Impervious Surface – an Environmental Indicator

Center *for* Land Use Education

Impervious surfaces are one result of community growth that can be directly measured. It is an important indicator -- an understandable measure of our surroundings. It is used to show changes in environmental conditions and to gauge the health of our natural resources. This article discusses the relationship between impervious surfaces and urban land uses.

Urban uses change the local water balance. As is illustrated in Figure 1, removal of natural land cover disrupts the water balance. Imperviousness changes the routing and timing for water to reach a lake or stream. Trees, shrubs and grasses are natural land covers. They shelter the soil surface from rain, wind and surface erosion, intercept precipitation, and filter rainwater. When rain reaches the ground, leaf litter and shallow roots are there to absorb it, as if they were a sponge, and recycle rainwater. Some rainwater strikes a surface, wets it, and some of the water eventually evaporates into the atmosphere. This absorption and recycling is called evapo-transpiration. Natural land covers encourage the lateral movement of shallow infiltrated precipitation into wetlands, lakes and streams. This movement of water is called "interflow." Natural covers also enhance the deeper water movement, or "base flow." On the average Wisconsin receives about 32 inches of precipitation annually, this ranges from 29 inches at Spooner to 37 inches at Lake Geneva (Wisconsin State Climatology Office, 2002). At the latitude and climate of Wisconsin, the cumulative evapo-transpiration generally accounts for around 70% of the total amount of the annual precipitation. Another 13% becomes stream flow and 17% groundwater (Steuer and Hunt, 2001).

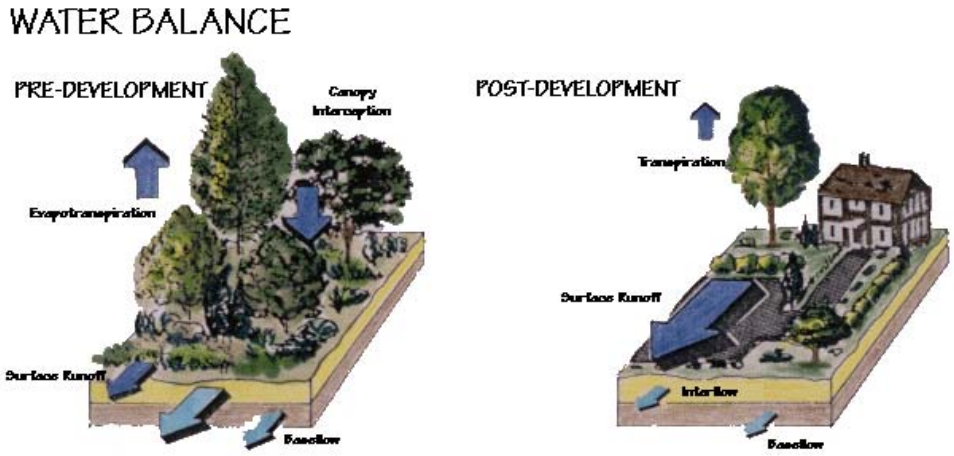

Figure 1: ***Water Balance Illustration. Source: Center for Watershed Protection***

Land use consists of many different land covers. Some are impervious to water while others are not. For example, impervious roof, driveway and sidewalk land covers along with pervious lawns, flower gardens, trees, and shrubs define residential land use. Compacted lawn and agricultural field soils are a middle ground between hard, impervious surface runoffs and spongy natural land covers. Where a parking lot may be 95% impervious, a residential lawn may be 40% impervious and natural land covers are nearly zero (Anacostia, 1991).

Several studies have estimated imperviousness for different urban land use categories. The table below summarizes two such studies. The percentages estimated in the studies are reflective of the general urban use category, but only define a percentage range. Each community should determine values that truly reflect their specific situation.

The unintended results of urban development attributed to imperviousness are:

- Removal of natural storage, retention, and recycling of precipitation

Table 1: **Urban land uses and imperviousness**

Land Use	Ultra Urban Connected Impervious Cover [1]	Chesapeake Bay Results [2]
High Density (lots < 0.5ac.) Residential	41%	33%
Multiple Family Residential	49%	44%
High Rise Residential	64%	--
Schools	39%	34%
Industrial	69%	53%
Commercial (strip malls and office parks)	83%	72%
Shopping Center	92%	--
Downtown Commercial	96%	--

- Significant increases in overland runoff into surface waters
- Decreases in stream base flow and groundwater recharge
- Widening of stream channels
- Increases in floodwater velocities
- Increases in the magnitude and frequency of flooding
- Channel morphology changes because of the altered hydrology (Anacostia, 1991).

Urban development requires the removal of some natural land cover to create a reliable hard surface and to facilitate access to and from our homes, work, schools, commercial, and recreational opportunities. It is essential that a system be developed which quickly and efficiently drains water away from these human activity areas. Flooding or ponding, whether temporary or longer termed, are on acceptable.

In urbanizing communities, impervious surfaces have replaced roots, leaf litter, and forest canopies that were once available to absorb and recycle precipitation. Where precipitation was able to percolate into the ground and infiltrate to the watertable or contribute to stream and lake base flows, now most precipitation runs off directly into our wetlands, lakes, and streams. Natural processes are no longer available to absorb and recycle rainwater and snow melt. Under natural conditions, overland runoff is a relatively minor component of the water balance. Urbanization suddenly makes runoff a significant and probably the most visible component of the hydrologic cycle. The absolute change resulting from a single parking lot may not seem significant, but the cumulative impact of several parking lots, roof tops, roads, divided highways and the like are significant. More water is able to reach a stream or lake more quickly. Existing stream channels will likely not be able to effectively handle the added stormwaters. Waters flow over channel banks. What had been small rain showers, which often never reached the streams as overland flow, now result in bank full floods or worse.

Our neighbors to the west in the Minneapolis area have been witness to these problems. Since 1993 and the Mississippi River flooding, communities in the metropolitan region have experienced three 100-year floods. This is either a very unfortunate statistical aberration, or the imperviousness of the watersheds has indeed altered the frequency and magnitude of flood events. Costs amounted to several million dollars to cities which involved removing residences and installing storm water retention facilities.

Community Actions

- ❑ Adopt community planning policies to:
  - ✓ Identify surface water resources
  - ✓ Identify natural features associated with water resources, such as forested areas, steep slopes, and wetlands
  - ✓ Establish policy statements to create natural buffer zones around surface water bodies and wetlands
  - ✓ Establish policy statements to preserve and enhance natural features
  - ✓ Establish design policies to retain stormwater runoff and encourage inflow and base flow

- ❑ Adopt tools to implement a comprehensive plan that will address the unintended impacts of imperviousness:
  - ✓ Enact overlay zoning districts, which encourage no development or construction activities within all surface water riparian zones
  - ✓ Enact cluster options or Planned Unit Development amendments to existing zoning ordinances, which provide methods and priorities to protect sensitive natural features from development in exchange for possible design incentives to private developers
  - ✓ Include conservation easements with third-party oversight provisions in subdivision control ordinance requirements to permanently preserve and maintain sensitive natural features
  - ✓ Enact landscaping ordinances to require tree planting and landscaping standards for new and renovated parking lots, street rights-of-way, and new subdivisions

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