Changes in Precipitation

Issue

Weather extremes pose a challenge to water and related land management within Coon Creek (Appendix B, pages 5 - 10; Appendix C). Recent episodic events such as drought, high intensity mini-storms, and weather variations can damage soil, water, and lead to a general scarcity of water.

In addition, the pending publication of Atlas 14, Volume 8 appears to clarify through a larger more representative sample of precipitation that the larger less frequent storm events may be as much as 30% larger than originally thought and planned for when sizing ponds, pipes, culverts and other water management infrastructure and that 100 year floodplains may be significantly larger than the original floodplain studies conducted in the 1970's had estimated.

From a local water management perspective there are four critical impacts regarding precipitation and potential climate change:

1. How increasing hydrologic variability may affect water supply and demand and stormwater collection and treatment.

2. How changes in climatic patterns potentially may have large impacts on the watershed in the coming century.

3. How increasing hydrologic variability (e.g., wetter wet seasons and drier dry seasons) will pose challenges for Coon Creek since topography limits the ability to create artificial areas to store excess precipitation for use during the anticipated extreme dry periods.

4. How changes in precipitation frequency and/or intensity will affect local floodplain management programs and the operation, maintenance and performance of the stormwater treatment systems and best management practices.

Goal

1. To gather and disseminate weather data and climatic information, and provide meteorological expertise in support of Watershed District water and related resource management decisions and weather related management activities.

2. To ensure validity, integrity, and utility of weather information provided for Watershed District use.

3. To provide precipitation frequency estimates for the Coon Creek Watershed

Objectives

1. Coordinate requests for meteorological assistance and related research by other units of a long-term and/or Watershed scope.

2. Use meteorological data in water and related resource management decisions.

3. Install, operate, and maintain Watershed District weather stations in accordance with this chapter and related policies unless those standards would conflict with the primary objective of a station operated for research purposes.

4. Locate year-round Watershed District weather stations to optimize the multidisciplinary needs for real-time weather and climatological data when consistent with the primary objective of the site.

5. Share costs for installing, operating, and maintaining weather stations between or among benefiting functions.

6. Operate weather stations precipitation gages in compliance with the Memorandum of Agreement and work plan between the Watershed District, Anoka Conservation District, Minnesota DNR and the University of Minnesota.

Introduction

The principle impacts of climate change would manifest themselves through changing precipitation patterns that may result in more severe drought or floods and varying stream flow patterns and lake levels.

The uncertainty caused by potential climate change relative to its impacts on water resources poses a daunting challenge for Flood control, water quality management and water resources such as lakes and wetlands and stormwater professionals responsible for managing water resources in the watershed. Therefore, water management authorities must anticipate, plan for and adapt to the potential effects of climate change.

Current Situation

The 2000-2010 Comprehensive Plan noted that a “key Factor and Major Issue Facing the Watershed was “Unusual or Prolonged Adverse Environmental conditions.

That plan noted that weather extremes have always posed a challenge to water and related land management and that episodic events such as

drought, high intensity mini-storms, and wildfire have created or set the stage for problems such as excessive erosion and sedimentation which can affect the public health, safety and welfare. The concern was that increases in the variability and intensity of weather extremes may be leading to an increased shifting of greater portions of the District's resources to emergency response and that if the trend continued it would be difficult to manage in an orderly and equitable manner.

Atlas 14

In January 2013 the District became aware of a project being conducted and released for technical review by the National Oceanic and Atmospheric Administration (NOAA) called Atlas 14. Atlas 14 contains precipitation frequency estimates with associated confidence limits for the United States and is accompanied by additional information such as temporal distributions and seasonality. The Atlas is divided into volumes based on geographic sections of the country.

The Atlas is intended to replace Technical Publication 40, and associated documents, as the official documentation of precipitation frequency estimates and associated information for the United States. It includes discussion of the development methodology and intermediate results. The Precipitation Frequency Data Server (PFDS) was developed and published in tandem with this Atlas to allow delivery of the results and supporting information in multiple forms via the Internet.

The Atlas provides precipitation frequency estimates for 5-minute through 60-day durations at average recurrence intervals of 1-year through 1,000-year. The estimates are based on the analysis of annual maximum series and then converted to partial duration series results.

The information in NOAA Atlas 14, once adopted, will supersede precipitation frequency estimates contained in Technical Paper No. 40 "Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years" (Hershfield, 1961), NWS HYDRO-35 "Five- to 60-minute precipitation frequency for the eastern and central United States" (Frederick et al., 1977) and Technical Paper No. 49 "Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States" (Miller et al., 1964).

The results are provided at high spatial resolution and include confidence limits for the estimates. The Atlas includes temporal distributions designed for
use with the precipitation frequency estimates and seasonal information for heavy precipitation. In addition, the potential effects of climate change were examined.

The new estimates are based on improvements in three primary areas:

1. Denser data networks with a greater period of record,
2. Application of regional frequency analysis using L-moments for selecting and parameterizing probability distributions and
3. New techniques for spatial interpolation and mapping.

The new techniques for spatial interpolation and mapping account for topography and have allowed significant improvements in areas of complex terrain.

Event	Annual Probability	TP-40 (inches)	Atlas 14 (inches)	Percent Change
2 Yr	50%	2.78	2.9	1.8%
5 Yr	20%	3.5	3.8	8.5%
10 Yr	10%	4.1	4.6	12.1%
25 Yr	4%	4.7	5.8	23.4%
50 Yr	2%	5.3	6.7	27.6%
100 Yr	1%	5.9	7.6	29.9%

Climate Change

According to the U.S. Environmental Protection Agency (EPA), the climate of the earth is changing because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases, primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. Projections by the Intergovernmental Panel on Climate Change suggest that temperatures in Minnesota could increase by about 4°F (with a range of 2-7°F) in winter, spring, and fall, and by somewhat less in summer. Precipitation is projected to increase by around 15% in winter, summer, and fall, with little change projected for spring.

If the climate warms, the ice-cover on lakes and streams would melt earlier. Many lakes and streams in the northern hemisphere already are showing these effects (Magnuson and others, 2000; Hodgkins and James, 2002).

According to the 2003 report on climate change by the Soil and Water Conservation Society, total precipitation amounts in the United States and the Great Lakes region of Canada, are increasing, as are storm intensities. Precipitation records in the Twin Cities area indicate that the annual average precipitation has increased, as shown in the following examples:

Period	Avg Annual Precipitation (inches)	Pct Change
1960-1990	28.32	
1970-2000	29.41	3.8%
1980-2010	30.30	3.0%
1990–2010	32.59	7.6%

The potential effects of climate change are also being evaluated as part of Atlas 14. Other Volumes of Atlas 14 have analyzed the 1-day annual maximum series for linear trends in mean and variance and shifts in mean to determine whether climate change during the period of record was an issue in the production of this Atlas.

Precipitation frequency studies make the implicit assumption that the past is prologue for the future, i.e. that climate is stationary. Tests for linear trends in means and variance and shifts in mean were conducted on the 1-day annual maximum time series to verify the suitability of the data for this Atlas. At this writing the results of that analysis are not available for public review.

Strategies to Achieve the Goal

Strategies to help reduce the effects of unusual or prolonged environmental conditions include:

Development Regulation

Assist in the application of best management and best development practices that not only improve the resiliency of the resource but encourage its sustainability.

Capture and Retain maximum amount of precipitation.

Break up routing of stormwater to maximize retention and detention to benefit water quality, flood control, habitat and water supply.

Adopt ‘treatment train’ approach to the management and retention of water.

Add an advisory notice to permit reviews that provide the Atlas 14 100-year elevations.

Planning, Programming and Budgeting	Risk assessments must be done to understand the uncertainties associated with the effects of climate change.
	Address climate impacts on major subwatersheds.
	Promote subwatershed planning to address the sub-regional/sub-watershed nature of increasingly "localized" storm and environmental events or conditions.
	Continue to develop the District's hydrologic model as a basis for supplying information and tools to lessen present and future impacts.
	Review all stormwater standards and sizing criteria and evaluate performance in light of changes in precipitation.
	Verify the District's Atlas 14 XP-SWMM model.
	Investigate with member cities, the DNR, FEMA and CAC the benefits and impacts of making the District Atlas 14 XP-SWMM model the regulatory flood plain model for the Watershed.
Public & Governmental Relations	Provide assistance to cities, when needed in characterizing their water resources and how these resources could be affected by climate change.
	Provide leadership within the watershed district on long-term issues with protecting existing water supplies (including potential changes in state water policy).
	Continue discussing with the TAC and CAC the implications of increasing rainfall amounts on design and maintenance of water resources and administration of individual municipal floodplain programs.
Research and Monitoring	Support research to develop Sand Plain-specific climate change models in order to foster a sustainability/vulnerability analysis handbook on climate change impacts.
	Ensure that the location of weather stations meets multiple-use management and/or research needs of the Watershed District
	Ensure the installation, operation, and maintenance of weather stations in accordance with accepted standards.
	Assure the transmission of information to MDNR within established standards and guidelines.