Forestry Commission

Research Information Note 231

Issued by the Research Division of the Forestry Authority

THE EFFECTS OF REVISED WINDINESS SCORES ON THE CALCULATION AND DISTRIBUTION OF WINDTHROW HAZARD CLASSES

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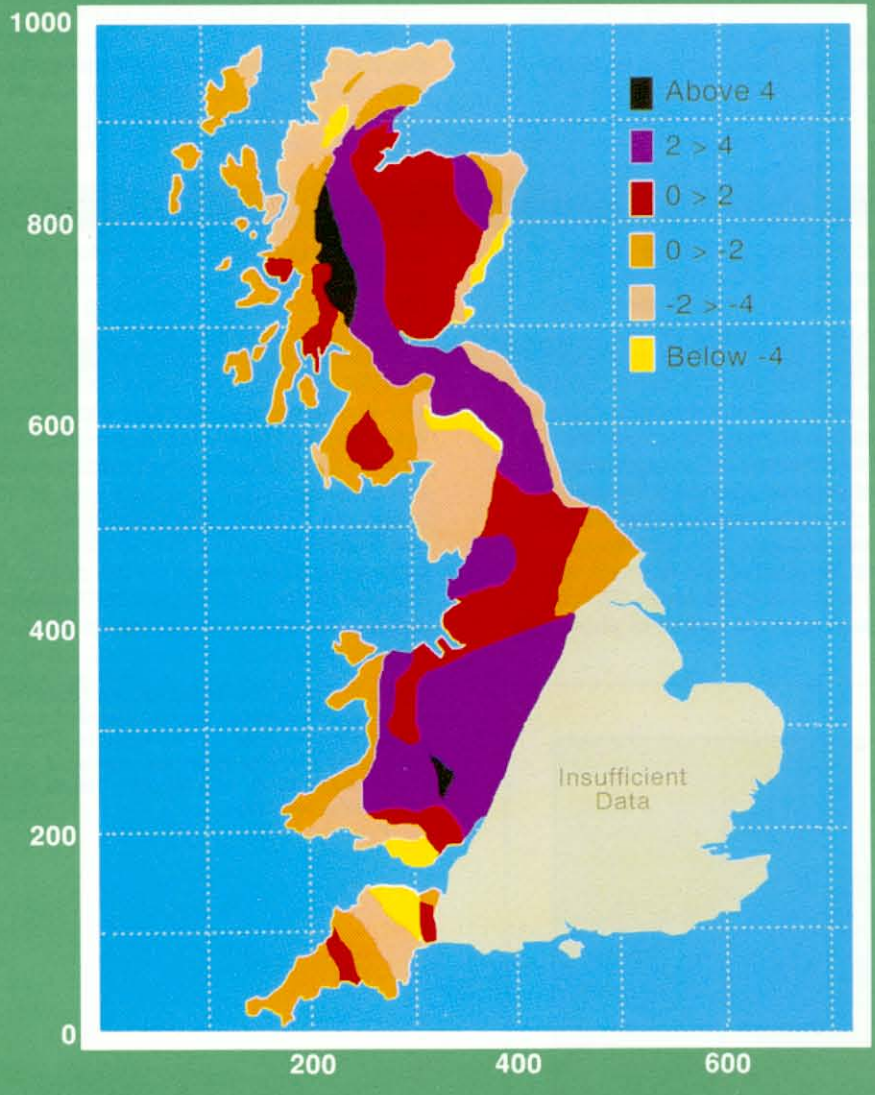

Abstract

Revised windiness scores for the windthrow hazard classification have recently been published in Research Information Note 230. Scores for the components of wind zone, elevation, topex and aspect are compared using the revised and original methods. Guidance is given here on the locations and topographic types where hazard class is most likely to change. Examples calculated using a geographic information system (GIS) confirm that the revised scores can give significant changes in the distribution of hazard classes; 49% of the area in the study showed a change of hazard class, and the highest class, hazard class 6, was almost completely removed.

Introduction

A new analysis of tatter flag data has provided revised windiness scores (Quine and White, 1993) for the windthrow hazard classification (Miller, 1985). As a result of this revision, the weighting between the windiness components of wind zone, elevation, and topex has been altered, and scoring for aspect has been introduced. The scoring for soils and the hazard class thresholds remain unchanged. Updating hazard class information prepared under the original scoring system may not be straightforward because of lack of information on the windiness components, particularly topex. This Note identifies situations where the revised scoring system is likely to have an important effect.

We strongly re-emphasise that the windthrow hazard classification is a simple model for predicting the threat of windthrow, and therefore most applicable to medium- and long-term planning across substantial forest areas. Use of the hazard classification at the compartment level must be tempered with local knowledge and observation. However, local knowledge should be incorporated by selection of terminal heights or, after consultation with Research Division, through informed changes to the wind zone score. Arbitrary changes to the component scoring to achieve a shift in hazard class are not recommended as these prevent comparisons between sites and frustrate attempts to update the classification.

Scoring Comparisons – Component Changes

The magnitude and direction of change in the hazard classification of a site will depend on location and topography. Changes to wind zone score can bring about the greatest single component change (-7 to +6) and are most easily defined (front cover). Changes to elevation score (e.g. +2.4 at 190 m) and topex score (e.g. -3.4 at topex 15) can cancel or compound each other. The complex nature of this interaction is demonstrated in Figure 1 which shows net change in topex and elevation score for different values of the two components. The net changes give increased hazard class scores for sites at low to moderate elevation (<300 m) with moderate topex (20–50), while other sites have reduced scores or show little change. Aspect scores can either compound or counteract these changes by increasing (W, funnelling sites) or reducing (E) scores.

To assess the likely effect of the revised scores for a particular forest, the appropriate reading for location from the front cover should be combined with that for typical values of elevation and topex from Figure 1; representative aspect scores can also be assessed. This will establish whether the changes compound or cancel one another, and gauge the direction and magnitude of any change. Net changes of score of 2 or more are likely to have a significant effect on the distribution of hazard classes, and should be investigated by detailed reworking of the hazard class map.

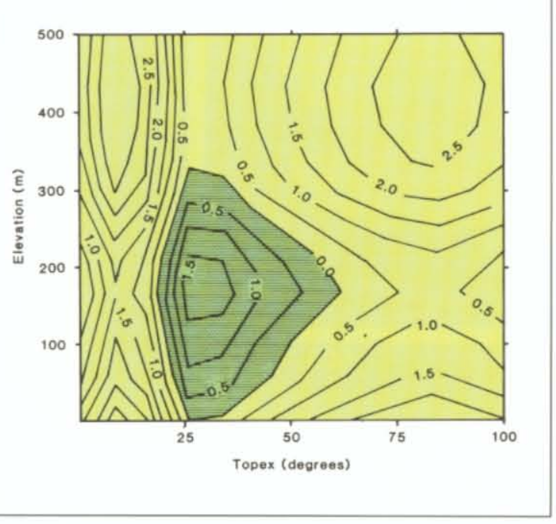

Figure 1. Score differences for combinations of topex and elevation between the revised (detailed aspect method of scoring) and original scoring systems. Positive values (dark green) for the difference represent an increase in hazard class score, and negative values (light green) represent a reduction.

Front Cover: Map of the score differences between the revised and the previous (1985) wind zone maps. Positive values for the difference represent an increase in hazard class score, and negative values represent a reduction.

Scoring Comparisons – Examples

These component comparisons indicate the possible complex effects arising from the revised scoring system. To demonstrate this, and to gauge the effects on the distribution of hazard classes, a number of examples have been calculated.

The examples have been based on eight windthrow monitoring areas established to observe the onset and progression of windthrow (Quine and Reynard, 1990). Detailed soil maps (1:10 000 scale) obtained for each area were digitised and placed in a GIS known as IDRISI (Eastman, 1992). Elevation, aspect, total topex and topex by sector were computed for each area from a digital terrain model (DTM). DTM-based topex values were compared with field measurements and found to be satisfactory. Soil scores were calculated from the digital soil map. Windiness scores were compiled from the terrain data using both the original method (Miller, 1985) and the revised method (Quine and White, 1992); for the latter the detailed aspect method of scoring was followed. Hazard class maps were created within the GIS and the distribution by area for each method compared.

The results by hazard class are summarised in Table 1 as percentages of the total area of the eight monitoring areas (4943 ha). There was no change in hazard class when comparing the original and the revised methods for approximately 51% of the monitoring area; 30% showed an increase of one hazard class and 4% showed an increase of two hazard classes; 15% showed a decrease of one hazard class. There was a general reduction in the spread of hazard classes with an increase in area covered by hazard classes 4 and 5 at the expense of classes 3 and 6. The most significant change caused by the revised scoring system was the almost complete elimination of hazard class 6 in the areas studied. These results reflect the particular characteristics of the eight monitoring areas and cannot be extrapolated to all forest areas.

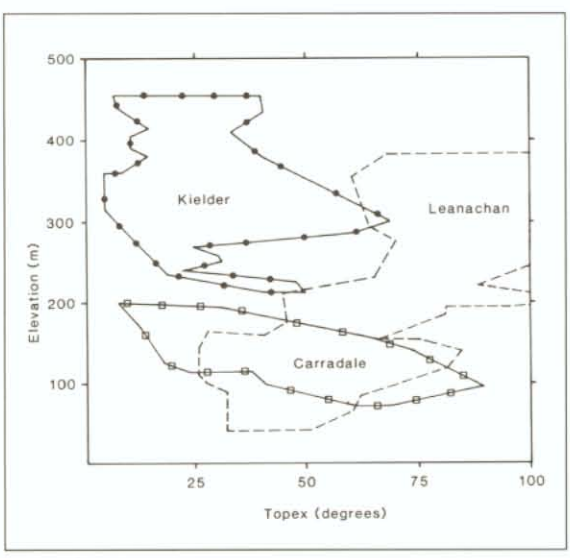

Figure 2. Topex and elevation range for the three windthrow monitoring areas referred to in Table 2, for comparison with Figure 1.

Results from three of the monitoring areas demonstrate the recommended method of determining the net change in hazard class score, and illustrate the resultant shifts in hazard class. The three areas are parts of Leanachan Forest (Highland), Kielder Forest (Northumberland), and Carradale Forest (Argyll). The topex/elevation range of each area has been determined from the DTM and is shown in Figure 2; this can be compared directly with Figure 1 to determine the topex/elevation score change.

By combining the wind zone score change of +5 at Leanachan (grid reference: 220775 on the front cover) with a topex/elevation score change of +1.5 to -2.5 (Figures 1 and 2), a net change of +6.5 to +2.5 is obtained. This suggests that a significant increase in hazard class is likely, particularly where the aspect score is positive. Comparison of original and revised hazard class maps confirms this (Table 2A), with 75% of the area increasing by one hazard class and the remainder increasing by two hazard classes or more.

At Kielder (grid reference: 365590 on the front cover) the wind zone change (-2.0) and topex/elevation change (+1.0 to -3.0) combine to give a net change of -1.0 to -5.0. This suggests that a significant reduction in hazard class is likely, and this is confirmed (Table 2B) with 56% of the area decreasing by one hazard class.

At Carradale (grid reference: 175645 on the front cover) the wind zone change (-0.5) and topex/elevation change (+1.5 to -1.0) combine to give a net change of +1.0 to -1.5. This suggests that no wholesale movement of hazard classes is likely, but some shift may occur where the net change in score is accentuated by the aspect score or where the score is close to a hazard class threshold. Table 2C confirms that 66% of the area shows no change in hazard class, but that 31% of the area increases by one hazard class, and 3% of the area decreases by one hazard class due to aspect and threshold effects.

Note on Tables

Figures in highlighted boxes show percentages of areas where there was no change in hazard class. Figures above the diagonal show percentages of areas where hazard class increased with the revised scoring; those below show where hazard class decreased. Cells marked '–' have no area; those marked '+' have trace area only.

Table 1. Cross tabulation of percentage of total monitoring area (4943 ha) by hazard class; classified by original (Miller, 1985) and revised (Quine and White, 1993) windiness scores.

			Hazard class from revised windiness scores					
			1	2	3	4	5	6
		Total % area	–	4.8	14.3	35.3	45.1	0.5
Hazard class from original windiness scores	1	3.5	–	2.1	1.4	–	–	–
	2	8.8	–	1.7	6.0	1.1	–	–
	3	23.8	–	1.0	6.1	15.4	1.3	–
	4	23.5	–	–	0.8	16.0	6.7	–
	5	29.5	–	–	–	2.8	26.7	–
	6	10.9	–	–	–	–	10.4	0.5

Table 2. Cross-tabulation of percentages of individual monitoring areas by hazard class, classified by original (Miller, 1985) and revised (Quine and White, 1993) windiness scores.

A. Leanachan Forest, Highland – 654 ha

			Hazard class from revised windiness scores					
			1	2	3	4	5	6
		Total % area	–	15	19	57	9	–
Hazard class from original windiness scores	1	26	–	15	11	+	–	–
	2	14	–	+	8	6	–	–
	3	59	–	–	+	51	8	–
	4	1	–	–	–	–	1	–
	5	–	–	–	–	–	–	–
	6	–	–	–	–	–	–	–

B. Kielder Forest, Northumberland – 689 ha

			Hazard class from revised windiness scores					
			1	2	3	4	5	6
		Total % area	–	+	1	19	80	+
Hazard class from original windiness scores	1	–	–	–	–	–	–	–
	2	–	–	–	–	–	–	–
	3	1	–	+	1	–	–	–
	4	8	–	–	+	8	–	–
	5	46	–	–	–	11	35	–
	6	45	–	–	–	–	45	+

C. Carradale Forest, Argyll – 263 ha

			Hazard class from revised windiness scores					
			1	2	3	4	5	6
		Total % area	–	6	3	39	52	–
Hazard class from original windiness scores	1	–	–	–	–	–	–	–
	2	7	–	6	1	–	–	–
	3	–	–	–	+	+	–	–
	4	71	–	–	2	39	30	–
	5	21	–	–	–	+	21	–
	6	1	–	–	–	–	1	–

Conclusions

Trials of the revised scoring method suggest that it will result in complex changes in the distribution of hazard classes in a forest area, and a generalised conversion from original to revised hazard class is not possible. Priority areas for application of the revised scores are:

- where the wind zone map (front cover) indicates a major difference in the wind zone score;
- where the landform gives rise to important changes in the elevation and topex scores (Figure 1).

In addition, the revised scoring method should be used in any new survey, and in resurveys of areas where managers are unhappy with existing hazard class assessments.

References

EASTMAN, J.R. (1992). *IDRISI user's guide (Version 4.0).* Graduate School of Geography, Clark University, Massachusetts.

MILLER, K.F. (1985). *Windthrow hazard classification.* Forestry Commission Leaflet 85. HMSO, London.

QUINE, C.P. and REYNARD, B.R. (1990). *A new series of windthrow monitoring areas for upland Britain.* Forestry Commission Occasional Paper 25. Forestry Commission, Edinburgh.

QUINE, C.P. and WHITE, I.M.S. (1993). *Revised windiness scores for the windthrow hazard classification: the revised scoring method.* Forestry Commission Research Information Note 230. Forestry Commission, Edinburgh.

ISSN 0267 2375

Issued by: Research Publications Officer, The Forestry Authority, Research Division, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH