Geomorphometric characteristics of New Zealand landslide dams

Oliver Korup, 2004
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Outline

• Introduction

• Data acquisition

• Status of landslide dams, trigger mechanisms and landslide types

• Geomorphometric properties

• Prediction potential for landslide dam stability

• Discussion and conclusions
Introduction

• Landslide dams are amongst the most obvious and widely recognized of such features in New Zealand.

• The purpose
  - Overview the present state of knowledge on landslide dams
  - Expanded the inventory of landslide dams
LANDSLIDE DAMS IN NEW ZEALAND

Existing lake (area in m³)
- 1.0E+3 - 1.0E+4
- 1.0E+4 - 1.0E+5
- 1.0E+5 - 1.0E+6
- 1.0E+6 - 1.0E+7
- 1.0E+7 - 1.0E+8

× Former landslide dam
Data acquisition
Data acquisition

Previously published accounts
(Adams, 1981; Perrin and Hancox, 1992; Hancox et al., 1997)

Air photos & 25 m DEM

Unpublished sources
Status of landslide dams, trigger mechanisms and landslide types
Status of landslide dams, trigger mechanisms and landslide types
Trigger mechanisms

- Earthquake: 28%
- Rainstorm: 3%
- Other: 3%
- Unknown: 59%
- Tentatively coseismic: 11%
Status of landslide dams, trigger mechanisms and landslide types

Landslide Type

- Rock-block slide: 6%
- Complex: 5%
- Other: 2%
- Unknown: 34%
- Rock fall, slide: 9%
- Debris flow: 12%
- Rock avalanche: 27%
Geomorphometric properties
Geomorphometric properties

(A) Landslide dam
- Landslide dam height $H_D$ (m)
- Landslide dam length $L_D$ (m)
- Landslide dam width $W_D$ (m)
- Landslide dam volume $V_D$ (Mm$^3$)
- Landslide type*
- Trigger mechanism*
- Age*
- Status*

(B) Landslide-dammed lake
- Lake length $L_L$ (m)
- Lake width $W_L$ (m)
- Lake area $A_L$ (km$^2$)
- Lake perimeter $P_L$ (km)
- Lake volume $V_L$ (Mm$^3$)

(C) Upstream catchment
- Catchment area $A_C$ (km$^2$)
- Maximum altitude $E_{\text{max}}$ (m)
- Minimum altitude $E_{\text{min}}$ (m)
- Relief $H_R$ (m)
- Relief ratio $R_R$ (m/km$^{-2}$)
- Melton’s ruggedness number $R_M$
- Modal slope $\phi_{\text{mod}}$ (°)
Geomorphometric properties

Lake

Dam Crest

Landslide

$A_c$

$H_R$
Geomorphometric properties

![Graph showing relationship between lake volume and landslide (dam) volume.](image)
Prediction potential for landslide dam stability
• Casagli and Ermini (1999)

\[ I_b = \log \left( \frac{V_D}{A_c} \right) \]

\[ I'_b = \log \left( \frac{V_D}{A_c H_D} \right) \]

\[ I_i = \log \left( \frac{V_D}{V_L} \right) \]

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Prediction potential for landslide dam stability

\[ I_s = \log\left(\frac{H_D^3}{V_L}\right) \]
Prediction potential for landslide dam stability

\[ I_a = \log\left(\frac{H_D^2}{A_C}\right) \]
Prediction potential for landslide dam stability

\[ I_r = \log\left(\frac{H_D}{H_R}\right) \]
Prediction potential for landslide dam stability

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Discussion and Conclusion
Discussion

• Geomorphometric parameters
  - $H_D$
  - $V_D$
  - $V_L$
  - $A_C$
  - $H_R$

• Discharge & Hydraulic head
Conclusion

• Three new dimensionless bivariate index
  - Backstow index \((I_s)\)
  - Basin index \((I_a)\)
  - Relief index \((I_r)\)

• \(E_{\text{max}}, H_R, A_C, R_R\) show significant differences for sites of former and existing landslide-dammed lakes.
Thank you for your attention
Prediction potential for landslide dam stability

\[ I_i = \log\left(\frac{V_D}{V_L}\right) \]
Prediction potential for landslide dam stability

\[ I_b = \log \left( \frac{V_D}{A_c} \right) \]
Prediction potential for landslide dam stability

\[ I_b' = \log\left(\frac{V_D}{A_c H_D}\right) \]
Multivariate statistical

- Principal component analysis
- Cluster analysis
- Discriminant analysis