A Biography of Waller Creek

A Case Study in Urbanization and Environment

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The Research Problem

How has Austin's urbanization changed the natural environment, to what extent, and when? It is not necessary to survey the entire city to gain an appreciation of these changes; much can be learned by focusing on a portion of a single watershed. Case studies and reconnaissance surveys such as these are used frequently for preliminary exploration of complex phenomena and for planning larger research projects. The value of such a study relies on how well the case represents the processes found throughout the environment. A good "case" for our study is the University of Texas campus. It lies almost entirely within the Waller Creek watershed and its growth since the late nineteenth century is closely related to Austin's development as a major city. In focusing on Waller Creek, we will address how the development of the campus has 1) changed the natural groundcover in the watershed; 2) the extent of the modifications; and 3) when these changes occurred.

Effects of Urbanization on Environment: An Overview

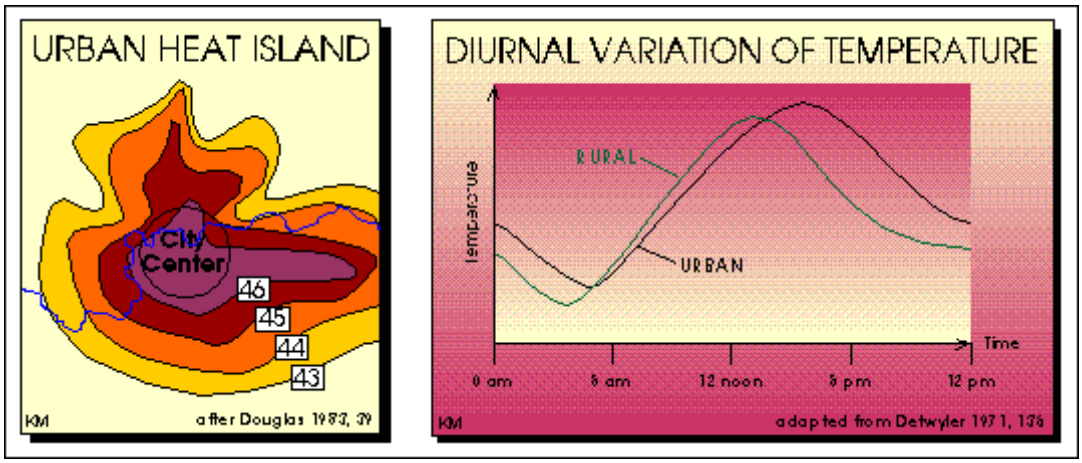
The interaction between society and environment is a fundamental theme of much geographical research. Cities are an excellent place to study these interactions. The process of urbanization results in large numbers of people gathering in relatively small areas. There the effects of habitation are concentrated and focused. Human effects on the atmosphere, lithosphere, hydrosphere, and biosphere are often so pronounced that cities can be said to create their own environments. They do this in a number of ways:

1) Effects on the Atmosphere and Climate

Cities create their own environments and, as they do so, they exert powerful effects on the atmosphere and climate. Among the most important of these are:

a) The Creation of Heat Islands

Cities are made of concrete, asphalt, brick, stone, and steel. These materials absorb and reflect energy differently than vegetation and soil. They absorb more radiant energy and radiate this energy back into the atmosphere at different times through the day. The result is that cities are warmer than the surrounding countryside, sometimes considerably. Furthermore, cities remain warm well into the night when the countryside has already cooled.



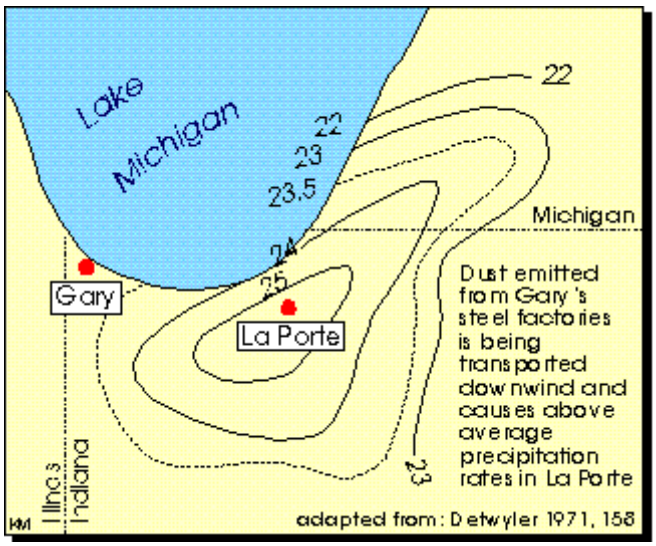
This heat influences air circulation and patterns of precipitation.

b) Changes in Air Quality

Human activities release a wide range of emissions into the environment including carbon dioxide, carbon monoxide, ozone, sulfur oxides, nitrogen oxides, lead, and many other pollutants. Some of these emissions are toxic and have claimed many lives in some cities when concentrations reached dangerous levels as in the "killer smogs" of London in the 1950s and 1960s. Others emissions such as carbon dioxide, act to trap heat in cities. Cities also release quantities of dust into the atmosphere, with effects like those mentioned next.

c) Changes in Patterns of Precipitation

The dust and emissions released into the atmosphere alter patterns of precipitation over the cities and in areas downwind. Cities often receive more rain than the surrounding countryside since dust can provoke the condensation of water vapor into rain droplets. Dust carried downwind from cities and industry can increase rain in city shadows. One of the most notable of these rain shadows, the La Porte anomaly in Indiana, is diagrammed below.

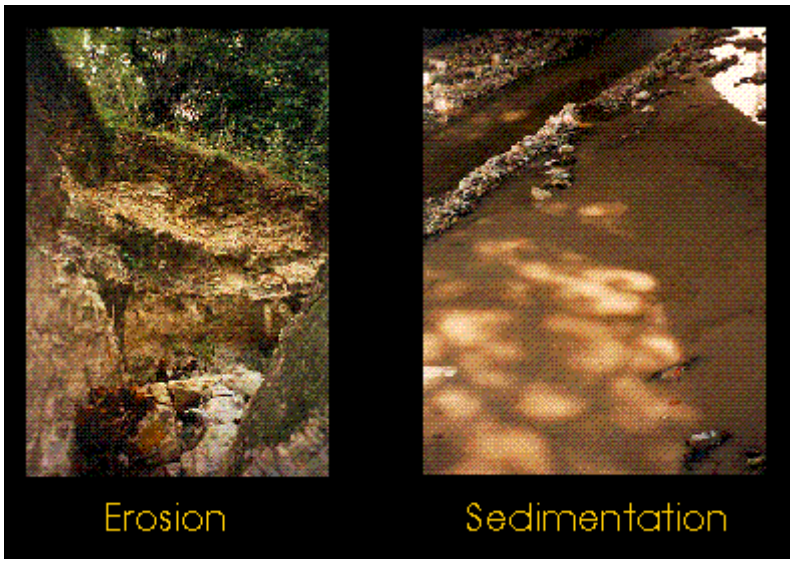


2) Effects on the Lithosphere and Land Resources

Urbanization has similar effects on land resources. Natural land cover is disturbed as cities are built leading to:

a) Erosion and other changes in land quality

Rapid development can result in very high levels of erosion and sedimentation in river channels.



b) Pollution

Pollutants are often dispersed across cities or concentrated in industrial areas or waste sites. Lead- based paint used on roads and highways and on buildings is one such example of a widely dispersed pollutant that found its way into soil. But humans also bury tremendous amounts of waste in the ground at municipal and industrial dumps. These materials can severely contaminate soils. Even such commonplace items like gasoline storage tanks at filling stations have the potential to cause serious contamination. When this problem was discovered a decade ago, hundreds of storage tanks had to be removed and replaced with safer containers. The most extreme cases of industrial pollution, as at Love Canal in Buffalo, New York, have forced the abandonment of large tracts of land.

3) Effects on the Biosphere

As humans establish cities, they disturb habitats and destroy others. But, at the same, time they import new species of plants and animals and create habitats for other unintended species.

a) Modification of Habitats

Modifications can take place in many ways. Natural ground cover is replaced with grasses and decorative plants, although many native species will be left in place. Fertilizers spread across lawns finds its way into water channels where it promotes the grow of plants at the expense of fish. Waste dumped into streams lowers oxygen levels during its decay and caused the die-off of plants and animals. Sometimes, cities allow native species, such as squirrels and raccoons, to increase far above their natural concentrations.

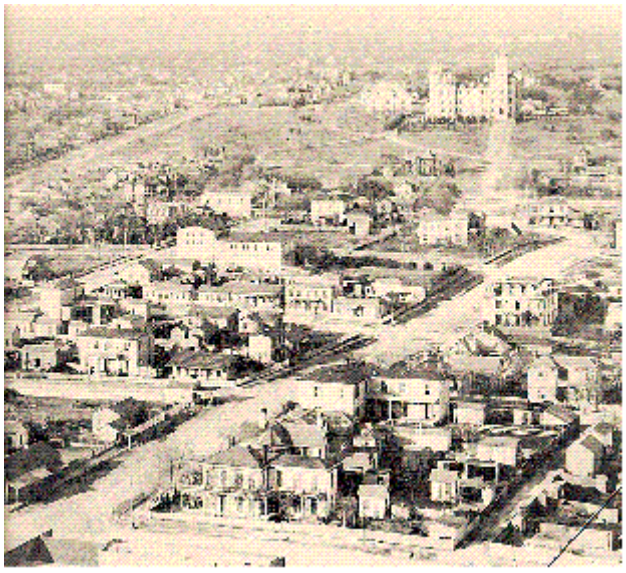
b) Destruction of Habitats

In some cases, entire habitats are eradicated by urbanization and native species are pushed out of cities.

c) Creation of New Habitats

New habitats are also created for some native and non-native species. Urbanization has, for example, eliminated many bat colonies in caves, but has provided sites such as bridges for these species to nest. Cities also create habitats for some species considered pests, such as pigeons, starlings, sparrows, rats, mice, flies and mosquitoes.

Sometimes we hardly notice these changes. This view of Austin from the 1890s is notable for the sparsely vegetated landscape it captures. Today, Austin is richly vegetated by live oak, cedar, and many other natural and imported species. The University of Texas campus owes its present lush appearance to a program of tree planting dating back to the 1930s.



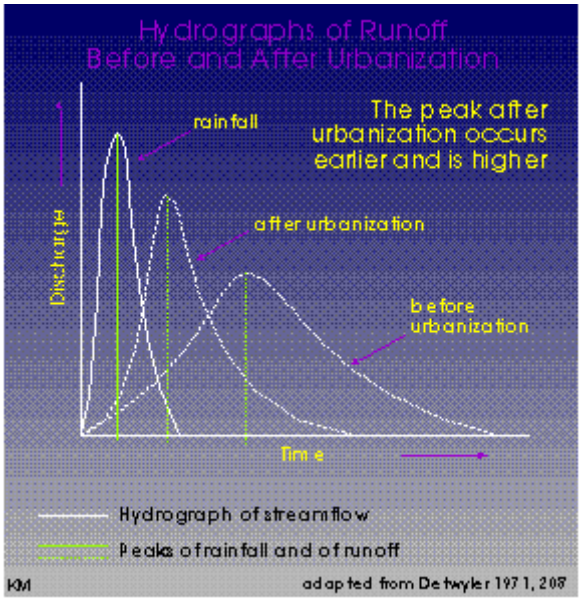
The first picture shows the University of Texas at Austin as seen from the Capitol before 1895. On the second picture a part of the University of Texas campus and downtown Austin as it is today can be seen.

4) Effects on the Hydrosphere and Water Resources

Urbanization has a great effect on hydrology, for a number of reasons.

a) Flow of Water into Streams

As cities grow, natural groundcover changes dramatically. Natural vegetation and undisturbed soil are replaced with concrete, asphalt, brick, and other impermeable surfaces. This means that, when it rains, water is less likely to be absorbed into the ground and, instead, flows directly into river channels. Not only does more water reach the stream channels, but it arrives far more quickly after a storm. Natural vegetation slows run-off, concrete and asphalt speed the flow. The result diagrammed below indicates how urbanization speeds run-off and produces higher peaks of flow.



b) Flow of Water through Streams

Higher, faster peak flows change streams channels that have evolved over centuries under natural conditions. The result is a spread of the channel vertically and horizontally to carry the extra flow. Rapid erosion of stream banks and down-cutting of stream beds occurs. When the existing stream beds cannot handle the increased flow, they flood the surrounding urban area, particularly development within adjacent floodplains.

Flooding can be a major problem as cities grow and stream channels attempt to keep up with these changes.

Click here to see examples of flood damage in Austin.

i) Methods for Controlling Flooding

Often humans intervene to speed the flow of water through stream channels and to control erosion. Many different methods exist to control flooding and the flow of streams. Banks may be reinforced with plants, rock, or concrete retaining walls. In extreme cases, a stream may be "channelized," that is totally lined with concrete. Such channelization turns the stream into a very efficient culvert. Unfortunately, such channelization has the disadvantage of simply shifting the burden of the extra water flow downstream to other communities.

Click here to see examples of flood control measures in Austin.

It would be nice to find a photo of the Los Angeles River, the diversion of the Trinity River in Dallas, Bogey Creek here in Austin will be fine, though.

ii) Encroachment of Flood Plains

As they grow, cities also tend to encroach on flood plains. These are low-lying areas that can hold and absorb overspill from stream during periods of high water. This encroachment of courses places humans in the way of floods. But encroachment also effects a watershed's ability to manage waterflow naturally. Excess flow may be kept out of floodplains by forcing extra flow downstream at higher speeds, with obvious consequences. Erosion and down-cutting will increase and the danger to downstream communities will increase.

c) Degraded Water Quality

These changes in the flow of precipitation into and through urban watersheds holds a number of consequences of water quality.

i) Increased sedimentation

An increased area of exposed and soils and higher runoff speeds means that more sediments are carried into local and downstream watersheds. This leads to increased rates of sedimentation.

ii) Pollutants in runoff

As water washes across urban surfaces, it dissolves and carries pollutants into streams and rivers. Toxic chemicals, oil, and other pollutants are all deposited in the watershed, sometimes in sediments. Also, most cities use rivers to dispose of the affluent from sewage treatment. Nowadays, it is relatively rare in the United States for untreated sewage to be discharged into waterways since storm and sanitary sewers have been divided for the most part into separate systems, but it does happen from time to time. Chemical tests of water samples are often required to identify pollutants but, sometimes, the color and smell of the water provide clues.

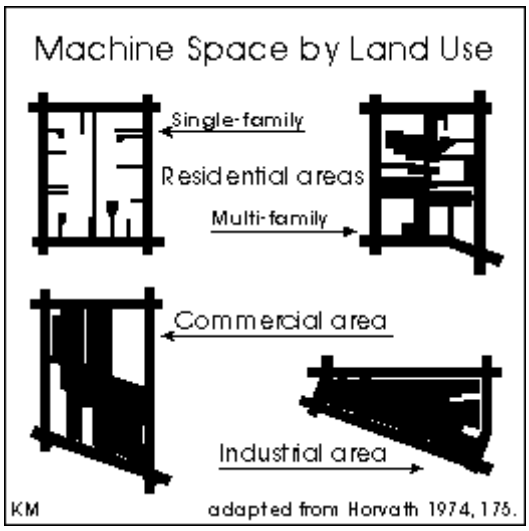
Click here to see examples of pollution of Austin rivers.

5) The Interaction of Effects

One of the most interesting aspects of these processes is that they interact to reinforce one another. Atmosphere disturbances caused by urban activities increase precipitation, which increases erosion, which carries more sediment into river channels. Disturbances of land can cause disturbances of aquatic environments and increased levels of dust in the atmosphere. These cyclic and cumulative effects mean that urban ecological relations can become particularly complex. One change leads to another and another in a complicated, spiraling series of feedback loops.

6) How These Effects Develop

Sometimes it is easy to see how urbanization shapes the environment, particularly in peripheral areas were large suburban developments may consume hundreds of acres per year. But the impacts of urbanization begin early. Sometimes, the period of initial urban settlement produces the most radical changes in watersheds as tracts of land are cleared for the first time. Encroachment continues long beyond initial settlement as an almost continuous process. These maps of "machine space" show how the area of impermeable surfaces increases through time.



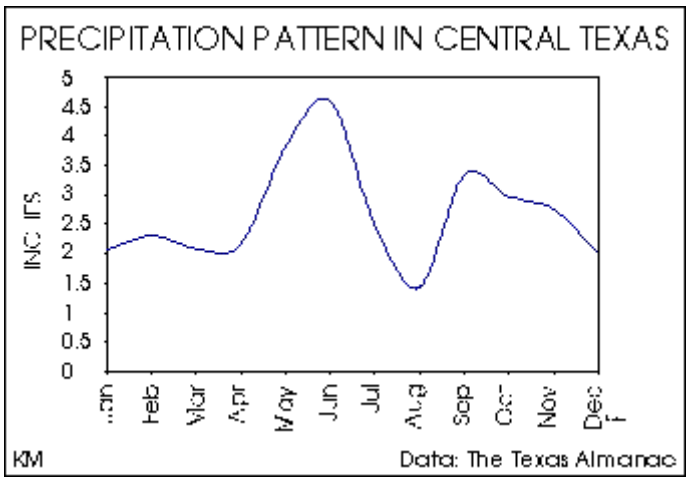
Click here to see examples of encroachment of Austin rivers and streams.

7) Consequences for Human Populations

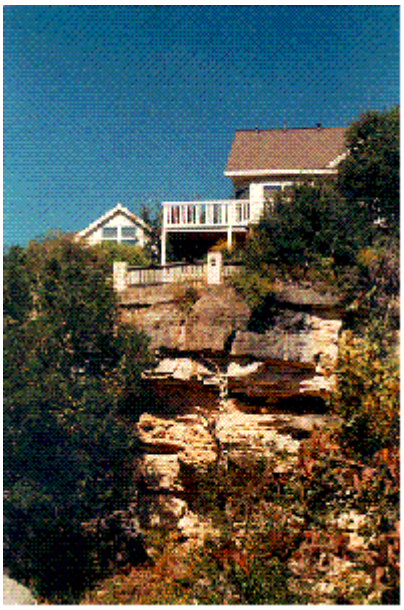
These changes in urban environments have obvious consequences for their human populations. Increased levels of airborne and waterborne pollutants have adverse effects on human life. Large cities and cities in mountain basins are particularly prone to air quality problems stemming from the burning of fossil fuels for transportation, electrical generation, and heat. Urban water supplies have to monitored carefully for increased levels of toxins. Changes in the flow of water through cities sometimes leaves them vulnerable to flash floods. More subtle effects are sometimes noted. Many people moved to the desert regions of the American Southwest between the 1930s and 1960s for health reasons, to escape respiratory problems in the dry, relatively pollen-free environment. But they brought along decorative plants and trees which added pollens to the air in such quantity that there is now little difference between the pollen counts in cities such as Phoenix and Tucson and cities to the east and north.

8) The Special Environmental Situation of Austin

Austin has environmental characteristics that accentuate some of the problems caused by urbanization. Periods of the highest precipitation peak in the spring and fall. These are the times when seasonal shifts over North America bring moist air from the Gulf of Mexico in contact with colder air masses from the north into contact over Austin. This means that Austin can have weeks of exceptionally heavy rains in the spring and fall followed by months of little precipitation. During the high peaks, Austin's drainage system is subject to flash floods.



The incidence of flash floods is increased because much of Austin rests on thin soils atop relatively impermeable bedrock. This means that less rainfall can be absorbed into the ground. When soils are saturated, water runs into local stream channels in greater quantity and at greater speeds.



Techniques for Assessing the Effects of Urbanization

In the project we will focus on the development of the section of the Waller Creek watershed that contains the University of Texas campus. We are interested in how the development of the campus has 1) changed the natural groundcover in the watershed; 2) the extent of the modifications; and 3) when these changes occurred. We have a very good digital map of campus that we can use as the base for our study. Each person will be responsible for selecting one section of campus for detailed investigation. The steps in our study are:

A) Divide campus into study sections and assign responsibilities.

B) Acquire a copy of the digital campus map from the anonymous ftp server on **austin.grg.utexas.edu** in the **CAMPUS** subdirectory. Alternatively, the file can be obtained from the download directory by clicking on each file while holding down the shift key.

C) Cut your section out of the complete map and compress the resulting file. Do not rotate your section or it will be very difficult to reassemble the sections at the end of the study.

D) Survey your study area on foot to check your digital map and gather direct evidence of the timing and sequence of changes.

E) Gather archival and historical sources including photographs and air photographs that allow you to track and date changes in groundcover. We will try to localize changes to particular decades, rather than years. Good sources of information include the library of the Center for American History (the Barker Texas History Center), the Austin History Center (a branch of the Austin Public Library), and the State Archives. Information is also available from the UT Physical Plant and air photographs can be obtained from many sources including the City of Austin, Texas Department of Transportation, and private providers like Miller Blueprint. PCL library has an excellent set of color air photographs of all of Travis County from 1984.

F) Develop a coding scheme (levels and symbology) for the information you have gathered. We must develop this scheme together as a class so that we maintain consistent coding for all sections of campus.

G) Use the information you have gathered and the coding scheme to map the changes in your study area.

E) Analyze your findings and compare them to the figures we calculate for campus as a whole.

Further Reading

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