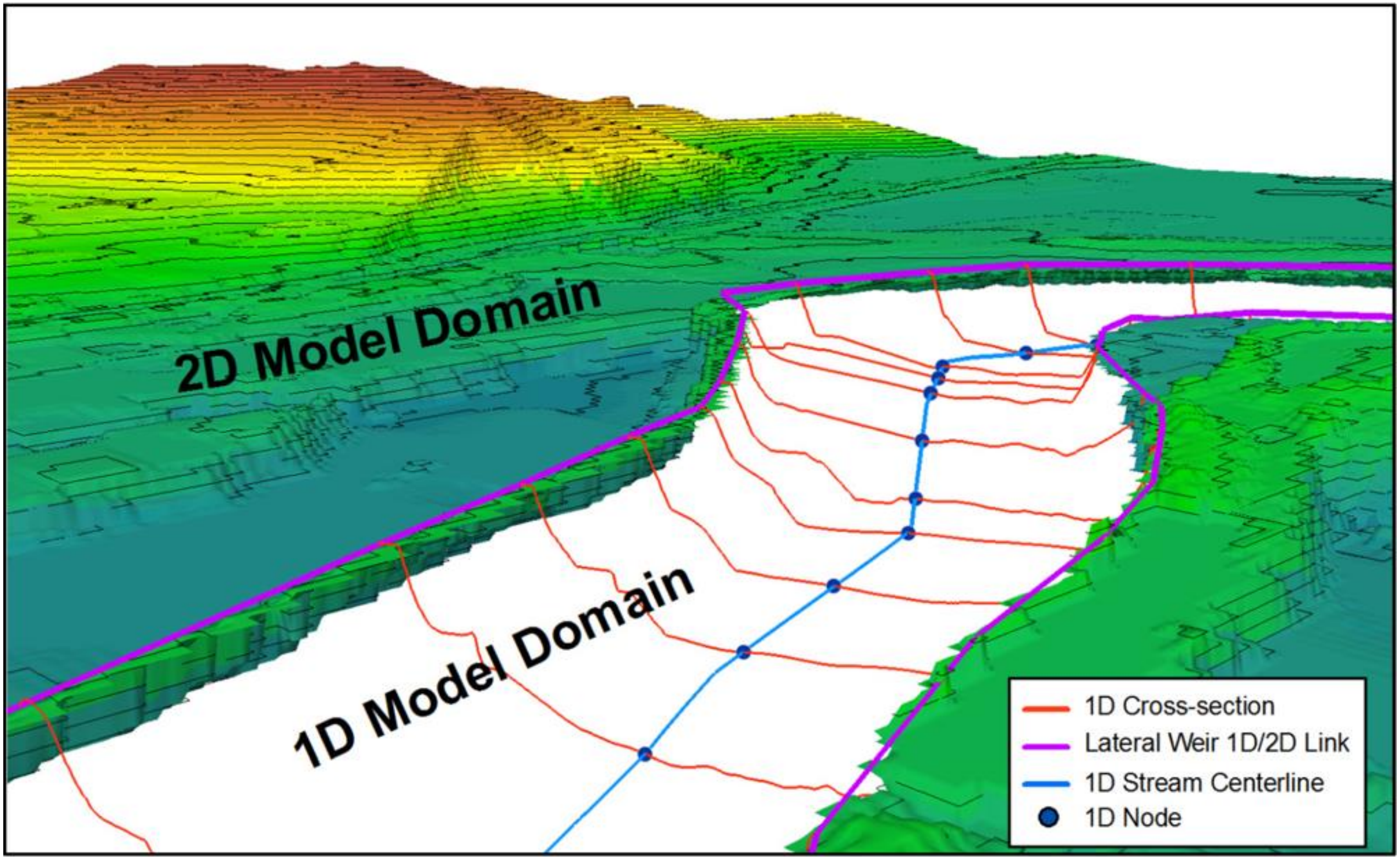
2D Surface Model

2D Mesh (TIN or Grid) generated from LiDAR data

High-res LiDAR data is available for most of MD from DNR and/or NOAA

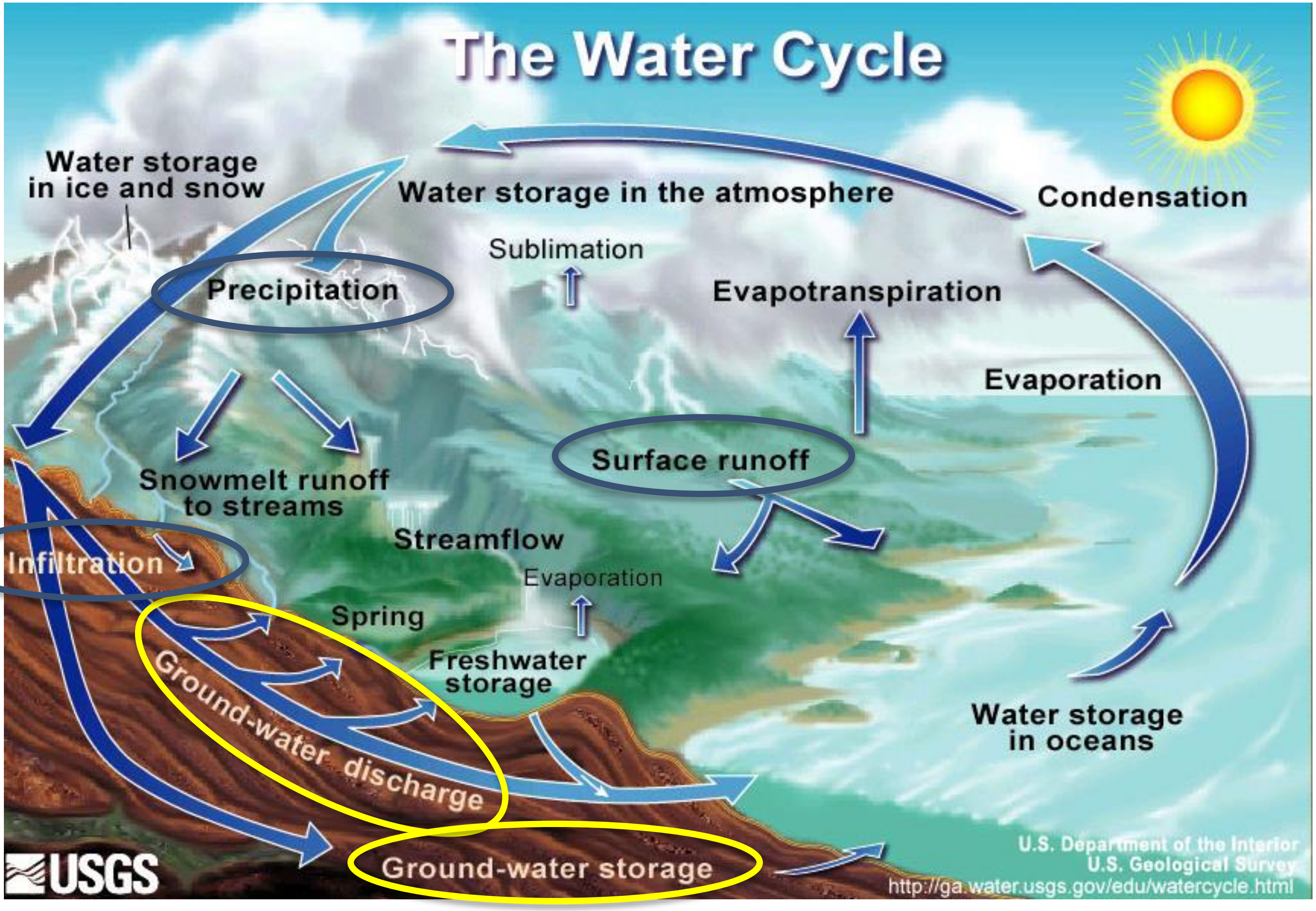
2D Model is enhanced to account for surface features, e.g., bldg. footprints, roads, walls, fences

Dynamic Linkage Between 1D-2D Models



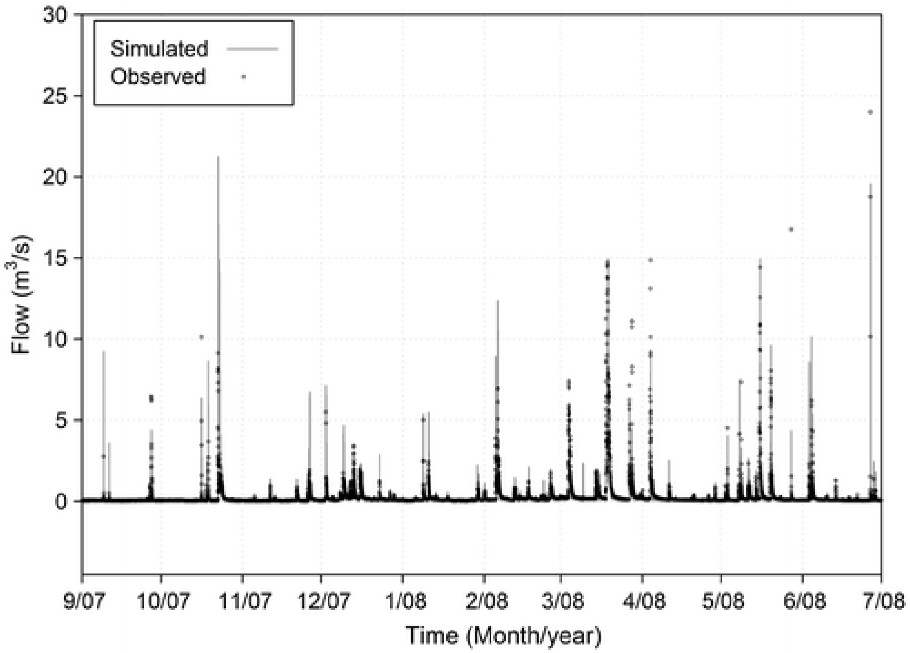
Gilles, et. al., “Inundation Mapping Initiatives of the Iowa Flood Center: Statewide Coverage: Detailed Urban Analysis”, Water 2012, 4(i), 85-106.

Hydrologic Model



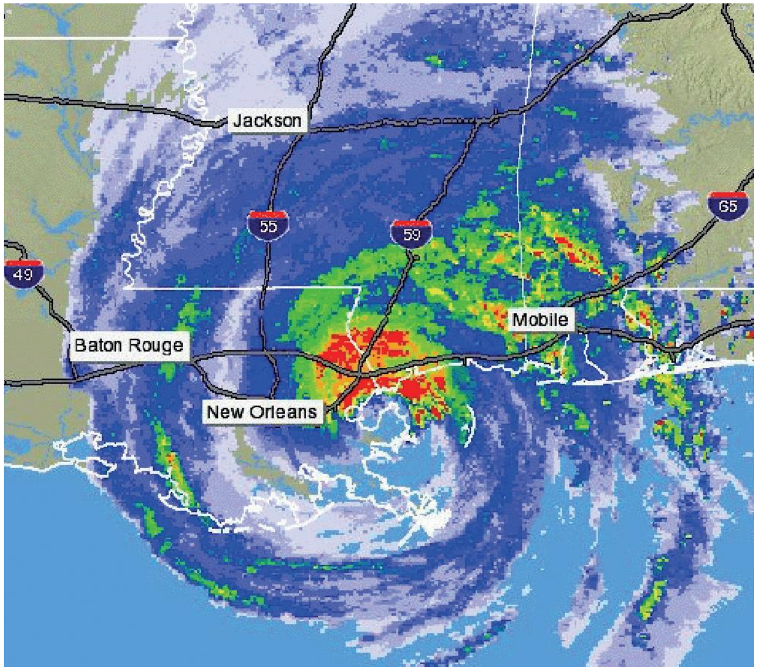
Model Calibration and Validation

- Model must be calibrated and validated to ensure accuracy
- Streamflow/stage data, GW gauges, high water marks, permanent rain gauges, water quality data
- Useful to install temporary network of flow monitors, rain gauges and samplers



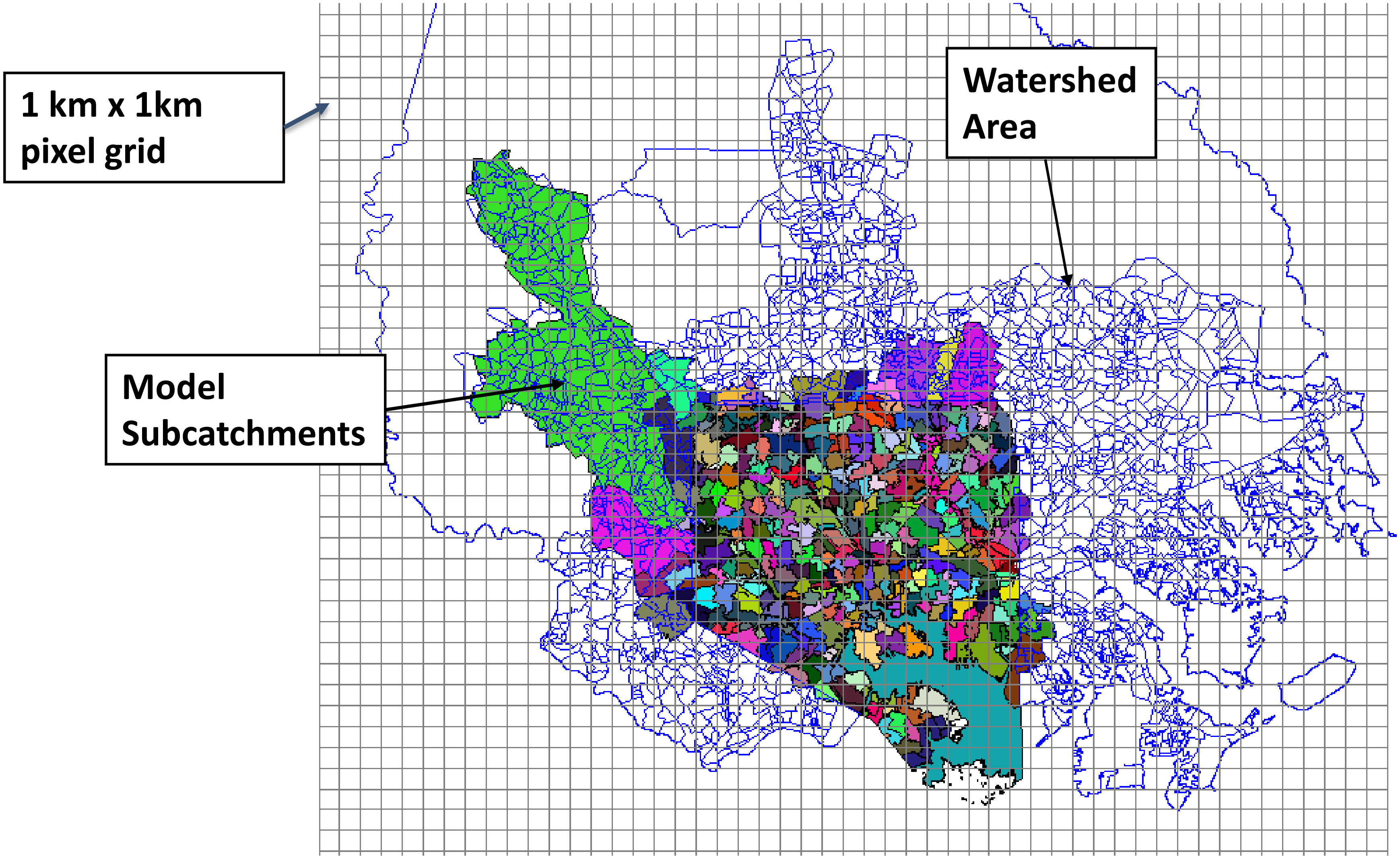
High Resolution Precipitation Data - Gauge-Adjusted Radar Rainfall (GARR)

- Method to increase spatial resolution of the precipitation data
- NEXRAD weather radar imagery used in conjunction with rain gauges
- Rain gauges used to calibrate radar imagery



Hurricane Katrina, August 2005
OneRain

GARR Example



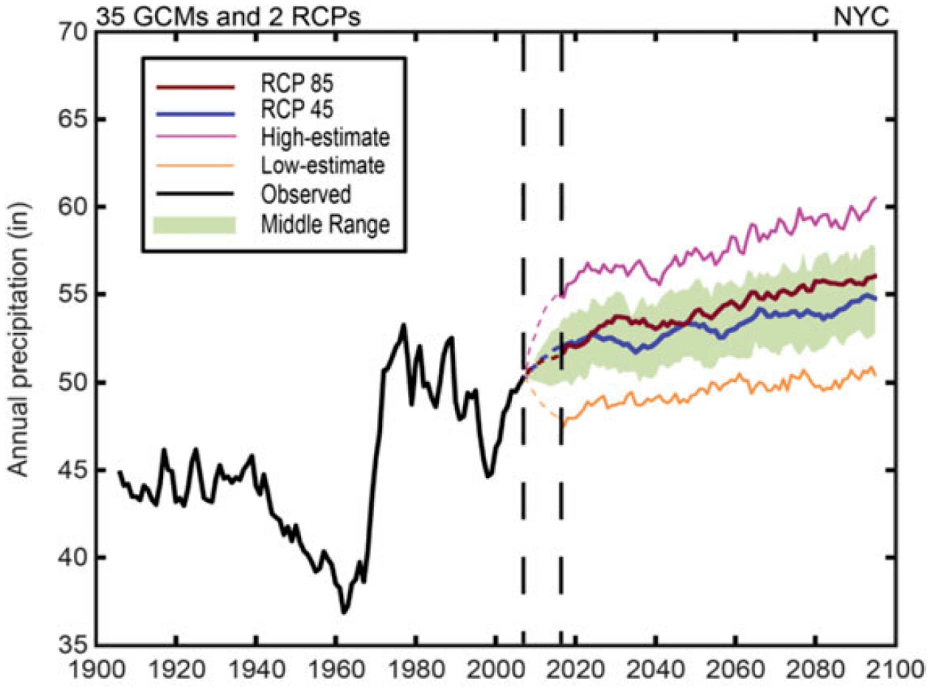
Precipitation Scenarios

- "Everyday Events" – e.g., 2-month return
- "Design Events" – e.g., 10-year return
- "Extreme Events" – e.g., 100-year return

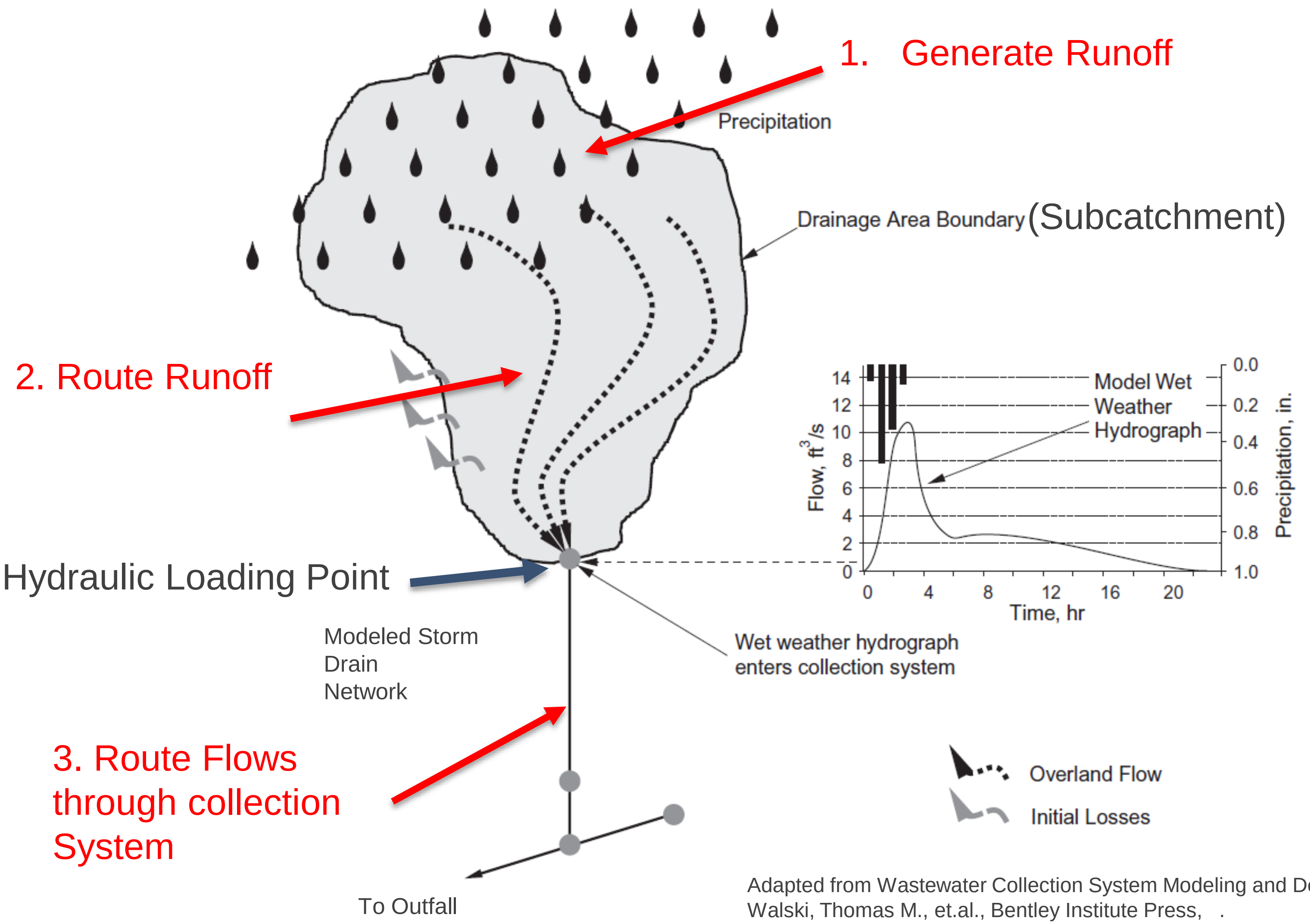
Continuous Simulations can capture all of these types of events (back-to-back), also ensuring that the appropriate antecedent soil moisture conditions and GW levels are used.

Climate Change Risk Assessment

- Develop range of plausible future scenarios to bound uncertainty based on climate model projections
  - Precipitation
  - Sea level
  - Temperature



Flow Processes in Urban Watershed Models



Adapted from Wastewater Collection System Modeling and Design, Walski, Thomas M., et.al., Bentley Institute Press, .

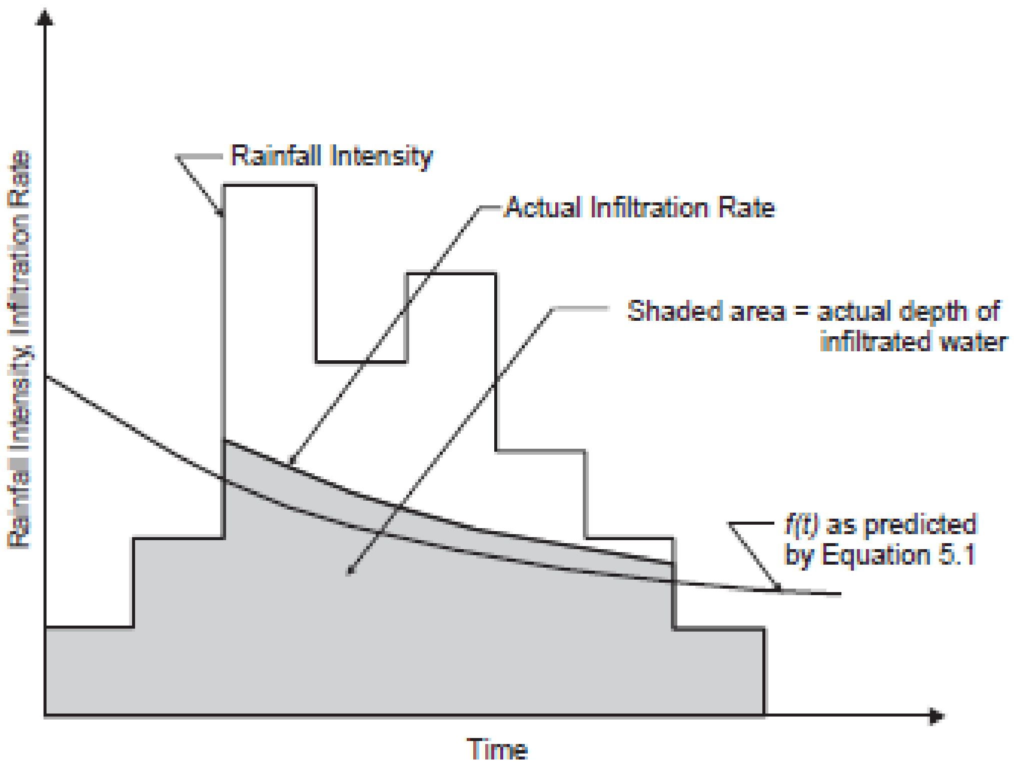
Infiltration

Three widely used methods of modeling infiltration

- Curve Number Method
- Horton Method
- Green-Ampt Method

Horton Infiltration Method

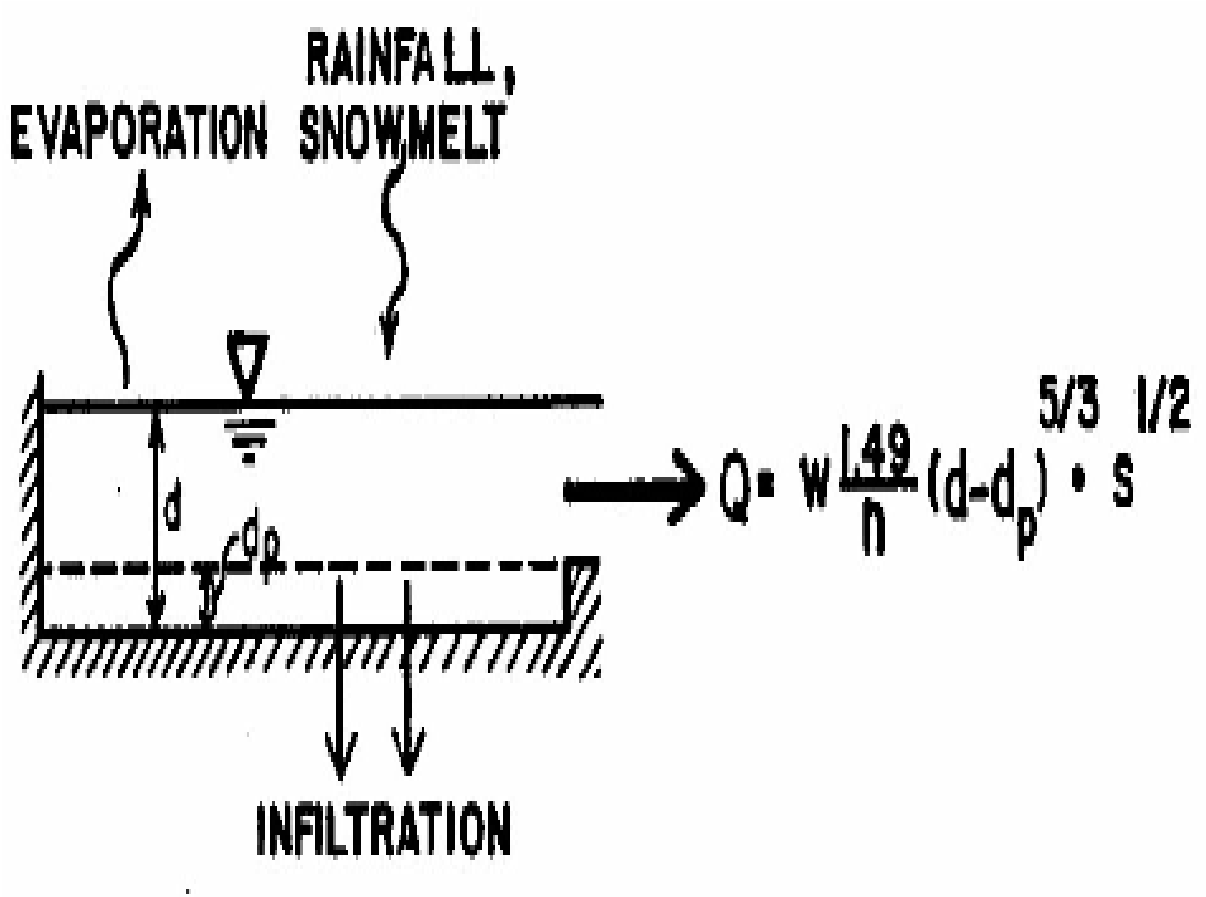
- Widely used
- Empirical method
- Modeled using 3 parameters
  - Max. infiltration rate
  - Min. infiltration rate
  - Decay constant



Green-Ampt Infiltration Model

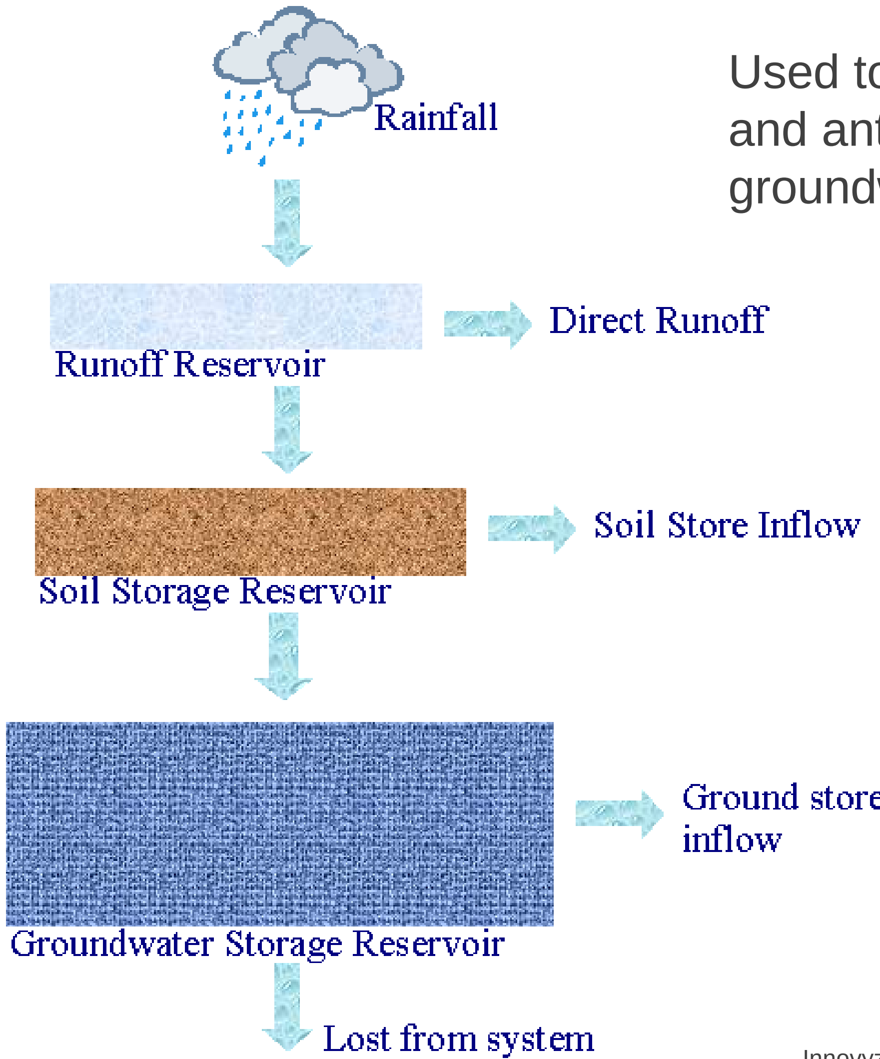
- Physically-based model – Requires 3 input parameters
  - Average capillary suction – specify value in inches or mm depending in units setting
  - Saturated hydraulic conductivity – Value is equivalent to the limiting infiltration rate in the Horton model; units are mm/hour or inches/hour; refer to NRCS Soil Survey for values
  - Initial moisture deficit – fractional difference between soil porosity and actual moisture content
- This is the preferred approach, if the input data is available.

SWMM Runoff Routing Method – Non-Linear Reservoir Routing



Storm Water Management Model, Version 4: User's Manual, Huber, W.C., Dickinson, Robert E., et al., Environmental Research Laboratory, Office of Research and Development , U.S. Environmental Protection Agency, 1992.

Groundwater Infiltration Routine



Used to represent the seasonal and antecedent variation in groundwater infiltration

Innovyze, Broomfield, CO.

Benefits of a System-Wide Model

- Support MS4s, TMDLs, NPDES, CIPs, future land use planning.
- Start simple, expand scope over time
- Tool for the robust evaluation of current conditions, planned improvements and future change.

Questions?

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