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THE RELATIONSHIP BETWEEN WEATHER PARAMETERS AND THE 10 HOUR TIME LAG FUEL MOISTURE

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1. Introduction

A relationship exists between various weather parameters and the 10 hour time lag fuel moisture (FM). Temperature (T), wind speed (WS), relative humidity (RH), cloud cover, and timing plus amount of rainfall all affect the moisture content in dead materials on the ground. This paper will look at how temperatures, wind speed, and relative humidity affect the 10 hour time lag fuel moisture at 25 fire weather observing sites in the Cheyenne Fire Weather District (Figure 1 and Table 1). Those parameters were chosen as they are readily available at all observing stations.

Table 1
25 Verified Fire Weather Stations
in the Cheyenne District

Wapiti	Nemo
Dubois	Custer
Lander	Wind Cave
WICC	Minnekahta
Grass Creek	Casper
Hyatt Ranch	Chadron
Shell	Rawlins
Medicine Wheel	Esterbrook
Burgess	Kennedy Ranch
Hunter	Brush Creek
Bearlodge	Fox Park
Piedmont	Goose
Tyrell	

(See Figure 1 for location of stations. Other stations in the District are not currently verified.)

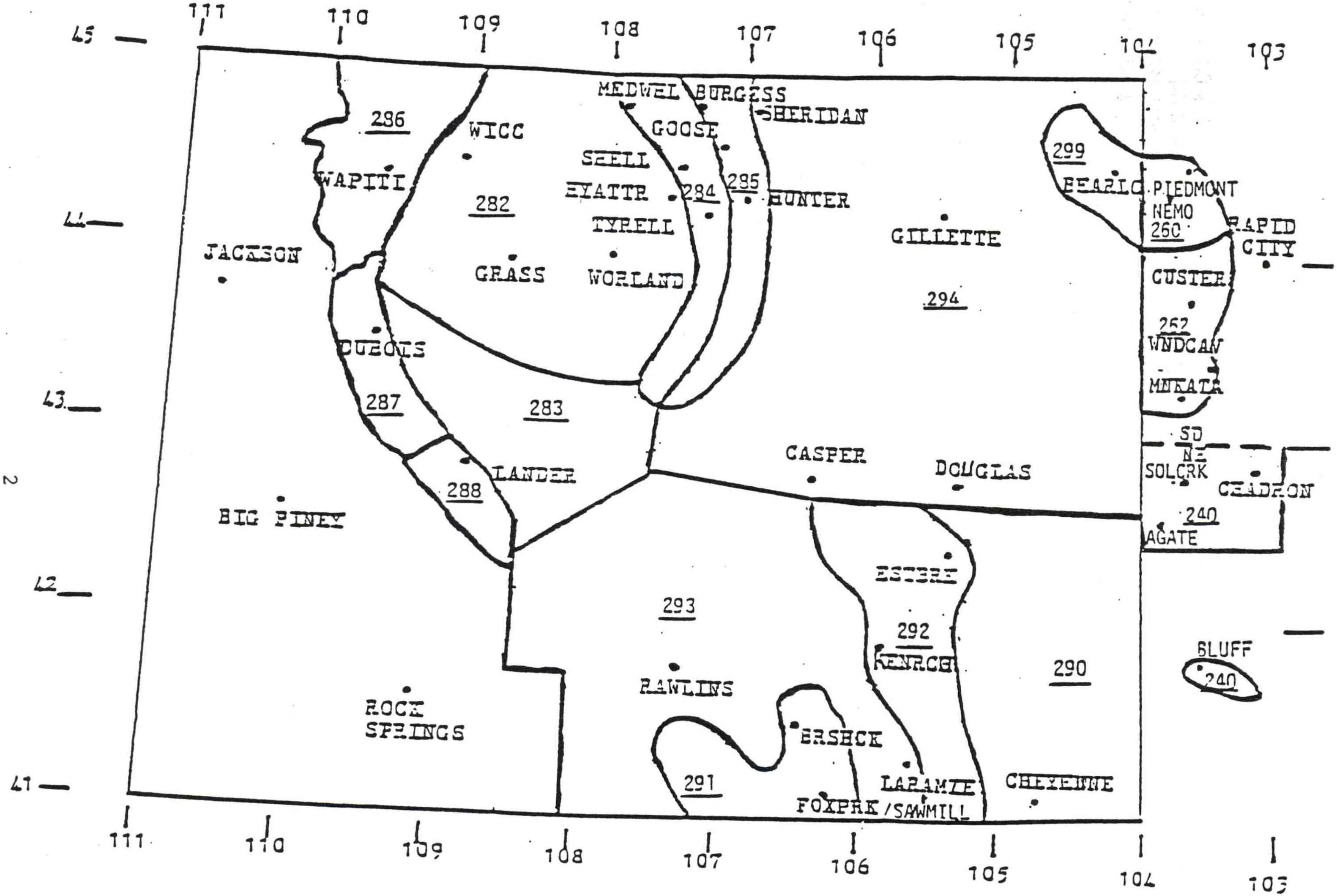

Figure 1. Fire weather zones for Wyoming.

The 10 hour time lag fuel moisture is defined as the amount of water in a fuel expressed as a percent of the oven dry weight of that fuel. When fuel moisture is low, fires start easily and burn rapidly. When fuel moisture is high, fires ignite slowly and burn poorly. The 10 hour time lag fuel moisture is used because it represents the group of dead fuels that support most fires and is also reported daily at each fire weather observing station. The 10 hour time lag fuel moisture means that it takes 10 hours for a piece of fuel to recover to its original moisture content due to evaporation after a rain. The size of a 10 hour time lag fuel is a branch, or cone, one-quarter of an inch to an inch in diameter (Fire Behavior Course S-390, 1981).

Factors other than weather can also contribute to the moisture content of a fuel. These include: elevation, aspect, slope, tree canopy cover, size of fuels, compactness of fuels, proximity of fuels to soil, and seasonal plant growth stages. In general, these factors are constant for a particular site, with the main variables being weather related parameters.

2. Procedure

The standard 1:00 p.m. MST fire weather observation was used to obtain all of the weather data as well as the 10 hour time lag fuel moisture information. Three years of data (1986-1988) of the 1:00 p.m. MST observation were used at each of the 25 fire weather sites that are verified (Table 1). The months of data used were May through September, with the total number of 1:00 p.m. MST observations being 12,523.

These observations were input into a regression equation analysis program (Stone, 1985), which is available for the AFOS system. This program calculates a number of statistical parameters, including correlation and regression coefficients, based on input data.

To nobody's surprise, relative humidity had the highest correlation coefficient to fuel moisture of the three parameters. The correlation coefficient of humidity was .80, compared with .31 for temperature and .21 for wind speed.

The resulting regression equation was computed:

$$FUEL = .328(RH) - .028(T) + .043(WS) + 1.21$$

This equation had a multiple correlation coefficient of .801. By a process of elimination, the temperature and wind speed parameters were systematically removed from the equation. The resulting equation was:

$$FUEL = .314(RH) + .451$$

This equation had a multiple correlation coefficient of .798. Since this coefficient only differs from the one found in the original equation by .003, the second equation could be used to obtain similar results. This second equation is more efficient since it depends upon only one independent variable as compared with three independent variables from the first equation (Panofsky and Brier, 1968).

Individually, relative humidity explained around 64 percent of the variance of the 10 hour time lag fuel moisture, while temperature explained about 10 percent, and wind speed 4 percent. Similarly, the equation itself (and its parameters of temperature, relative humidity, and wind speed) accounted for 64 percent of the fuel moisture variance. The greatest contribution to explaining the variance in the 10 hour time lag fuel moisture came from relative humidity. The remaining 36 percent of the variance could probably be explained by the variability of cloud cover and, more importantly, by the 24 hour precipitation total from the previous day.

3. Conclusion

This analysis of fuel moisture indicates that relative humidity plays the predominant role in determining the 10 hour time lag fuel moisture. It also shows that other weather variables and physical geographical parameters most likely explain the remaining 36 percent of the variance in 10 hour time lag fuel moisture. Some of these variables play an uncertain role, namely the extent of cloud cover plus the amount and timing of rainfall. Each station may have different results for the exact figures, but the average for all stations shows that, by far, the greatest weather factor influencing the 10 hour time lag fuel moisture is the relative humidity. In the absence of precipitation, a "quick and dirty" rule of thumb is that the fuel moisture would equal about one third of the relative humidity.

4. References

Boise Interagency Fire Center, 1981: Fire Behavior Course S-390, Unit 5, Boise, ID.

Panofsky, H. A. and Brier, G. W., 1968: Some Applications of Statistics to Meteorology, Pennsylvania University Press, University Park, PA, pp. 111-113.

Stone, H. M., 1985: Correlation and Regression Program-REGRS, Eastern Region Computer Programs and Problems #11, NWS Eastern Region, Scientific Services Division, Bohemia, NY.