7-2009

Water Demand and Supply Outlook for Greater Chicago Area

Ben Dziegielewski
Southern Illinois University Carbondale

WATER DEMAND AND SUPPLY OUTLOOK FOR GREATER CHICAGO AREA
Extended Abstract

Ben Dziegielewski, Department of Geography and Environmental Resources,
Southern Illinois University Carbondale, benedykt@siu.edu

Study Area

Sustainability of existing water supply systems is a concern in many urbanizing regions of the United States. One of such areas is the City of Chicago and the surrounding 11-county region of Northeastern Illinois. The region includes about 250 municipalities with total resident population of nearly 9 million. It encompasses the counties of Boone, Cook, DeKalb, DuPage, Kane, Kankakee, Kendall, Grundy, Lake, McHenry, and Will (Figure 1). Nearly 96 percent of the population is served by about 530 public water supply systems and nearly 400,000 residents rely on private wells. Other significant water users included 12 large power plants, 352 golf courses and about 30,000 acres of irrigated cropland.

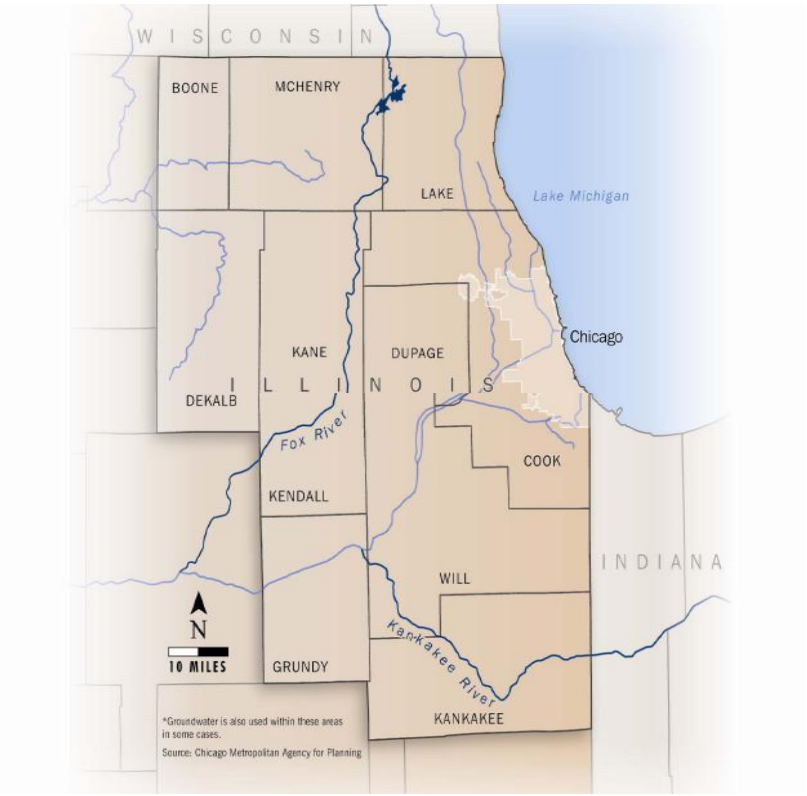

Figure 1. Study area map.

The long-term availability of water supply for this urbanizing area is a concern because of court ordered limits on water allocation from Lake Michigan, minimum flow

requirements in the Fox River basin and ongoing dewatering of the local aquifers. In an effort to avert potential future water supply problems a study was undertaken to determine the long-term water supply and demand outlook for the 2005-2050 time horizon. The first phase of the study was the development of three water demand scenarios by major user sector and geographical sub-areas for the period 2010-2050.

Future Water Demands

The three demand scenarios represent alternative paths in the possible growth of water demand: extension of current trends (CT or baseline), less resource intensive (LRI or low growth) and more resource intensive (MRI or high growth) paths. Future demands were also evaluated with respect to their sensitivity to regional and global climate change. Table 1 shows the projected demands for each of the three scenarios.

The scenario results indicate that total water withdrawals in the 11-county area on Northeastern Illinois will continue to increase to meet the demands of growing population and meet water requirements of the concomitant growth in the economy of the region. Table 1 show that the growth in total demand could be faster or slower depending on which assumptions and expectations about the future conditions will prevail.

Table 1. Summary of Water Withdrawal Scenarios for Northeastern Illinois (in MGD)

Sector	2005-R	2050-CT	2050-LRI	2050-MRI
Public supply	1,255.7	1,570.2	1,217.9	1,837.2
Self-supplied I&C	191.6	291.6	222.1	391.4
Self-supplied domestic	36.8	41.2	37.3	49.3
Irrigation and agriculture	62.0	55.4	43.8	60.7
Power plants (makeup)	52.3	52.3	66.4	90.8
Power plants (through flow)	4,207.2	3,830.2	2,472.3	3,830.2
Total - all sectors	5,805.6	5,840.9	4,059.8	6,259.6
Total w/o through-flow power	1,598.4	2,010.7	1,587.5	2,429.4
Gross per capita rates (gpcd)	182.8	166.0	131.1	200.6

Under the "current trends" scenario, public-supply withdrawals are projected to increase from 1,255.7 million gallons per day (mgd) in 2005 to 1,570.2 mgd by 2050 – an increase of 32 percent. However, under the LRI scenario (with conservation) the demand would increase only by 2.4 percent. Without conservation, under the MRI scenario, the 2050 demand could increase by 54.5 percent.

Changes in future climate will also affect water demands. Climate models indicate that in Illinois by 2050 there may be an average annual normal temperature departure of up

to +6 °F, and a possible departure from normal annual precipitation in a range from -5 inches to +5 inches per year from the 1971-2000 long-term normal values. The changes in normal annual temperature and precipitation would also result in average-weather changes during the growing season. The temperature increase of 6 °F will also apply to the summer growing season. The distribution of precipitation changes is expected to range from +2.5 inches to -3.5 inches during the growing season. The effects of these changes on future demands will vary by user sector, depending on each sector's sensitivity of water withdrawals to air temperature and precipitation.

The results show that future demands in all sectors are likely to be higher if future annual average air temperature increases and/or annual precipitation decreases. If, by 2050, temperature increases by 6^{o} F, total withdrawals would increase by 178.0 mgd (9.1 percent) above the baseline (CT) scenario values. The largest increase in total withdrawals above the baseline scenario would be 229.5 mgd (or 11.7 percent) by 2050, resulting from the combined effect of the temperature increase and a decrease in summer precipitation.

The three demand scenarios also capture the effects of alternative geographic patters of urban growth. Table 2 shows the distribution of current and future withdrawals of water by geographical areas (counties) and by the three major sources of water supply in the study area: groundwater, local rivers, and Lake Michigan.

Table 2. Scenario Water Withdrawals by Geographical Area and Source (in MGD)

County/Source	2005-R	2050-CT	2050-LRI	2050-MRI
By county:				
Boone	9.0	9.9	7.9	11.5
Cook	1,024.5	1,171.6	915.3	1,340.3
DeKalb	15.0	21.3	17.1	25.4
DuPage	111.2	124.2	103.5	142.2
Grundy	11.2	22.1	18.0	52.4
Kane	61.5	101.9	67.8	135.7
Kankakee	37.6	40.6	33.9	54.0
Kendall	12.0	31.3	19.8	62.3
Lake	105.3	131.6	103.1	160.1
McHenry	50.6	64.7	46.7	100.1
Will	160.2	291.5	254.3	345.2
By supply source:				
Groundwater	285.9	461.0	359.1	587.6
Local rivers	236.5	327.1	275.3	445.0
Lake Michigan	1,076.1	1,222.7	952.9	1,396.9
All sources	1,598.4	2,010.7	1,587.5	2,429.4

R= reported, CT= current trends, LRI = less resource intensive, MRI= more resource intensive;

Under the baseline (CT) scenario, the highest increments in total withdrawals between 2005 and 2050 are projected for Cook and Will Counties; the lowest for Boone, DeKalb and Kankakee Counties. The highest percentage increases in withdrawals are projected for Grundy and Kendall Counties.

Under the low growth (LRI) scenario, the growth in total withdrawals would be slower in all counties with the highest reduction relative to the baseline scenario in Cook County. Under the high growth (MRI) scenario, Cook and Will Counties show the highest growth in withdrawals between 2005 and 2050. Grundy, Kane, Kendall, McHenry and Will Counties show the highest percentage increases (greater than 100 percent). A significant portion of the shifts in county-level withdrawals is the result of the assumed shifts in the distribution of population growth between Cook and DuPage versus Kane, Kendall and McHenry Counties.

Water Supply Implications

The future scenarios have different implications for dealing with the water supply situation in the region. The mix of water supply sources will change throughout the period from 2005 through 2050 because of differential growth rates among water systems and geographical subareas with different mixes of supply sources.

In all three scenarios, groundwater withdrawals are projected to increase faster than surface water withdrawals. Under normal weather conditions, by 2050, groundwater withdrawals would increase by 84.3 percent (210.9 mgd) under the baseline scenario. The corresponding increases of groundwater withdrawals under low growth and high growth scenarios would be 43.6 percent (109.0 mgd), and 134.9 percent (337.4 mgd), respectively. Water withdrawals from surface non-lake water (rivers), would increase between 2005 and 2050 by 54.2 percent under the baseline scenario. The corresponding increases under low-growth and high-growth scenarios would be 29.8 percent (63.2 mgd), and 109.8 percent (232.9 mgd), respectively. Finally, water withdrawals from Lake Michigan would increase by 20.1 percent (204.7 mgd) under the baseline scenario, it would decrease by 6.4 percent (65.1 mgd) under the low growth scenario, and increase by 37.2 percent (378.9 mgd) under the high-growth scenario. These large shifts in the mix of supply sources would have important implications for acquiring additional supplies and investments in water infrastructure.

All three regional sources of supply face limitations with respect to water availability. Water levels in both shallow sand and gravel and deep bedrock aquifers in the western part of the study area have decline and additional declines are likely with increased withdrawals. Such declines could lead to increases in salinity of deep well water as well as increases in concentrations of radium, barium, and arsenic in well water. In 1980, total withdrawals from the deep aquifer reached 180 mgd and the declines in water levels and water quality problems forced some of the groundwater systems to switch to

Lake Michigan water. By 1997, the deep aquifer withdrawals declined by nearly two thirds – to below the estimated safe yield of 65 mgd. Increase pumping from the shallow aquifer could lead to similar problems and could also affect base flow in local rivers thus limiting availability of river water to meet new growth in demand.

Water supply from Lake Michigan is limited by the total amount of the Illinois diversion as established by a U.S. Supreme Court Consent Decree. The amount of water available is limited to 3,200 cubic feet per second (or about 2.1 billion gallons per day) as measured over a forty-year accounting period. Because the storm water runoff of the diverted Chicago and Calumet rivers, lake lockage, leakage, navigation-makeup water, and discretionary diversion to maintain the Chicago Sanitary and Ship Canal are counted against the total diversion, the amount of water which could be used for public water supply is much less. During 2005 water year, the total diversion was 2,771 cfs (1,791 mgd) and the running average of the diversion for 1981 through 2005 is 3,196 cfs (2,066 mgd), or only 4 cfs under the annual allocation. This implies that increased withdrawals of Lake Michigan water for public supply may require reductions in the other diversions. An added concern is the potential effect of warmer climate on the hydrology and water levels in the Great Lakes system which may potentially lead to changes in the available withdrawals from Lake Michigan. Changes in climate will also affect future water demands.

Summary

The scenario forecasts of future water demands in the 11-county planning area in Northeastern Illinois revealed the possibility of potentially large increases in total water withdrawals by 2050. The baseline and high-growth scenarios, when viewed in the context of regional supply limitations, make a compelling case for the need to actively manage regional water demands. Total withdrawals in 2050 under baseline scenario would likely increase by 36 percent (or 530.4 mgd) and the increase could be as high as 64 percent (or 949.1 mgd) under high-growth scenario. Meeting these additional demands would require large capital outlays for water infrastructure and would likely have significant impacts on the regional sources of water supply, especially groundwater aquifers and local rivers.

In summary, the overall recommendation based on the results of this study is to encourage water planners in Northeastern Illinois to recognize the need to create and maintain an expanded knowledge base about both regional and local water demands by all sectors and subsectors of water users. This knowledge base is needed to support the development of updated long-term forecasts of water demand and formulation of a regional program of water supply management.