Erosion – why hill sides fail

This winter there has been a barrage of storm after storm throughout the North Island Hill country. In some parts the erosion is far worse than the carnage of February ’04. Understanding simple erosion why hillsides fail is vital for future proofing your property against the next event.

All slopes have a natural angle of repose or angle at which the slope is stable and will not fail. This is a bit like piling a mountain of sugar up on the kitchen table – there is a slope there it will no longer fall down. A stable slope angle is dependent on several factors that include:

- the type and strength of the underlying rock type,
- the slope length, angle, and consistency from the top to the bottom,
- the type of vegetation present,
- the depth of soil over the rock, and
- the weather

Much of the erosion prone land in the North Island is formed from sedimentary material – mostly referred to as mudstone, siltstone or sandstone. This material was laid down under the sea in the last two to five million years and then gradually uplifted to form what we see today. In geological terms it is very young and because of its youthfulness it can be prone to severe erosion. The erosion susceptibility is dependent on how hard or consolidated this material is, whether it was laid down in bands or it is massive, the presence of fractures, whether it is lying flat or it is tilted, and the type and consistency of the material present. All these factors will influence the type of erosion that occurs.

Often the underlying rock type may vary up or down a long slope. This variation may cause changes in moisture mobility which affects its strength. As a consequence the variation in material will cause a variation in the stable slope angle. If part of the slope is removed, by tracking or a stream that continuously removes the toe of the slope, the inherent stability over the whole slope can be significantly reduced. If you did this to your pile of sugar what would happen?

Springs on a slope have the effect of adding to the weight of the soil, by continuously wetting them and also lubricating any underlying slip plane. Therefore on areas where there are springs, the natural stable slope is a lot lower than for those without.

The impact of vegetation on slope stability can be both positive and negative. On the negative ledger, some vegetation can act as a sponge, increasing the weight loading significantly on slopes following heavy rain. This alone will reduce slope stability, and pastures with high covers can do this. A lot of good country slipped this winter because there was too much roughage about. Some woody vegetation will dry soils out, and as a consequence increase infiltration of heavy rainfall into cracks. This negative effect is often counteracted by added strength provided by roots of these trees.

On the positive ledger, larger roots that have some tensile strength act just like reinforcing in concrete. Like concrete, if there are enough of them and they overlap, plus anchor into stable material, the trees create a stable environment. The unstable slope angle under pasture is increased to create a stable slope with spaced trees. Tree roots also have the ability to dry out the soil and any potential slip plane.

The depth of soil above the base rock affects stability. Soils with greater depth often have the ability to hold more moisture. This is great for plant growth during dry periods, but during wet

periods this increased moisture adds to the weight loading of the soil and reduces the stable slope angle. Steeper slopes often have shallower soils because it has fallen or eroded off.

In respect to weather, recent rainfall duration and intensity is one of the main driving forces for slope failure. Weather direction can also play a part by causing rain shadows where some faces maybe affected whilst the other side of the hill may not be. Dry summers can promote soil cracking that can permit rapid entry of water into the slip plane. A multitude of frosts could do the same.

Often when you look at slopes for future sites of failure, there are several situations that stand out. The first are those areas where there is an often small non typical bulge in the landscape, usually above which there is often a small hollowing with rushes present. Another is where actively down-cutting gully systems or streams are taking the toe of the slope and have created a steepened bank. Areas of large cracks on a hill face is often the upper end of a slip plane that will fail if enough moisture gets down into the slip plane and the soil above it wets up significantly.

Once slopes do fail in the sedimentary hill country, it takes between 40 and 80 years to achieve 80% of pasture production obtained prior to the erosion occurring. Over-sowing with low fertility drought tolerant pasture species will speed this recovery up significantly. However it is not economic to do this, unless the land was running in excess 12 stock units per hectare. More often than not the pastoral land that is slipping was only carrying 5-8 stock units or less.

The most effective way of future proofing your property from erosion is by tree plantings. The degree and severity of erosion present will dictate how much root reinforcing your hill slope requires and this is governed by planting density. Planting trees is like an insurance policy. And trees are like any insurance broker – you can’t back date the planting date if the slope has failed.