Nonpoint Source Best Management Practices to Mitigate Climate Change*

Introduction

The world's weather is changing. That in itself is not unusual. Over centuries and millennia, the global climate shifts somewhat. But usually little change is expected on the scale of a human lifetime. However, over the last several decades, and particularly recent years, much of the world, including the U.S., has been subject to increasing numbers of extreme weather events. Furthermore, these extreme events—such as floods, droughts, heat waves, wildfires, tornados, and blizzards—in many cases are of greater magnitude than in the past. Scientists attribute this to changing climate conditions created by warmer global average temperature and the resultant increased retention of energy in the lower atmosphere. And climate projections from the Intergovernmental Panel on Climate Change (IPCC)—comprised of representatives from 130 countries—indicate the warming of the earth will continue for the foreseeable future due to continual atmospheric increases of greenhouse gases such as carbon dioxide and methane.

What this means for Michigan is that temperature and precipitation patterns are likely to change significantly from what the state has experienced over the last couple of centuries. Climate change models predict that Michigan's future will be significantly hotter than it is now. By 2100, the IPCC projects that Michigan summers will range somewhere between those now experienced in Arkansas to those of western Oklahoma or northern Texas. Winters are anticipated to range from those that currently occur in Ohio to those of southern Missouri. Numerous changes in water quality and the delivery of pollutants to Michigan's surface waters are expected due to these changes in Michigan's weather.

Temperature Increases

Warming temperatures are expected to shift species ranges north, leading to the replacement of cold weather species with those tolerant of warmer conditions. Some of this has already happened. Between 1990 and 2006, plant hardiness zones shifted about half a zone northward. The composition of forests in the Great Lakes region is also changing with many tree species shifting northward while being replaced by more southerly varieties. Many iconic north woods tree species, such as pines and spruces, will lose their cool-weather advantages and be slowly replaced over the next century by hardwoods. When these species changes occur in a riparian zone, water quality could be impacted by a loss of canopy cover leading to warmer water temperatures, which could threaten the suitability of designated trout streams to support coldwater fish communities. The vegetation changes could also lead to a loss of ground cover if new growth does not readily replace lost species, leading to erosion and greater delivery of pollutants through the less vegetated area. In the aquatic environment, warmer weather is expected to increase the occurrence of nuisance population levels of both plants and algae, degrading water quality conditions. Still another problem is the increased length of summer stratification in lakes adds greater risk of oxygen depletion, putting many organisms in danger of dying from lack of oxygen. Such anoxic conditions could also mobilize sediment bound phosphorous and some metals, creating associated water quality problems.

<u>Precipitation Changes</u>

The future direction of precipitation changes in Michigan is less certain than that of temperature. On one hand, the earth's northern hemisphere is expected to get wetter, but on the other hand, the interiors of continents are expected to be drier. Additionally, changes in the Great Lakes region are difficult to predict because of the direct influence of the Great Lakes themselves on area weather. The best current prediction is that the Great Lakes region will not only experience more frequent intense precipitation events, but that these will be concentrated in late winter (more falling as rain rather than snow) and spring with a corresponding decrease in summer rainfall. The frequency of heavy rainstorms, both 24-hour and multiday, will continue to rise and estimates are they could increase 50-100%. The shift to increased springtime rainfall is another threat to water quality. Soils are typically saturated at this time of year, so rainfall events quickly lead to large amounts of surface water runoff, which transport pollutants to water bodies while inundating landscapes and streams with more water than they can handle, creating flood conditions. This is also the time of year when many farm fields and construction sites lack vegetative cover, exacerbating the transport of pollutants while eroding the land surface and stream banks.

Though it is thought that the annual average precipitation will remain about the same in the Great Lakes area, rainfall amounts will not fully compensate for drying effects of warmer climate. Additionally, the seasonal shift in rainfall patterns will lead to longer periods of dry weather in the summer with declining soil moisture levels increasing the potential for drought conditions. This will generate additional threats to water quality, including less summer groundwater recharge to streams thereby decreasing or even stopping flows in some streams. Decreasing summer low flows in streams could also harm stream health by making them more susceptible to solar warming and direct warmwater inflows from summer rain storms. Consequently, many streams and lakes now supporting coldwater fish may no longer support that type of aquatic community in the future. Water bodies in general will be more susceptible to invasive species as native species adapted to cold water ecosystems disappear when waters warm above their tolerance levels.

<u>Water levels</u>

Water levels for the Great Lakes and inland lakes are generally expected to drop as precipitation will not be sufficient to counter increased evaporation rates from warmer summers and less ice cover during the winter. However, the degree of evaporation is uncertain and the variability in predictive precipitation patterns, particularly for Michigan, is partly due to this as well as the amount of lake effect precipitation the state will receive versus that from system precipitation events. Declining lake water levels also affect ecosystem health by potentially lowering water below shoreline habitat such as wetlands and fallen trees, depriving some species of important breeding, nursery, feeding and shelter areas. Additionally, the loss of these absorbent filters in the riparian zone will increase the potential for pollutants to enter these water bodies and degrade water quality, particularly given the predictions for more intense rainfall events. As surface water levels in lakes and streams fall, there will be pressure to increase water extraction amounts from groundwater, which could further decrease surface water levels. Yet another problem is that lower water levels combined with warmer water temperatures may increase the length and magnitude of summer anoxic conditions in some stratified lakes and accelerate the accumulation of mercury and other toxic contaminants in the food chain.

Nonpoint Source BMP Considerations

Climate change projections for changes in temperature, precipitation and vegetation patterns need to be considered when selecting, designing and installing best management practices (BMPs).

Temperature Change Mitigation

Expand the use of green infrastructure and low impact development to (1) reduce *summer* stormwater runoff of warm water into surface waters, and (2) enhance groundwater recharge to provide more coolwater input to surface waters.

Increase riparian tree canopies to decrease the amount of direct solar radiation heating surface waters, wetlands and floodplains.

Remove dams that no longer serve their purpose to reduce the surface area of impounded river water warmed by solar radiation in the summer.

Protect and restore wetlands and floodplains to adsorb stormwater runoff and increase the amount of groundwater recharge of cool water to streams during the summer.

Precipitation Change Mitigation

Utilize more low-impact development techniques to reduce stormwater runoff and increase groundwater recharge.

Install larger-sized stormwater infrastructure to accommodate increased stormwater and river flows from bigger precipitation events. This is particularly important for transportation river crossings and municipal stormwater systems.

Expand the use and size of greenbelts to filter increased stormwater runoff before it reaches surface waters.

Protect and restore wetlands and floodplains to rivers to absorb stormwater runoff to: (1) minimize the magnitude of streambank erosion from high flow stream events, and (2) increase the amount of groundwater recharge to streams during the low-flow summer period. Minimize development and conversion of wetlands and floodplains.

Install rain barrels at buildings to provide irrigation water for nearby vegetation, particularly during the summer.

Reuse gray water for irrigation where feasible to minimize water withdrawals from both surface water and ground water.

Convert sprinkler, spray and open trough irrigation systems to underground drip lines to minimize evaporative loss of irrigation water, particularly during the summer.

Increase conservation easements on forested lands to protect forested land cover and thereby reduce stormwater runoff and soil erosion, while preserving the groundwater recharge functions of these ecosystems.

Vegetation Change Mitigation

When installing a new greenbelt or enhancing/expanding an existing one, use a diverse set of plant species paying particular attention to those species with the ability to survive warmer, longer and drier summers, yet are also able to withstand longer periods of saturated spring soil. A diverse plant assemblage is also important to help mitigate the impacts of anticipated increases in pest populations and the arrival of new pests due to a warming environment.

Use xeriscape landscaping in dry or exceptionally sunny locations to minimize the need for summer irrigation water.

Plant more trees to increase the acreage of forested land cover, which protects against soil erosion and minimizes stormwater runoff, while enhancing groundwater recharge and sequestering carbon from the atmosphere.
