

# **Topography Meter:**

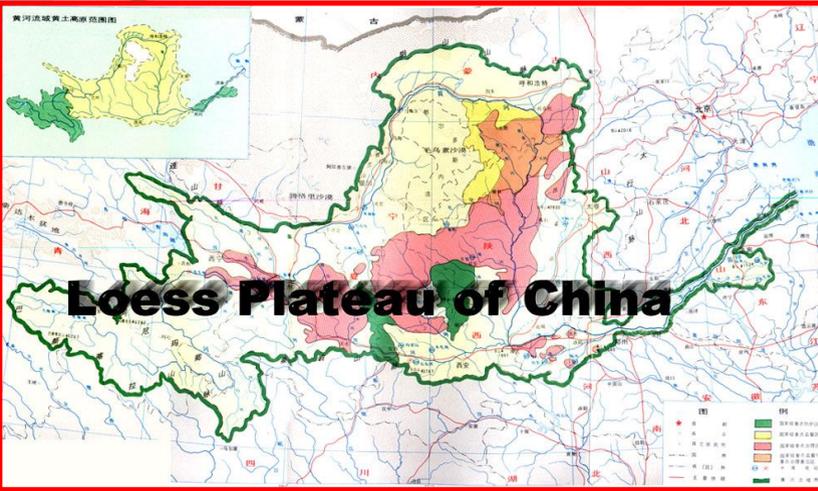
**a measurement system applicable for gravity-erosion experiments using a novel 3D surface measuring technique**

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# 1. Gravity erosion on the Loess Plateau



- Gravity erosion is the mass failure on the steep slope. On the Loess Plateau of China, forms of gravity erosion include avalanche, landslide, earth flow, creep, etc.
- Gravity erosion is an important process controlling the sedimentary structure and growth patterns of the steep slope, and also one of the major sources causing large amount of soil loss to the lower reaches. Especially, gravity erosion is very popular and very serious on the Loess Plateau of China with sparse plants.

# 2 How to measure the gravity erosion

- Have a statistics on the flow characteristics
- Calculate the volume with the slide area and the thickness of the slide
- Use the strain probe to continuously detect soil creep in situ

A problem common to all of the techniques is that the data were observed after the failure events, and the gravity erosion was **not separated from other forms of erosion.**

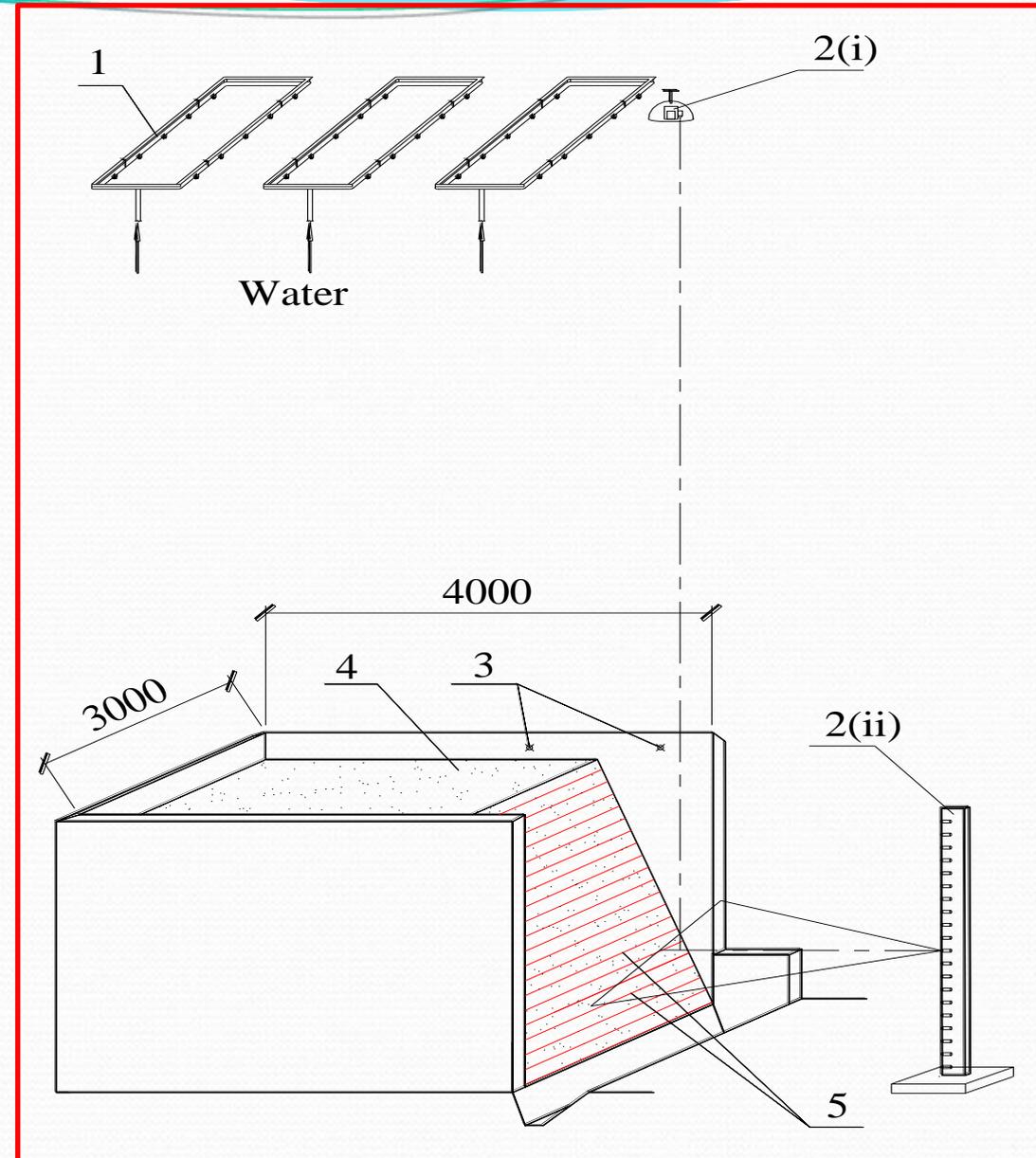
No such techniques have been applied to the 3D object in the dynamic motion

- **Digital photogrammetry:** The philosophy of capturing the geometry and visualizing at the same time works.
- **3D shape measurement:** Compute the 3D model of a face by projecting a simple colored stripe pattern onto the face

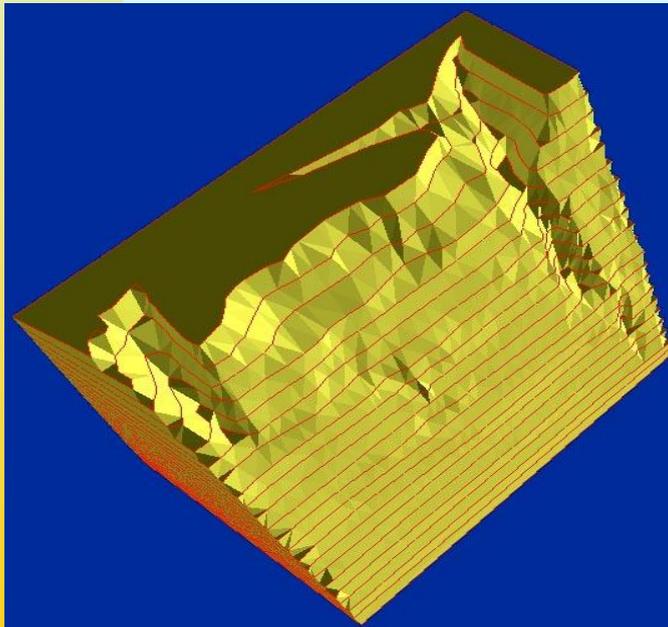
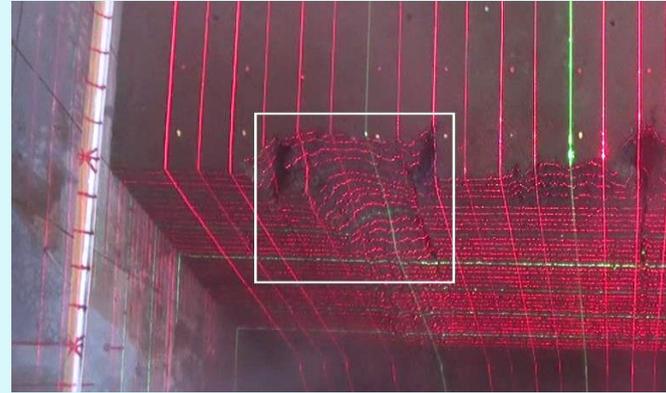
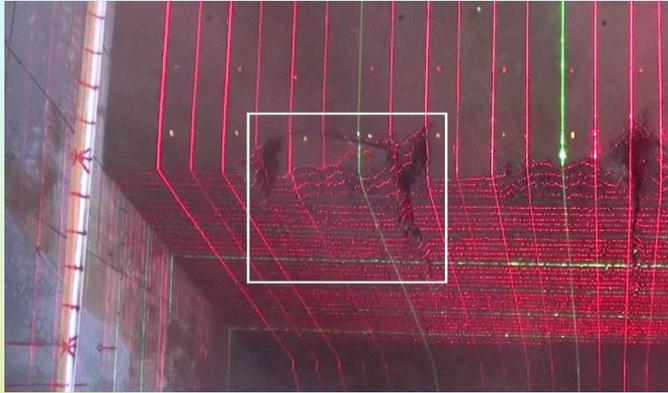
# 3. Observation method and materials

A stripe pattern with equidistant horizontal lines is generated by a laser source, and is recorded by a camera with sighting direction perpendicular to the light pattern. As the slope terrain deforms over time, the erosion process is recorded by video, and then imported into the computer to acquire a snapshot image at particular time sequence. Given depth in ArcGIS, the 3D geometric shape of the target surface can be computed accurately.

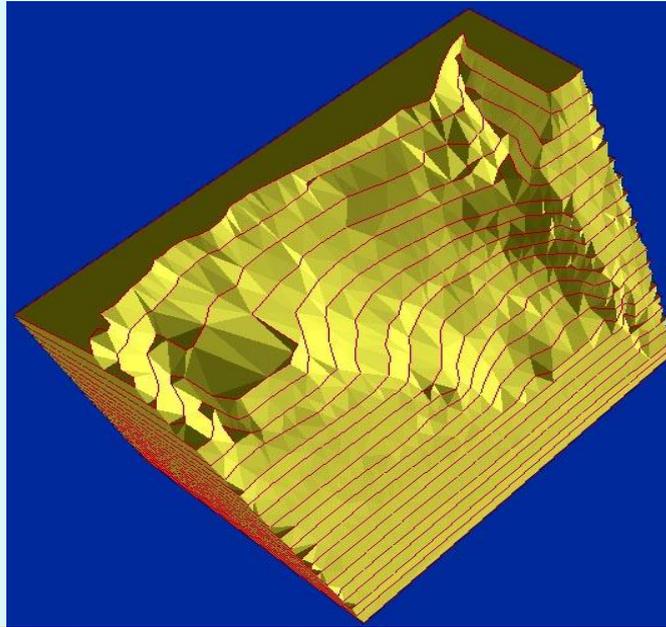
1 Rainfall simulator, 2 topography meter (i camera with a collimator and ii laser source), 3 calibration points, 4 model slope, and 5 projected laser lines.



# Volume of the failure mass



Landform after 21'25'' rainfall



Landform after 21'27'' rainfall

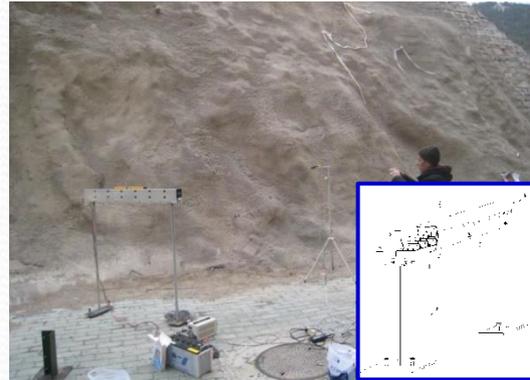
The amount of gravity erosion was the difference between the volume of the slope in the moments before the incident with that after the incident

# To observe the gravity erosion using Topography Meter



Landslide experiment

MX-2009-G



1<sup>st</sup> TM

MX-2009-W



2<sup>nd</sup> TM



Portable laboratory

MX-2010-G



3<sup>rd</sup> TM

MX-2014-G



4<sup>th</sup> TM

MX-2018-G



5<sup>th</sup> TM



Field experiment

5 generations of TM, 6 approved Chinese invention patent, and 3 projects of NSFC

# Used in the field observation



Portable laboratory



Rainfall simulation

- ✓ A paper in Review of Scientific Instruments
- ✓ A Release in AIP

AIP

<https://publishing.aip.org/publishing/journal-highlights/bringing-landslide-laboratory-remote-regions>

## Bringing the Landslide Laboratory to Remote Regions

Through use a portable laboratory and a topography meter, researchers in China can measure the frequency of random landslides on the steep slopes of China's Loess Plateau

From the Journal: [Review of Scientific Instruments](#)

However, despite the prominent geomorphic role gravity erosion plays on the slopes – which affects an area of more than 200,000 square kilometers in the upper and middle reaches of China's Yellow River – the process isn't well understood due to the complexity of soil failure occurrence and behavior, according to Xiang-Zhou Xu, a professor of Dalian University of Technology in Dalian, China.

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## “便携实验室” 测量黄土高原山体滑坡频率

徐向舟说：“黄土高原地区，尤其是黄土丘陵沟壑区和黄土台原沟壑区，受到重力侵蚀的严重影响。”如何定量评估陡峭斜坡上各种土体破坏的影响，对于控制山体滑坡灾难至关重要。