Hydrology Concepts Guide for the Unit on a Rational Method Hydrograph Model for the Urban Desert Southwest USA

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Roy Schiesser, Chandler-Gilbert Community College, Gilbert, AZ, USA
Benjamin L. Ruddell, Arizona State University, Mesa, AZ, USA

[1]Background

Hydrology is the science that encompasses the occurrence, distribution, movement and properties of the waters of the earth and their relationship with the environment within each phase of the hydrologic cycle. This link is an excellent primer from the United States Geologic Society (USGS) http://ga.water.usgs.gov/edu/hydrology.html. *Take a look and peruse the key topics.*

* What are the critical and essential roles played by hydrologists in modern society?

Flood management is of interest to public agencies and private business, due to the potential loss of life, property and environmental degradation that results from poor practices. One of the public agencies involved in this area of study is the Federal Emergency Management Agency (FEMA) http://www.floodmaps.fema.gov/. Note here that this page is a direct link to the Federal Flood Insurance Program and flood maps.

Here is a link to a portal of information and archives about flooding in the United States http://water.usgs.gov/floods/. Try clicking on the lower left by selecting *'Arizona'* from the *'Water by State'* menu. Note the thorough and professional publications and service to the public evidenced on this page. Try returning to the home page and clicking *'Today's Water Conditions'*. Select the *'Draught Map'*. Note our region.

Studies of weather and climate are essential since weather and climate are one of the key processes in hydrologic systems. The National Oceanographic and Atmospheric Administration (NOAA) is the public agency that takes the responsibility for studies of weather, climate and ocean systems. Open this link http://www.noaa.gov/, and specifically for flooding open this link http://www.noaawatch.gov/floods.php. Note the public information documents, digitally updated maps and at the lower left the link to the American Red Cross.

Careers

Check out this interesting list of jobs with the NOAA

http://search.usa.gov/search?affiliate=noaa.gov&v%3Aproject=firstgov&query=jobs

The USGS has this current jobs page including student job placements

http://www.usgs.gov/ohr/

Here is FEMA and their jobs page

http://www.fema.gov/careers

[1] Note: The digital tool and this lab guide utilize the Rational Method from the Flood Control District of Maricopa County, Drainage Design Manual. http://www.fcd.maricopa.gov/Pub/manuals/hydrology.aspx.

Flooding and Hydrology

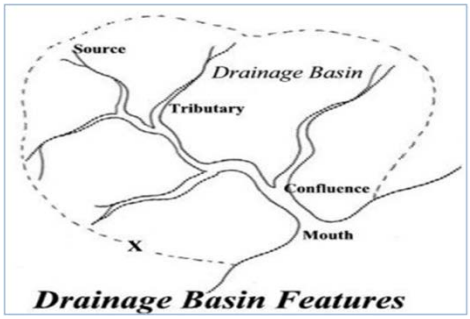
Quick Introduction

The movement and storage of water defines the **hydrologic cycle**. Open this link http://ga.water.usgs.gov/edu/watercycle.html and review the processes that result in the movement of water.

* What is ***infiltration and surface runoff***?

* What do you think might affect infiltration and surface runoff?

Hydrologic studies of the earth have revealed that each region drains water into a known basin (or basins) and that it is common that these basins are defined and controlled by a river or river system. This defined region is called a ***drainage basin***.

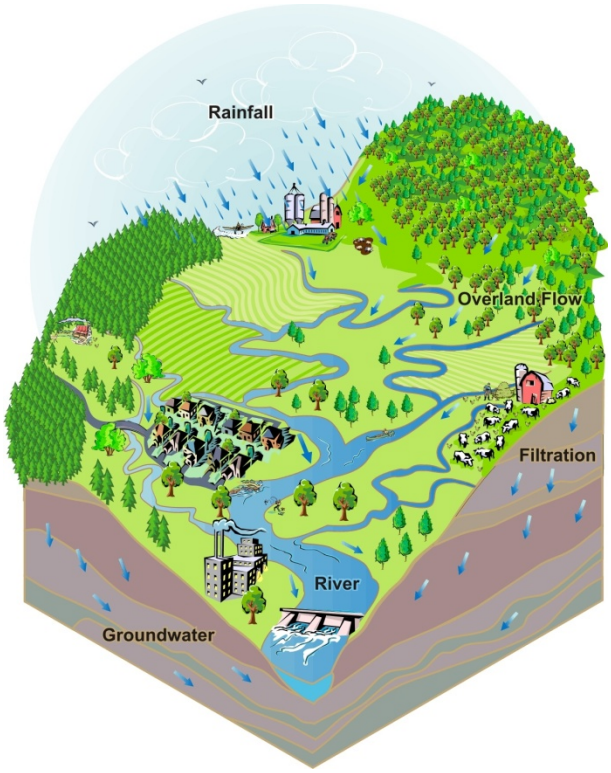


http://golearngeo.wordpress.com/2010/03/31/drainage-basin/
http://www.mississippiriveradventures.com/mississippi_river.htm

Note that in the idealized diagram and in the illustrated map of the Mississippi River basin there is a dominant river channel, a single channel that receives the water in the basin by virtue of tributaries, surface flow and groundwater movements. Instruments called stream gauges provide direct measurement of water heights and flow within stream channels. Note here the type of available data http://waterwatch.usgs.gov/?id=ww_current.

Storm Events and Flooding

During storm events water will move through the basin into the river channel. The total volume of water moving past a defined location is called the ***discharge (Q)***. The discharge is measured in cubic feet per second (ft^3/sec). ***If the discharge is greater than the volume of the river channel then a flood will occur***. Visualize this model as it applies to this handy diagram



Areas within and downstream of this basin would be subject to flooding when Q (discharge) > than channel volume.

http://prairierivers.org/rivers/rivers101/

Stream Gauge Data

http://watershed.montana.edu/old%20hydrology%20web/Stream_project.htm

Flooding within a drainage basin is due to natural and anthropogenic variables. (http://dictionary.reference.com/browse/anthropogenic?s=t). So, we can think of flooding as a *natural phenomenon that deserves a balanced approach*. The variables may be divided into two large categories: ***drainage basin characteristics and storm parameters***.

Drainage basin characteristics
- The *area* of the drainage basin (usually in acres where 640 acres = 1 square mile or mi^2)
- The *length* of the river channel (usually in miles or mi)
- *Topographic relief* or slope (usually in feet per mile or ft/mi)
- *Vegetative and soil characteristics* (runoff characteristics expressed as a numerical factor or coefficient).

These characteristics appear as both the Runoff Coefficient and the Watershed Resistance Coefficient (K_b) and may collectively be coded as 'Land Use Codes'.

Storm Parameters
Storm Frequency is the statistical probability that a storm of known intensity would occur in a given year. For example, a storm with a 10% chance of occurring in a given year is often referred to as a '10 year event'. A storm with a 1% chance of occurring in a given year is often referred to as a '100 year event'. The chance of recurrence of a storm of given intensity is the same each year, given regional climate and weather patterns. The statistical probabilities of '10 or 25 or 50 or 100 year events' will show up over long periods of time, measured in decades, hundreds or even thousands of years. http://ga.water.usgs.gov/edu/100yearflood.html

* How can we have two '100-year floods' in a year?

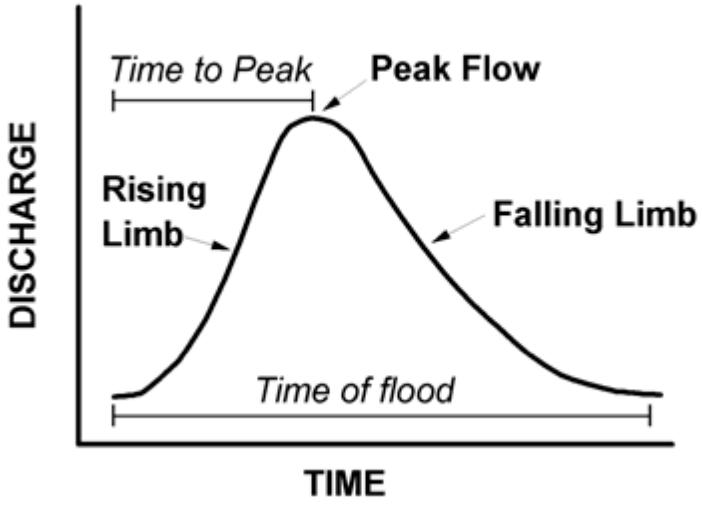
Rainfall Intensity is a measure of the intensity of precipitation within a defined region. Rainfall intensity is measured as inches per hour (in/hr). The data is based on maps of historical data maintained by the NOAA coupled with statistical modeling for drainage basins. Here is a sample http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=in.

Time of Concentration is that time at which saturation causes all parts of the basin to contribute to the total discharge (Q). That amount of time is estimated to be the amount of time for water to flow from the most remote part of the basin to the outlet of the basin. Time of concentration is measured in hours (hr) and noted as T_c.

Peak Discharge is reached at the time of concentration (T_c) for small drainage basins and single river channels. This represents the time at which there will be a maximum value of discharge in ft^3/sec.

The peak discharge may be compared to channel volumes for predictions of floods in small basins.
Hydrographs
Graphing is an excellent tool for analyzing data and the relationships between variables. In hydrology the hydrograph is a key analysis tool. The ***hydrograph shows the variation in discharge over time.***

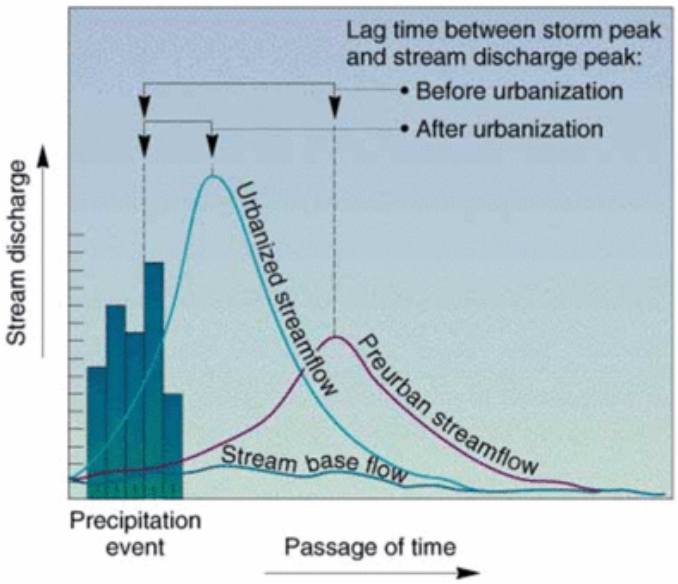
Hydrograph display of time and discharge. Note the 'time to peak' flow, also called ***Time of Concentration (Tc).***



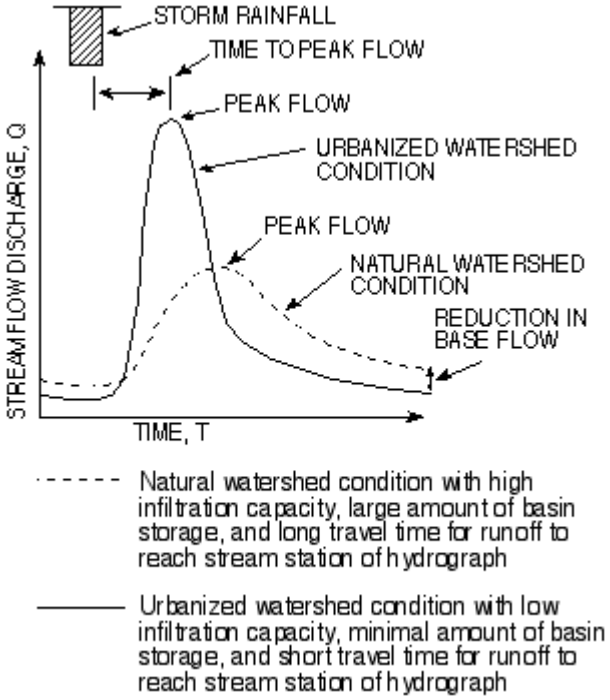
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/08090/images/fig2_1.gif

Follow these links and make an analysis http://pubs.usgs.gov/fs/fs07603/, http://ga.water.usgs.gov/edu/urbaneffects.html.

Note these hydrographs



http://www.eoearth.org/article/Surface_water_management



http://www.dnr.state.oh.us/water/pubs/fs_st/stfs03/tabid/4159/default.aspx

Closing Ideas

A comprehensive and balanced approach to public policy is a sustainable future. This reflects informed decision making which results in environmental vitality and the infrastructure required for modern life. Play this link for a real-world example.

http://gallery.usgs.gov/videos/488