

Appendix 10.4

Kansas Prescribed Fire Emissions

Appendix 10.4 Kansas Prescribed Fire Emissions

Kansas Agricultural and Prescribed Burning

Kansas is a largely agricultural state, with approximately 47.2 million acres of land in farm production. The predominant crops grown in Kansas include winter wheat, corn, sorghum, soybeans, and hay. In 2009, cattle and calves totaled 6.3 million head; hogs totaled 1.74 million head in 2008. As the leading producer of wheat and third largest producer of beef cattle, Kansas is one of the most productive agricultural States in the United States. Total agricultural production value for livestock and products for the State was estimated to be \$7.21 billion for 2009¹. As part of the State's agricultural operations, approximately 5 million acres of land are burned each year.

An emissions inventory for prescribed and agricultural burning activities in the CENRAP states for 2002 was prepared by Sonoma Technology, Inc.² The following tables and charts summarize the annual emissions from burning.

Table A10.4.1 2002 Kansas Nonpoint Fire Emissions, by Type of Burn and Pollutant

Burn Type	Acres Burned	PM ₁₀	PM _{2.5}	CO	NO _x	SO ₂	NH ₃	VOC
		<i>2002 tons</i>						
Rangeland	3,625,270	75,943	52,901	652,250	23,185	10,160	7,487	43,483
Cropland	1,390,520	23,227	22,156	153,313	5,909	777	3,950	11,401
Prescribed	38,106	1,450	1,226	14,424	228	114	143	881
Totals	5,053,896	100,620	76,283	819,987	29,322	11,052	11,579	55,765

Table A10.4.2 2002 Kansas Crop Residue Burning Emissions, by Crop and Pollutant

Crop residue type	Acres Burned	PM ₁₀	PM _{2.5}	CO	NO _x	SO ₂	NH ₃	VOC
		<i>2002 tons</i>						
Wheat	1,058,014	17,420	16,610	118,902	4,523	603	3,216	8,194
Hay/Alfalfa	189,085	2,252	2,148	12,701	408	54	290	1,143
Corn	126,956	3,039	2,906	18,902	880	107	373	1,760
Soybeans	9,996	210	200	1,252	34	5	24	154
Other	6,469	306	292	1,557	65	9	46	150

Figure A10.4.1 2002 Acreage Burned in Kansas

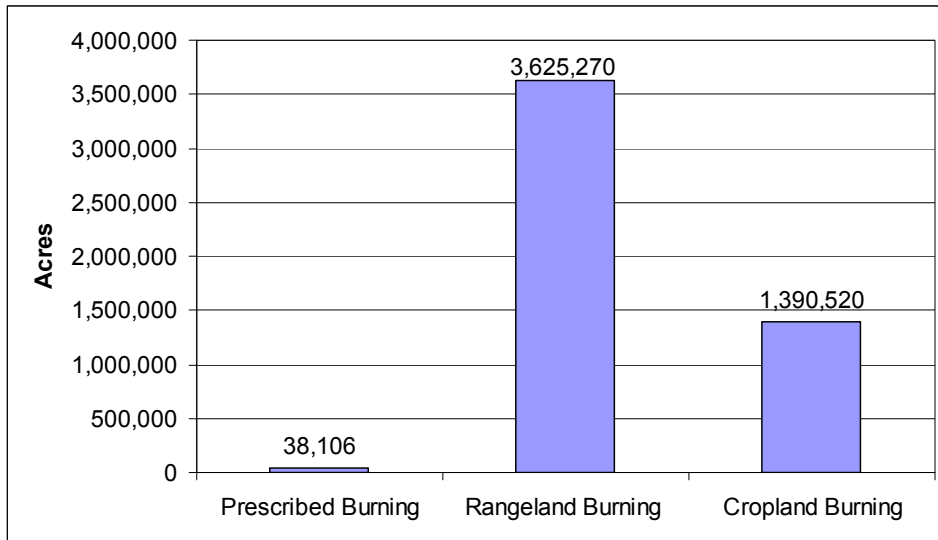


Figure A10.4.2 2002 Cropland Burning in Kansas

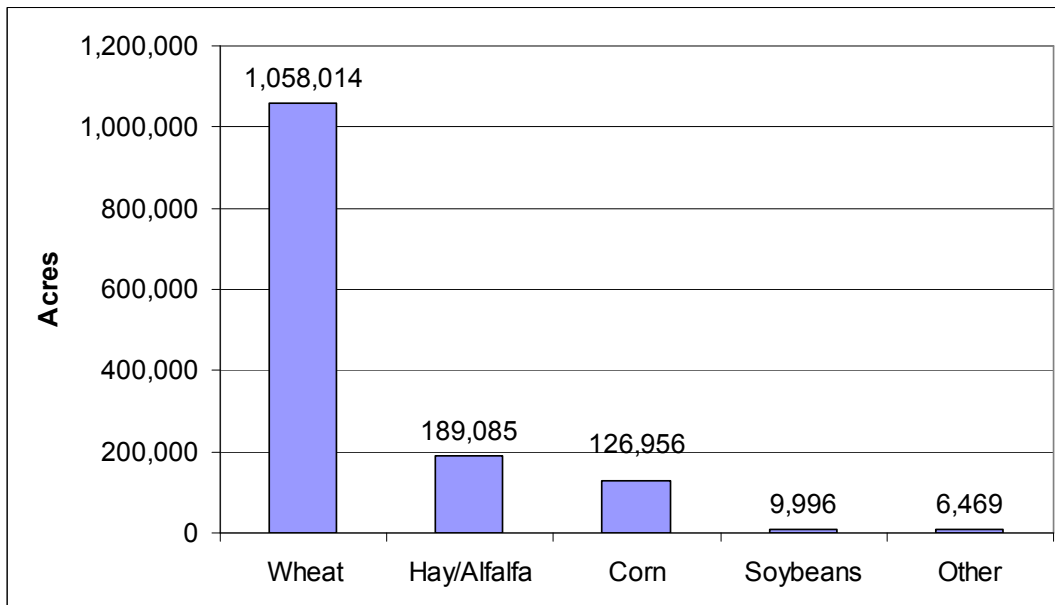
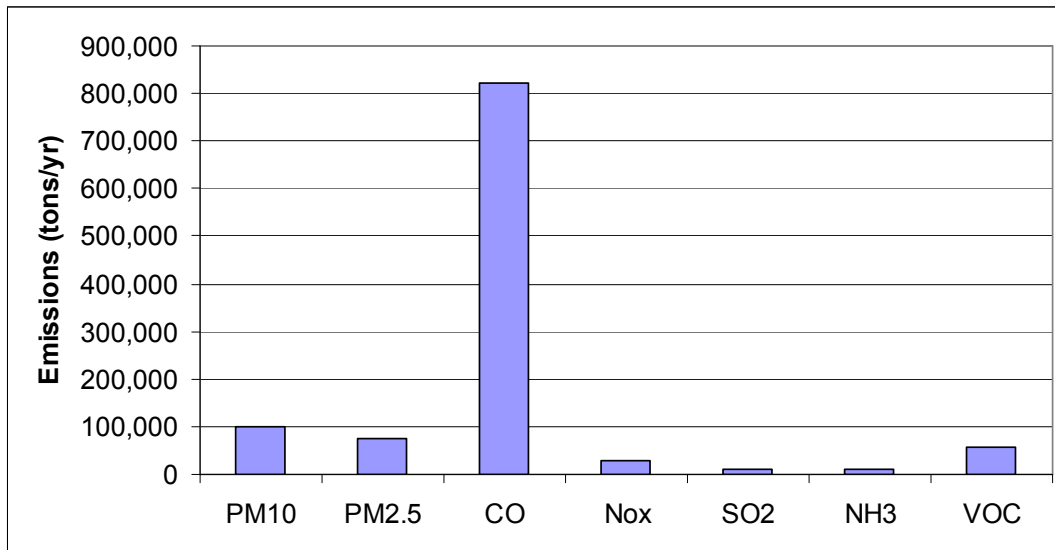


Figure A10.4.3 2002 Emissions from Fires in Kansas



Flint Hills Rangeland Burning

The impacts from agriculture burning are especially a concern in the Flint Hills region of Kansas. The approximately 4.1 million acre Flint Hills region is a band of typically flat-topped hills in eastern Kansas that extend from Marshall County in the northernmost part to Chautauqua County in the southernmost part of the state. The Flint Hills region contains some of the last remaining tall grass prairie in the world. Soils in the Flint Hills are rich but thin on alternating layers of limestone and shale, and have essentially remained unplowed. The dominant grass species found in this region include big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and Indian grass (*Sorghastrum nutans*)³. Other species that are not endemic to Kansas but that have become naturalized include Kentucky bluegrass (*Poa pratensis*) and Japanese brome (*Bromus japonicus*).

Historically, the grasslands of central North America experienced fire, drought, and heavy grazing by bison and other ungulates. Fires were initiated by lightning and by Native inhabitants, which influenced the development of fire-tolerant grasses and suppressed woody vegetation. Today, ranchers in Kansas continue to use fires to manage rangelands, and research conducted by Kansas State University supports these practices. The burning cycle mirrors natural burns that maintained the quality of the grasslands historically. Fire serves to control undesirable invasive species, and improves the quality of forage for cattle production⁴.

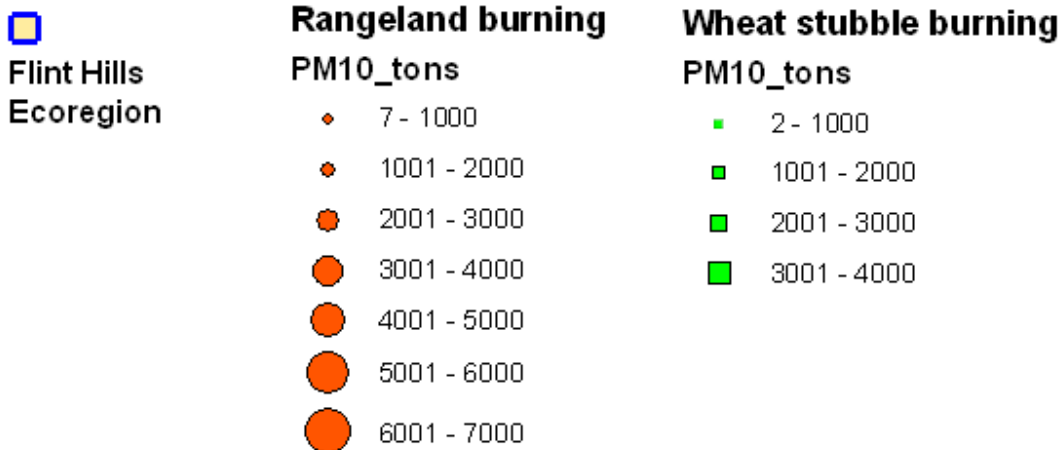
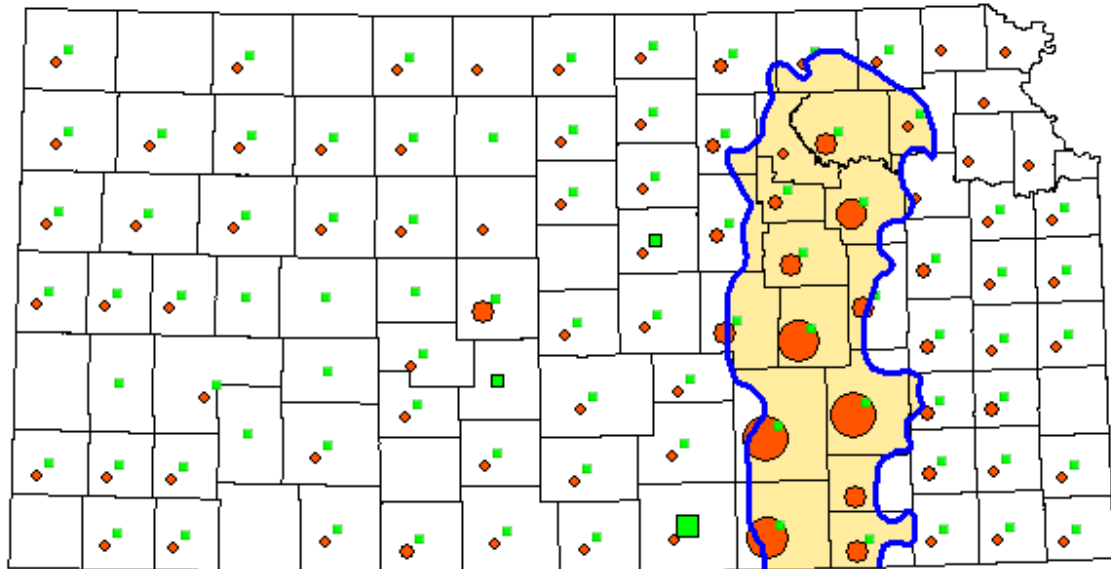
Wheat Stubble Burning

Wheat farmers have traditionally burned stubble fields before fall planting in order to remove residue for easier planting, while at the same time providing control of some disease organisms and weed species⁵.

The following map, Figure A10.4.4, shows how emissions of particulate matter, the

predominant haze-related pollutant from fires, vary in relation to geography, particularly the Flint Hills region. Note that the source of this data is EPA's National Emissions Inventory, which does not track fine particulates (PM_{2.5}), but rather PM₁₀. As Figure A10.4.3 above shows, however, the majority of grass fire particulate emissions are PM_{2.5}.

Figure A10.4.4 PM₁₀ Emissions from Rangeland and Wheat Stubble Burning in Kansas, by County (2002 National Emissions Inventory)



Prescribed Burning

As interpreted by EPA for emissions inventory purposes, prescribed burning means setting fire to vegetation in order to prevent the buildup of fuel that, if left unburned, could lead to dangerous wildfires. Considering the frequency of rangeland burning (three out of every five years is average), prescribed burning is not a major source of emissions in Kansas. As indicated in Table A10.4.1 above, prescribed burning accounts for only 0.8% of the total acres burned.

Discussion of Data

According to the STI baseline inventory estimates, a total of 5,053,896 acres were burned in the State of Kansas in 2002. The largest percentage of acres burned (71.7%) was rangeland. Cropland burning is the second largest percentage of burning in Kansas (27.5%), and is primarily attributed to residue burning of wheat stubble, with burning of alfalfa, corn, and soybean residue making up the balance. Prescribed burning accounts for the smallest percentage of total acres burned (0.8%). Heavy rangeland burning occurs primarily in eastern Kansas in the Flint Hills region, where as much as 80% of the total acreage of rangeland is burned in several counties. Western Kansas accounts for a much smaller percentage of rangeland burning. Crop residue burning in continuous wheat is primarily an issue in central Kansas.

Future Emissions from Agricultural Burning

According to Walt Fick, Associate Professor in the Department of Agronomy at Kansas State University, the emissions from rangeland burning in the State of Kansas will likely remain constant in the future.⁶ Significant land use changes are not expected to reduce the acreage currently used for cattle grazing and the beef cattle industry is not expected to decline in Kansas.

Regulation of Agricultural Open Burning

Agricultural open burning in Kansas is regulated by Kansas Air Regulation (K.A.R.) 28-19-648, which exempts open burning for agricultural purposes from other open burning regulations so long as certain conditions are met. Such conditions include contacting local fire officials if required by the local governing body, contacting local traffic control and airport authorities if conditions exist that would create safety hazards, and supervising the fire until it is extinguished. The regulation allows for local jurisdictions to adopt more restrictive ordinances governing agricultural burning.

The Kansas State Fire Marshall's office keeps a database of fire incidents as reported by local fire departments. However, prescribed burns in Kansas may or may not be reported to the local fire departments, depending on the specific regulations within each township.

Historical Impacts of Agricultural Burning

While agricultural burning is beneficial to farming and ranching operations, it also has negative impacts that must be addressed. Agricultural burning can present safety hazards, contribute to ozone and particulate matter pollution in downwind areas, and impair visibility in Class I areas.

Public safety has been the largest concern of landowners and public officials. This has been particularly true for smoke causing visibility impairment on highways and near airports. Outreach efforts by the Kansas State University Cooperative Extension emphasize proper burn practices that minimize fire danger. These practices include burning when wind speeds, cloud cover, relative humidity, and temperature are at desirable levels. Landowners are also encouraged to notify neighbors and local fire departments before they burn.

Monitoring evaluations have confirmed that rangeland burning increases the level of air pollutants in Kansas, but the levels rarely exceed the federal air quality standards. One such exceedance occurred in April 2003. On April 12 and 13, 2003, three monitors in the Kansas City ozone monitoring network recorded readings in excess of the federal 8-hour ozone standard. The Kansas Department of Health and Environment (KDHE) also received numerous complaints from other cities and states as far away as Tennessee about high ozone and particulate matter readings attributed to the burning in Kansas during this time.

After receiving the complaints, KDHE contacted Kansas State University (KSU) range management researchers and learned that due to severe drought conditions persistent in that region, a burn ban had been placed by the Kansas Fire Marshal's office. Just prior to April 10, 2003, a small yet sufficient amount of precipitation was received that allowed the local fire officials to temporarily lift the burn ban. This resulted in many fires occurring on April 10, 11, and 12. This compressed time schedule for burning, coupled with weather conditions that kept smoke and air pollutants from dispersing, caused large amounts of air pollutants to be trapped in the lower layers of the atmosphere and transported downwind across the Kansas City metro area and eastward into the Tennessee Valley. Together, these factors resulted in Kansas City monitors exceeding the ozone standard and high readings of particulate matter in monitors across eastern Kansas and neighboring states. While the 2003 event was exceptional, burning in the Flint Hills continues to pose a concern to downwind areas.

During the spring of 2006, KDHE conducted a special monitoring project in which monitors were placed in the towns of Admire and Dwight, Kansas to measure particulate matter and to collect samples for carbon analyses. During the seven week study, the monitors did not measure levels of particulate matter that exceeded the federal 24-hour average of $150 \mu\text{g}/\text{m}^3$. However, there were four recorded short-term spikes in the hourly data during high burn days, with particulate matter levels reaching over $850 \mu\text{g}/\text{m}^3$ during one of the recorded episodes. The carbon analyses resulted in high organic carbon to elemental carbon ratios, which indicated that the majority of carbon sampled originated from vegetation fires⁷.

Visibility Impacts at Class I Areas

The impact of planned burning to visibility at Class I areas was evaluated by Sonoma Technology, Inc. during the development of both the planned burning emissions inventory and the causes of haze assessment for the CENRAP region. To view these documents in their entirety visit <http://www.kdheks.gov/bar/index.html>

The July 30, 2004 study conducted as part of the planned burning inventory analyzed ambient speciated $\text{PM}_{2.5}$ data from the IMPROVE network at two Class I areas (Caney Creek and Upper Buffalo Wilderness Areas) to determine which chemical compositions characterize prescribed burning activity. The study found that levels of elemental carbon and non-soil potassium were elevated on days during or after agricultural burning in the area. However, the contribution of elemental carbon, the primary marker of smoke, is a

small part of the PM_{2.5} mass. While elemental carbon has relatively high extinction efficiency, the mass concentrations are small and do not contribute significantly to light extinction. Ammonium sulfate is typically the largest contributor to light extinction and does not tend to originate from burns.²

Figure A10.4.5 Species Contributing to Light Extinction at Hercules-Glades Wilderness Area

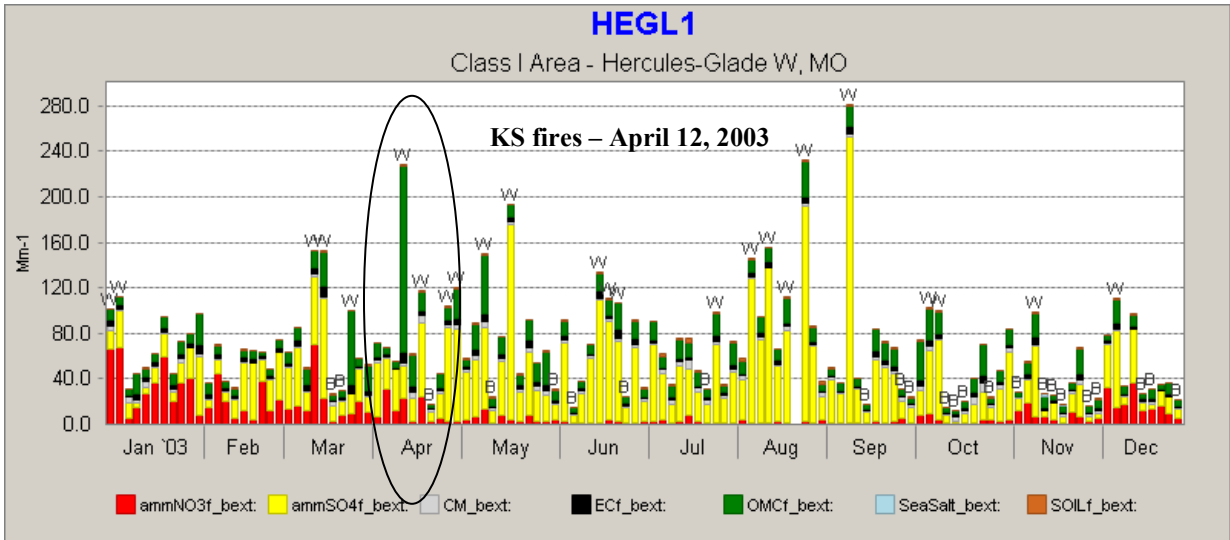
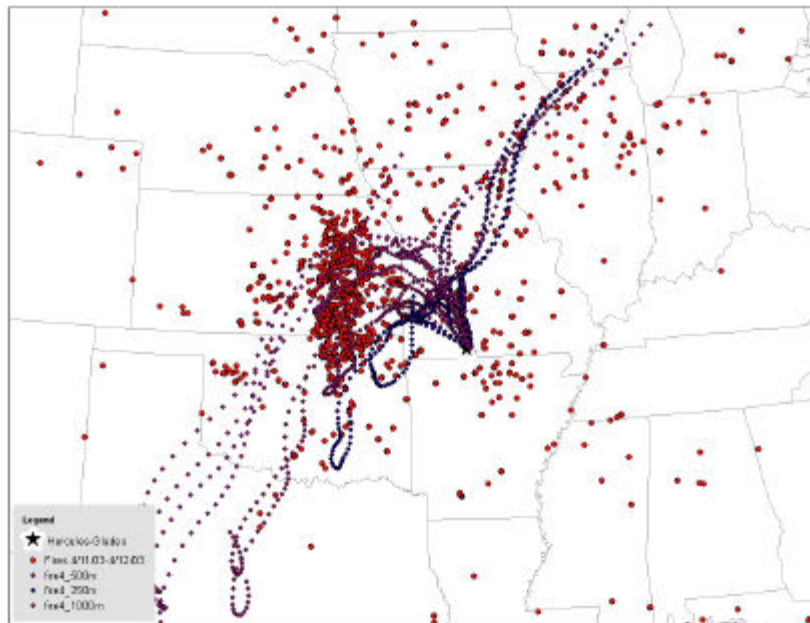


Figure A10.4.6 Back Trajectory Map for Hercules-Glades for April 12, 2003



As part of the causes of haze assessment completed August 31, 2005, STI assessed the aerosol components that contribute to poor visibility in the CENRAP region. The study found that fires infrequently contribute to visibility impairment observed on the 20% worst days. The receptor modeling tool Positive Matrix Factorization (PMF) was used to

establish factors to characterize ambient data. These factors were inferred to represent specific source types. Data analyzed at Hercules-Glades on two days when the biomass burning factor was highest (April 12, 2003 and May 9, 2003) showed the factor only accounted for 7% of the median mass, and 6% of the mass on the worst visibility days. The study concluded that the biomass burning factor was substantially less important to visibility than coal burning and other factors.⁸

Outreach and Mitigation Efforts

In the fall of 2003, KDHE staff presented information regarding the effects of the Flint Hills burning on ozone levels to agricultural representatives at a conference at Kansas State University. KSU range management researchers, KSU Research and Extension, the Kansas Department of Agriculture, the Kansas Livestock Association, and other agricultural representatives were all present at the meeting. With the help of the organizations present, KDHE launched a public outreach campaign to address impacts from fires. KDHE provided information prior to the burn season to local fire departments, the Kansas Livestock Association, and the Kansas Farm Bureau. In addition, the KSU Media Department sent out news releases. Following the outreach efforts in 2004, KDHE and EPA Region 7 have continued to meet with the parties mentioned above on an annual basis to address burning impacts.

Research and Model Development

The National Weather Service (NWS) office issues a rangeland fire danger index for six regions across the State of Kansas and is updated automatically as weather conditions change. The danger index ranges from low, moderate, high, very high, to extreme and is determined by temperature, humidity, and wind speed. In addition to the fire danger index, NWS provides a fire weather planning forecast and fuel moisture data, and an experimental weather activity planner to assist landowners in planning burns.

EPA Region 7 is working on a customized version of the BlueSky RAINS model for the State of Kansas. Blue Sky RAINS is a web-based information system to help manage prescribed and agricultural burning. The model merges the technology of BlueSky, developed by the U.S. Department of Agriculture, and the Rapid Access Information System (RAINS) developed by EPA Region 10. BlueSky estimates the cumulative impacts of smoke from prescribed, wildland, and agricultural burning. RAINS uses geographical information system (GIS) technology to provide an internet mapping service. The combination of these two applications provides land managers with the ability to analyze potential smoke impacts from regional burning activities. County extension officials in two counties used the model on a trial basis during the burning season of 2006. Efforts to expand the use of the model to other counties in the state are underway for 2007.

Kansas State University is performing a study to spatially and temporally map seasonal burning of the Flint Hills. The study is being sponsored by EPA Region 6 and will be led by Douglas Goodwin, a professor in the KSU Geography Department. Maps of the Flint Hills annual burning for 2001-2006 will be prepared using remote sensing data from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. MODIS data was selected as appropriate for this study because of the large coverage, high temporal

frequency, and low cost. MODIS data will be obtained, free of charge, from NASA for each of days of the burning season (March–June) for the project years 2001-2006. Remote sensing and GIS analyses will be used to produce weekly maps and composite maps of burned areas for each of the years. The study will also provide tabulated values of total acreage burned, and the dates of burning. This study will be useful for smoke management efforts in the future because it will aid the development of improved emissions inventory from Flint Hills burning.

Smoke Management Initiative

The Kansas Department of Health and Environment (KDHE) is developing the Kansas Smoke Management Initiative, a comprehensive plan to address the negative impacts of open burning in the state. The Kansas Smoke Management Initiative is an effort to coordinate with a variety of partners to address all types of open burning in the state including rangeland, cropland, residential, and commercial/industrial burning. The goals of the Smoke Management Initiative are outlined below.

While the Kansas Department of Health and Environment recognizes the importance of fire as a range management tool, our goal is for landowners to manage burning in a way that reduces the impacts of smoke. KDHE is working towards developing a better understanding of the impact of rangeland burning on air quality by improving the emissions inventory, and performing ambient air monitoring in the vicinity of heavy burning activity. KDHE is partnering with the Center for Disease Control to study the health impacts of burning. KDHE will also coordinate with the agricultural community to develop best management practices (BMPs) to reduce the smoke impacts and support an expanded time window for burning. The Department will also support the development of tools that ranchers and local officials can use to determine proper burning conditions. Finally, the department is reviewing the possibility of changing the State's regulations to require local governments to address burning in their local ordinances.

The state will also address crop residue burning and will work with the agricultural community to set a goal to reduce the acreage of croplands burned each year and to develop outreach materials outlining possible incentives not to burn, and alternatives to burning.

In addition to addressing agricultural burning in the State, KDHE has set a goal to eventually eliminate all residential burning of household trash and yard wastes in the state. The short-term objective will focus on the elimination of open burning of household wastes within municipalities. Outreach materials will be developed and distributed through local agencies to educate the public on the health impacts of residential trash burning.

A mid-term objective will focus on the elimination of the burning of yard waste in municipalities. This will entail developing and promoting incentives and alternatives to burning such as mulching, composting, and establishing drop-off centers. Finally, a long-term objective will focus on the elimination of household trash and yard waste burning in rural areas.

Each of these efforts to reduce residential burning will require coordination with the Bureau of Waste Management (BWM). The BWM is responsible for approving solid waste management plans which are submitted every 5 years. These plans could incorporate provisions to develop the infrastructure needed to provide the services or alternatives necessary to reduce open burning.

Lastly, the Initiative will address the issue of commercial and industrial open burning which is prohibited in the State of Kansas. Commercial and industrial open burning persists in some cases because it is an inexpensive and convenient means of disposal. The existing regulations are adequate to regulate burning. However, more effort is needed to educate business owners and to enforce the current regulations.

Addressing smoke management in Kansas will be an ongoing effort that will require the support of many groups including the agricultural community, local fire and police officials, and local government officials. KDHE will pursue a Memorandum of Understanding with these groups by March of 2008. These partnerships will help guide the process and ensure that the resulting Smoke Management Initiative meets the needs of the communities impacted by burning. The Initiative will not only provide benefits of improved health and air quality in Kansas communities, it will support the regional efforts to reduce visibility impairment in Class I areas.

References

1. U.S. Department of Agriculture National Agricultural Statistics Service. *Kansas Farm Facts 2009*. Kansas Field Office. 2009.
2. Sonoma Technology, Inc. *Research and Development of Planned Burning Emission Inventories for the Central States Regional Air Planning Association*. July 30, 2004.
3. Ricketts, T., Dinerstein, E., and Olson, D. *Terrestrial Ecoregions of North America: A Conservation Assessment*. Washington DC: Island Press. 1999.
4. Owensby, C. et al. *50 Years of Range Research Revisited*. Kansas State University Cooperative Extension Service. 1995.
5. Kansas State University Extension Agronomy. *Agronomy e-Update No. 40*. July 12, 2006. <http://www.agronomy.k-state.edu/DesktopModules/ViewDocument.aspx?DocumentID=1538>
6. Fick, Walt. Associate Professor, Department of Agronomy, Kansas State University. Personal Communication. March 15, 2007.
7. Kansas Department of Health and Environment Bureau of Air and Radiation. *Ambient Air Monitoring Project: Prairie Burning in the Flint Hills, Kansas*. 2007.
8. Sonoma Technology, Inc. *Analyses of the Causes of Haze for the Central States (Phase II)*. August 31, 2005.