The Evolution of Stream Restoration

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The Evolution of Stream ~~Restoration~~ Management

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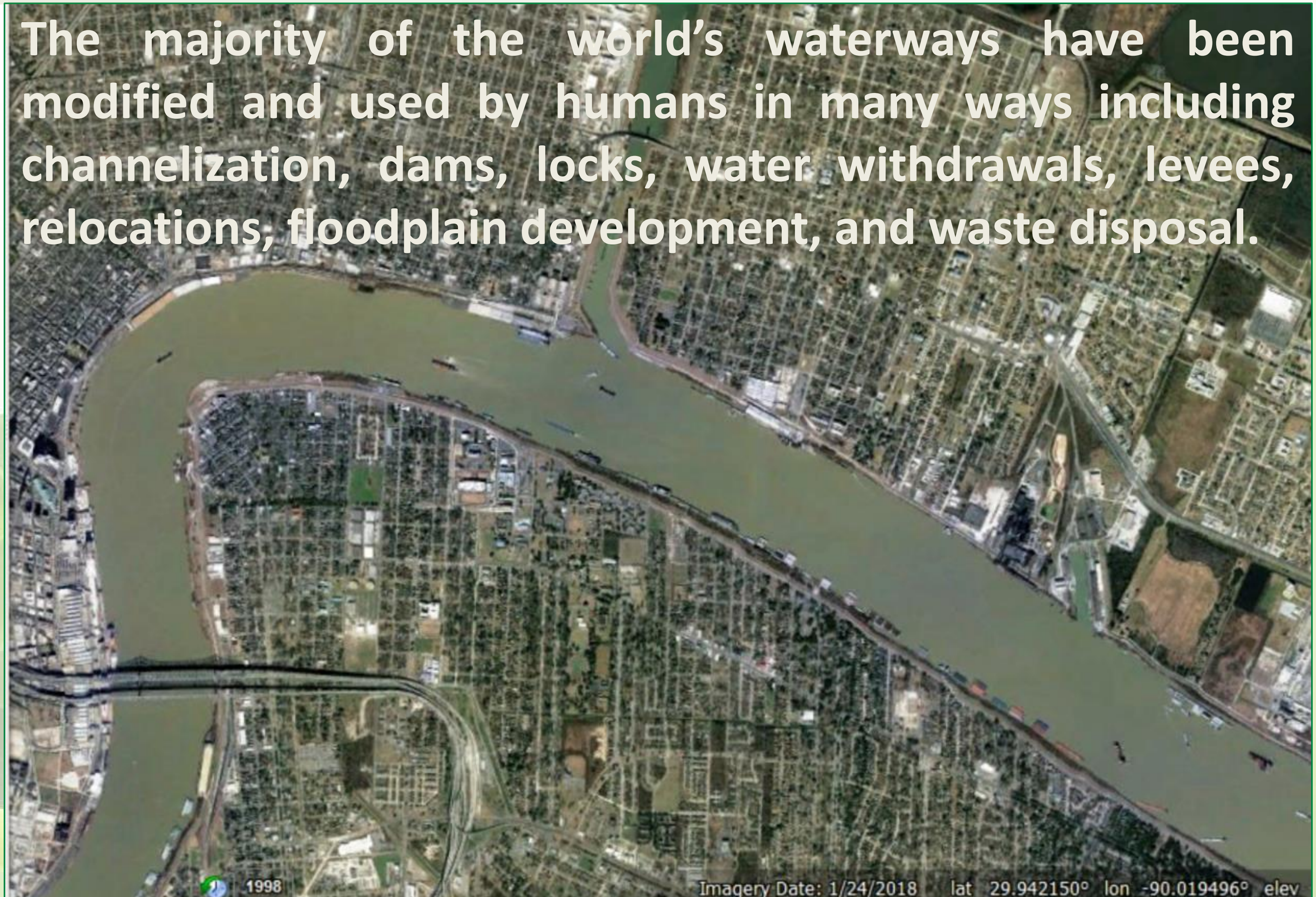
Stream Management – **Historic**

The majority of the world's waterways have been modified and used by humans in many ways including channelization, dams, locks, water withdrawals, levees, relocations, floodplain development, and waste disposal.



Google Earth Imagery. Accessed 10/21/2018

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Stream Management – Historic

- Ancient civilizations used waterways predominantly for agriculture purposes and flood control
  - Over 5,000 years ago, Egyptians built the first large-scale dam, the Sadd-el-Kafara dam (Dam of the Pagans) (Mays, 2008).
  - Over 3,000 years ago, levees were constructed in ancient Egypt along the left bank of the River Nile for more than 600 miles (Needham, 1971).
  - The earliest known river relocation is the ninth century diversion of the Opak River in Java Indonesia for the construction of a temple (Mays, 2008).

By Crisco 1492 - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=31513760

http://www.hydriaproject.info/en/egypt-sadd-al-kafara-dam/relevance9

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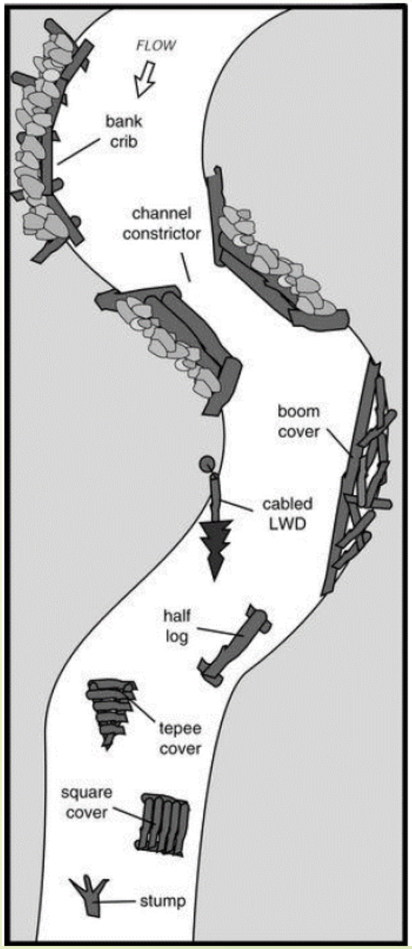
Stream Management – Historic

Impetus for stream management in the United States

- Navigation → channelize and dredge
- Flood control
  - Levees built along the Mississippi starting in the 1700's
- Irrigation → stream diversion and water appropriation
- Gold rush → stream diversions and water appropriation
- Energy → dams for mills
- Waste disposal
- Fish management → in-stream structures



Thompson and Stull, 2004.

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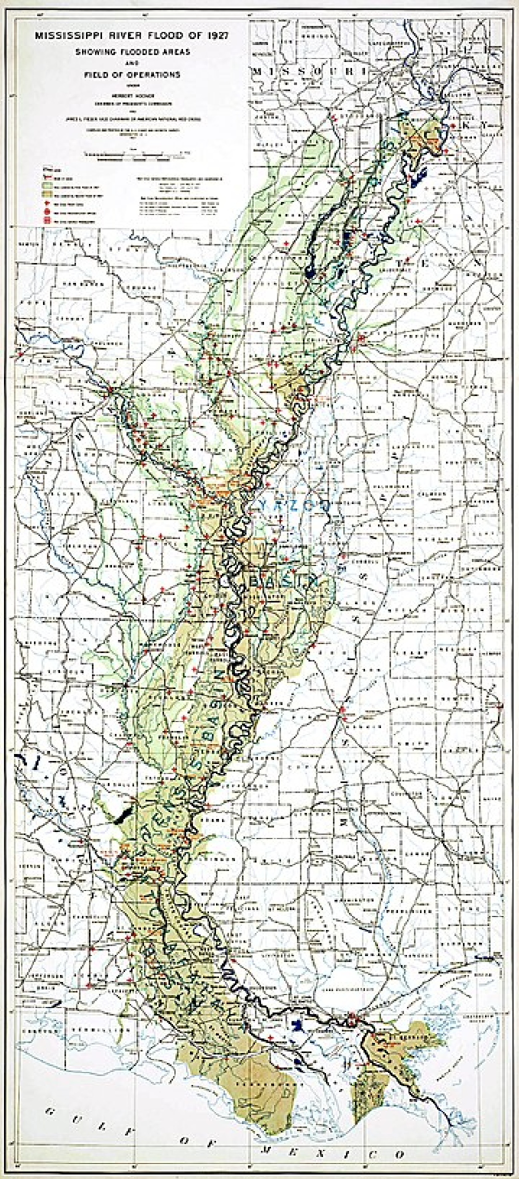
Stream Management – Historic

- Levees Only Theory – Flood control so that great floods could be passed through
- By the 1920's, there were 1,500 miles of levees along the Mississippi

Stream Management – **Historic**

- In the spring of 1927, the Mississippi levees breached in 145 places and flooded 27,000 square miles.
- The most destructive flood in US.



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National Photo Company Collection (Library of Congress)

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Stream Management – **Historic**

The 1927 flood influenced our stream management policy for a long time

- The response was to channelize waterways and install levees and dams
- By 1970s, 235,000 miles of waterways had been channelized; 6,000 miles of levees built; and over 600 dams were installed (Riley, 1998)

South Florida Water Management District

Stream Management – Historic Philosophy

- A Puritan minister in Boston justified the colonists' acquiring Native American land for little to no payment. "The Indians made no use of it," [i.e., neither streams, rivers, or land] he asserts, "but for Hunting."
- Initially, the U.S. Army Corps of Engineers only considered rivers and streams for their value for navigation.
- Leaving water in streams was widely considered to be a waste of water (1800's) (Apple, 2001).
- Hunters and fishers have never been passive recipients of nature's bounty; they managed forests and waterways, burning underbrush, diverting streams, and generally altering the environment (Cronon, 1999).
- In reference to water rights, "Use it or lose it" (Apple, 2001)
- "In view of the fact that our lakes and streams were formed by natural processes and were not created or especially designed for the species of fish which we desire, it is logical to believe that with adequate knowledge and a definite design or purpose in mind, we can improve on nature and make some of our waters more favorable for the desired species." (Tarzwell, 1935)
- Between 1890 and the late 1920s the conservation movement within the United States considered the environment a resource that should be used in its entirety to promote efficient development (Hays, 1959)
- US Army Corps was charged with taming the Mississippi River (Wikipedia Contributors, October 2018)
- Historically, federal policy towards river management was economically focused by using channelization, levees, and dams.

Stream Management – Philosophy Evolution

A major change in societal values occurred in the 1960s and 1970s.

- By the early 1970's, two-thirds of the nation's lakes, rivers and coastal waters were unsafe for fishing or swimming, and untreated sewage was dumped into open water (EnvironmentalWorks.com).
- In 1968, DDT was measured in 584 of 590 fish samples, with levels up to nine times the FDA limit (PBS.ORG)
- In 1969, bacteria levels in the Hudson River were at 170 times the safe limit.
- In 1969, record numbers of fish kills were reported, over 41 million fish. This includes the largest recorded fish kill ever – 26 million killed in Lake Thonotosassa, Florida due to discharges from four food processing plants. (PBS.org)
- In June 1969, the Cuyahoga River caught on fire.

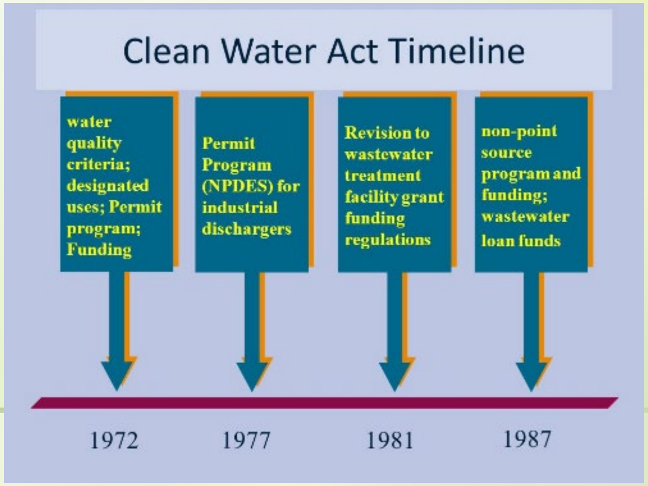
Cleveland Press Collection at Cleveland State University Library

- In 1969, record numbers of fish kills were reported, over 41 million fish. This includes the largest recorded fish kill ever – 26 million killed in Lake Thonotosassa, Florida due to discharges from four food processing plants. (PBS.org)
- In June 1969, the Cuyahoga River caught on fire. Previously, the mayor called the Cuyahoga River "an open sewer through the center of the city" (Allegheny Front, 2015)
- In 1970, 30 percent of drinking water samples had chemicals exceeding the recommended Public Health Service limits (PBS.org)
- In 1971, FDA reported that 87 percent of swordfish samples had mercury at levels that were unfit for human consumption
- No signs of visible life, not even leeches and sludge worms occurred in the Cuyahoga River.
- Unregulated dumping of untreated waste into rivers "that was just what the river was there for" (Allegheny Front, 2015)

Stream Management – Philosophy Evolution

This philosophy changed resulted in new regulations

- 1968 Wild & Scenic Rivers Act
- 1969 National Environmental Protection Act
- 1972 Clean Water Act – goal is “to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters” [33 U.S.C. § 1251(a)].



Stream Management – Regulatory Authority

- Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers jurisdiction over dredge and fill activities in waters of the United States

US Army Corps of Engineers

Stream Management – **Regulatory Authority**

- Section 401 of the Clean Water Act gives states (i.e., Ohio EPA) authority to protect water resources from water quality degradation
- Section 402: National Pollutant Discharge Elimination System (NPDES) requires a permit for discharge of any pollutants, to control point and non-point source pollution

OhioEPA
Ohio Environmental Protection Agency

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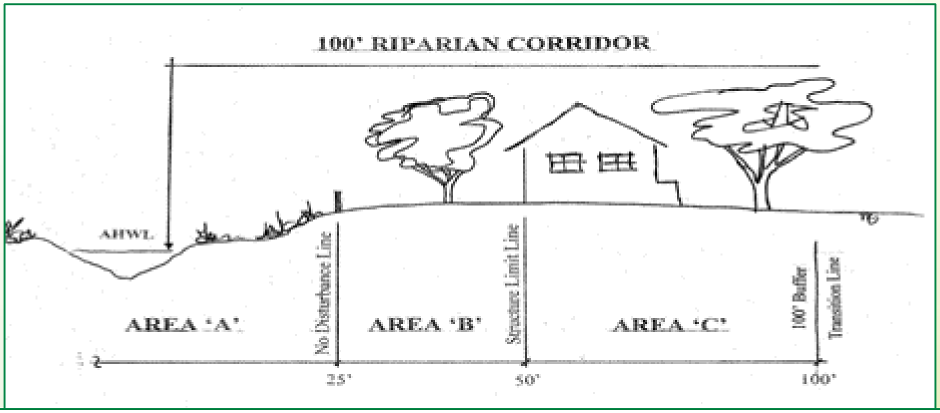
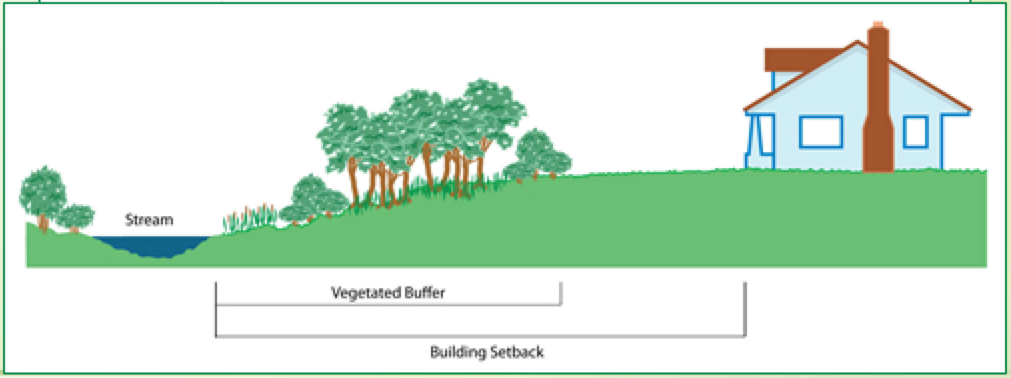
Stream Management – **Regulatory Authority**

- Many local zoning regulations and ordinances provide for riparian and wetland setback requirements, stormwater management, and floodplain restrictions





Stream Management – Current Conditions

Even with changing regulations and the change in paradigm, stream degradation is accelerating

Stream Degradation is Accelerating

- Streams are widening, eroding, undercutting, downgrading, and water quality is degrading and habitat is being lost

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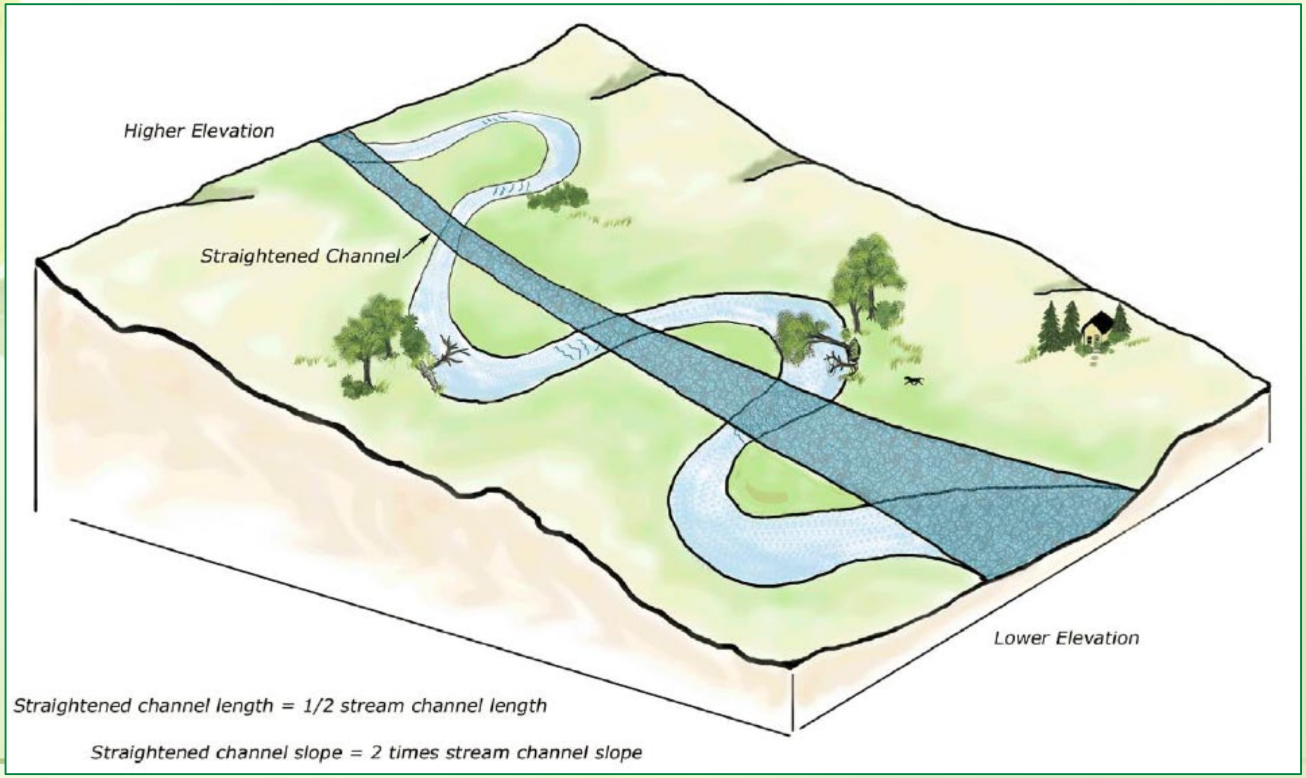
Stream Degradation is Accelerating

Increased flow from Channelization

- Decreases channel length
- Increases channel slope
- Increases flow velocity

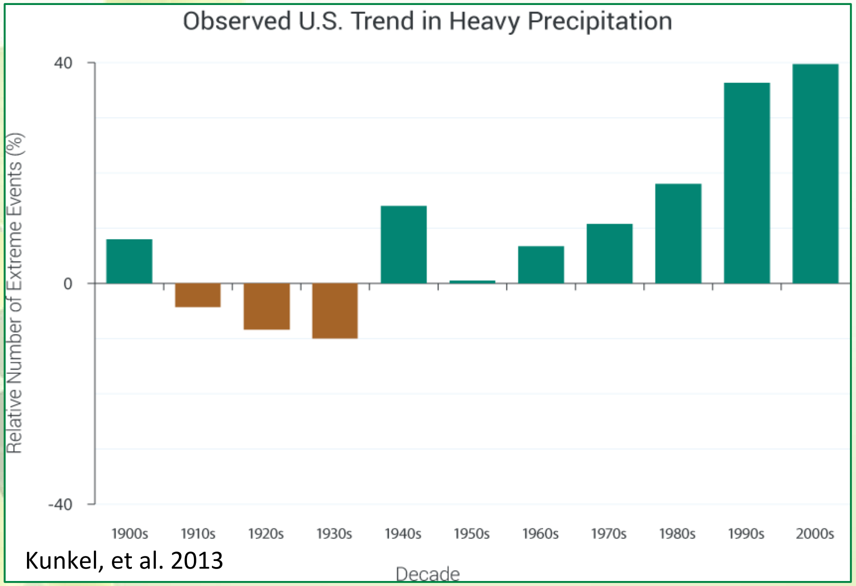


http://www.chemungcountyswcd.com

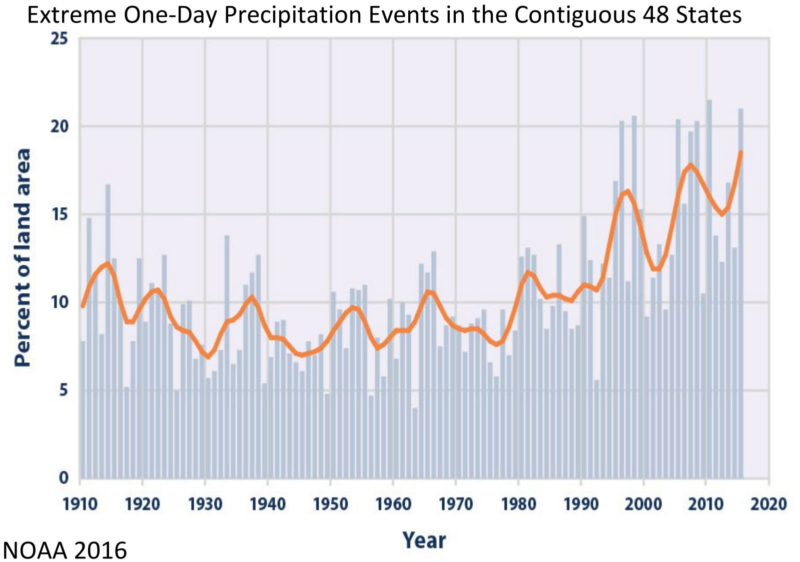
Stream Degradation is Accelerating

Increased water flow from changes in precipitation

- A larger percentage of precipitation now comes in the form of intense single-day events.
- Extreme single-day precipitation events remained fairly steady between 1910 and the 1980s, but has risen substantially since then.



Kunkel, et al. 2013



NOAA 2016

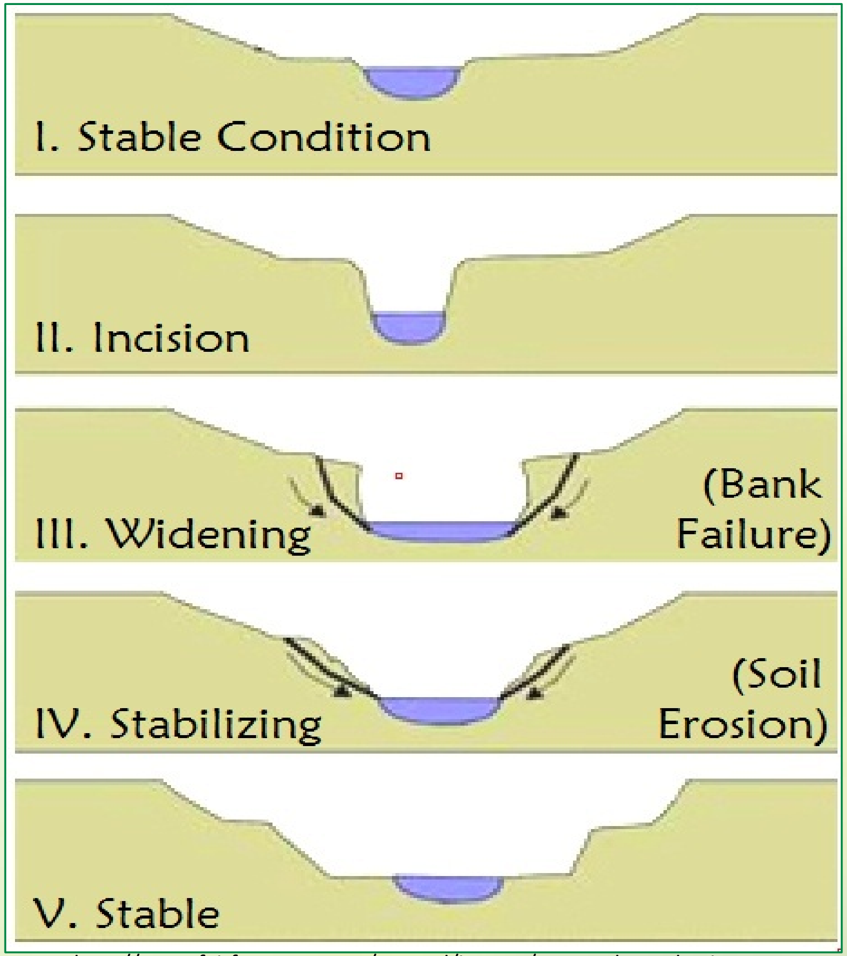
Stream Degradation is Accelerating

Increased flow and water quality from changes in land covers

- Impervious areas can generate five times more runoff than a wooded area of the same size
- Interrupts groundwater recharge
- With increased runoff velocity and volume → flash flooding
- Increasing runoff temperatures, sometimes up to 10°F, affect temperature sensitive species in receiving waters and can decrease amount of dissolved oxygen
- Increased pollutants in runoff draining to water resources

Stream Degradation – Stream Changes

Increased runoff means increased water in the streams.
Increased water means that streams have to adjust



http://www.fairfaxcounty.gov/nvswcd/images/streamchannelev.jpg

Stream Management = Watershed Management

Rather than focusing on a single stream function and/or address issues that are occurring in a particular stream reach, management of waterways is shifting to management of the overall watershed

Watershed Management – Watershed Action Plans

- Comprehensive effort to address causes of water quality and habitat degradation in a watershed with the focus on the quality of the water resource
- Water resource refers to the physical, chemical and biological characteristics of a water body; and the flora, fauna and human uses it supports

Watershed Management – Watershed Action Plans

Build Public Support - collaborative effort

- Municipalities
- County Soil and Water Conservation Districts
- Local watershed or conservancy groups
- State agencies including Ohio EPA, ODNR, USFWS, etc.
- Private organizations
- Citizens

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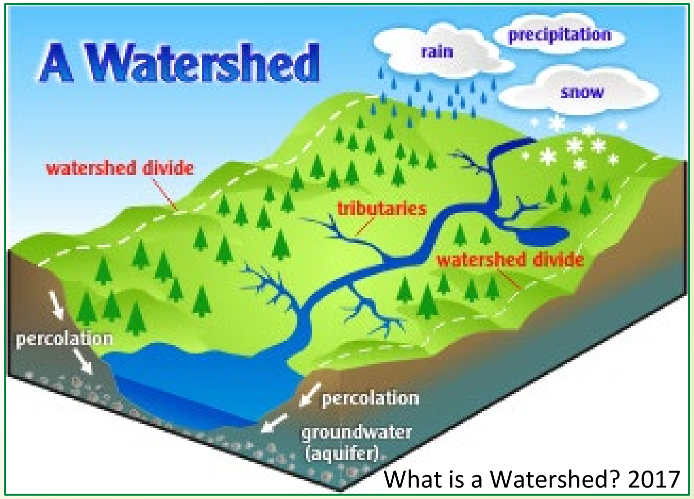
Watershed Management – Watershed Action Plans

Create an Inventory of the Watershed

- Delineate the watershed
- Identify land uses and land covers
- Assess the quality of the water resource



What is a Watershed? 2017

- Identify human features that affect quality of the resources
- Basin-wide watershed assessment – baseline conditions
- Evaluate stormwater management throughout the watershed

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Watershed Management – Watershed Action Plans

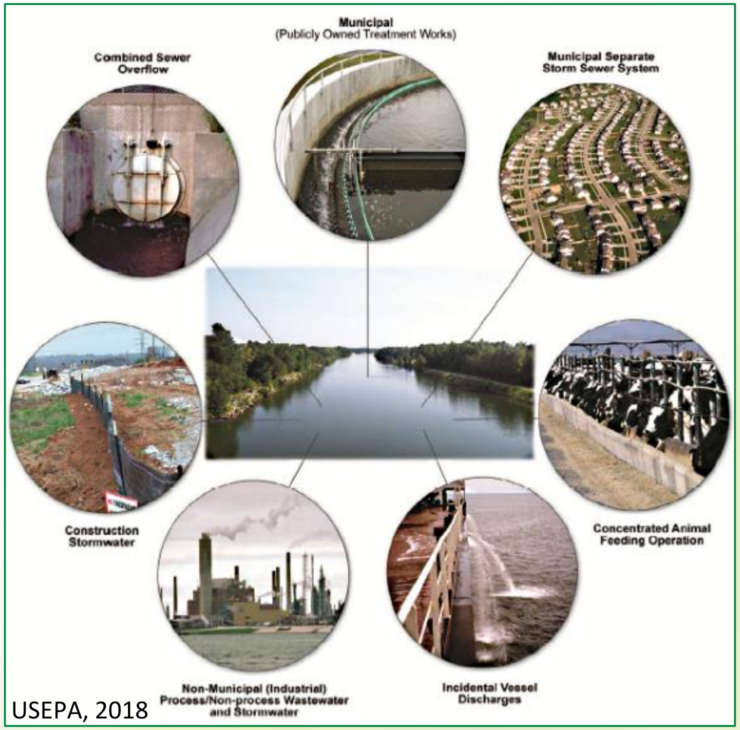
Define the Problems

- Identify the pollutants
- Identify the sources of pollutants
- Identify high quality areas to protect

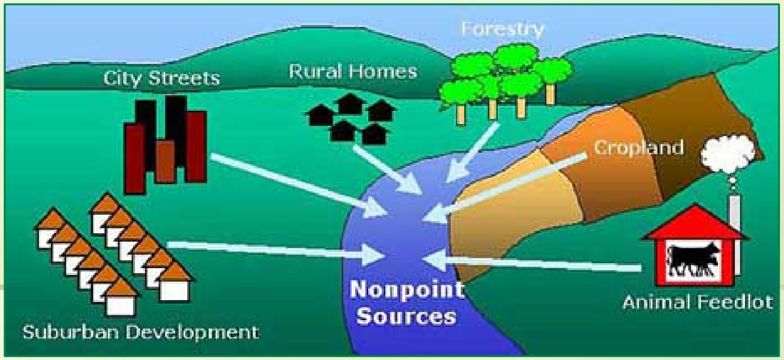
Watershed Management – Watershed Action Plans

Pollutants

- Construction site runoff
- Wastewater outfalls
- Agricultural runoff
- Chemicals and heavy metals
- Herbicides
- Fertilizers - nutrients
- Storm water runoff from impervious surfaces



USEPA, 2018



NOAA, 2004.

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Watershed Management – Watershed Action Plans

Pollutants into waterways

- Polluted stormwater runoff can be transported through municipal separate storm sewer systems (MS4s), and then discharged, untreated, into streams

USEPA, 2018

Watershed Management – Watershed Action Plans

Identify high quality areas to protect

- Exceptional warmwater habitat
- Coldwater habitat
- Salmonid Streams
- Endangered Species
- Scenic Rivers

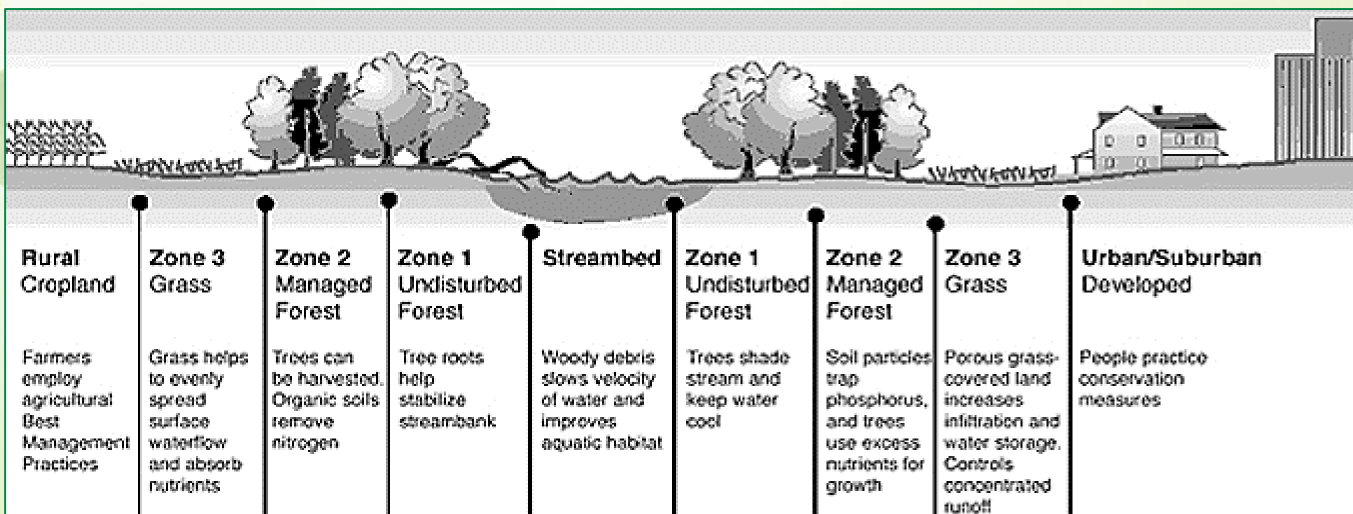
Watershed Management – Watershed Action Plans

Develop Solutions and Set Goals

- Consider water uses and needs in the watershed
- Evaluate potential solutions for identified problems
- Set goals based on measurable indicators
- Select solutions to achieve the goals

Watershed Management – Watershed Action Plans

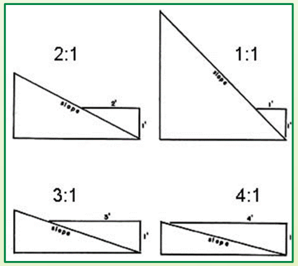
- **Stream protection – riparian buffer**
  - Avoid development activities such as grading, land clearing, and buildings along streams
  - Maintain setback from stream for farm activities
  - Avoid mowing within buffer zone
  - Protect existing vegetation and replace vegetation



https://riverrestoration.wikispaces.com/Riparian+zones

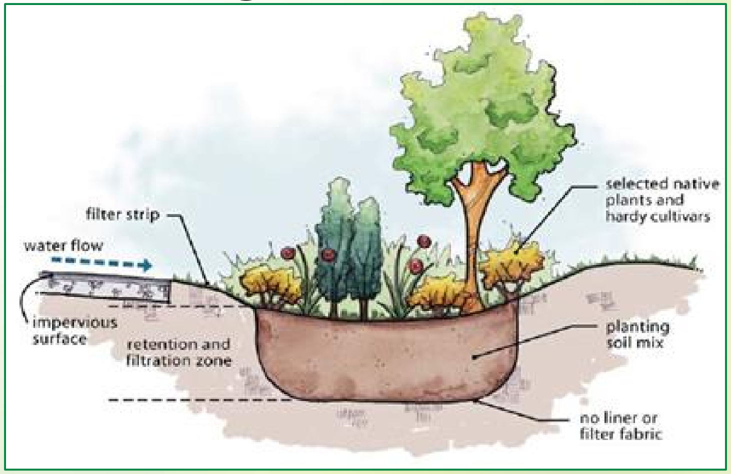
Watershed Management – Watershed Action Plans

- **Channel and bank restoration**
  - Restore channel meanders
  - Re-connect to the floodplain
  - Re-grade the bank to attain stable angle of repose



Watershed Management – Watershed Action Plans

- **Manage Stormwater in the Watershed for volume and pollutant removal**
  - Evaluate existing stormwter facilities and retrograde as needed
  - Install additional water quality and management basins
  - Green infrastructure
  - Reduce imperviousness
  - Low Impact Development
  - Plant trees
  - Control point and non-point source pollutants
  - Involve and educate residents



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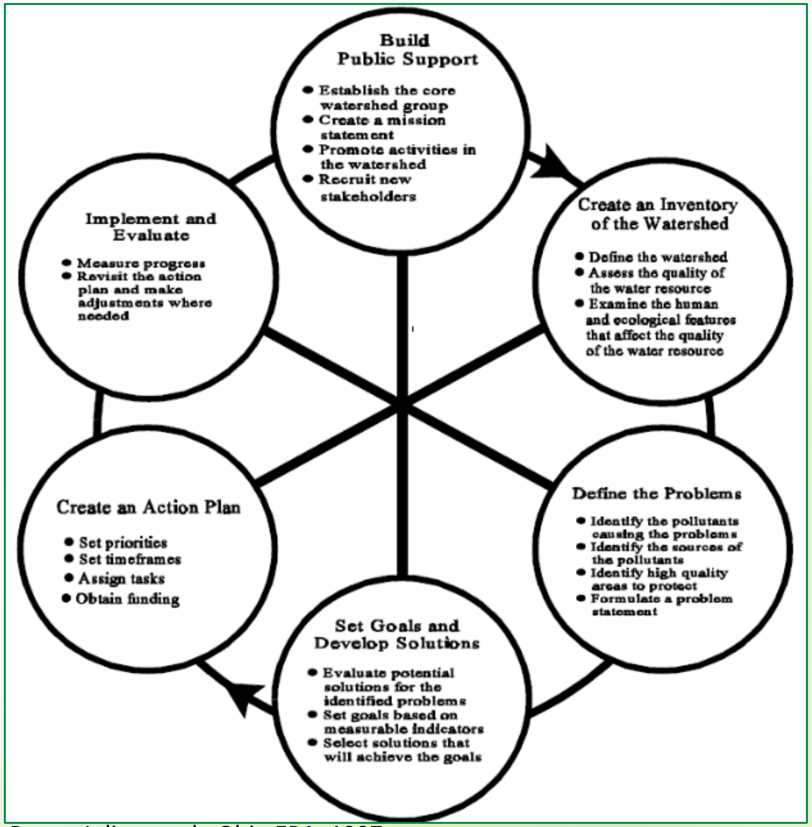
Stream Management – Watershed Action Plans

Create an Action Plan

- Set priorities
- Set timeframes
- Assign tasks
- Obtain funding

Implement and Evaluate

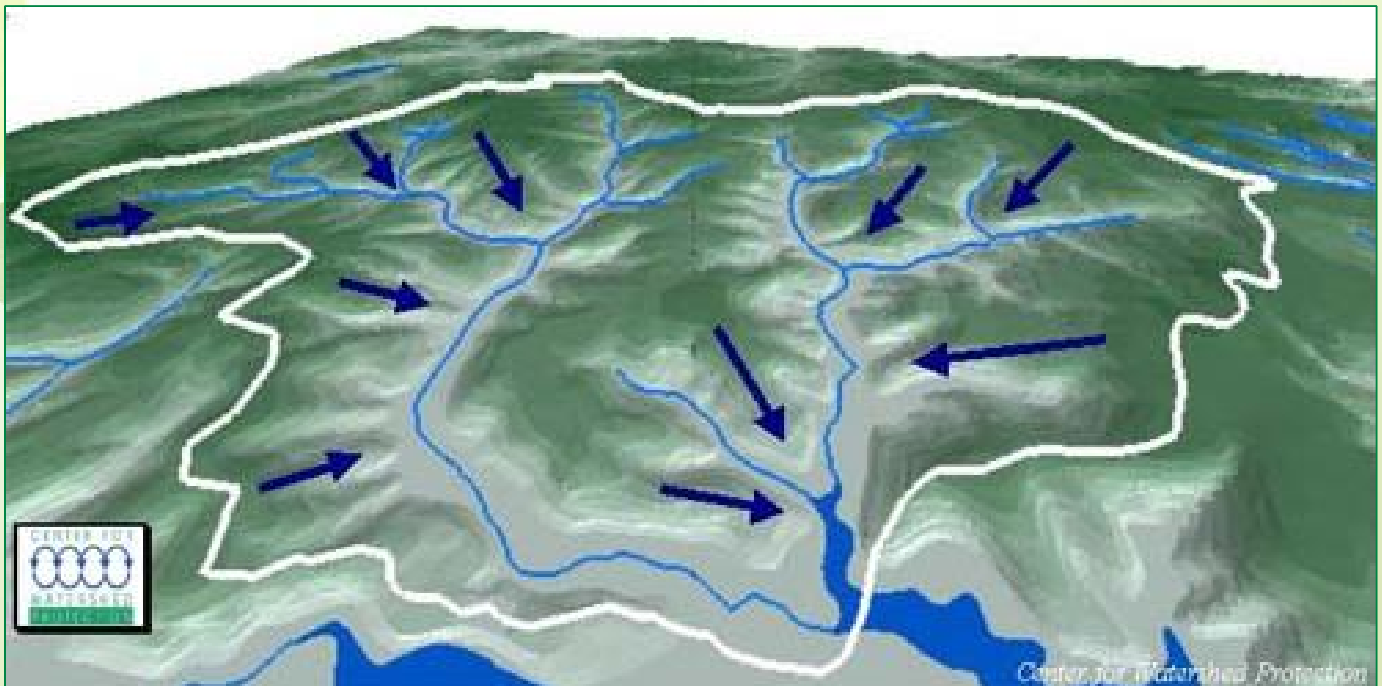
- Measure progress
- Revisit the action plan and adjust as needed



Perez, Julio, et. al., Ohio EPA, 1997

Stream Management – **Evolution**

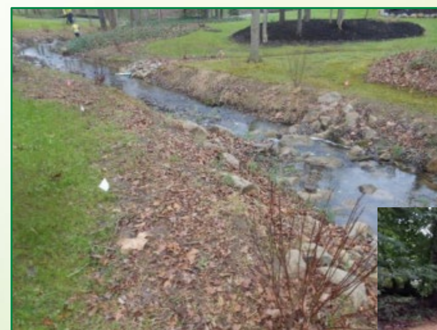
- **Stream management has evolved over time from single use goals frequently focused on a short reach to a watershed approach, considering multiple uses, values and functions**

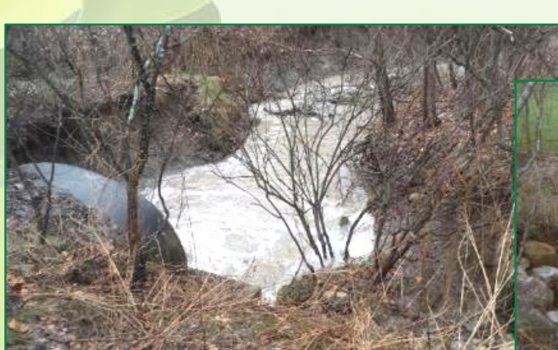


Stream Management – Watershed Case Study

Unnamed Tributaries of Chagrin River, Lake County

- Goal to stabilize 1,800 linear feet of streambank and prevent more than 1,800 tons of sediment from entering the Chagrin River and Lake Erie
- Actual stabilization = 1,505 lf
- Sediment savings = 3900 lbs





Stream Management – Watershed Case Study

Chagrin River Bank Stabilization- Chagrin Falls, Cuyahoga County

- Identified as a priority area in the Watershed Action Plan to eliminate impacts to water quality by reducing pollution from excessive streambank erosion and sedimentation.

The stream bank of the Chagrin River eroded approximately 75 feet

Stream Management – Reach Case Study

- **Chagrin River Bank Stabilization – Hunting Valley, Cuyahoga County**

Stream Management – Reach Case Study

- **McFarland Creek – Bainbridge Township, Geauga County**

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References 1

- Apple, Daina Dravnieks. 2001. *Evolution of U.S. Water Policy: Toward a Unified Federal Policy*. Forest Service Research Paper. Washington, DC: USDA Forest Service, Washington Office. 20 p. https://www.fs.fed.us/research/publications/wo/wo_2001_apple_d001.pdf
- A Tale of Two Rivers-Mississippi River Flood of 1927
- Banner, Stuart. "The Taking of Indian Lands: Perspectives of Native Americans and European Americans, 1707-1765." The Taking of Indian Lands, Views of Colonists, Indians and the King, Harvard University Press, 2005, nationalhumanitiescenter.org/pds/becomingamer/growth/text7/indianlands.pdf.
- Bureau of Reclamation, and Lower Colorado Region Web Team. July 12, 2017. "HOOVER DAM." US Department of the Interior, Bureau of Reclamation, 12 July 2017, www.usbr.gov/lc/hooverdam/aboutus.html.
- Cronin, Leonard. 1995. *A Journey through Ancient Kingdoms and Natural Wonders; World Heritage Sites of Australia, New Zealand and South East Asia*; Reed Books: Sydney, Australia; p. 170.
- Cronon, William. 1983. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. Hill and Wang, New York.
- Crisco 1492 - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=31513760
- Frankel, Todd C. March, 14, 2018. "Taming the Mighty Mississippi." The Washington Post, WP Company, www.washingtonpost.com/graphics/2018/national/mississippi-river-infrastructure/?noredirect=on&utm_term=.aabedcd15d9f.
- Frazer, Lance. "Paving Paradise: the Peril of Impervious Surfaces." Environmental Health Perspectives, National Institue of Environmental Health Sciences, July 2005, www.ncbi.nlm.nih.gov/pmc/articles/PMC1257665/.
- Hays, Samuel P. 1959. *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890–1920*. Harvard University Press, Cambridge, MS.
- Hawes, Ellen and Markelle Smith. "Riparian Buffer Zones: Functions and Recommended Widths." April 2005. Eightmile River Wild and Scenic Study Committee. Yale School of Forestry and Environmental Studies. Accessed 4 Sept. 2017. http://eightmileriver.org/resources/digital_library/appendicies/09c3_Riparian%20Buffer%20Science_YALE.pdf
- Kunkel, Kenneth E., Thomas R. Karl, Harold Brooks, James Kossin, Jay H. Lawrimore, Derek Arndt, Lance Bosart, David Changnon, Susan L. Cutter, Nolan Doesken, Kerr y Emanuel, Pavel Ya. Groisman, Richard W. Katz, Thomas Knutson, James O'Brien, Christopher J. Paciorek, Thomas C. Peterson, Kelly Redmond, David Robinson, Jeff Trapp , Russell Vose, Scott Weaver, Michael Wehner, Klaus Wolter, and Donald Wuebbles. "Monitoring and Understanding Trends in Extreme Storms: state of knowledge." Bull. Am. Meteor. Soc., 94 (2013), pp. 499-514. Accessed 3 Sept. 2017. http://climate.rutgers.edu/stateclim_v1/robinson_pubs/refereed/Kunkel_et_al_2013.pdf
- Lave, Rebecca. Neoliberalism and the Production of Environmental Knowledge. Environment and Society: Advances in Research 3, 2012, www.envirosociety.org/wp-content/uploads/2015/07/3.2-Rebecca-Lave-Neoliberalism-and-the-Production-of-Environmental-Knowledge.pdf.
- Madrigal, Alexis C. May 20, 2011. "What We've Done to the Mississippi River: An Explainer." The Atlantic, Atlantic Media Company, www.theatlantic.com/technology/archive/2011/05/what-weve-done-to-the-mississippi-river-an-explainer/239058/.
- Mays, L.W. 2008. "A very brief history of hydraulic technology during antiquity". Environ. Fluid Mech. 8, 471–484.
- Nassam, B. and V. McCoy. "Riparian zones." *Riverrestoration*, riverrestoration.wikispaces.com/Riparian zones. Accessed 4 Sept. 2017. https://riverrestoration.wikispaces.com/Riparian+zones
- Needham, Joseph. 1971. Science and Civilisation in China: Volume 4, Physics and Physical Technology, Part 3, Civil Engineering and Nautics. Cambridge: Cambridge University Press; Brian Lander. "State Management of River Dikes in Early China: New Sources on the Environmental History of the Central Yangzi Region." T'oung Pao 100.4-5 (2014): 325-62.
- NOAA (National Oceanic and Atmospheric Administration). 2016. U.S. Climate Extremes Index. Accessed October 2018. www.ncdc.noaa.gov/extremes/cei.
- Ohio Environmental Protection Agency, August 30, 2016. *A Guide to Developing Nine-Element Nonpoint Source Implementation Strategic Plans in Ohio, Version 1.1*. Division of Surface Water Program. Columbus, Ohio.

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References 2

- Perez, Julio, Daniel Halterman, Laurel Hodory, and Dave White. June 2007. *A Guide to Developing Local Watershed Action Plans in Ohio*. State of Ohio Environmental Protection Agency, Division of Surface Water. Columbus, Ohio.
- Schueler, T. "Controlling urban runoff: a practical manual for planning and designing urban BMPs." 1987. Metropolitan Washington Council of Governments. Washington, DC.
- Stream Corridor Restoration: Principles, Processes, and Practices. October 1998. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3. Accessed 4 Sept. 2017. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/restoration/?cid=stelprdb1043244
- Thigpen, Janet. "Stream Processes; A Guide to Living in Harmony with Streams." August 2006. Chemung county Soil & Water Conservation District. Accessed 3 Sept. 2017. http://www.catskillstreams.org/pdfs/chemungstreamguide.pdf

- Thigpen, Janet. "Stream Processes; A Guide to Living in Harmony with Streams." August 2006. Chemung county Soil & Water Conservation District. Accessed 3 Sept. 2017. http://www.catskillstreams.org/pdfs/chemungstreamguide.pdf

- Thompson, Douglas M. and Gregory N. Stull. 2002. "The Development and Historic Use of Habitat Structures in Channel Restoration in the United States: The Grand Experiment in Fisheries Management." Géographie physique et Quaternaire Volume56, Issue1, 2002, p. 45–60. . Les Presses De L'Université De Montréal. Digital Publication: July 14, 2004. https://www.erudit.org/en/journals/gpq/2002-v56-n1-gpq737/008604ar/
- Turyk, Nancy, P. McGinley, K. Rasmussen. December 2004. "Bettering the Branch: An Overview of the Current Conditions Habitat, Water Quality, and General Morphology." University of Wisconsin-Stevens Point. Accessed 4 Sept. 2017. https://www.researchgate.net/publication/253950962_Bettering_the_Branch_An_Overview_of_the_Current_Conditions_Habitat_Water_Quality_and_General_Morphology
- US Department of Commerce, and National Oceanic and Atmospheric Administration. December 19, 2004. "Nonpoint Source Pollution." NOAA's National Ocean Service Education, National Oceanic and Atmospheric Administration, oceanservice.noaa.gov/education/kits/pollution/04nonpointsource.html.
- United States Environmental Protection Agency, March. 2008,"Handbook for Developing Watershed Plans to Restore and Protect Our Waters." US EPA www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters.
- United States Environmental Protection Agency, August 15, 2018. "Handbook for Developing Watershed Plans to Restore and Protect Our Waters." US EPA. www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters.
- US Environmental Protection Agency, September. 7, 2018 "Stormwater Discharges from Municipal Sources." US EPA, www.epa.gov/npdes/stormwater-discharges-municipal-sources.
- US Environmental Protection Agency - Streams and Wetlands, Public Domain, https://commons.wikimedia.org/w/index.php?curid=51969385
- Western Illinois University. "Mississippi River Flood of 1927" (Date digitized 2017). Western Illinois university (Owner). U.S. Coast and Geodetic Survey, Washington D.C. http://collections.carli.illinois.edu/cdm/ref/collection/wiu_rmaps/id/79
- "What Is a Watershed?" 2017. Hawaii Association of Watershed Partnerships. hawp.org/what-is-a-watershed/.
- Wikipedia contributors. October 4, 2018. "Great Mississippi Flood of 1927". In Wikipedia, The Free Encyclopedia. Retrieved 23:03, October 10, 2018, from https://en.wikipedia.org/w/index.php?title=Great_Mississippi_Flood_of_1927&oldid=862387814
- Wikipedia contributors. October 21, 2018. "Point source pollution". In Wikipedia, The Free Encyclopedia. Retrieved 08:06, October 23, 2018, from https://en.wikipedia.org/w/index.php?title=Point_source_pollution&oldid=865102521

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