Evaluating the Impact of Geoid Model Variations on Landslide Susceptibility: A Case Study in Taiwan's Mountainous Regions

1. Introduction

(1)The study aims to evaluate the impact of different geoid models on landslide susceptibility.

(2) Due to the different DEM used, the calculated geoid models are not the same, and these differences may lead to different landslide susceptibility analysis results.

(3)The study uses the commonly used geoid model $P_i = \frac{1}{1+e^{-y_i}}$ (TWGeoid2014) in Taiwan as a standard and compares it with other geoid models (EGM96, EGM2008, TWGeoid2023, and TWGeoid2024).

Geoid Model	Description	Study case	S
EGM96	The global model expanding to degree and order 360	Case 2	T _s E ₁ E ₂
EGM2008	The global model expanding to degree 2190 and order 2159	Case 3	T_s Z_0 Z_1 d
TWGeoid2014	The local model using 90- meter resolution DEM for terrain effects	Case 1	C Z,
TWGeoid2023	The local model using 270- meter resolution DEM for terrain effects.	Case 4	Z _y Z, K:
TWGeoid2024	The local model using 20- meter resolution DEM for terrain effects	Case 5	Z ₀ Z ₁ ar K:

Table. 1 Geoid model description and study case.

2. Study Area





P_i: Probability of positive events in each grid y_i: Logistic function value of each grid α : constant x_{ki}: values of landslide factors

3. Method

This study uses logistic regression to analyze landslide susceptibility and selects the commonly used landslide factors related to elevation, such as aspect, slope, curvature, relief and roughness.

Logistic regression:

 $y_i = \alpha + \sum_{i=1}^k \beta_i x_{ki}$

 β_i : Regression coefficients of each factor

lope:

 $=\frac{\sqrt{E1^2+E2^2}}{}$ $= (Z_1 + 2Z_4 + Z_6) - (Z_3 + 2Z_5 + Z_8)$ $_{2} = (Z_{6} + 2Z_{7} + Z_{8}) - (Z_{1} + 2Z_{2} + Z_{3})$: Slope

 $_{\circ}$: Elevation of the grid point to be calculated. $_1 \sim Z_8$: Elevation values of eight adjacent grids respectively Grid size

Curvature: $\sim 2 - 2$ 7 07 7

$$= \frac{\partial^2 Z}{\partial x^2} \approx \frac{Z_4 - 2Z_0 + Z_6}{L^2}$$
$$= \frac{\partial^2 Z}{\partial y^2} \approx \frac{Z_2 - 2Z_0 + Z_7}{L^2}$$
$$= \frac{\partial^2 Z}{\partial x \partial y} \approx \frac{-Z_1 - 2Z_3 + Z_6 - Z_1}{L^2}$$
$$= \frac{\partial^2 Z}{\partial x \partial y} \approx \frac{-Z_1 - 2Z_3 + Z_6 - Z_1}{L^2}$$

 $_{0}$: Elevation of the calculation point $_{1}$ ~Z₈: Elevations of the grids round the calculation point : Curvature



Schematic of grid-based elevation for slope and curvature.









Relief: (The roughness is to convert elevation into slope)

$$\sum i(Z_i - \overline{Z})^2$$

$$n_c-1$$

S: Standard deviation of the elevations around the calculation point

- n_c: Number of points
- Z_i: Elevation of each point

 \overline{Z} : The average elevation of each point

$\mid Z_2 \mid Z_3 \mid Z_4 \mid$ Z_1 Z_5 $Z_6 \mid Z_7$ $Z_8 | Z_9 | Z_{10}$ $Z_{11} | Z_{12} | Z_{13} | Z_{14} | Z_{15}$ $|Z_{16}|Z_{17}|Z_{18}|Z_{19}|Z_{20}|$ $|Z_{21}|Z_{22}|Z_{23}|Z_{24}|Z_{25}$

Fig. 3

Schematic of grid-based elevation for relief and roughness.

7. Conclusion

(1) According to the landslide susceptibility difference maps, the results using TWGeoid2014 showed the smallest difference compared to EGM2008. (2) According to the ROC curves, the results for all geoid models were identical. (3) In the flood inundation susceptibility analysis under rainfall conditions, more significant differences were observed in the downstream areas, with the largest discrepancy value when using TWGeoid2024.

(4) The impact of different grid resolutions on the discrepancy values was minimal, with all resolutions showing relatively large differences when compared to EGM2008.

European Geosciences Union General Assembly 2025, 27 April – 2 May, Vienna, Austria