Urban drainage issues and management

What you need to know
How the urban area affects the water cycle
How the urban area experiences problems due to modification of the water cycle
How Sustainable Urban Drainage Systems (SUDS) help
How river restoration and conservation helps in damaged catchment areas

Introduction:

The water cycle, with its many transfers and stores is a closed system. Many factors can affect the speed at which it operates naturally, for example, type of rock, gradient of the ground etc. Likewise changing a natural area to an urban area will impact upon the cycle due to changes in storage capacity and influence the speed at which key flows and transfers occur.

The urban water cycle

The biggest change to a natural environment when it becomes urbanised is the change to the land surface. Natural landscapes usually comprise of soil or rock, with a surface layer of vegetation. This combination is an integral part of the natural water cycle and helps to modify the flow of water through the cycle. When precipitation occurs, the vegetation acts as a barrier and intercepts the rainfall. This stops the rapid saturation of the soil which could result in flash flooding. When intercepted, vegetation then stores some of the water as stemflow and gradually the water will infiltrate into the soil and travel as throughflow into the river system if it is not taken up by the vegetation and returned as evapotranspiration. These natural controls upon the water cycle are interrupted and altered when an area is urbanised.

Concrete and asphalt (tarmac) surfaces are impermeable and impervious. When precipitation hits these surfaces in urban areas, water collects on the ground as puddles and then runs off straight into city drainage systems, to be fed into a river. This means that the storage element and the slowing down of the cycle by underground transfer is by-passed. Surface run-off becomes the dominant transfer in the urban water cycle.

In most urban areas there is a network of drains whereby precipitation runs into them during a rain event and this water is removed from the urban area out to a nearby river. Whilst the idea behind this is that it removes the problem of water in the urban area, the local river receives a greater discharge much quicker than it would do prior to urban growth and it can lead to the downriver bankfull limit being reached much quicker than normal, resulting in increased flood risk downstream of the urban area.

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Urban water cycle problems

A dominant issue associated with the urban water cycle is the increasing likelihood of flooding in the city. The main reason for this is the increase in surface runoff due to the changes to the land surface. Local rivers in urban areas are likely to flood in flash flood events giving rise to a number of damaging consequences:

- The larger volume, velocity, and duration of flow in the nearby river increases the amount of abrasion taking place which erodes more intensively and provides more material to be transported.

- The morphology of the urban area also contributes to the speed at which the water reaches the river as streets act like streams, collecting stormwater and channelling it straight into waterways or pooling it in low-lying depressions within the city. This can lead to localised flooding in urban areas and can be very costly to city authorities, which will have to repair affected infrastructure, particularly during hazardous flash floods.

- The issue with the network of drains is that they often become blocked by urban waste and as a result they overflow and can then cause localised flooding in city streets. Where sewage mixes with the drain water, sewage can spill out into streets. *In developing world cities, where informal squatter settlements lack organised drainage and sewage systems, the flooding of sewage into residential areas is common. The risk to human health is great.*

- The quality of the water that reaches the river is also affected by it having travelled through an urban area. Pollutants will be collected by the water on the impervious surfaces and this will be washed into streams, rivers and lakes, contaminating them. This has an irreversible effect on the aquatic environment.

- As well as the impact on runoff and potential flooding events, the urban water cycle affects other aspects of the system. A reduction in infiltration through a city over time will lead to the water table dropping and any natural water bodies which are still in the urban area will eventually dry out. *Wetlands and forests on the edges of cities have been affected in this way and this has led to habitat destruction affecting many species without human intervention strategies.*

Sustainable Urban Drainage Systems (SUDS)

As a result of the flooding threat to cities and the impacts of increased runoff on channel shape and the aquatic environment, SUDS aims to provide drainage solutions that look for an alternative to channelling water directly into the river system. This is done in various ways:

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- During a storm event, water can be stored in large man-made ponds and then the water is released at timely intervals after the storm to limit the flood risk and reduce the erosive capability of large volumes of water on nearby rivers.

- Infiltration basins are created. These are man-made depressions, engineered to hold back surface water and allowing it to infiltrate slowly into the soil. This reduces the volume of runoff and recharges groundwater reservoirs. Basins are often landscaped to appear natural and of value to the local community. Many are used as football pitches or park areas when not required for flood control.

- Swales and filter trenches are also used. Swales are shallow, flat-bottomed drainage areas which capture rainwater. Swales can also be designed to act as infiltration features, by being designed to slow down the flow of water and let it infiltrate into the soil. Filter trenches are narrow trenches, filled with gravel which allow storm water runoff to be collected. They enable water to infiltrate slowly into the soil. They are also used to treat pollution as they filter water before it enters the soil. This ensures that river water quality is maintained.

- Urban planning: buildings are constructed to intercept run off water by collecting it on roofs in a form of rainwater harvesting and reusing it for irrigation or domestic uses within the city. Green roofs are also encouraged where vegetation will then return some of the water back to the atmosphere through the process of evapotranspiration.

River restoration and conservation

The aim of this strategy is to restore, enhance and preserve the river environment. It also seeks to inspire people living within urban areas to be stewards in regards to river management. The strategies are wide-ranging and include ecological as well as physical management practices.

The reason why restoration is needed is due to the fact that many urban rivers have been changed to accommodate the growing population. Artificial walls have replaced natural river banks, runoff quality is often poor and the ecology of the river has often been changed by the introduction of invasive species as a result of historic poor water quality. One of the most popular methods is to restore river banks: removing artificial banks can increase the growth of vegetation which will reduce runoff directly into the channel. Even more important than that is the impact it can have on species diversity. Biodiversity will increase as the area becomes more natural again.

Due to urban areas producing lots of waste and pollution, one of the most important aspects of river conservation is passing laws concerning permitted effluent releases and policies designed to prevent pollutant discharge into rivers. These laws often address pollution at its source, for example, at factory source. As well as legislation being passed, there needs to be effective monitoring, active enforcement agencies and consequences that deter non-compliance with the laws.

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Non- point-source pollution, such as agricultural runoff, is more difficult to address with legislation as the instigator releasing the pollution is difficult to track down. In this case, land use zoning that requires structures, homes, or farms to be set back a certain distance from a river to prevent pollution is one option. Keeping river edges natural with a rich variety of plants and trees, rather than cutting it away to widen the channel, can also help to prevent runoff as well as reduce erosion on the riverbank. The vegetation will act as a filter to any pollution and will improve water quality.

A brilliant example of SUDS & River Restoration – Cheonggyecheon, Seoul (2002+)

Challenge!

Think about what you have read within this detailed resource package. What specific strategies mentioned can you see in action in Seoul?