Modeling the number and size of forest fires in Canada

Introduction

This paper is devoted to a problem of developing statistical models for forecasting the number and size of forest fires in Canada. Fire management and size-biased sampling are likely to have affected the historical record. This is because many small fires were likely undetected, while many detected fires were actioned. This would bias naïve models of the relations between fire weather and the fire regime parameters of interest. It is becoming important to develop more sophisticated models that account for this effect in order to make reliable forecasts under climate change.

Statistical analysis

Below we have a photo of the big fire in Fort McMurray:

Fig. 1 - Fort McMurray fire. Canada. Foto: @jagomegaur/Twitter.

In Fig. 2, on the left side, we have the representation of the number of fires by year, between 1950 and 2015. On the right side in Fig. 3 we have a representation of the number of fires by year:

Fig. 2 - Evolution fires vs year.

Fig. 3 - Graph of the number of fires by year.

Below on Fig. 4, we have the representation of the evolution of the mean size of fire vs year and on Fig. 5 we have the relationship between number of fires(ts) and mean size of fire (mean size).

Fig. 4 - Evolution of the mean size of fire vs year.

Fig. 5 - Evolution of number of fires vs mean size of fire.

The model is little significant for variable n. We can conclude that for the whole data there is no relation between the number of fires and the mean size of the fire. The intercept has a high significance (0.0001), but the coefficient of the independent variable t(n) is no significant. Analysis of regressions of the total data:

| Coefficients | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------|----------|------------|---------|----------|
| (Intercept)  | -12.0541 | 1.0595     | -11.30  | 8e-06    |
| t(n)         | 0.0082   | 0.0003     | 29.81   | 0.0000   |

Fig. 6 - Representation of the Analysis of regression of the total data.

The relationship between number of fires(n) and mean size of fire (mean size), using logarithmic scales:

| Coefficients | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------|----------|------------|---------|----------|
| (Intercept)  | -11.5041 | 1.0595     | -10.80  | 8e-06    |
| t(n)         | 0.0082   | 0.0003     | 29.50   | 0.0000   |

Fig. 7 - Number of fires(n) vs mean size of fire (mean size), using logarithmic scales.

Conclusions

With these temporal dataset of the number of fires we calculated a distribution which approaches the fire density within the mean, the variance and skewness of the proposed distribution, in order to model the number and size of forest fires. We can conclude that for the whole data there is no relation between the number of fires and the mean size of the fire.

References

1. A leisurely look at the bootstrap, the jackknife, and cross-validation. B Efron, G Gong - The American Statistician, 1985
11. The jackknife, the bootstrap and other resampling plans. B Efron, 1982