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Quantitative spatial distribution and human vulnerability assessment for site-specific loess landslide

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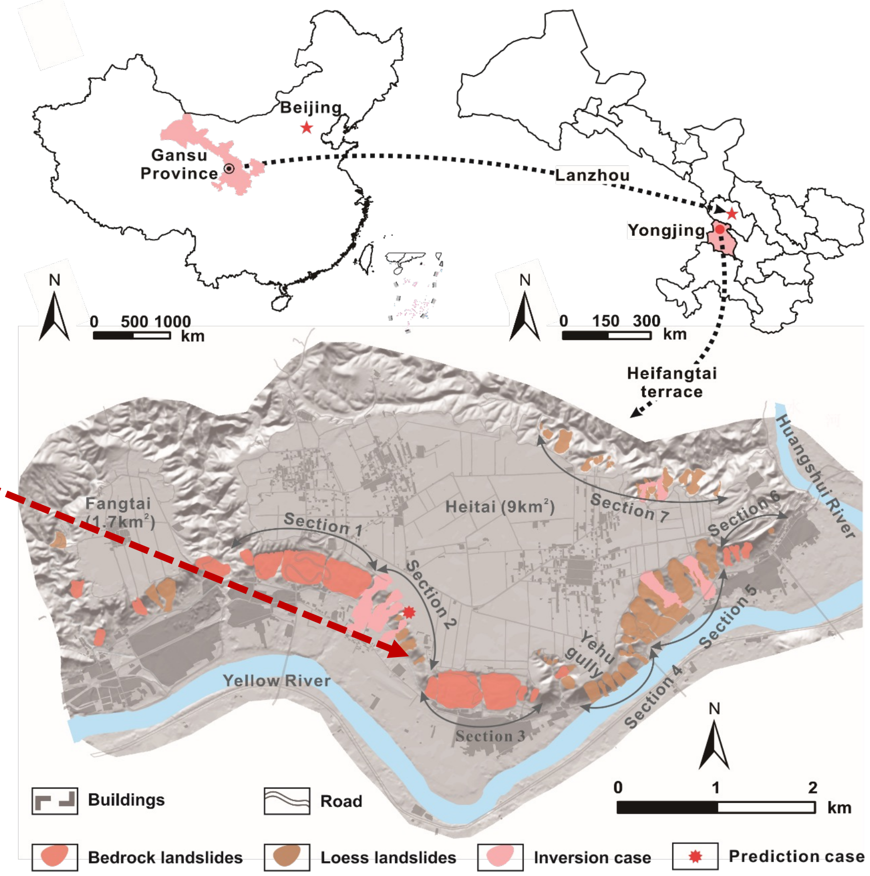
Tuesday, May 24, 2022

EGU General Assembly 2022

How to ensure more security for mountain people?

Release Links

Early warning system EWS successfully predicted six** (10 times so far) **landslides in Heifangtai



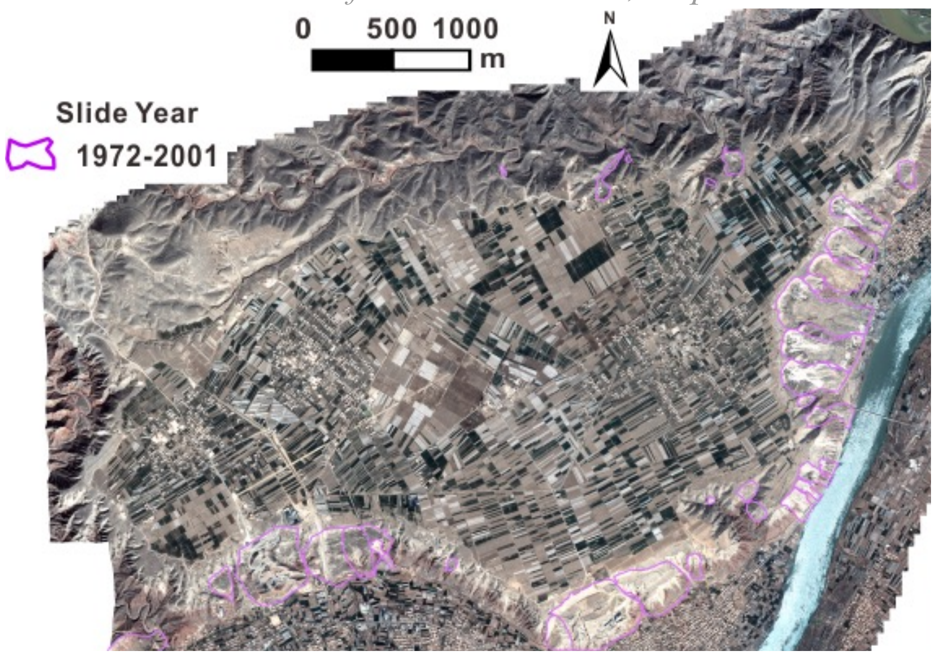
Early warning system (EWS) is getting reliable, and numerical method is very helpful for landslide inversion;

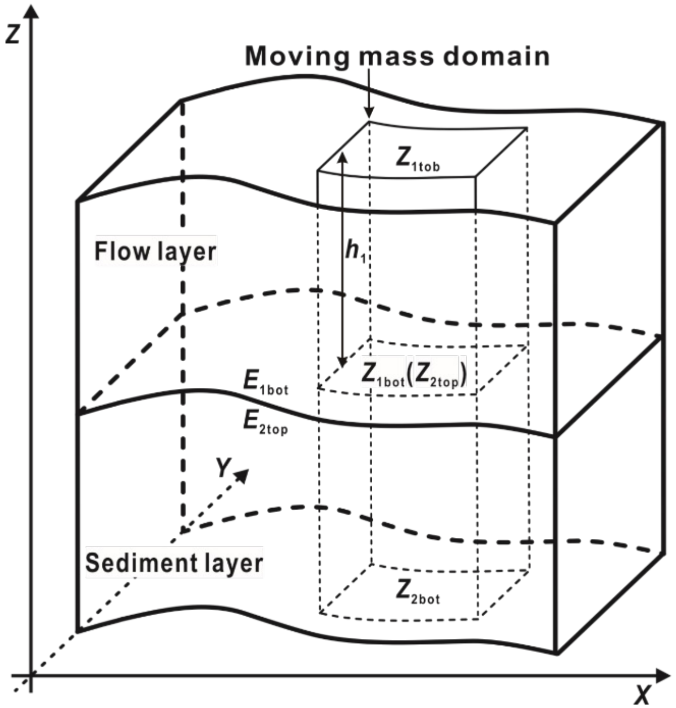
The landslide distribution and location of Heifangtai, 215 landslides occurred at more than 82 sites

- **Can we give spatial distribution while building the EWS?**
- **Can numerical simulations guide us to escape?**

Model 1: for spatial distribution

from 1972 to 2020, 26 periods in total





Schematic model of the Massflow model

(Ouyang et al, 2013, 2015; 2017)

Assumptions:

- ***Volume and numerical parameters are independent;***
- ***Hazard is equal to all combinations of Volume V and numerical parameters λ;***

***Step* 1: Inverting to find optimal parameters**

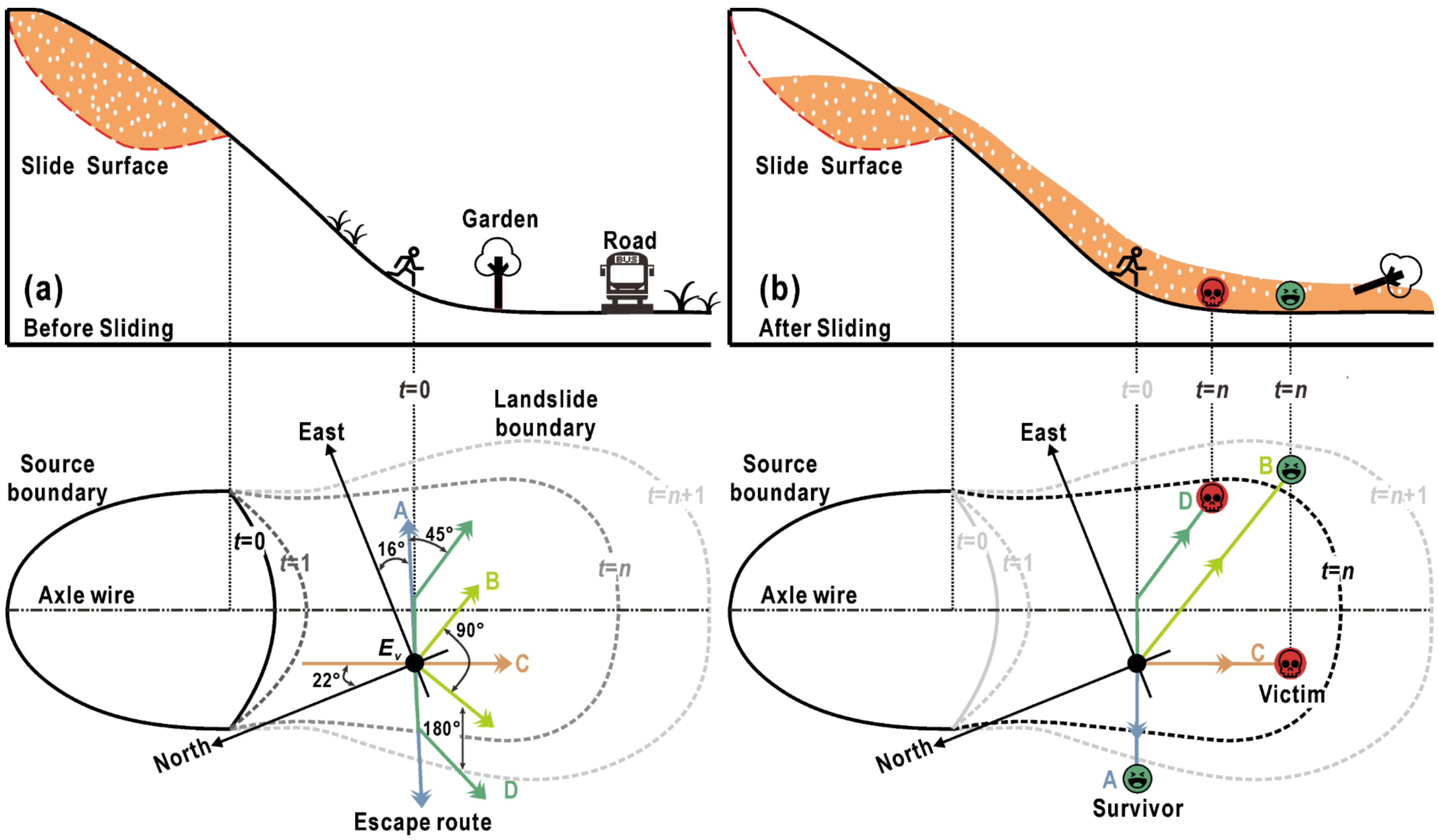
***Step* 2: Testing the accuracy of parameters**

***Step* 3: Simulating potential possible scenarios**

$$P_f(V \mid \lambda) = P(V)P(\lambda) = \sum P(V)P(\lambda)$$

P_f is the spatial probability corresponding to V and λ;
P(V) is the the probabilities of landslide volume;
P(λ) is the the probabilities of numerical parameter;

Model 2: for human vulnerability



Schematic diagram of the human escape scenario simulation model

GitHub: https://github.com/Nedasd/human-vulnerability-assessment

Assumptions:

- ***the scenario simulation parameters are independent;***
- ***human who caught by landslide will death (vulnerability=1);***
- ***the potential victims run at a uniform speed until they reach a safe area;***

Hazard zone and landslide velocity

↓

Scenario 1

when slope failure,
is anyone within the hazard zone?

↓ *Yes*

Scenario 2

what speed & route will this men choose?

↓ *Find a way to flee*

Scenario 3

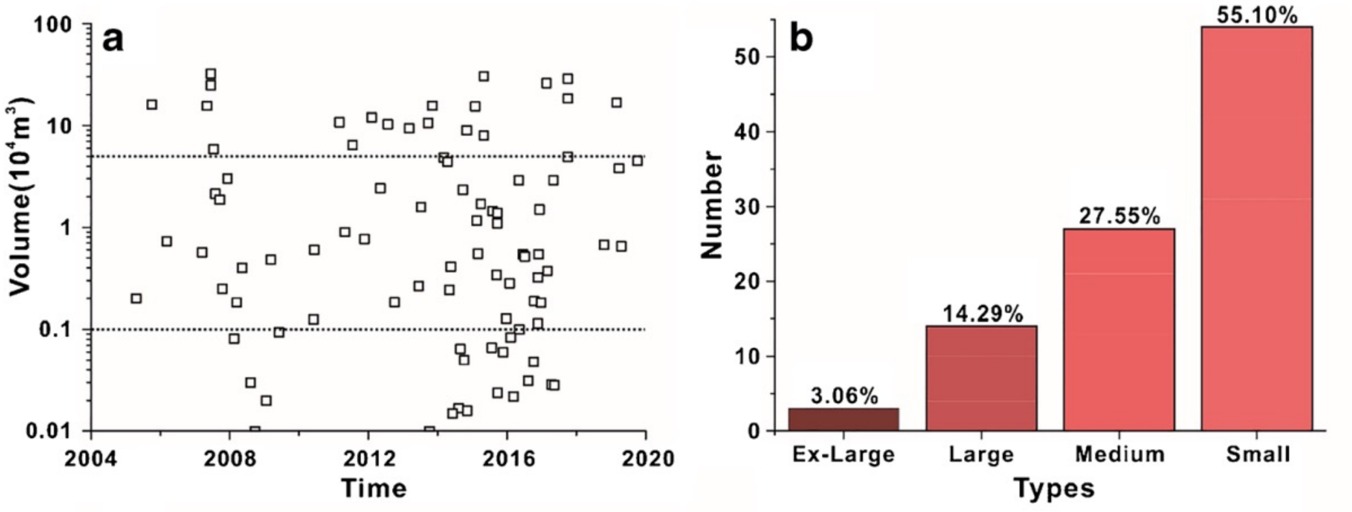
did this man survive?

$$P_{HV} = P_{TEP} \times P_{EP}$$

$$= P_{TEP} \times P_{PER:TEP} \times P_{E_v:TEP} \times P_{CM}$$

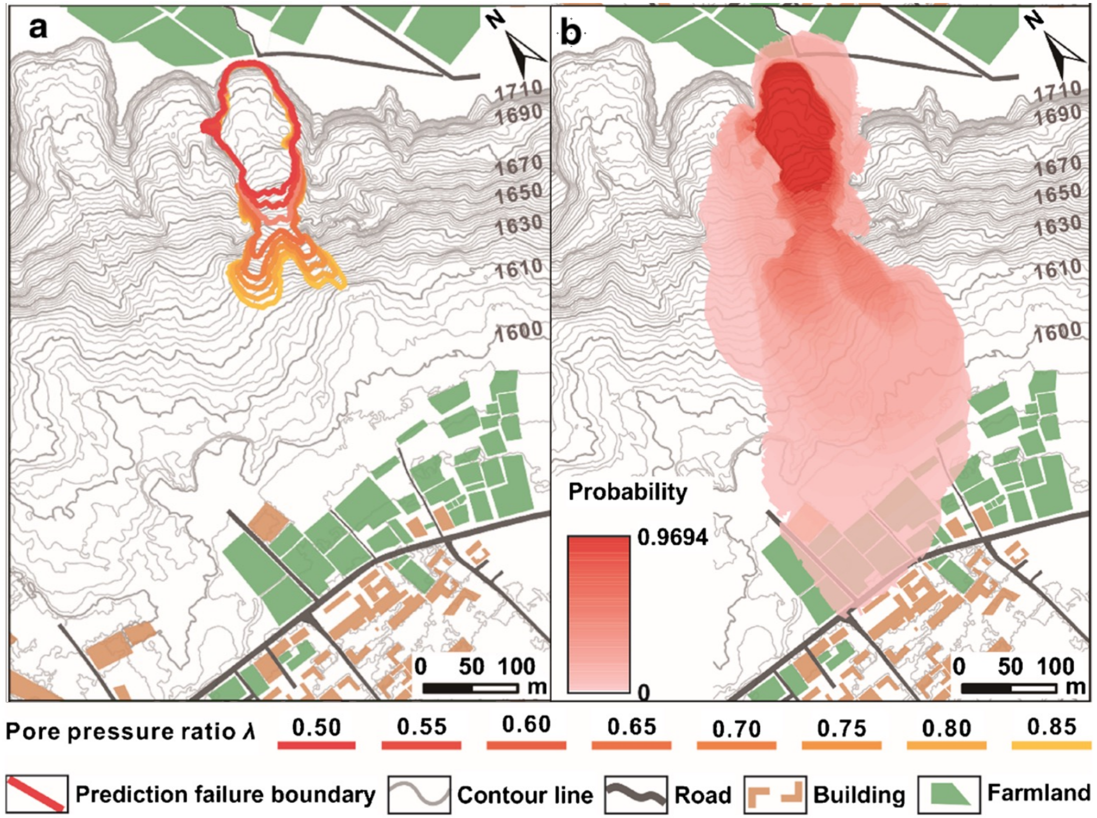
P_{HV} is the probability of human vulnerability;
P_{TEP} is the the probabilities of exposure time;
P_{EP} is the the probabilities of escape behavior;
$P_{Ev:TEP}$ is the probabilities of escape speed;
$P_{PER:TEP}$ is the probabilities of escape route;
$P_{Ev:TEP}$ is the probabilities of cumulative mortality;

Results



Volume occurrence probability of the HFT between 2004 and 2019
***a** Date and volume of landslide occurrence.*
***b** Probability of landslides with different types.*

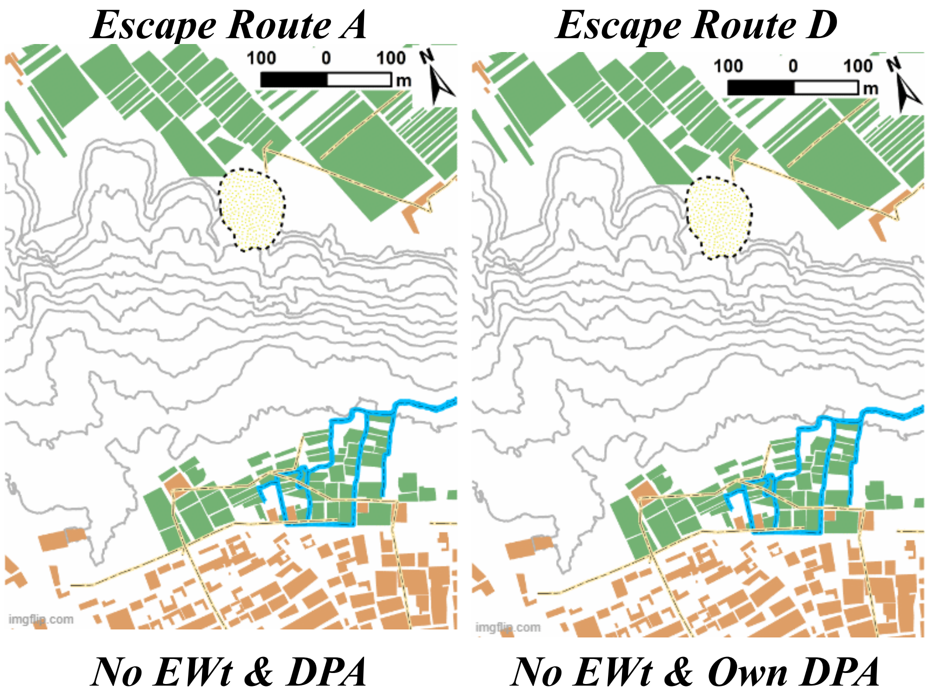
- **According to landslide database with a sample size of 98, small landslides with a volume of 1e3-5e5 m^3 are predominant;**



The spatial distribution under different combinations
***a** large landslide with a volume 1.66e5 m3*
***b** Distribution probability after landslide DC#4*

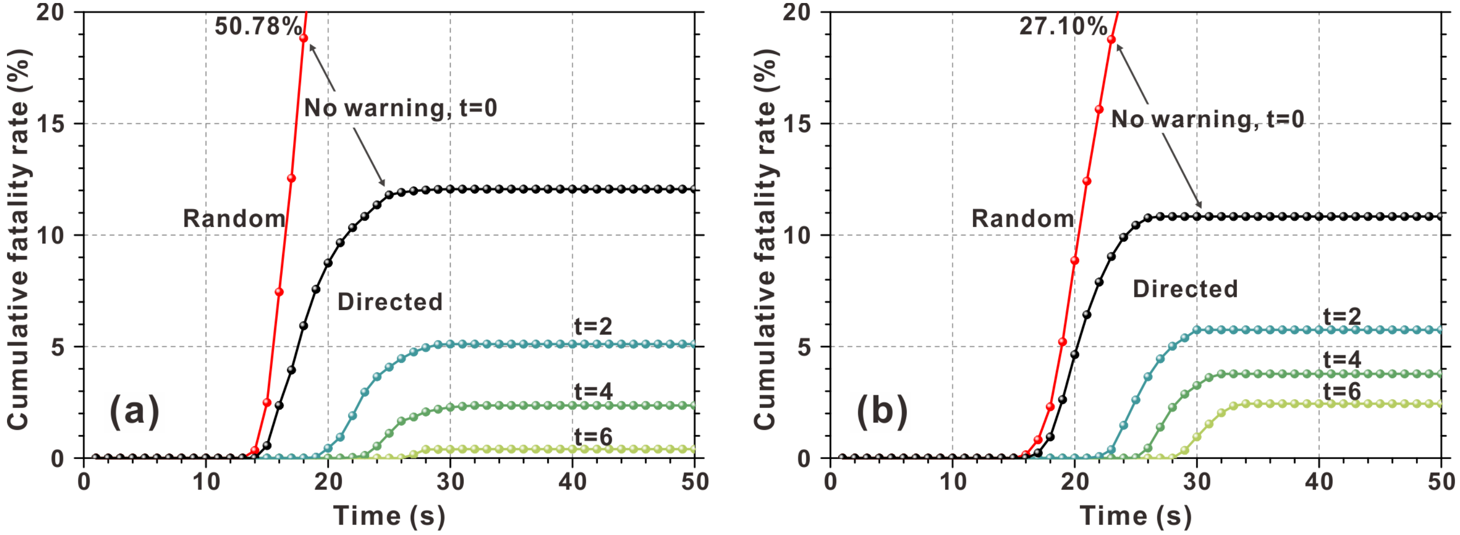
- **Fewer houses are threaten by this landslide, but most of the land will be buried;**

Results



Locations of personnel fatalities under different scenario condition

Route A, run perpendicular to the sliding direction;
Route D, run route A then run diagonally with respect to the sliding direction;
DPA, disaster prevention awareness, does the victim know the source location and center axis?
EWt, does people get warning when slope failure? If they got, they will escape before failure.



The cumulative mortality CM varies with the effective warning time

a to d is escape Route A to escape Route b

- **Getting 6s effective warning time could make cumulative mortality lower than 2.5%;**

- **Obtaining the central axis of landslide ahead will greatly help with surviving;** *(lower the CFR 3-10 times)*

Concluding remarks

- Numerical model for site-specific landslide spatial distribution evaluation is feasible;
- Obtaining the central axis before landslide failure and escaping away from it is helpful;
- Getting effective warning time for fleeing is the most powerful tool for surviving;

Thanks for your attention~

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Result Source:

Zhou Q, Xu Q, Peng D, et al. Quantitative spatial distribution model of site-specific loess landslides on the Heifangtai terrace, China[J]. Landslides, 2021, 18(3): 1163-1176.
Zhou Q, Xu Q, Zeng P, et al. Scenario-based quantitative human vulnerability assessment of site-specific landslides using a probabilistic model[J]. Landslides, 2022: 1-16.

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