

## **Linking Land Cover to Ecosystem Health**

**Chester Arnold**

**By Eric LeFlore '11**

Chester Arnold was one of the introductory speakers at Connecticut College's *Smart Growth?* Conference in March of 2011. He laid the groundwork for the conference and really explained how human land use, and subsequently land cover, can substantially affect many different aspects of the environment. Arnold is the Associate Director for The University of Connecticut's (UConn) Center of Land Use Education and Research, which he helped to create. He also works as a Water Quality educator for the Department of Extension at UConn, where he has worked since 1987. Outside the university, Arnold co-founded the Nonpoint Education for Municipal Officials Project (NEMO), which helps land use directors understand the connection between land use and water resource protection. In all of these settings Arnold is concerned with land cover, what is actually on the surface of the earth, and how that affects the environment. The ways humans utilize the land around them has direct consequences on the ecosystem. This paper will summarize Mr. Arnold's work and lecture while also providing additional information to aid in understanding the effect of human land use on the surrounding environment.

Arnold uses geographic information systems (GIS) software to analyze data on the land cover in a specific area of interest. For Arnold, that area is the state of Connecticut. Arnold's work takes information from remote sensing images, aerial photographs or satellite images, and inputs that data into GIS software so that information can be quantified and analyzed. The products of the GIS software are maps that have the data overlaid so they can be easily understood. He looks at what is actually on the land, such as impervious surfaces and developed

land, forest, manicured turf and grass, and agricultural lands. These different land cover categories can be shown on maps produced in the GIS software so that each of these different categories can be connected to different implications on the ecosystem. Arnold's work analyzes these different categories and also teaches land managers to analyze and utilize this type of data. From there, land managers can make educated and environmentally friendly decisions regarding their tracts of land.

The reason that land cover is important to environmental quality is that land cover severely affects water as it moves on or in the ground and can also impact the chemical properties of that water. Eventually, the water does make its way to streams and rivers, to lakes and ponds, to oceans, or even to the water table in the ground, but it may have been contaminated from various chemicals along the way. Some surfaces allow water to infiltrate into the ground while others do not allow the water to pass into the ground water system. When water does not directly infiltrate into the soil, it moves across the surface of the earth and is referred to as "runoff". The area that water flows over or through on its way into a water source, a river or lake, is known as a watershed. Land cover's effects on the water cycle have trickle down effects on organisms and entire ecosystems. Arnold thinks that land cover needs to be involved in the next water regulations because of its major effects on watershed health.

The aforementioned land cover categories are a result of how people, states, and organizations are using the land. The following explanations of the various categories are from Arnold's lecture from the conference. Under the category of developed land and impervious surfaces fall things like buildings and paved areas. These objects do not allow water to infiltrate them and therefore have extreme effects on discharge, the amount of water that flows through a river or stream. (This will be discussed later in this paper.) Also calculated is the amount of land

that is used for agricultural purposes, which encompasses all sorts of farms and agrarian areas. Due to the pesticides and fertilizers used in these areas, agricultural lands present another challenge to water protection. The substances used on the crops contain phosphorous and nitrogen which then get dissolved into water and have effects on the aquatic plant life. This has trickle down effects to the entire ecosystem. Forest land is another category of land cover that is important in Connecticut. This is land that, for the purposes of this data set, is left unmanaged or “wild”. The manicured turf and grass category is identified as open land but land that is managed. This includes people’s lawns, golf courses, recreational parks, and so on. They also contribute fertilizers to the water cycle.

The main crux of Arnold’s presentation was that based on the data he has been analyzing, which shows that the amount of impervious cover and developed areas is increasing in Connecticut. Arnold took data from 1985 and compared it with data as recent as 2006. This allows Arnold and his colleagues to understand the trends of land cover change in Connecticut. Based on the data and the maps produced, Arnold concluded that impervious land cover has increased substantially in the 20 years of data that has been analyzed. Impervious cover is not the only land cover category to increase, manicured turf and grass has also increased. These two categories have increased at the expense of agricultural land and forest. This means that the land that is very good for absorbing water into the ground has been converted to land that increases the amount of runoff and also increases the amount of fertilizers being washed into the watersheds. An increase in runoff has major impacts on the waterways of the area. Arnold showed a chart that exhibited discharge numbers after a rain event for a river in a natural environment on one curve with a second curve exhibiting a river that had impervious surfaces near it. The general and typical trend after a rain event is a gradual increase in discharge until it

slows and eventually levels off back to normal flow. However, when impervious surfaces are added to the equation, the typical curve is accented in every direction; the amount of water flowing increases, the water reaches the river quicker, and flows downstream quicker past where the discharge is being measured. This results in faster and more extreme flood like conditions for the area, changing the dynamics of the river ecosystem.

The decrease in amount of forest cover has other effects as well. Having forested land helps in carbon sequestration, helps to continue the water cycle, helps maintain air quality, and helps to regulate temperature. Losing this land can contribute to a host of environmental problems. As forested land is being cut away, the quality of that forest is impacted. Arnold explained that there are multiple types of forest, each with different ecological implications. He described the different types of forest for his research as: core forest, an intact area that is forest surrounded by forest; perforated forest, forest with holes cut out of the forest landscape, for example driveways for houses with forests around; edge forest, an ecological concept where forest met with areas of non-forest in a linear fashion; and lastly patch forest, which is basically urban tree canopy, trees surrounded by developed land. He went on to say that forested land is usually left out of land management plans but it is integral to overall ecosystem and watershed health. When Arnold works with town officials and land managers, he usually tries to push the protection of core forests.

Arnold went on to discuss many maps that showed these changes in land cover. The loss of forest and agricultural land cover as well as the increase in impermeable surfaces and manicured turf and grass is extremely visible when comparing the 1985 map to 2006 map. Arnold explained that there is a distinct pattern to these changes: these areas are linked to urban sprawl. He spoke about the growth along the Interstate 95 to Interstate 91 corridor, identifying

three areas in Connecticut that have increased their impervious cover: a section in southwestern Connecticut, a section around Hartford, and also a section around New Haven. Both Hartford and New Haven have grown since 1985, thus resulting in increased amount of development and impervious cover. The area in southwestern Connecticut is the “overflow” from New York City. These trends are similar to what is seen across the entire country – people are not living within the larger cities, but are working in cities and living outside of that city. This is a classic example of urban sprawl with the shadows of cities expanding outward from a main hub. As these shadows grow in size, more and more land is covered by impervious surfaces, leading to the plethora of ecological issues, as discussed above.

Chester Arnold helped to set the stage, laying the foundation for a weekend of great lectures, by providing data that illustrated growth and urban sprawl while also talking about how that sprawl affects the environment. The ecological functions and values Arnold described are the reason policy makers and land managers need to be aware of how they are utilizing and protecting the land. The data provided by Arnold gives helpful insights to what needs to be discussed and monitored: the expansion of impervious cover. If future land management plans consider impervious land cover, areas will be able to grow in a smarter fashion and have fewer negative impacts on the environment.

## **Bibliography and Extra Information**

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