Stormwater Runoff

Executive Summary

Stormwater runoff is excess rain or snowmelt that is not absorbed into the ground, but instead runs into surrounding waterways. Runoff results from two main factors: the inability of a surface (e.g., pavement) to absorb water and/or the amount of precipitation exceeds the absorptive ability of the surface. Runoff can erode landscapes and damage structures, and it can pick up a wide variety of pollutants and carry them to surrounding waterways, thereby contaminating the waterway. Contaminated water can be detrimental to human health, environmental health, and recreation. The intensity of runoff and its effects may increase with climate change.

Highlights

- The occurrence and effect of stormwater runoff is site-specific. Mitigation requires surveying and designing for the specific needs of the site.
- Combined rainwater and sewer systems require special mitigation consideration.
- In the Midwest, climate change is projected to increase the frequency and intensity of storms, resulting in increased runoff and associated pollution.

Limitations

- Because specific regional features contribute to the overall impact of stormwater runoff, different Missouri regions may experience different types and magnitudes of stormwater consequences.
- The effects of stormwater runoff have been better researched in urban settings. Consequently, there is more uncertainty about the effects of runoff in rural settings.

Research Background

Stormwater runoff results from the inability of the ground to absorb precipitation during and after storm events. Different surfaces have different absorptive abilities: surfaces with complete vegetation coverage have higher capacity to absorb and filter stormwater, while impervious surfaces, like pavement, will absorb no stormwater.[1,2] Intense storm events can overwhelm even well-vegetated surfaces. Runoff can erode landscapes and carry pollutants into surrounding waterways, such as the Missouri River, Mississippi River, and Lake of the Ozarks.

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Runoff sources and pollutants

The amount of runoff and types of pollutants vary by geography.[3] Urban and suburban environments have different runoff issues compared to rural regions, which are dominated by agricultural and forestry activities.

In urban areas, heavy metals (e.g. lead, copper, zinc, nickel, cadmium, and chromium) and contaminants from gasoline can run off highways and urban industrial sites.[4,5] Once in waterways, these contaminants can negatively affect drinking water (e.g., wells or reservoirs) and contribute to the kill off plants and animals, thereby reducing recreational opportunities (e.g., fishing).[1]

In rural areas dominated by agriculture and forestry, agricultural runoff (e.g. pesticides, fertilizers, and pathogens) and sediment are major runoff pollutants. Once in waterways, these pollutants can kill off plants and animals and negatively affect recreational opportunities.[1] Pathogens and some pollutants can also negatively affect human health.[1]

Glyphosate (Round-Up) is the predominant runoff pollutant in Missouri, according to the US Geological Survey.[6] Both rural, agricultural practices and suburban lawn care practices contribute to glyphosate pollution.[6]

Interventions to reduce runoff pollution

A variety of interventions can eliminate runoff and pollution. The use of green building features, such as green roofs and rain barrels, can collect stormwater from buildings and prevent runoff.[2] Other forms of green infrastructure, such as vegetated swales, can filter and intercept stormwater before it reaches bodies of water. Kansas City has an extensive green infrastructure program that incorporates several of these mitigation strategies.

Low-impact development techniques substantially reduce pollution runoff compared to traditional development techniques.[7,8] Heavy metals and other pollutants can be filtered using filters and swales, however the type of filter or swale must be chosen based on the type of pollutant.[9,10]

Under the Clean Water Act, certain categories of industry and municipal separate sewer systems are required to obtain stormwater discharge permits. In addition, land disturbance of one acre or greater, usually associated with new development or construction projects, is required to obtain a stormwater discharge permit. The main requirement of a land disturbance permit is development of a Stormwater Pollution Prevention Plan (SWPPP). In the SWPPP, site-specific best management practices (BMPs) are described for use by the on-site construction crew to minimize soil exposure, soil loss, and pollutant discharge. The goal of the SWPPP is to prevent sediment from leaving the site. In Missouri, Clean Water Act enforcement is delegated by the Environmental Protection Agency to the Missouri Department of Natural Resources.

Climate change and stormwater runoff

Climate change is associated with the increase of extreme weather incidents, such as extreme floods and droughts. Projections suggest that climate change will intensify stormwater runoff in Missouri in a variety of ways.[11,12] First, climate change is projected to an increase in the number and intensity of extreme precipitation events (i.e. ≥2 inches of precipitation fall in a day).[13,14] Increases in precipitation will cause increases in runoff and pollution, potentially exacerbating issues of water contamination and erosion. Moreover, summers are likely be drier, as the length and intensity of droughts will increase.[13] Longer droughts can result in drier and more bare land, which in turn can lead to more erosion and sediment pollution when storms do occur.[13]

Additional considerations

The sources and pollutants of stormwater runoff vary by geography. As seen in the above examples, urban and rural areas face different runoff issues and pollutants, so one must consider this context when designing interventions. Also, federal and state regulations can treat runoff differently depending on whether it comes from a point (localized, like a single factory) or nonpoint source. An in-depth examination of the federal and state regulatory structures for each would be useful for understanding the effects of regulatory incentives or mandates on reducing runoff.[15] Lastly, in some areas, such as Kansas City, water runoff management systems intersect with sewage management systems (called "combined sewage systems"). Increases in runoff can overflow sewage systems, thereby spreading waste and disease.[16] These systems require special attention when designing interventions to reduce runoff.

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