Cimarron River Basin

January 2009

General Description

The Cimarron Basin covers nearly 6,800 square miles of the southwest corner of Kansas. Nine 8-digit Hydrologic Unit Codes (HUCs) make up the basin. The basin includes all or parts of 14 counties. The major river in the basin is the Cimarron. There are no major federal reservoirs in the basin. Principal tributaries of the Cimarron River in Kansas are the North Fork Cimarron, Crooked Creek, Bluff Creek and, on occasions of high runoff, Bear Creek.

The Cimarron River has its source in Union County, New Mexico. It flows across the Oklahoma panhandle and the southeast corner of Colorado and enters Kansas nine miles northwest of Elkhart in Morton County. The Cimarron River leaves the state in the south-central portion of Meade County and reenters 30 miles east in Clark County. The river leaves the state for the last time in Comanche County and eventually joins the Arkansas River near Tulsa, Oklahoma.

Population and Economy

There were an estimated 54,300 residents in this basin in the year 2000.(1) According to the Kansas Division of Budget,(2) the total population of the 14 counties that are contained in whole or in part in the Cimarron basin had a population of 104,067 in 2000. By 2040, the county population is projected to decrease to 101,257.

This basin illustrates major demographic changes which are taking place in Kansas. In the past 40 years, two trends have dominated the state and the basin: 1) Rural counties have lost population, sometimes more than 10% every decade; and 2) Urban counties, particularly in the greater Wichita area and Kansas City areas, are gaining population at an even greater rate.

In the Cimarron Basin, counties with meat packing plants in the immediate vicinity are gaining population. Ford County, for example, went from a population 20,938 in 1960 to 33,268 in 2000. Other counties, however, are losing population. Comanche County, with a population of 3,271 in 1960, had a population of 1,636 in 2000.

The economy of the basin is very dependent on agricultural production. Crops grown include wheat, corn, grain sorghum, soybeans, forage sorghum and alfalfa.(3)

Seward County Community College offers opportunities for higher education.

Livestock production is an important component of the basin's economy. Beef cattle are the predominant livestock produced in the basin. Large cattle feeding operations are common. Beef processing is also a major economic factor in the basin.(3)

Gas and oil production is widespread and very important to the basin's economy. The first gas wells were drilled in the Hugoton field in the early 1920's, which remains a major national gas producing area. Other minerals are of minor importance to the basin.

Recreation is an increasing part of the economics of the basin, as is industry. The state parks and associated recreation and wildlife areas draw hunters to the area. The growing industrial contribution to the basin economy is primarily related to energy production, including ethanol. As of December 2008, an ethanol plants is permitted in Grant County and one ethanol plant is operational in Seward County. In 2007, Abengoa Bioenergy, a Spanish energy company, announced that Hugoton Kansas would be the site of the state's first cellulosic ethanol plant.

Physical Characteristics

Geology and Soils

The High Plains portion of the Cimarron River basin is underlain chiefly by Pliocene and Pleistocene deposits of which the Ogallala is the principal water-bearing formation of the area. The Ogallala formation consists primarily of unconsolidated sand, gravel, and silt formed from the igneous rocks of the Rocky Mountains and the sedimentary rocks of eastern Colorado. These materials were carried into Kansas and deposited by streams. These Pliocene and Pleistocene deposits occur in thicknesses up to 700 feet and are thickest in the south-central part of the basin.

Land Use/Land Cover

Land use in the basin typically is dominated by cropland (52.7%) or grassland (33.5%) or Conservation Reserve Program Land (13.1%). Less than one percent of land within the basin is comprised of residential, commercial/industrial and municipal use, open water and barren ground.

The Cimarron basin has the second lowest stream bank miles, 13,950, of the twelve major river basins in Kansas.

Within a 100-foot corridor along each bank, about 67% of the riparian area is pasture/grassland followed by cropland (25%).[4]

Climate

The climate of the basin is characterized by moderate to low precipitation, relatively high wind velocities, fairly rapid rates of evaporation, a wide range of temperatures and abrupt, sometimes violent changes in weather (Table 1).

Drought is a naturally recurring feature of this climate as exemplified by the Dust Bowl of the 1930s and the drought of 1952-1957. It is perhaps the most pervasive natural hazard affecting Kansas and other agricultural areas of the central United States. Kansas has been impacted by severe drought periodically throughout the present decade.

Wildlife and Habitat

The Cimarron River basin is located within the High Plains physiographic region which is comprised of rolling sand plains, rangeland, and cropland. Native vegetation in this region includes sand sagebrush, sand bluestem, prairie sandreed, little bluestem, blue grama, buffalograss, side oats grama, western wheatgrass, and scattered isolated sites with alkali sacaton and inland saltgrass.

Numerous threatened and endangered species occur in the Cimarron Basin. Of these, one is an amphibian, ten are birds, two are mammals, four are reptiles and four are fish.

In April 2001, the U.S. Fish and Wildlife Service listed the Cimarron River in Clark, Meade and Seward counties, from U.S. Highway 54 bridge downstream to the Kansas-Oklahoma border, as critical habitat for the Arkansas River Shiner, a threatened species.

Southwest Kansas is a leading edge of the downstream movement of salt cedar. Salt cedar (also known as “tamarisk”), Russian olive and other invasive phreatophytes (a deep-rooted plant that obtains its water from the water table or the layer of soil just above it) have become a significant problem along the Cimarron River, Crooked Creek and other streams in the Cimarron basin.

Meade Lake State Park, located south of Meade, is the first state lake in Kansas.

Meade State Park was originally carved out of the Turkey Track Ranch in 1927. The location for the lake was chosen because springs fed by the Ogallala aquifer provided an adequate base flow. The state park and wildlife area comprise 803 acres of land and water.

Water Resources

The High Plains aquifer is the primary source of water in western Kansas. Nearly all of the reported water used in the Cimarron Basin is from ground water.[5] The High Plains aquifer is composed of several hydraulically connected aquifer units of which the largest is the Ogallala. It has been intensely developed, mostly for irrigation, leading to significant ground water declines.

The Cimarron basin contains 6,421 miles of intermittent and 432 miles of perennial streams for a total of 6,853 stream miles. The density of 1.0 stream miles per square mile, places the basin last among the twelve major river basins.

The Ogallala portion of the High Plains aquifer (Ogallala-High Plains aquifer) is characterized by low recharge and high declines. The expected "usable life" of the aquifer, when the aquifer is no longer able to support the current high rates of pumping, varies widely due to differences in amount of saturated thickness, hydraulic conductivity, withdrawals and other variables. The total irrigated acres in the Kansas High Plains increased 2.4% from 1999/1993 to 2001/2003. During the same time period there was an increase in corn, alfalfa and soybeans, crops that are typically water intensive. There has also been a wide spread adoption of more efficient irrigation systems. Even with the improvements, though, the aquifer is still declining.

Irrigation accounted for more than 97% of all reported water pumped or diverted. Municipal use accounted for less than one percent of water used in the basin; industry, recreation, stockwater and other uses combined equal less than three percent (2006).[5]

The High Plains aquifer is highly variable in Kansas. The amount of water in storage, the depth to water, the hydraulic conductivity (how readily the water moves through the sediments in the aquifer), the amount of withdrawals and the recharge rates all vary significantly throughout the basin.

Water Management

A majority of the basin is closed or restricted for new water appropriations. The State Chief Engineer's action on Southwest Groundwater Management District No. 3 (GMD3) rules took effect November 21, 2002. All the townships that were previously closed to new water development remain closed. Several additional townships were also closed and seventeen townships remain open to new appropriations.

Applications filed prior to the effective date for water from townships open at the time of application will be processed under the planned depletion standards. Applications for water after that date in any of the still open townships will be processed subject to the state-wide safe yield standard.

Minimum desirable streamflow (MDS) has not been set at any sites in the basin. No watershed districts have been organized in the basin.

The county conservation district is the primary local unit of government responsible for the conservation of soil, water and related natural resources within the county boundary. Each county within the Cimarron River basin has a county conservation district. Two Resource Conservation and Development (RC&D) districts serve the counties of the Cimarron basin: the Santa Fe Trail RC&D and the Coronado Crossing RC&D. The RC&Ds are designed to help community leaders develop rural economies by improving and conserving local natural, human and economical resources.

Resources

1. US Census data, 2000

2. Kansas Division of Budget 2007. County population estimates,

3. U.S. Department of Agriculture, Kansas 2006-2007 County Farm Facts, Agricultural Statistics and Ranking.

4. Wilson, Brownie, Assessment of Riparian Areas Inventory, State of Kansas, 2003. http://www.kgs.ku.edu/Hydro/Publications/ofrIndex.html

5. Kansas Department of Agriculture-Division of Water Resources, December 13, 2007. Water Right Information System Database.

6. USDA-Natural Resources Conservation Service, Resource Conservation and Development Information. http://www.ks.nrcs.usda.gov/partnerships/rcd/

7. Kansas Water Office. 2003. *Kansas Water Plan*, Cimarron Basin and Water Quality Sections.

8. Kansas Water Resources Board Water Plan Studies Cimarron Unit. June 1962.

Cimarron National Grassland

The longest stretch of publicly-owned riparian habitat in Kansas is located within the Cimarron National Grassland in Morton and Stevens counties. The Grassland, administered by the USDA Forest Service, covers approximately 108,175 acres in the southwest corner of the Cimarron River basin.

Rock cliffs, cottonwood groves, grassy fields, yucca and sage brush are scattered throughout the land. Elevation ranges from 3,150 to 3,540 feet. Seasonal variety is provided by native grasses and riparian vegetation along the Cimarron River. The geology of the area is sandstone, shale, limestone, sand and gravel.

The third highest point in the basin of Kansas is located on the Grassland, Point of Rocks, at 3,540 feet. From this elevation, Colorado and Oklahoma are visible on clear days. Point of Rocks and other land features within the Grasslands were important landmarks for travelers on the Santa Fe Trail, which stretches across the Grasslands forming the longest publicly owned portion of the Trail in the country.

The drought of the 1930's left the land in poor condition. Under Bankhead-Jones Farm Tenant Act in 1938, the federal government began purchasing the devastated land to restore it. Originally known as Land Utilization Projects, the lands were renamed Cimarron National Grassland in June 1960. Today the land is managed for wildlife, water conservation, livestock grazing, recreation and mineral production.

Cimarron River Basin
Management Categories

WATER MANAGEMENT CATEGORIES

The following categories include issues identified in the Cimarron basin plan as items that require attention in addition to the basin priority issues. These issues are addressed within the following management categories:

- Water Management
- Water Conservation
- Public Water Supply
- Water Quality
- Flood Management
- Water-Based Recreation
- Wetland and Riparian Management

These categories also correspond to the state-wide management categories and policies of the *Kansas Water Plan* found in Volume II. These documents contain new policy issues and the existing policy and statutory framework that relate to the management categories.

ISSUE: WATER MANAGEMENT

Southwest Kansas Groundwater Management District No. 3 (GMD3), is the major water management entity in the basin. A majority of the basin is closed or restricted for new water appropriations. The State Chief Engineer's action on GMD3 rules took effect November 21, 2002. All the townships that were previously closed to new water development remain closed. Several additional townships were also closed, and 17 townships remain open to new appropriations.

Applications filed prior to the effective date for water from townships open at the time of application will be processed under the planned depletion standards. Applications for water after that date in any of the still open townships will be processed subject to the state-wide safe yield standard.

Minimum desirable streamflow (MDS) levels have not been established for any sites in the basin.

The GMD3 has contracted with the Kansas Geological Survey (KGS) to map the practical saturated thickness (PST) of the Ogallala aquifer in their district. The PST, as determined primarily by well logs, is the net thickness of saturated sediments that significantly contribute to well yield from the water table down to the bedrock surface. It differs from the saturated thickness which is the total thickness of saturated sediments between the water table and the bedrock surface. The PST can provide a more accurate picture of water availability and may also provide insight into future water level trends at the scale of an individual well.

In 2006, the Kansas Water Office (KWO) calculated the median annual water level changes in wells from 1981 to 2005 for GMD3. Based upon the assessment, the data assembled for the 1981 through 2005 period indicates there was no statistically discernable change in the rate of ground water declines for southwest Kansas.

In 2007, the KWO, GMD3, and the U.S. Bureau of Reclamation contracted with the KGS for the development of a hydrologic model of the GMD3 region. The model will provide additional information on the water budget, and be able to project aquifer and stream flow responses to various future management scenarios.

Applicable *Kansas Water Plan* Objectives

- Reduce water level decline rates within the Ogallala aquifer and implement enhanced water management in targeted areas.

- Achieve sustainable yield management of Kansas surface and ground water sources outside of the Ogallala aquifer and areas specifically exempt by regulation. Sustainable yield management would be a goal that sets water management criteria to ensure long term trends in water use will move as close as possible to stable ground water levels and maintenance of sufficient streamflows.

Applicable Programs

The following programs help to meet the objectives in the Water Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- State Conservation Commission: Water Right Transition Assistance Program
- Kansas Geological Survey and Kansas Department of Agriculture-Division of Water Resources: Water Well Measurement
- Kansas Geological Survey: High Plains Aquifer Technical Assistance Program
- Kansas Geological Survey: Stream Aquifer Interactions
- Kansas Water Office: Assessment and Evaluation Program/Ogallala Special Study Phase II, Cooperative Agreement with U.S. Bureau of Reclamation
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive Program (EQIP)

ISSUE: WATER CONSERVATION

Water conservation is essential for the effective management of water resources in the basin to assure that a sufficient, long-term supply of water is available for the beneficial uses of the people of the state. Conservation is defined by Webster as a careful preservation and protection of something, especially the planned management of a natural resource to prevent exploitation or destruction. Water conservation is a part of maintaining a long-term water supply for Kansas.

Water conservation activities apply to all uses: irrigation, municipal, industrial, etc., from all sources. Irrigation accounted for more than 97% of all reported water pumped or diverted. Municipal use accounted for less than one percent of water used in the basin, industry for one percent and recreation, stockwater, and other uses combined equal about 3 percent (2006).

Of the 614 public water suppliers in Kansas that have an approved conservation plan in place as of December 31, 2008, 16 plans have been approved in the Cimarron basin. Two hundred and forty nine plans have been approved for irrigation water rights (2006 data). The number of diversion points in western Kansas that reported irrigation application rates over the regional average decreased from 1991 to 2005. Of the total number of wells in the Cimarron basin that were reported to have diverted water in Kansas in 2006, more than 97% had meters.

Applicable *Kansas Water Plan* Objectives

- Reduce the number of public water suppliers with excessive unaccounted for water by first targeting those with 30 percent or more unaccounted for water.
- Reduce the number of irrigation points of diversion for which the amount of water applied in acre feet per acre (AF/A) exceeds an amount considered reasonable for the area.
- All non-domestic points of diversion meeting predetermined criteria will be metered, gaged or otherwise measured.
- Conservation plans will be required for water rights meeting priority criteria under K.S.A. 82a-733 if it is determined that such a plan would result in significant water management improvement.

Applicable Programs

The following programs help to meet the objectives in the Water Conservation management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture, Division of Water Resources: Water Appropriation Program
- Kansas State University Research and Extension: Water Conservation and Management Program
- State Conservation Commission: Water Resources Cost-Share
- Kansas Water Office: Water Conservation Program
- USDA - Farm Services Agency: Conservation Reserve Program

ISSUE: PUBLIC WATER SUPPLY

The primary approach to addressing public water supply issues in the basin focuses on ensuring that there are adequate supplies of surface and ground water within the basin to meet future water demands, reducing the number of public water supply systems that are vulnerable to drought, and ensuring that systems have the technical, financial and managerial capacity to meet future needs for water quality and quantity.

There are 24 public water suppliers in the basin, including two rural water districts in Comanche County. All public water suppliers in the basin rely on ground water for their source of supply.

Coping with drought presents a challenge for public water suppliers. During drought periods the amount of raw water available typically is reduced at the same time customer demand for water increases. Although ground water is not as susceptible to droughts as surface water, public water suppliers that have an insufficient number of well or capabilities to meet increased demand are vulnerable. While all suppliers may be potentially impacted, some are particularly vulnerable. Of the public water suppliers in the basin, eight (36%) were considered drought vulnerable in 2006.

Applicable *Kansas Water Plan* Objectives

- Ensure that sufficient surface water storage is available to meet projected year 2040 public water supply needs for areas of Kansas with current or potential access to surface water storage.
- Less than five percent of public water suppliers will be drought vulnerable.
- Ensure that all public water suppliers have the technical, financial and managerial capability to meet their needs and to meet Safe Drinking Water Act requirements.

Applicable Programs

The following programs help to meet the objectives in the Public Water Supply management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas Department of Health and Environment: Public Water Supply Program
- Kansas Water Office: State Water Planning Program
- Kansas Water Office: Water Conservation Program
- Kansas Department of Health and Environment: Capacity Development Program

ISSUE: WATER QUALITY

Water quality and related water resource issues are addressed through a combination of watershed restoration and protection efforts utilizing voluntary, incentive based approaches, as well as regulatory programs.

The Section 303(d) list submitted to and approved by the U.S. Environmental Protection Agency (EPA), identifies 19 river segments and four lakes in the Cimarron River basin as water quality impaired. Among the streams, the greatest number of impairments was caused by excessive levels of chloride. Among the lakes, eutrophic conditions indicative of excessive algae production was the predominant cause.

Other pollutants limiting the use of the Cimarron River basin streams are fecal coliform bacteria, pH, sulfate and ammonia. Additional lake impairments were caused by dissolved oxygen depletion, pH and excessive aquatic plants. Each parameter causing impairment requires preparation of a Total Maximum Daily Load

(TMDL). Seven watersheds and three lake TMDLs were developed for the Cimarron basin. The TMDLs describing the goals to reduce pollution and achieve water quality standards and the plans to meet those goals were submitted to EPA on June 29, 2000. The majority of these TMDLs were approved on September 11, 2000.

Eight counties in the basin have adopted state approved sanitary/environmental codes, with Comanche County recently having adopted codes.

- Reduce the average concentration of bacteria, biochemical oxygen demand, solids, metals, nutrients, pesticides and sediment that adversely affect the water quality of Kansas lakes and streams.
- Ensure that water quality conditions are maintained at a level equal to or better than year 2000 conditions.
- Reduce the average concentration of dissolved solids, metals, nitrates, pesticides and volatile organic chemicals that adversely affect the water quality of Kansas ground water.
- Maintain, enhance or restore priority wetlands and riparian areas.
- Nutrient reduction goals will be included in all WRAPS projects within the basin.
- All public water suppliers will complete and implement a source water protection plan.

Applicable Programs

The following programs help to meet the objectives in the Water Quality management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Health and Environment: State Water Plan Program (Contamination Remediation)
- Kansas Corporation Commission: Conservation Division Programs
- Kansas Department of Health and Environment: Local Environmental Protection Program
- State Conservation Commission: Nonpoint Source Pollution Control Program
- State Conservation Commission: Water Resources Cost-Share Program

ISSUE: FLOOD MANAGEMENT

Flooding is a natural, recurring event associated with streams and rivers that has resulted in the formation of natural floodplains over time. While this inundation provided benefits under natural conditions, encroachment of urban and agricultural development onto floodplains has resulted in the potential for flood damage. In addition, some areas of Kansas are particularly prone to flash flooding which is characterized by a rapid rise in water level, fast-moving water and much flood debris.

Kansas Water Plan flood management guidance has emphasized targeting watershed dam construction assistance to priority watersheds encouraging participation in the National Flood Insurance Program and preparing updated floodplain maps for priority communities.

In 1993 the Kansas Department of Agriculture-Division of Water Resources launched the *Kansas Flood Mapping Initiative.* The FY 2005 *Kansas Water Plan* Flood Management Policy Section identified Seward County as a priority to be mapped, and digitized in the Cimarron basin. The map is under development and will be finalized and digitized in late 2009.

Applicable *Kansas Water Plan* Objectives

- Reduce the vulnerability to damage from floods within identified priority communities or areas.

Applicable Programs

The following programs help to meet the objectives in the Flood Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture - Division of Water Resources: Water Structures Program/Floodplain

Management
- Kansas Department of Agriculture - Division of Water Resources: Water Structures Program/Dam Safety
- Kansas Division of Emergency Management: Hazard Mitigation Grants Program
- FEMA: National Flood Insurance Program
- State Conservation Commission: Watershed Dam Construction Program
- State Conservation Commission: Watershed Planning Assistance Program

ISSUE: WATER-BASED RECREATION

The Cimarron basin has the least number and lowest percentage of public water-based recreation sites of any basin in the state.

In 2007, a 2,700-square foot educational center was completed at Meade State Park. The educational center overlooks the 80-acre Meade Lake and serves as an event facility with plans for future educational displays. Construction of the year round use educational center was endorsed by the Cimarron Basin Advisory Committee and was included in the 2003 *Kansas Water Plan*, Cimarron Basin Section.

Clark State Fishing Lake, a 300 acre impoundment with 900 acres open for public hunting, is located in Clark County.

Hunting is not as obviously tied to water resources as some other recreational activities such as boating and fishing, but significant activity occurs in the Cimarron basin on public wildlife areas, public and private wetland areas and adjacent to private streams and ponds. Hunting expenditures contribute significantly to the basin's economy.

Applicable *Kansas Water Plan* Objectives

- Increase public recreational opportunities at Kansas lakes and streams.

Applicable Programs

The following programs help to meet the objectives in the Water-Based Recreation management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Wildlife and Parks: Rivers and Stream Access
- Kansas Department of Wildlife and Parks: Fish Impoundments and Stream Habitats Program

ISSUE: WETLAND AND RIPARIAN MANAGEMENT

The primary approach to wetland and riparian management in the basin focuses on providing technical and financial assistance to landowners to protect and restore these resources in priority watersheds through the implementation of best management practices.

Riparian lands in the Cimarron basin have been seriously impacted by the infestation of non-native phreatophytes. Of greatest concern are the effects tamarisk (salt cedar) and Russian olive are having on the basin's native riparian ecosystems.

Applicable *Kansas Water Plan* Objectives

- Maintain, enhance or restore priority wetlands and riparian areas.

Applicable Programs

The following programs help to meet the objectives in the Wetland and Riparian management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Forest Service: Forest Stewardship Program and Conservation Tree Planting Program
- Kansas Department of Wildlife and Parks: State Parks and Wildlife Areas Planning and Development
- Kansas Department of Wildlife and Parks: Wildlife Habitat Improvement Program

Cimarron Basin High Priority Issue
Management of the Ogallala High Plains Aquifer
January 2009

Issue

Management of the Ogallala-High Plains aquifer and associated alluvial aquifer is needed to reduce the rate of decline and to conserve the life of the aquifer.

Vision

Sufficient water resources in south western Kansas to support healthy, economically strong communities and rural lifestyles, today and for future generations.

Goal

Conserve and extend the life of the Ogallala - High Plains aquifer through management by aquifer subunits, targeting water conservation activities to high priority subunits, improved characterization of the aquifer and implementing strategies for improved agricultural practices with limited water resources.

Description

The High Plains aquifer is the primary source of water in western Kansas. Nearly all of the reported water used in the Cimarron basin is from ground water.(5) The High Plains aquifer is composed of several hydraulically connected aquifer units of which the largest is the Ogallala. It has been intensely developed, mostly for irrigation, leading to significant ground water declines. The Ogallala portion of the High Plains aquifer (Ogallala-High Plains aquifer) is characterized by low recharge and high declines. The expected "usable life" of the aquifer, when the aquifer is no longer able to support the current high rates of pumping, varies widely due to differences in amount of saturated thickness, hydraulic conductivity, withdrawals and other variables. The total irrigated acres in the Kansas High Plains increased from 2,681,000 to 2,746,000 acres between 1991-1993 and 2001-2003, a 2.4% increase.(9) During the same time period, there has been an increase in corn, soybeans and alfalfa acres, crops that are traditionally water intensive, as well as wide spread adoption of more efficient irrigation systems.(9) The annual water level measurements indicate that in most areas, for most years, for a five year or more trend the Ogallala-High Plains aquifer is declining. (10)

It has long been known that the aquifer was in decline in southwest Kansas, at least for localized areas. In 1958, the Kansas Water Resources Board issued a preliminary report highlighting the water "mining" problem in the Cimarron basin. More recently, the Statistical and Geostatistical Analysis of the Kansas High Plains Water Table Elevations, 2006 (1) shows Stanton, Grant and Stevens Counties have had water level drops of over 30 feet in the past ten years. Southwest Kansas still has significant amounts of ground water in storage, however, with much of the Cimarron basin projected to have enough ground water to support widespread pumping for 50 years or more, if the past water level decline trends continue. There are areas within Stevens, Grant and Stanton Counties though, where the aquifer is projected to decline within 25 years to where widespread pumping will not be feasible.

Figure one below is an estimated projection of how many more years the aquifer could support an assumed level of pumping, in this case with a well every quarter section, pumping at 400 gpm for 90 days. It projects the ground water level trends from 1996 to 2006 into the future; if the trend had been increasing, the area is shown as blue. This methodology is suitable to the Ogallala portion of the High Plains aquifer because of the extensive data base available on the historic water level change and related variables.(7)

A majority of the basin is closed or restricted for new water appropriations. The Chief Engineer's action on Southwest Kansas Groundwater Management District No. 3 (GMD3) rules took effect November 21, 2002. All the townships that were previously closed to new water development remain closed. Several additional townships were also closed and 17 townships remain open to new appropriations. Applications filed prior to the

effective date for water from townships open at the time of application will be processed under the planned depletion standards. Applications for water after that date in any of the still open townships will be processed subject to the state-wide safe yield standard.

The High Plains aquifer is highly variable in Kansas. The amount of water in storage, the depth to water, the hydraulic conductivity (how readily the water moves through the sediments in the aquifer), the amount of withdrawals and the recharge rates all vary significantly throughout western Kansas.

Water Appropriations

Approximately 2,124,038 acre feet of water are appropriated for use from ground water within GMD3. There are about 5,361 active ground water rights from 5,156 wells.[5]

Water Use

Nearly all of the reported water used in the Cimarron basin is from ground water. Irrigation accounted for more than 97% of all reported water pumped or diverted. Municipal use accounted for less than one percent of water used in the basin; industry, recreation, stockwater and other uses combined equal less than 3 percent (2006). The 2006 reported water use from the Cimarron basin was more than 1,000,000 acre feet.[5]

There has been wide spread adoption of more efficient irrigation systems in the Kansas High Plains from flood and center pivot to center pivot with drop nozzles.[9] A companion study by Kansas State University in 2006, found that the number of acres irrigated is a more important determinant of changes in water use than the adoption of more efficient irrigation systems.[2] The authors concluded that if the irrigated acres are held steady after conversion to a more efficient irrigation system, net water use would, on average, change little; it is with a decrease in irrigated acres that a reduction in water use is assured.

Activities and Progress

Various programs and activities have been initiated to reduce the decline rate of the Ogallala-High Plains aquifer and extend and conserve the aquifer. Tools such as ground water and surface water computer models and more detailed aquifer characterization have been developed. In the Cimarron basin, the determination of Ogallala High Plains aquifer subunit priority areas, setting subunit goals and developing management plans to reach these goals has been the responsibility of GMD3 and Kansas Department of Agriculture-Division of Water Resources (DWR) for areas outside the district.

Good data are essential to the determination of decline rates. Data development includes ground water models to better understand the aquifer and subunits. Water flowmeters, now required on almost all wells, provide improved information on withdrawals. Annual water level measurements, index wells and weather station data provide information contributing to better computer models.

Under a Cooperative Agreement between the U.S. Bureau of Reclamation and the Kansas Water Office (KWO), the state and GMD3 have contracted with the Kansas Geological Survey to develop a ground water Modflow model of the southwest district, incorporating characterize the hydrologic system and water availability. The model will provide more information on water in storage and allow future management scenarios to be projected.

Voluntary programs have been offered and targeted to areas determined by the management entity responsible for that area, GMD3 within district boundaries and in the fringe areas by DWR. The USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) provides grants to transition from irrigated cropland to dryland production, for a minimum of four years.

State programs have offered incentives to retire water rights, however that opportunity has not been provided to the Cimarron Basin area.

Regulatory programs have included the DWR Blatant and Recurring Overpumpers (BRO) program which

makes special requirements on irrigators that have pumped in excess of their water rights to get them back into compliance. In addition, Kansas Water Appropriation laws protect senior water rights from impairment by junior water right pumping. In 2008, DWR administered a junior water right that was impairing a senior right in Stevens County.

Progress toward reducing the decline rate was evaluated by the KWO in 2006 using water level data from 1981-2005. The median annual water level changes were calculated for each region and standardized or indexed to antecedent moisture conditions using the Palmer Drought Severity Index (PDSI) for the appropriate region. The comparison of pre-1993 and 1993-2005 periods concluded that there was no discernable change in the rate of water level declines in the Ogallala–High Plains region. It also concluded that as of 2005, in the southwest Ogallala aquifer area (GMD3 and DWR in fringe areas), there has been no statistically significant change, at a five percent error level in the rate of decline.[3]

It should be noted that the reduction of total water use through the voluntary and regulatory programs is small. A measurable reduction in decline rates will likely take many years or decades, unless participation in reductions are greater.

are used to guide state and federal efforts on water conservation. GMD3 has adopted the below map in their management plan. The DWR is working to identify priority subunits for the aquifer fringe. Specific target areas are defined for areas eligible for enrollment in the Conservation Reserve Enhancement Program (CREP), EQIP quick response areas and Water Right Transition Assistance Program (WTAP).

The priority rank shown on this map is based on an area's total score from two databases: estimated usable lifetime and density of ground water use. Useable lifetime is defined as the ability to support a 400 gpm well yield, on every quarter section, pumping for 90 days. Rank 1 indicates areas with a short estimated usable lifetime and a history of higher ground water usage. Rank 4, the lowest concern areas, have a relatively long useable lifetime and low total water use.

Recommended Actions

1. For priority aquifer subunits, develop specific goals and management strategies to extend and conserve the life of the aquifer.

2. Develop and maintain a ground water flow model of GMD3 area for evaluating management decisions and establishing conservation goals.

3. KWO will continue coordination among GMD3, DWR, stakeholders and other agencies.

4. Provide opportunities to permanently and temporarily reduce water use through voluntary programs (state, federal and local).

5. Develop local ownership and leadership of aquifer issues to assist in local adoption of specific conservation goals and programs.

6. Educate water users, decision makers and the general public on the conditions of the aquifer and methods and opportunities to reduce water use.

7. Evaluate the long-term impact of climate change on supply and demand for water resources in the basin.

8. Seek crop insurance option for limited irrigation crops from USDA Risk Management Agency.

9. Consider interstate discussions on water conservation and planning where aquifer subunits cross state boundaries and are not directly impacting an existing surface water compact.

10. Explore opportunities to augment aquifer recharge through artificial recharge during flood events and other means as feasible.

11. Support research into high value, lower water use crops that would be suitable for the region.

Resources

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Cimarron Basin High Priority Issue
Arkansas River Shiner
January 2009

Issue

A portion of the Cimarron River is listed as critical habitat for the federally threatened Arkansas River Shiner, by the U.S. Fish & Wildlife Service. Coordination is needed among local landowners and the federal and state agencies responsible for managing the Arkansas River Shiner to identify solutions that may improve the condition of the species' habitat, to promote and restore healthy ecosystems, to maintain the integrity of landowners' rights, and to determine if the fish is extirpated from Kansas and if recovery is possible.

Description

The Arkansas River shiner (*Notropis girardi*) is a small minnow with a rounded snout and small mouth. Shiners are usually sandy above and silver laterally, grading to white on the belly. Dorsal scales are typically outlined with dark pigment. The shiner feeds mostly on aquatic invertebrates and spawns during the months of May, June and July in conjunction with flows following heavy rains. Eggs drift with the current during high flows until hatching occurs. If conditions are favorable, the shiner may reproduce several times during this period.

The U.S. Fish and Wildlife Service (USFWS) listed the Arkansas River shiner as threatened under the Endangered Species Act (ESA) in November 1998. Prior to listing, USFWS stated that limited survey data suggested the shiner only occupied 205 miles of its historic range. Historically, almost the entire Cimarron River main stem and several major tributaries were inhabited by the shiner. The shiner was last captured from the Cimarron River in August 2004 near Guthrie, Oklahoma by SWCA Environmental Consultants. A recent study of fish in Kansas reported that "Due to the lengthy absence of reported collections of the Arkansas River Shiner, *Notropis girardi,* from Kansas (and the attendant lack of probability of reproductive populations), we propose its addition to the list of extirpated fishes in Kansas."[(5)]

Protection of the Species

The ESA requires that when a federal action (such as funding through grants) may affect a listed species, the responsible agency or individual must enter into consultation with the USFWS. Activities on federal lands or federal actions that may affect the Arkansas River shiner or its critical habitat will require consultation with the USFWS. Individuals, organizations, states, local and tribal governments and other non-federal entities are affected by the designation of critical habitat only if their actions occur on federal lands, require a federal permit, license or other authorization, or involve federal funding.

Portions of the critical habitat designation for the federally threatened Arkansas River Shiner include the Cimarron River in Clark, Comanche, Seward and Meade counties from the US Highway 54 bridge downstream to the Kansas-Oklahoma border (Figure 1).

The Arkansas River shiner receives protection in Kansas under the Kansas Nongame and Endangered Species Conservation Act of 1975 (Figure 2). Any time an eligible project is proposed that will impact the species preferred habitats within its probable range, the project sponsor must contact Kansas Department of Wildlife and Parks. Kansas Critical Habitat, as described by Kansas Administrative Regulations, for the Arkansas River shiner in the basin includes all reaches of the main stem Cimarron River located within the state.

Reasons for Species Decline

Declines in the Arkansas River Shiner populations cannot be isolated to a single factor; any combination of changes may have contributed to a reduction in the species' range and abundance. Reductions in streamflow and the occurrence and magnitude of high flow events, most likely produced by the diversion of water for irrigation have altered the nature of streambeds impacting the opportunities for shiner spawning.

Competition with introduced fishes also contributed to diminished distribution and abundance of the shiner in the Cimarron River. Incidental capture of the shiner and potential introductions of non-native minnows during pursuit of commercial baitfish species may contribute to reduced population sizes. The adverse affects of drought and other natural factors may have also contributed to the species' decline in this region.

Invasion of phreatophytic non-native plants, such as tamarisk (salt cedar) and Russian Olive, have further depleted streamflow and produced water quality changes that are not favorable to the Arkansas River Shiner. Naturally occurring saline inflows are concentrated by the high water use of phreatophytes. In some areas, tamarisk growths have narrowed the stream channels and resulted in deepening of the streams.

Cimarron River and High Plains Aquifer Conditions

Ground water table declines in the Ogallala-High Plains aquifer caused by high-volume, consumptive pumping of ground water for irrigation have occurred near the Cimarron River in southwest Kansas. These water level declines have decreased or eliminated ground water discharge to the perennial stretches of the river, thereby decreasing flow to or shortening the length of the perennial reaches. The primary area of perennial stretch shortening has occurred in northwest Seward County. The main location of current decrease in perennial streamflow is in southeast Seward County and southwest Meade County.(2)

Saltwater derived from mineral dissolution from the Permian bedrock intrudes into the overlying Ogallala-High Plains aquifer in southeast Seward County and southwest Meade County. Saline water that intrudes to the Ogallala-High Plains aquifer affects the usability of water in parts of the aquifer for irrigation and domestic use due to the high sodium and chloride contents. The saline water in the High Plains aquifer discharges into the overlying Cimarron River in these same counties. The river generally increases in salinity through this area. The decrease in fresh ground water discharge, caused by declines in the High Plains aquifer upstream of the saline water intrusion has resulted in an increase in the salinity of the river.(3)

While the degree of sensitivity of the Arkansas River shiner to salinity of the water in its habitat is not well defined, studies have found that more species are present in water of lower conductivity.(1) USFWS has indicated that water quality degradation within the river basin can cause localized impacts to shiner populations.(7)

The presence of invasive non-native, salt-loving plants such as tamarisk may contribute to the degradation of water quality in the Cimarron River in Kansas. Salt cedar growths consume larger quantities of water than native vegetation and draw salts up to the surface from deep in the soil. These salts are secreted on the plants' leaves, which fall every year and give rise to increasingly saline surface and shallow soils. Salt cedar will tolerate this accretion of salt up to levels of 36,000 Mg/L, while native growths can only tolerate salinities on the order of 1,500 Mg/L.(1) When the area of growth is inundated by flooding or river rises, the salt is undoubtedly dissolved in the floodwaters and increases the salinity of the streamflow.

Management Plans

The Canadian River Municipal Water Authority (CRMWA) has prepared an approved Arkansas River Shiner Management Plan for the Canadian River in Texas and New Mexico.(1) The Oklahoma Farm Bureau has drafted a similar management plan for the Canadian and Cimarron Rivers. The purpose of these plans is to improve the condition of the Arkansas River Shiner habitat and to promote and restore healthy ecosystems. Additional goals of these plans include the exclusion for the need to designate some portions of the critical habitat and the eventual de-listing of the Arkansas River Shiner upon reestablishment of the species.

Recovery plans can be prepared by USFWS to list the specific actions needed to reverse the declines of a species. A recovery plan for the Arkansas River Shiner in Kansas has not yet been developed.

Opportunities for Watershed Improvement

Control of salt cedar will encourage sustained river flows by preventing peak flood flows from being excessively

reduced as the floods progress downstream. If the shiner is present and viable in the Cimarron River in Kansas, this should help induce spawning and provide for more efficient egg transport during spawning. Control of salt cedar will also restore more natural flow regimes and increase the daily volume of water in the stream. Water quality will be improved by eliminating the excess salinity caused by the salt cedar.

There are many resources in Kansas that promote conservation and watershed ecosystem health, including the Kansas Watershed Restoration and Protection Strategies (WRAPS). Watershed partnerships such as WRAPS in the Cimarron basin could form coordinated approaches for long-term management of tamarisk and reestablishment of native vegetation, as well as, other activities that may improve the quality and quantity of water conditions in the basin.

Recommended Actions

1. Determine, monitor and document the status of Arkansas River shiner populations in Kansas.

2. Pursue opportunities with the U.S. Fish and Wildlife Service to delist the Kansas Cimarron River as critical habitat for the Arkansas River Shiner.

3. Evaluate the riparian and stream conditions of the Cimarron River within the critical habitat reach, and seek opportunities to protect and restore the ecosystem health.

4. Complete a hydrologic Modflow model of the Groundwater Management District No. 3 and determine the ground water – surface water conditions along the Cimarron River within the critical habitat reach.

5. Target state and privately-funded tamarisk control projects to the Cimarron River within the critical habitat reach to improve the riparian conditions.

6. Continue facilitating discussion and cooperation between local property owners, U.S. Fish and Wildlife Service, Kansas natural resource agencies and organizations and other interested stakeholders.

Resources

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Cimarron Basin High Priority Issue
Salt Cedar and Other Non-Native Phreatophyte Control
January 2009

Issue

Tamarisk (salt cedar), Russian olives and other invasive high water consuming vegetation are choking out native riparian habitat along the Cimarron River and other southwestern streams.

Description

Riparian lands in Kansas have been seriously impacted by the infestation of non-native phreatophytes. Of greatest concern are the effects tamarisk and Russian olive have on our native riparian ecosystems.[4, 5] Tamarisk is a tenacious shrub/small tree that has a deep root system (up to 100 feet) and leaves a salt residue on the soil surface. Tamarisk, a native of southern Europe and central Asia, is classified as a deciduous shrub that rapidly attains a height of five to twenty feet and grows best in sandy soils along streams. Tamarisk was brought to the United States for ornamental purposes and most likely was first established in Kansas in the early 1900s when it was planted in windbreaks. It has been widely used for bank stabilization and windbreaks since it is well suited for the western United States. There are many different species of tamarisk that are referred to with different common names. These problematic and invasive tamarisk species are commonly referred to as salt cedar.

Tamarisk can adapt to poor subsurface water quality. Tamarisk utilizes salt to increase the osmotic potential of its deep, extensive root system, which allows it to draw water from greater depths than the native vegetation. Therefore, tamarisk tends to out-compete native obligate phreatophytes during drought periods. The salt is excreted by the leaves and is concentrated in the leaf litter, thus impeding the growth of native species where tamarisk has gained a foothold. Tamarisk uses significant quantities of water. Actual water use by tamarisk depends on several factors: water availability, climate, water quality, population density, stresses, etc. However, it has been found that tamarisk will consume more water than some native vegetation in the same setting.[1, 2]

Russian olive, a different type of invasive phreatophyte shrub or small tree, was introduced in Kansas for windbreaks and wildlife plantings. The Russian olive, with its tendency to spread quickly, is a menace to riparian woodlands, threatening hardy native Kansas species like cottonwood and willow trees. Russian olive outcompete native vegetation, interferes with natural plant succession and nutrient cycling, and chokes irrigation canals in Kansas.

The resulting invasive thickets of tamarisk and Russian olive provide poor habitat for livestock and wildlife, increase fire hazards, decrease water quality and generally use more water than native vegetation. The vegetation does, however, provide shelter protection for livestock. Infestations of phreatophytes in Kansas are roughly estimated to occupy greater than 50,000 acres.

Scientists with the U.S. Department of Agriculture (USDA) have stated that, "*tamarisk infestation has reached epidemic proportions and is one of the greatest disasters to ever befall native riparian areas in western United State,".*[3] The National Invasive Species Council has identified tamarisk as one of its primary targets for control.

Tamarisk affects the water supply in both quantity and quality. The decrease in alluvial ground water levels due to tamarisk increases the transit loss of water delivered from John Martin Reservoir in the Arkansas River. Tamarisk affects water quality by reducing in-stream flows and the concentrating of naturally occurring salts in tamarisk stands.

Scientists with the U.S. Department of Agriculture (USDA) have stated that . . . *tamarisk infestation has reached epidemic proportions and is one of the greatest disasters to ever befall native riparian areas in western United States*. (2) The National Invasive Species Council has identified tamarisk as one of its primary

targets for control.

Tamarisk affects the water supply in both quantity and quality. Tamarisk affects water quality by reducing in-stream flows and the concentration of naturally occurring salts in tamarisk stands.

Thick tamarisk stands promote narrowing of river and stream channels. Since tamarisk replaces native species, there is a loss of bio-diversity in the infested areas. In the Cimarron River basin, tamarisk is rapidly replacing the last remaining native Alkali sacaton (*Sporobolus airoides*) and western wheatgrass prairie. Wildfires are more intense in tamarisk infested areas; however, due to the nature of the tamarisk root crown, tamarisk recovers from fires quicker than native vegetation. Thus, fires tend to promote additional infestation. Tamarisk infestation is problematic in Kansas because it negatively impacts water quantity and quality, and results in the loss of land utilization options and value, as well as a loss of habitat.

Estimates of the number of acres infested in the United States are between one and two million acres. Tamarisk has been identified in nearly every county in Kansas, but is concentrated along streams and lakes in the western portion of the state. Tamarisk is prevalent along the mainstem and tributaries to the Arkansas and Cimarron Rivers, as well as, the shorelines of several of the state's federal reservoirs.

Helicopter surveys of the Cimarron River were conducted in 2005 and 2006 by the Kansas Department of Agriculture. Estimates from the 2004 survey indicate that about 26,178 acres (73%) of the riparian corridor from the Colorado-Kansas state line east to the Kansas-Oklahoma state line along the Cimarron River are infested with tamarisk (Table 1). According to a state-wide county survey conducted in 2004, more than 50,000 acres of the land surveyed in Kansas are infested with tamarisk. In the Cimarron basin counties, there are over 27,000 acres infested (Table 1).

Recommended Action

1. Continue to work with agencies and other groups on the water issue strategic plan and 10-Year Strategic Plan to coordinate and implement the variety of programs, research and educational efforts that are occurring or recommended.

2. Promote education and seek local input through the state's Basin Advisory Committees.

3. Continue an evaluation of the most effective and cost-efficient control measures for the basin.

4. As an effective control measure is identified for the basin, implement a wide scale, watershed-based control effort, with plans to replant with beneficial vegetation that helps stabilize the soil and provide other benefits the invasive species had provided.

5. Research and evaluate biological control of tamarisk using leaf beetles and/or other suitable organisms, but pilot it with extreme caution to avoid unintended consequences.

6. Deliver educational materials and technical information to legislators, property owners and the public within the basin related to non-native phreatophyte research and control through Kansas State University Ag Experiment Station & Cooperative Extension Service.

7. Quantify the actual non-beneficial use of water by tamarisk in the basin's different ecological settings. Existing research should be used and augmented with on-the-ground measurements of changes to both stream flow and ground water before and after tamarisk control activities. This research will help to establish the difference in water consumption in Kansas between non-native phreatophytes and typical riparian plant communities.

8. Evaluate the recovery benefits after tamarisk control to provide valuable information on the specie's true impact to water quality, wildlife habitat, water quantity, grazing land, risk reduction from flood damages and other features that impact the basin's ecology and economy.

9. Determine the potential disposal of tamarisk biomass holds for various value-added products such as ethanol, bedding, fiberboard, and fuel pellets, and identify how to harvest and remove tamarisk without damaging the riparian area.

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Cimarron Basin High Priority Issue
Bioenergy and Water
January 2009

Issue

Renewable fuel production is a growing issue in the Cimarron basin, where increased biofuel production provides economic opportunity. As new biofuel facilities are sited and changes are made to the basin's cropping patterns, more evaluation is needed of the impacts from the increased demand on both water supply and water quality.

Description

Gas and oil production is the second largest industry in Kansas and is very important to the Cimarron basin's economy. The first gas wells were drilled in the Hugoton field in the early 1920s, which remains a major national gas producing area. The growing industrial contribution to the basin's economy is also related to energy production, primarily ethanol. As of December 2008, there is an ethanol plant permitted for construction in Grant County, a permit pending in Stevens County and an operational ethanol plant in Seward County. Hugoton, Stevens County, will also be the site of the state's first cellulosic ethanol plant (Figure 1).

Water Quantity

Ethanol production, like many industrial and agricultural practices, involves a consumptive use of water. A 50-million gallon per year (MGY) ethanol plant uses about 200 MGY of water (or about 550,000 gallons per day), primarily from evaporation during cooling and wastewater discharge. Ethanol production technology has uses water more efficiently; plants today use about 50 percent less water than 10 to 15 years ago. It currently takes three to four gallons of water to produce one gallon of ethanol. Under Kansas law for appropriating water, ethanol plants, as any industry, must purchase water from a rural water district a municipality or acquire a water right. Parts of the basin are closed to new water appropriations; in closed areas, any new venture must purchase an existing water right, and any change in use of that appropriation must be approved by the Chief Engineer of the Kansas Department of Agriculture-Division of Water Resources to ensure that the net consumptive use does not increase.

Nonetheless, some have raised concerns that increased corn production, a water-intensive crop, may cause additional declines over time.[2, 3]

Most U.S. ethanol is made from corn, but it can also be produced from other feedstocks such as grain sorghum, wheat, barley or potatoes. In Kansas, more than half of the ethanol produced comes from grain sorghum, with most facilities using corn and sorghum interchangeably.[2]

Ethanol production using corn grain has exploded throughout the Midwest. This new demand for corn, and the new opportunities for value-added processing and cattle production in rural communities, has created a significant economic development opportunity throughout Kansas and in the Cimarron basin. However, the potential changes to the basin's cropping patterns, specifically increasing the number of irrigated corn acres, may negatively impact the aquifer and stream conditions.

According to the U.S. Department of Agriculture National Agricultural Statistics Service (NASS) the number of irrigated corn acres in southwest Kansas grew from 438,000 acres in 1990 to 726,000 in 2007.[5] However, despite the growth over this period, recent years do not reflect the highest recorded irrigated corn acres for this region. Improved agronomic practices and crop genetics have led to higher corn yields. In southwest Kansas, while there was a 16% increase in irrigated corn acres from 1993 to 2003, there was a 52% increase in irrigated corn production. [10] According to the Kansas Department of Agriculture, Stevens County ranks first in all Kansas counties for irrigated corn acres.

In 2006, approximately 16% of Kansas corn and sorghum crops were used for ethanol production, up 13%

from 2000. Corn production in Kansas may be slowing down. According to NASS, producers intended to plant eight percent fewer corn acres in 2008, as a result of multiple factors including crop rotation considerations and high input costs. In 2008, Kansas was expected to plant their largest soybean crops in history.[5]

Water Quality

Wastewater from ethanol plants is regulated by the Kansas Department of Health and Environment (KDHE), which administers both the federal National Pollution Discharge Elimination System (NPDES) permits and Kansas Water Pollution Control permits. In most instances, KDHE issues the state-level permit, which requires ethanol plants to use the wastewater for beneficial land applications rather than simply discharging into streams and rivers.

A rise in the number of corn acres may also impact the basin's water quality through increased fertilizer application and soil erosion. Corn has the greatest application rates of both fertilizer and pesticides per acre, higher than for soybeans and mixed-species grassland biomass. The switch from other crops or noncrop plants to corn may lead to higher application rates of highly soluble nitrogen. Harvested row crops, such as corn, have a higher potential for soil erosion than grasses or perennial crops. The potential water quality impact of an increased demand for corn may be mitigated through Best Management Practices (BMPs), especially those addressing soil erosion and herbicide applications.

Biodiesel

Biodiesel is produced using oils extracted from crops, animal fat or waste vegetable oil using a chemical process called transesterification. Most U.S. biodiesel is produced from soybean oil, although other vegetable oils such as canola, corn, cottonseed, flax seed, sunflower, or peanut oil can be used. As of December 2008, no biodiesel facilities are permitted for or located in the Cimarron basin.

Biodiesel production uses roughly three gallons of water per gallon, about a gallon of which is consumptive use. Wastewater from biodiesel plants, which may contain high amounts of oxygen, grease and oils, is regulated by the KDHE.

Cellulosic Ethanol

Cellulosic ethanol uses lignocellulose, the main structural material in any plant, as a feedstock. Cellulosic feedstocks require an extra step to break down the lignocellulose into fermentable starch, thus increasing production costs. The bulkier cellulosic feedstocks are also more costly to harvest, transport and store. Processing of cellulosic materials would require more water than corn, as the feedstock is dry. Research on cellulosic feedstocks, such as switchgrass, wood chips, and corn stover is ongoing. The U.S. Department of Energy has set 2012 as a target to achieve technological advances to make cellulosic ethanol cost competitive with corn ethanol. In 2007, Abengoa Bioenergy, a Spanish energy company, announced that Hugoton, Kansas would be the site of the state's first cellulosic ethanol plant. In conjunction with cellulosic ethanol research, some researchers are investigating the use of perennial polyculture crop systems for cellulosic feedstocks.

Production of cellulosic ethanol may have greater positive environmental impacts than grain based ethanol such as reduced greenhouse gas emissions, decreased fertilizer application and less reliance on water intensive crops.

Corn Research and Varieties

Breeding of corn hybrids that maximize yield for ethanol production while reducing additional strains on water supplies has been a focus of much research by universities and corn breeding companies. Drought tolerant hybrids, specifically transgenic drought resistant corn, are especially important in areas of western Kansas where rainfall averages fewer than 16 inches per year. In addition to drought tolerant varieties, industries are identifying corn varieties that produce higher yield and more ethanol per acre. High total fermentable ethanol corn hybrids provide higher levels of fermentable starch, the sum of all starches and simple sugars that ferment during the typical dry grind process.[4,7]

Recommended Actions

1. Coordinate, where applicable, the development, implementation, and public input process between the *Kansas Water Plan* and Kansas energy policy.

2. Maintain regulatory oversight by state and local government on the siting of ethanol and biodiesel plants, with special emphasis on educating applicants on the water supply and availability.

3. Look for water recycling opportunities within the biofuel facilities.

4. Promote research for less water dependent corn varieties and improved irrigation scheduling that maintains or increases crop yield without increasing water use, and encourage more use of grain sorghum, sweet sorghum and other lower water use crops.

5. Promote research and pilot projects for viable, commercial cellulosic ethanol production and other biofuels less dependent on water intensive crop production.

6. Increase corn water use efficiency (amount of grain produced per inch of water) through research and extension efforts. Educational emphasis should be placed on utilization of irrigation scheduling tools such as KanSched and the Mobile Irrigation Lab.

7. Evaluate the biofuel facility watershed and watersheds of input crops, and identify potentially environmentally sensitive areas and target programs to mitigate environmental impacts, such as stream buffers, grass filters, BMPs, etc.

8. Provide education and/or incentives for marginal lands that have expiring, un-renewable Conservation Reserve Program contracts to stay in a conservation planting, with special consideration to acres that could return to irrigation.

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