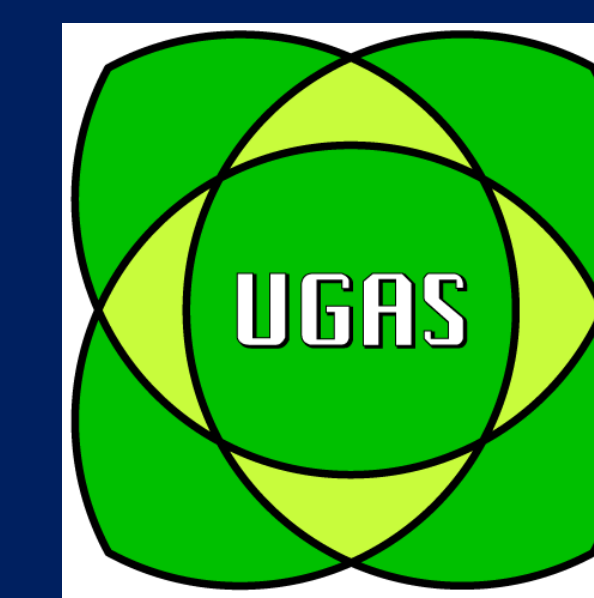


Reconstructing the history of landslides in northern Japan through dendrogeomorphology

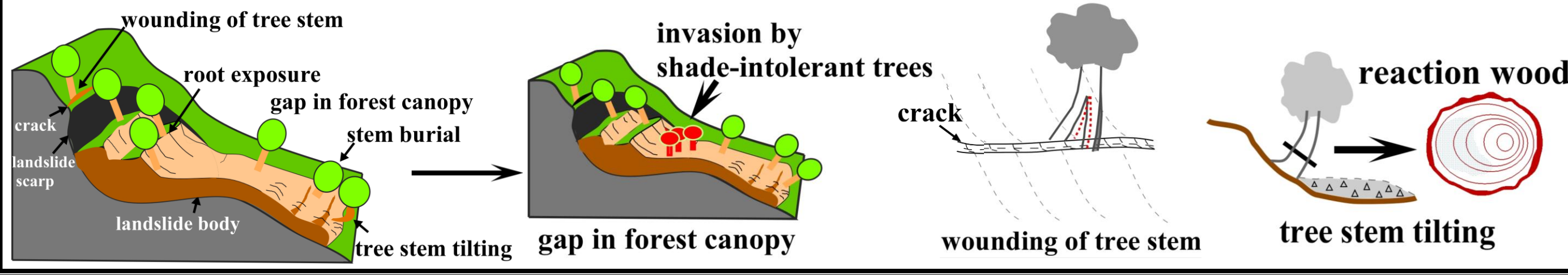


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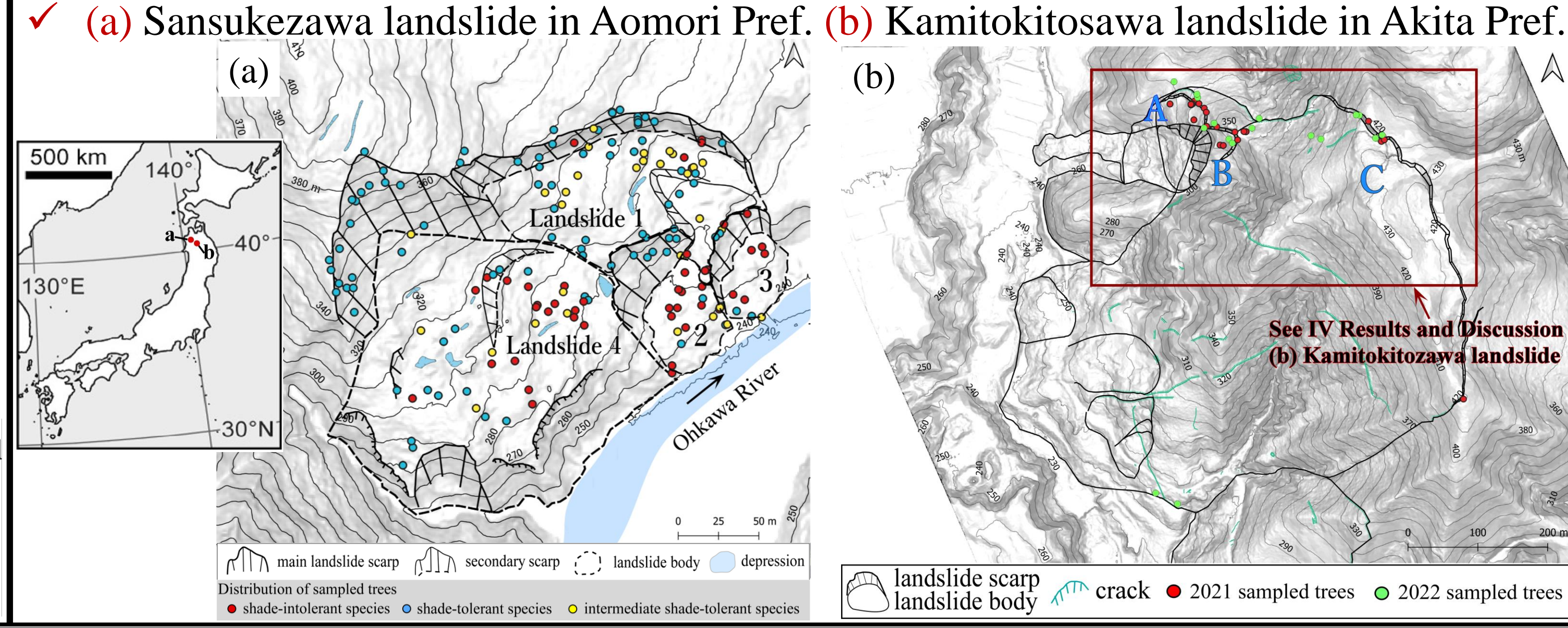
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I. Introduction

- Dendrogeomorphology serves as a method to determine the timing of historical landslide events.
- Trees affected by landslides have a growth disturbance (hereafter GD) response.
- This approach involves examining how landslides affect tree growth by analyzing tree-ring width variations, recovery timelines of injured tree stems, and the age of tree invasion and establishment in affected areas.
- This study attempted the reconstruction of the landslide history using dendrogeomorphological analysis.



II. Study sites



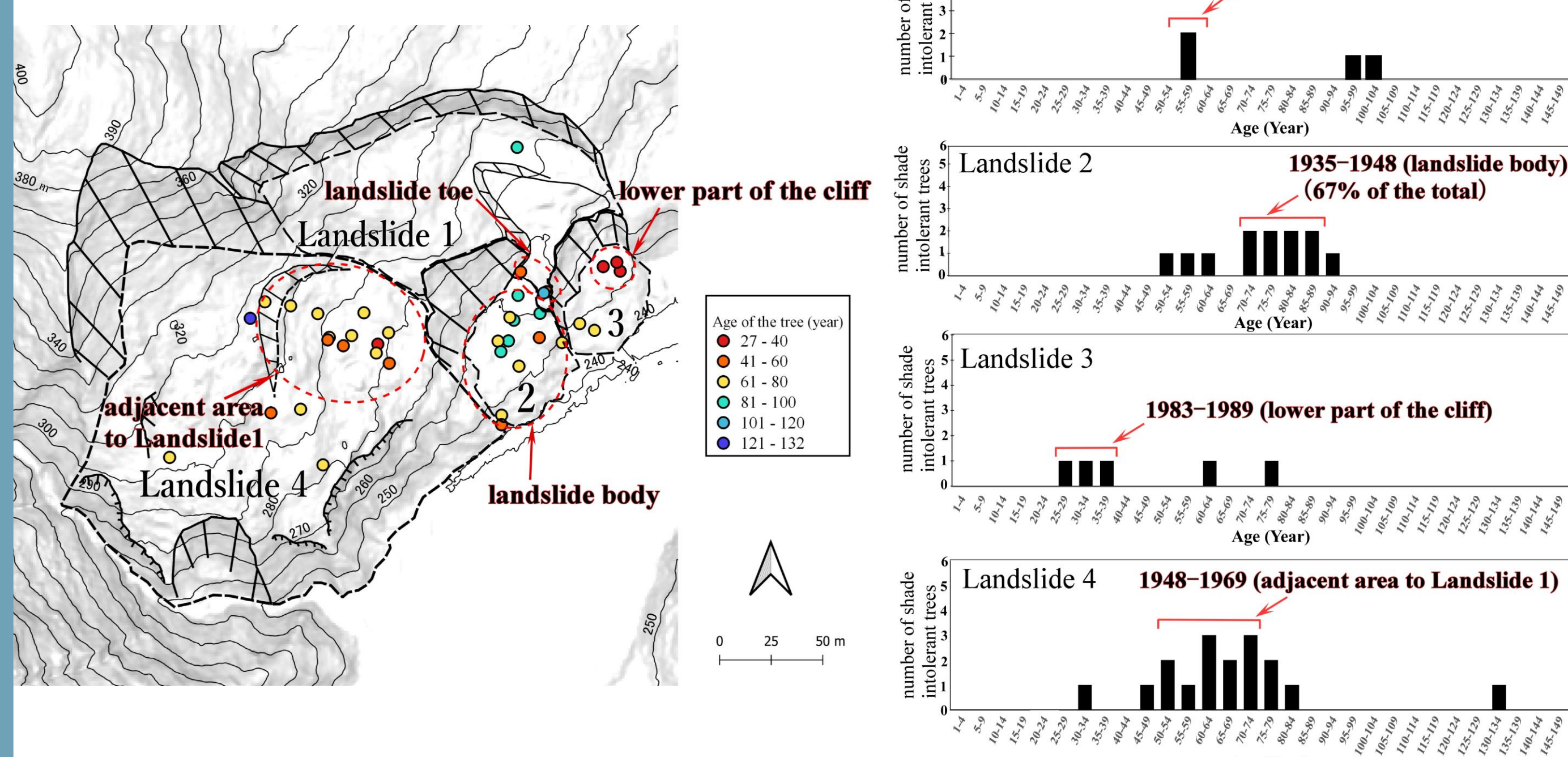
IV. Conclusion

- (a) Sansukezawa landslide
 - Variations in tree-ring width and age of establishment of shade-intolerant tree species indicated that multiple landslides occurred in the Sansukezawa landslide from 1901 to 2000.
 - The magnitude of these events varied, encompassing localized activities such as the enlargement of landslide scarps to more extensive landslide movements.
- (b) Kamitokitosawa landslide
 - Five cases of landslide activity, included scarp expansion, from 1999 to 2019 were inferred from the recovery timeline of wounded tree trunks.
 - It is possible to estimate when cracks were formed based on the analysis of recovery timeline of wounded tree trunks, and thus to understand landslide activity in more detail.

III. Results and Discussion

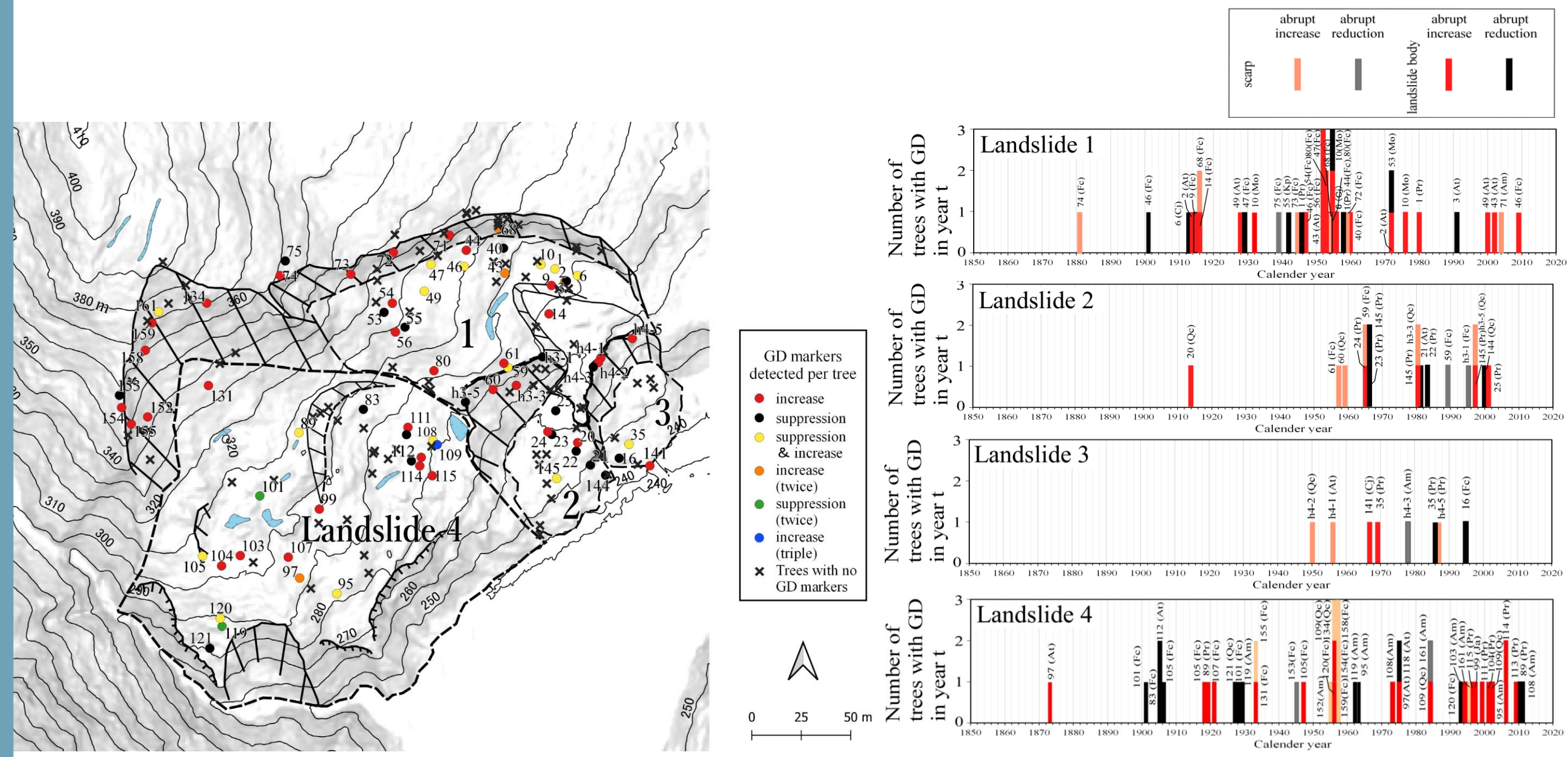
(a) Sansukezawa landslide

Estimation of the Landslide Chronology Using Invasion Years of Shade-intolerant Species



There were landslide occurrences in Landslide 1 from 1963 - 1966, in Landslide 2 from 1935 - 1948, in Landslide 3 from 1983 - 1989, and in Landslide 4 from 1948 - 1969.

Distribution of the GD in Tree-Ring Width Series



- There was a GD response at various ages.
- Depending on the tree, the GD response varied from a single GD reaction to multiple GD reactions.

(b) Kamitokitosawa landslide

Dendrochronological Investigations of Past Landslide Events Using Tree Ring Width Analysis

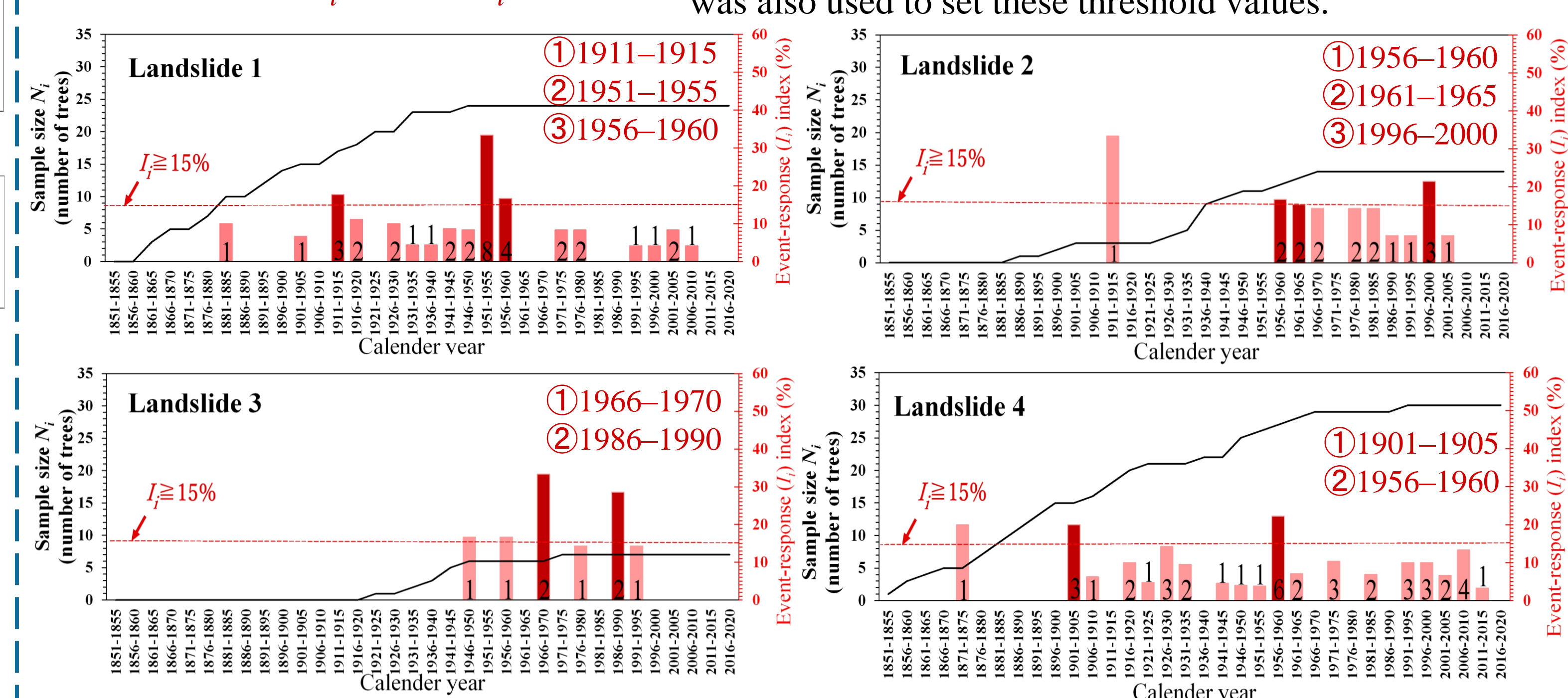
Event-response index (I_t) index (Shroder, 1978)

$$I_t(\%) = \frac{\sum GD_t}{\sum N_t} \times 100$$

Event-response index (I_i) proposed by this study

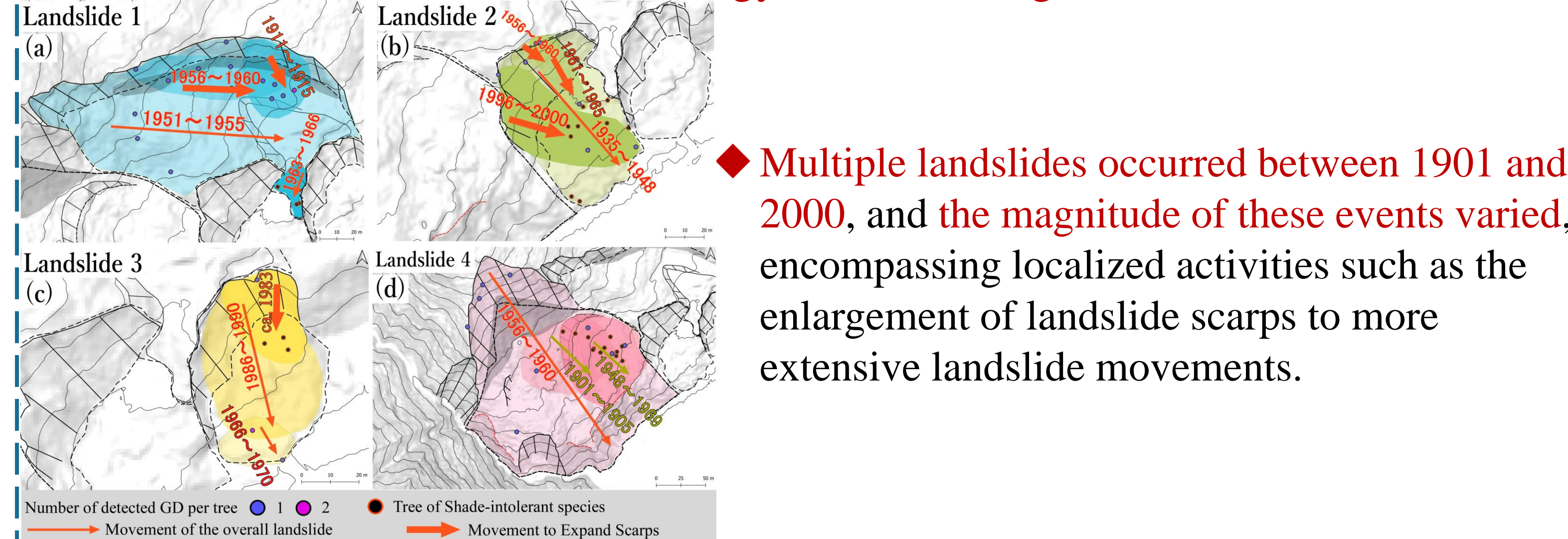
$$I_i(\%) = \frac{\sum_{i=t}^{t+4} GD_i}{\sum_{i=t}^{t+4} N_i} \times 100$$

To cover the delay in response, we opted for an alternative approach by using GD_i and N_i as frequencies over 5-year intervals for each of Landslide 1-4.



The results of the event response index (I_i) analysis showed that a total of 10 landslides had occurred in Landslide 1-4 (as indicated by ①-③ in the above Figs., respectively).

Reconstructed landslide chronology and their magnitudes



Multiple landslides occurred between 1901 and 2000, and the magnitude of these events varied, encompassing localized activities such as the enlargement of landslide scarps to more extensive landslide movements.

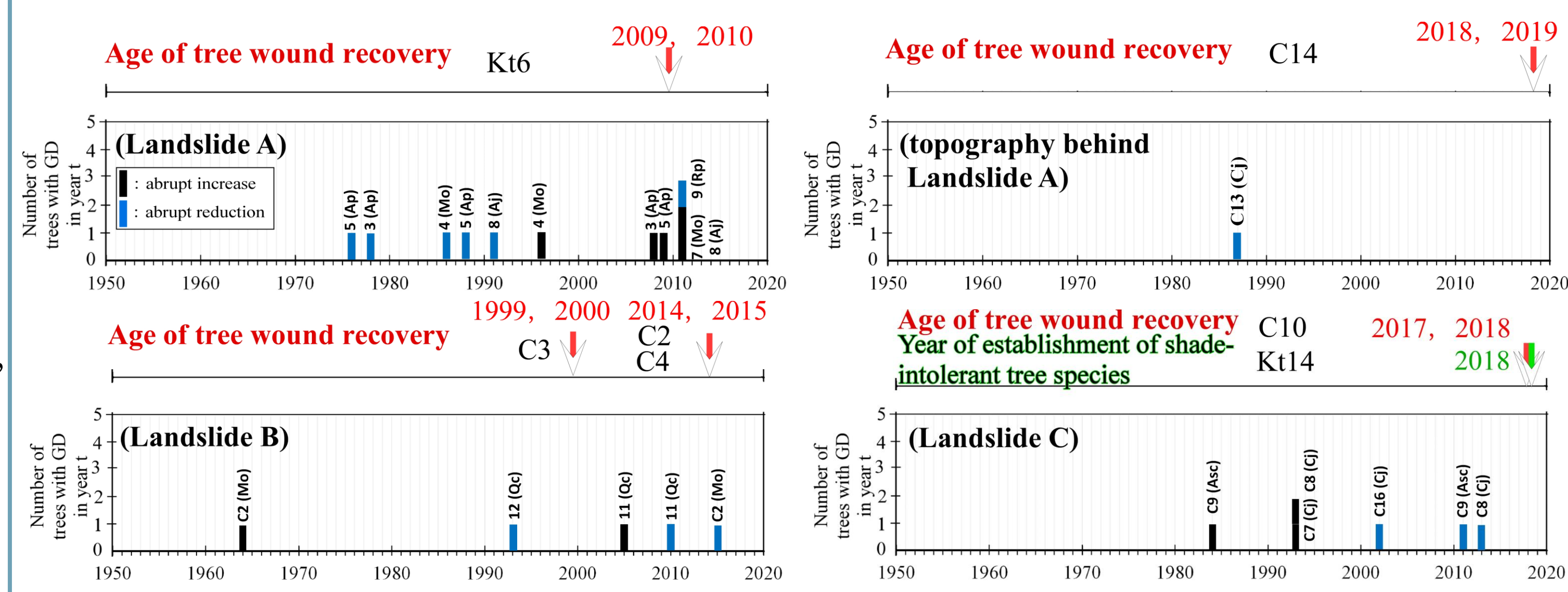
(b) Kamitokitosawa landslide

Investigation of the Age of Landslide Occurrence Based on the Recovery of Tree Stem Wounds.



Development of impending landslide events, inferred from the recovery timeline of split tree stems, included scarp expansion.

There were five instances of landslide activities recorded during the period from 1999 to 2019.



Age of tree wound recovery and GD response occurred contemporaneously in Landslide A