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WATER SOURCES AND SUPPLY - A HISTORICAL PERSPECTIVE

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By
Howard G. O'Connor
Kansas Geological Survey

Water Sources and Supply - A Historical Perspective

Although I have been asked to discuss "Water Sources and Supply - A Historical Perspective" what I really hope to do before I conclude is to whet your interest in the broader aspect of minerals and our economy and encourage you to become informed farmers, manufacturers, economists, politicians and above all citizens because our affluence and economic well-being are affected not only by the "mineral" water but by a host of other increasingly scarce or more costly industrial minerals.

In the time allotted I shall briefly discuss the (1) World Water Supply, (2) Kansas Water Supply, (3) Kansas Historical Water Developments, and (4) Where to from here?

World Water Supply -

Raymond L. Nace (1967) summarized the locations and volume of the world's water supply as shown in the following table:

<u>Estimated World Water Supply</u> (Adapted from Nace, 1967)		
Location	Water Volume cubic miles	% of Total Water
SURFACE WATER		
Fresh Water Lakes	30,000	.009
Saline Lakes & Inland Seas	25,000	.008
Rivers and Streams	<u>300</u>	<u>.0001</u>
	55,300	.017
SUBSURFACE WATER		
Soil Moisture	16,000	.005
Groundwater		
to depth of 13,100 ft.	<u>2,000,000</u>	<u>.61</u>
	2,016,000	.615

ICE CAPS AND GLACIERS	7,000,000	2.15
ATMOSPHERE	3,100	.001
OCEANS	317,000,000	97.2
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TOTAL	326,000,000	100

Five categories of water location are shown; surface water, subsurface water, ice caps and glaciers, atmosphere and oceans. It can readily be seen that more than 99 percent of the world's water is the oceans and the arctic and antarctic ice caps and glaciers. Water in all of the world's fresh and saline lakes, inland seas, rivers and streams comprises only .017 percent of the total supply. Soil water and groundwater comprise 36 times more water than surface water yet amounts to only .615 percent of the total supply.

Kansas Water Supply

Kansas is better endowed with water than some of her neighbors to the west and not as well endowed as some of her neighbors to the east. The available groundwater in storage is concentrated in central and western Kansas where precipitation and surface water supplies are smallest. The precipitation and potential for surface water supply developments are greatest in the eastern part of the state, but only small ground water supplies are generally available.

Precipitation ranges from an average of less than 16 inches in western Kansas to more than 40 inches in eastern Kansas. The average annual runoff has an even greater range, from less than 0.1 inch in

western Kansas to more than 10 inches in eastern Kansas, a hundred fold increase from west to east.

The average stream flow of all streams flowing from the state is 11.6 million acre feet (MAF) but has ranged from 43 MAF (Maximum, 1951) to 2.2 MAF (Minimum, 1956).

Ground water in storage has been estimated at 200,000,000 AF to 500,000,000 AF, ~~but the amount of water of good quality suitable for most uses probably is closer to the smaller figure.~~ (Best figure = 400 to 450 MAF)

Because of differences in the geology most of the states fresh ground water is located in the western half of the state where precipitation is least and recharge to the aquifers is low. Not much fresh groundwater is stored in the eastern half where precipitation is greatest and potential recharge is also much greater.

By way of comparison Kansas in 1975 had a little more than 3,000,000 acres under irrigation. Using 1.5 acre feet of water per acre as the state average gives 4.5 MAF per year as current irrigation requirements. The average flow of the Kansas River as it leaves the state is 4.7 MAF. The Kansas River flow comprises about 41 percent of the average stream flow from the state. In 1977 irrigation use probably equals or exceeds the average annual flow of the Kansas River. (5.6 MAF/year per James

Power, KWB, personal communication July 15, 1977),

Historical Development

Water developments in Kansas can conveniently be described in three phases, as follows: (1) an exploration phase (2) an exploitation phase and (3) a conservation and management phase.

The exploration phase began with the early settlement of Kansas and continued into the 1930's. Water requirements were relatively small and were relatively easily satisfied, in most instances, by use of local ground-water supplies, local streams, or the construction of small impoundments. The early irrigation developments fostered by the U.S. Bureau of Reclamation and Kansas Board of Irrigation Survey and Experiment were of small scale and only partially successful. Stream water was diverted from the Arkansas River at several western localities and ground water was pumped by windmills.

Public water supplies increased greatly in number during the latter part of this period. The dug well and the small impoundment constructed by men using human and animal power were very fashionable.

The years from the 1930's through the 1970's represent the exploitation phase. During World War II in the early 1940's considerable industrial growth occurred. More than 3,000,000 acres of land was brought under irrigation; 95 percent of the irrigation used ground water from about 20,000 wells. During this period the legislature passed the Kansas Water Appropriation Act and this marked the beginning of the effort to manage the use of water.

The intensive ground water development resulted from increased geologic and hydrologic information about the state's aquifers, better well construction, more efficient pumps, cheap fuel and improved irrigation technology. Irrigation brought growth, profits, expanded agricultural production, as well as new business and industrial production which enriched the state's economy.

The third stage, the conservation and management phase began in the 1970's and is continuing. As a result of concern caused by declining water levels in parts of the irrigated areas, concern for water quality and concern for the unappropriated use of water, the legislature passed the (1) Ground Water Management District Act, (2) Ground Water Exploration and Protection Act and (3) SB-4, Temporary Permit to Appropriate Water; this act mandates the securing of an appropriation right to use water except for domestic use. All of these laws are intended to assist in the management and conservation of water and improve the administration of water laws.

An improved and enlarged water level change network was initiated. Quantitative hydrologic and water quality studies were expanded. Modeling studies using computers and automated mapping techniques were initiated to provide an assessment of options for managing water supplies. Improved and expanded irrigation technology studies were begun and applied, and better more efficient irrigation systems manufactured and distributed.

Weather modification and evapotranspiration studies were begun, desalinization, water importation and recharge studies were made. Some of this research was highly successful yet none provided a viable answer to the problem of declining water levels.

To the legal, environmental, economic and political barriers of importing water have now been added the energy barriers. Large quantities of energy would be required to lift the equivalent of the average flow of the Kansas River at Kansas City two to three thousand feet in elevation and a distance of two to four hundred miles if such water quantities were available. There is no assurance that such quantities

of water are available at any price, for water today is a scarce commodity. At the same time it is the most abundant and least expensive of our resources on a world basis as delivered by nature.

It has been said that today it takes a period of about 15 years from conception through the necessary studies, funding, and construction for a multipurpose dam. I think it is unlikely that the legal, environmental, economic, social, political, and engineering hurdles for major water importation schemes could be completed in less than 25 years.

Kansas can be divided into western and eastern water areas. In the west large quantities of ground water are in storage and most of the water is pumped from ground water reservoirs and used consumptively by irrigation agriculture. In eastern Kansas ground water is less abundant but the recharge is greater. A larger portion of ground water pumped is used by industry and municipalities which are less consumptive in character than irrigation. Surface water supplies are meager in the west and moderately large but highly erratic in the east. For the most part we are mining water in western Kansas. Ground water is being used in eastern Kansas at rates comparable with average annual recharge rates or less. Hydrographs of many wells demonstrate this fact. Both areas have water problems but of different character.

In conclusion I would ask you to broaden your interest in water resources to include all of our mineral resources upon which our economy and our affluence are based and to consider the following:

1. Our industrial civilization as we know it has arisen in the last 200 years.

2. World population has grown from about one-half billion in 1800 to 4 billion today. The doubling rate is every 34 years.

3. Energy growth in the U.S. from 1850 to 1907 doubled every 10.0 years. From 1907 to 1960 the growth rate declined to a doubling period of 39 years. Since 1960 the doubling period is 16.3 years.

4. What happens in other parts of the world today does have an effect on our economy and our affluence in Kansas.

5. Water usage in parts of western Kansas has shown an exponential growth since the 1950's.

For those of you who have further interest in minerals, energy, water, and our affluence, you may be interested in the facinating publications of M. King Hubbert¹, geologist and geophysist, U.S. Geological Survey, and Charles F. Parks, Jr.², Professor of Geology and Mineral Engineering, Stanford University.

For the uninitiated who may not understand exponential growth I leave you with this story. " A farmer has a pond with one water lily in it. The lily population is doubling in size every day. In 30 days it will completely cover the pond killing all the fish in it.

The farmer does not want this to happen but he is busy and decides to postpone thinning until the plant covers half the pond.

The riddle is: on what day will the lily cover half the pond? The answer is on the 29th day, leaving the farmer just one day to save his pond."

My final question ----are we approaching the 29th day?

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1. Hubbert, M. King, 1976, Energy Resources: A Scientific and Cultural Dilemma: Bulletin Association of Engineering Geologists, v. 13, no. 2, p. 81-124.
 2. Parks, Charles F., Jr., 1968, Affluence in Jeopardy, Minerals and the Political Economy: Freeman, Cooper and Company, San Francisco, CA, 368 p.
_____, 1975, Earthbound-Minerals, Energy and Man's Future; Freeman, Cooper and Company, San Francisco, CA., 279 p.