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Robyn Harrison  
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Dear Robyn,

When I spoke at the One Plan (Land) hearing on 24/07/2008 at 10 am, the Chairperson (Ms Joan Allin) asked me what a policy document using my suggested net water balance (NWB) approach for highly erodible land (HEL) might look like.

Please find attached as Appendix One, an example of how the policy might be formulated and the form of a policy statement.

Thank you for the opportunity to provide a more definitive response to the Chairperson's question.

Yours faithfully,

**Grant Upchurch**

*Science with integrity, solutions that work*

# APPENDIX ONE: Example of Policy for Highly Erodible Land using Net Water Balance Protocols

## 1. Introduction

This example briefly describes the science and methodology to yield information that can be used to formulate a policy statement and then provides an example of a policy statement.

This example assumes the following data sources are available:

- Land Resource Inventory Maps and Land Use Capability surveys
- "Ground-truthed", remotely sensed data (preferably multispectral with a resolution of 1 pixel = 15 metres or better)
- Rainfall and evapotranspiration data and that the combination of on-ground meteorological network density and weather radar is adequate to provide rainfall intensity data at an hourly interval and isohyets at an areal resolution equivalent to SMAP and LUC polygon sizes or better.

This information is used in conjunction with the science of Dymond and Mackay (outlined in their expert evidence), but the method also allows empirical "black-boxing" of at-risk areas (including those where not all information is known) on the basis of observed thresholds relative to calculated risk.

## 2. Methodology

Using the February 2004 storms ("storm") as an example, it is possible to say empirically

that:

*"100% of the observed landslides (Figure 4) occurred over 3 days and a total rainfall of (say) 250 mm. The predominant soil group affected in the area highlighted was Orthic Brown soils "*

If time series remote sensing data were available it would also be possible to say:

(a) Feb2004 Observations

- *x mm RF fell over y days*
- *y ha of land was affected by erosion*
- *z1% of land was affected after 24 h (y1 mmRF)*
- *z2% of land was affected after 48 h (y2 mmRF)*
- *z3% of land was affected after 72 h (y3 mmRF)*
- *NWB = rainfall - evapotranspiration + irrigation ± storage .*

(b) This leads to statements about Feb2004 soil thresholds

- *severe: NWB24 <y1a mm, NWB48 <y2a, NWB72 <y3a*
- *moderate: NWB24 <y1b mm, NWB48 <y2b, NWB72 <y3b*
- *robust: NWB24 <y1c mm, NWB48 <y2c, NWB72 <y3c*

where

the NWB for severely affected soils is much less than robust soils for 24 hour duration

and

Risk = f (magnitude, intensity, duration) relative to a nominated threshold.

(c) Cumulative frequency curves can be constructed for the NWB data and used to assign risk to NWB24, NWB48 and NWB72 events.

(d) A reference critical NWB for each duration ( $NWB_{24,crit}$ ,  $NWB_{48,crit}$ ,  $NWB_{72,crit}$ ) needs to be assigned by Horizons Regional Council on the basis of the risk of it's statutory

responsibilities to regional resources and infrastructure. Nominally, I'd suggest a 50 year ARI based on a nominal length of ownership between generation and the design risk of bridges and culverts over state highways. Once a reference risk threshold is established policy can be formulated accordingly.

### **3. Policy Statement Example**

The policy example below relates only to the hill country land affected by the February 2004 storms but the methodology could equally be applied to the at-risk coastal dune fields. This is not a substitution of the NZLRI or LUC work already done but to be used in conjunction with it by allowing a risk to be attached for management purposes. For example, an event with an ARI of 1 year does not warrant policy attention but an event with an ARI of 50 years certainly does in terms of damage to livelihoods, infrastructure and natural resource base.

#### **"Policy 5.x: Statement of Intent Regarding Vulnerable Hill Country Land**

This statement is intended to provide clear, long term direction about the intent of policy goals concerning highly erodible land based on empirical evidence which allows a definite risk to be attached to processes contributing to the degradation of vulnerable land.

- (a) Land defined as Othic Brown soils within the highlighted area on Figure 4 will be retired from intensive pastoral farming by 2060 with the processes contributing to this goal beginning on 01 June 2010. General intent is outlined in (b) with specific intent outlined in (e), (f) and (g) for severe, moderate and robust land classes respectively.
- (b) Where the land is farmed, landholders will have the option of retaining the land in co-management under covenant with Horizons Regional Council or selling land blocks at market rates to the Council. Conditions and responsibilities for each of these two options are laid out in (c) and (d) in this section.

(c) Conditions and responsibilities for covenanting land:

- the land will not be rated
- land parcels must be larger than 5 ha (?; to be reviewed)
- costs will be met jointly by landholders and Council
- the land may be stocked at rates not exceeding 1 su/ha (to be reviewed)
- land placed under covenant should be forested (native or production forest) within a time frame yet to be defined
- (more ...)

(d) Conditions and responsibilities for sale of land:to council:

- the land parcel should be larger than 5ha (?)
- land parcels on adjacent lands which could be amalgamated as single units and having written agreement between landowners to sell to Council at the same time will be given priority
- (more ...)

(e) Severe land class:

- is defined as

*land parcels where more than zz% of land is affected by landslides when the following thresholds are exceeded*

*NWB24 <y1a mm*

*NWB48 <y2a*

*NWB72 <y3a*

*and*

*is defined as Orthic Brown soil*

- is regarded as most at risk and most able to benefit from avoidance and remedial measures
- (insert specifications here)
- (more ...)

(e) Moderate land class:

- is defined as

*land parcels where more than zz% of land is affected by landslides when the following thresholds are exceeded*

*NWB24 <y1a mm*

*NWB48 <y2a*

*NWB72 <y3a*

*and*

*is defined as Orthic Brown soil*

- is less vulnerable than severe land classes and able to derive some benefit from remedial and avoidance measures
- (insert specifications here)
- (more ...)

(e) Robust land class:

- is defined as

*land parcels where more than zz% of land is affected by landslides when the following thresholds are exceeded*

*NWB24 <y1a mm*

*NWB48 <y2a*

*NWB72 <y3a*

*and*

*is defined as Orthic Brown soil*

- is least vulnerable
- (insert specifications here)
- (more ...)

**<Policy Statement Example ends>**

**Extended tiles to Figures on next page**

Figure 1.

Distribution of land with a high potential for accelerated erosion (Highly Erodible Land from Proposed One Plan Figure 5-1)

Figure 2.

Average recurrence interval (ARI) for the February 2004 storms (Source: Horizons Regional Council, 22/07/2008; the purple, dark blue and light blue areas have ARI's of 75-100, 100.1-150 and >150 years.)

Figure 3.

Soil pattern in the affected area. The Orthic Brown soils have a high prevalence in the affected areas.

Figure 4.

Pattern of landsliding in the February 2004 storms.

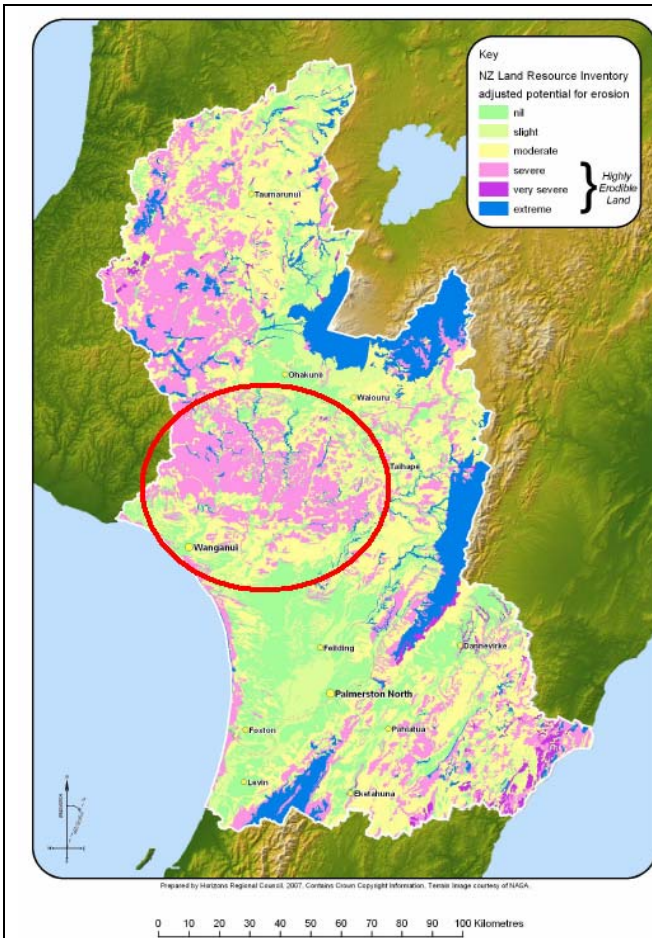


Figure 1 - HEL (source: POP Fig 5-1)

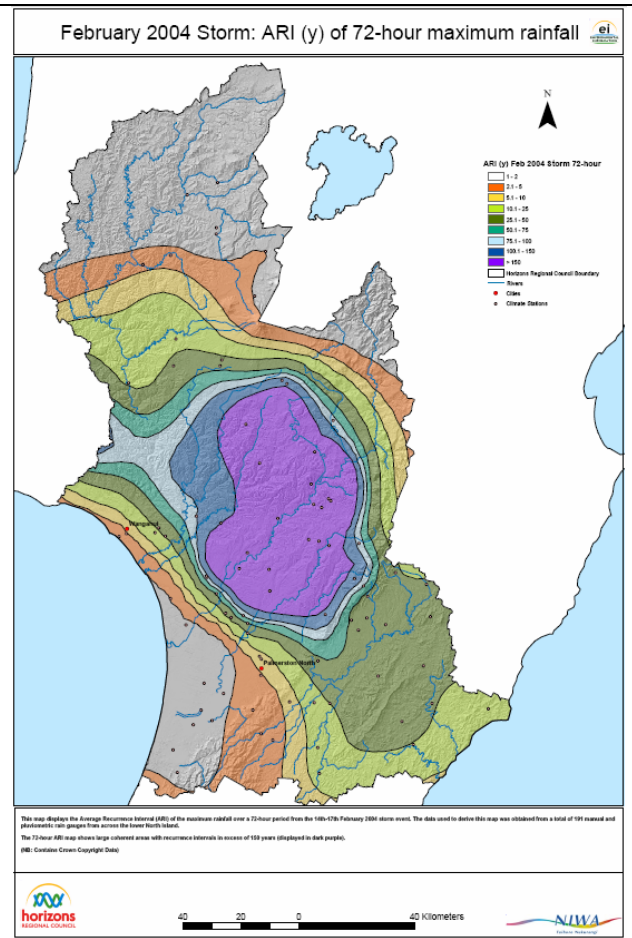


Figure 2 - as indicated

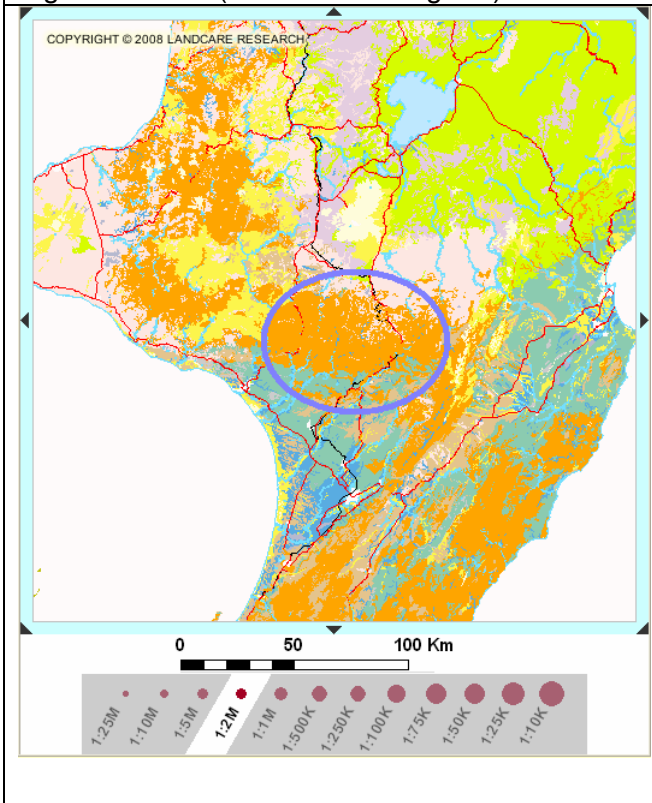


Figure 3 - Orthic Brown soils (coloured orange)

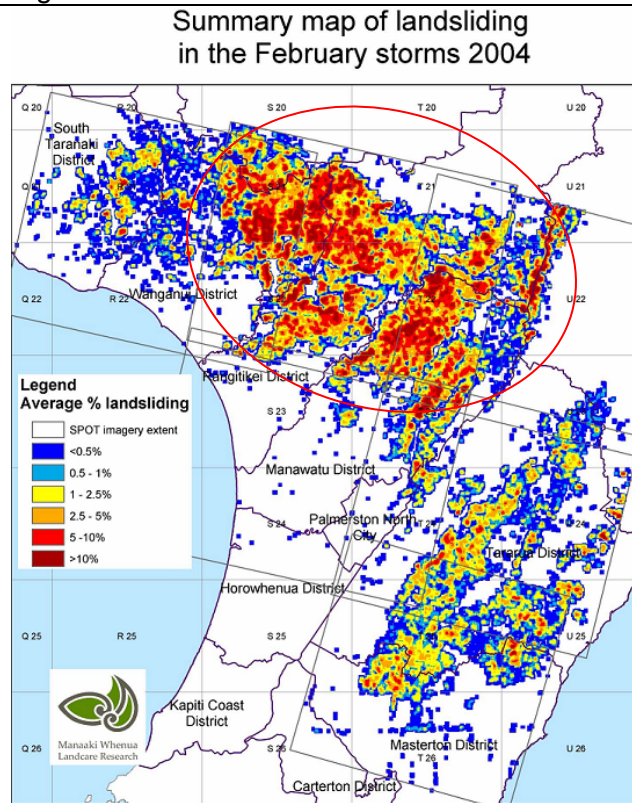


Figure 4 - as indicated