IMPACTS OF VEGETATION REGROWTH ON WIND DIRECTION OVER COMPLEX TERRAIN

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MODELLING WIND DIRECTION CAN BE RECAST IN PROBABILISTIC TERMS USING WIND RESPONSE DISTRIBUTIONS. THE IMPACTS OF VEGETATION REGROWTH ON WIND DIRECTION RESPONSE CAN THEN BE INVESTIGATED USING STATISTICAL COMPARISON TECHNIQUES.

INTRODUCTION

To align with emerging ensemble-based fire models and account for inherent uncertainties, it is useful to recast wind fields in a probabilistic framework. The variations in wind direction across complex terrain can be considered as the response of the wind flow to changes in the landscape. *Refer to the boxed section.*

An understanding of the impacts of physical parameters such as surface roughness on these directional responses is vital to the development of a statistical characterisation of wind fields.

COMPARISON TECHNIQUES

The impacts of post-fire vegetation regrowth on wind response across a mountainous valley landscape was assessed by conducting a statistical comparison of directional response distributions (DRDs) observed in 2007 and 2014 (Figure 1). The study region was heavily burnt in 2003.

A number of statistical techniques are available. In this study, a nonparametric comparison test is used with a null hypothesis of equality between the DRDs.

The test statistic is defined by Bowman (2006):

$$T_B = \frac{1}{2}\sum_i (\hat{w}_i - \hat{w})^2$$

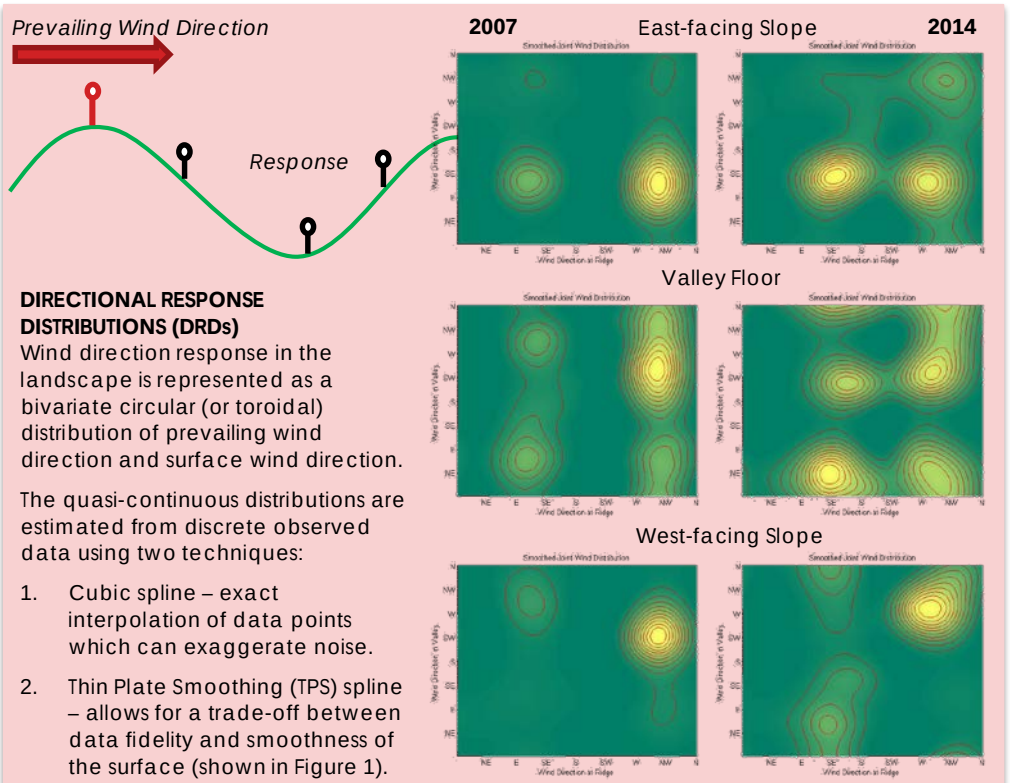
where $\hat{w}_i$ are the estimated DRDs from each year $i=\{2007, 2014\}$, and $\hat{w}$ is the estimated DRD from the combined datasets.

RESULTS

Table1: Results showing p-values from the comparison test under both estimation techniques.

	E-facing	Floor	W-facing
Cubic	0.1070	0.3820	0.1490
TPS	0.0000	0.0020	0.0010

Table 1 shows a clear difference in the magnitude of the p-values between the two estimation methods. The low p-values shown for the TPS spline indicate significant changes in the DRDs between the years, but the values are likely due to disproportionate weightings of small differences away from the modes of the distributions.



DIRECTIONAL RESPONSE DISTRIBUTIONS (DRDs)

Wind direction response in the landscape is represented as a bivariate circular (or toroidal) distribution of prevailing wind direction and surface wind direction.

The quasi-continuous distributions are estimated from discrete observed data using two techniques:

1. Cubic spline – exact interpolation of data points which can exaggerate noise.
2. Thin Plate Smoothing (TPS) spline – allows for a trade-off between data fidelity and smoothness of the surface (shown in Figure 1).

Figure 1: Wind response distributions (estimated using TPS spline) from points across the valley in (left) 2007 and (right) 2014.

Under the cubic spline, all three pairs show large p-values suggesting that all may be equal between the two years. The p-value for the valley floor is by far the largest, while the p-values for the slopes are much lower; showing more evidence that the DRDs may have altered between 2007 and 2014.

Figure 2: Difference in vegetation in the valley between (left) 2007 and (right) 2014.

CONCLUSIONS

These initial results show evidence to suggest that the directional response of wind flow across the valley has not been significantly altered by seven years of post-fire regrowth (Figure 2).

Analysis (not shown here) does suggest that wind speeds are significantly impacted by the increased vegetation. These combined findings have important implications for the construction of probabilistic wind models using physical parameters.

FURTHER WORK

Further work is required in this area to understand the sensitivity of the test to changes in the directional distributions, and also to further quantify the impacts of vegetation regrowth.

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References

Bowman, A.W.(2006) Comparing nonparametric surfaces. *Statistical Modelling*, 6(4):279-299.