Great Ocean Road drainage investigations: Using modern techniques to reduce below road landslide risk

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The Great Ocean Road is an iconic tourist destination that attracts twice as many visitors as the Great Barrier Reef and Uluru combined, generates $1.3 billion in visitor expenditure and supports 9,200 jobs. Built by 3,000 returned servicemen following WWI, it is remarkable for the majesty of its environmental landscape, venerable history, social and economic significance.

VicRoads, on behalf of the Australian and Victorian Governments who have jointly invested $153 million in the Great Ocean Road Upgrade and Resilience Program, is undertaking a diverse range of improvement and mitigative works to safeguard its long-term future.

Nestled between the sea and the rainforests, with an annual mean rainfall of around 900mm, the road sits above and below steep cliffs and is buffeted by the elements. Following bushfires at Wye River in 2015 and prolonged rain after, the road experienced over 120 landslips in September 2016, resulting in significant road closures. These events identified a pressing need for greater identification, analysis and mitigation of future geotechnical risk.

With an unstinting commitment to developing comprehensive modelling and innovative solutions to protect the future of the road, VicRoads engaged GHD to undertake an innovative pilot that would use first-of-kind drone surveys, develop drainage simulations and inform future practice.

The pilot area spanned five kilometres from Wye River to Kennett River and has resulted in the development of 2D hydraulic modelling, sophisticated data matrixes to improve the identification of high risk areas and better prediction of the impacts of uncontrolled flows.

Objectives

The project seeks to improve understanding of drainage on the Great Ocean Road, and changes within the road corridor which could reduce the contribution of drainage issues to the risk of landslides. The applicability to larger areas is a key consideration, so approaches should be efficient/repeatable:

- What is the range of flow estimates for gully catchments produced by various methods, and the relative amount of effort required?
- Can drone survey meet data needs by capturing the road form and associated longitudinal drainage?
- What is the performance of longitudinal drainage for various AEPs?
- What concepts can be developed to address deficiencies?

Method

Flow estimates were made for each of 9 gully catchments using seven common methods to compare the range of results and relative effort. The gully catchment analysis utilised 2009 Coastal LiDAR (1m DEM) and VicMap contours.

The performance of longitudinal (surface) drainage was assessed by undertaking, fine-scale hydraulic modelling of the road corridor (TUFLOW and HECRAS). This utilised drone LiDAR commissioned for the project. Adequate cross-drainage and fully blocked cross-drainage scenarios were simulated to provide upper and lower bounds.
Modelling results were compared to recorded below road geotechnical hazards and site observations, and concepts developed for a subset of sites.

Results

The VicRoads Rational Method provided the most conservative flow estimates for gully catchments (major cross culverts). Rain on grid modelling using ARR2016 parameters generally fell between the VicRoads Rational and rural Rational Method results.

A drone was used to capture high resolution survey of the road corridor with minimal traffic disruption. Fine scale hydraulic modelling utilising this data showed limited longitudinal drainage capacity in many areas, for both design events and the week of the 14 September 2016 landslides. Ocean side overflow locations in the hydraulic modelling showed good correlation with most of the recorded below road geotechnical hazards.

Conclusions

Gully catchment flows were estimated using various methods based on either ARR1987 or ARR2016. In many cases the simple VicRoads Rational Method is considered appropriate, as moderate conservativism may only require slightly larger cross-culverts. For larger gullies the difference may warrant more rigorous investigation, such as rain on grid modelling with ARR2016 inputs.

Generating streamlines in the road corridor from drone LiDAR provided initial identification of some high risk areas. Using 2-dimensional hydraulic modelling, prediction of locations of uncontrolled flow across the road to the ocean side slopes due to drainage capacity issues can be further enhanced.