



農業部農村發展及水土保持署
Agency of Rural Development and Soil and Water Conservation, MOA

河道凸岸地形對土石流運移影響 以花縣DF024為例

農村發展及水土保持署
減災監測組 林駿恩

113年3月18日



Outline

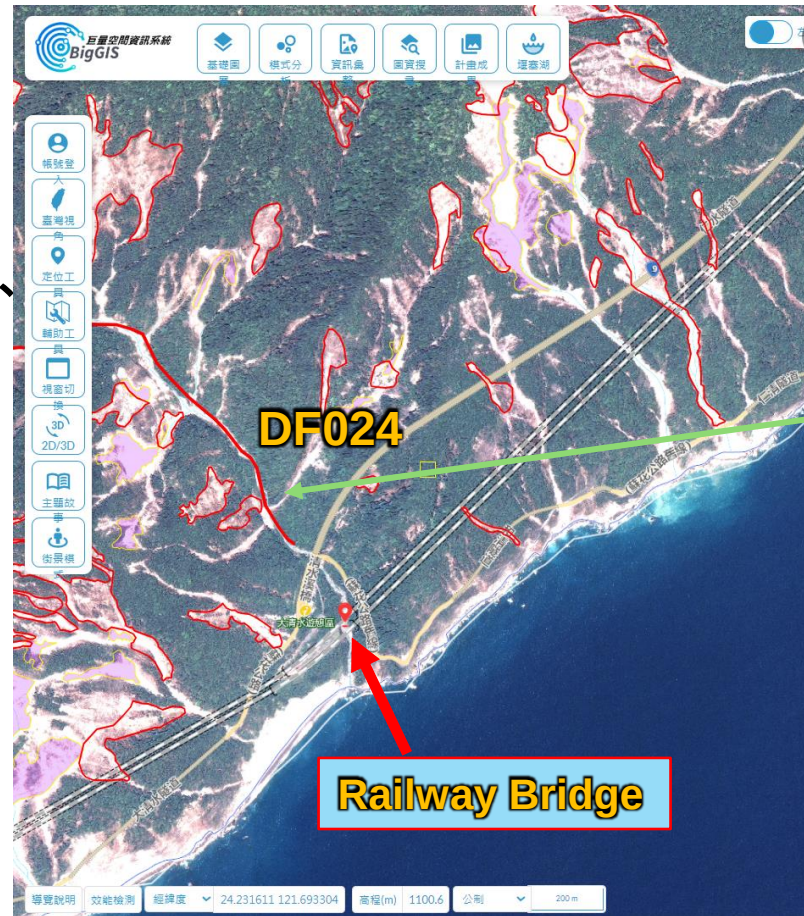
- The Hualien Earthquake Event
- Study Area
- Event Narrative
- Numerical Simulation
- Conclusions



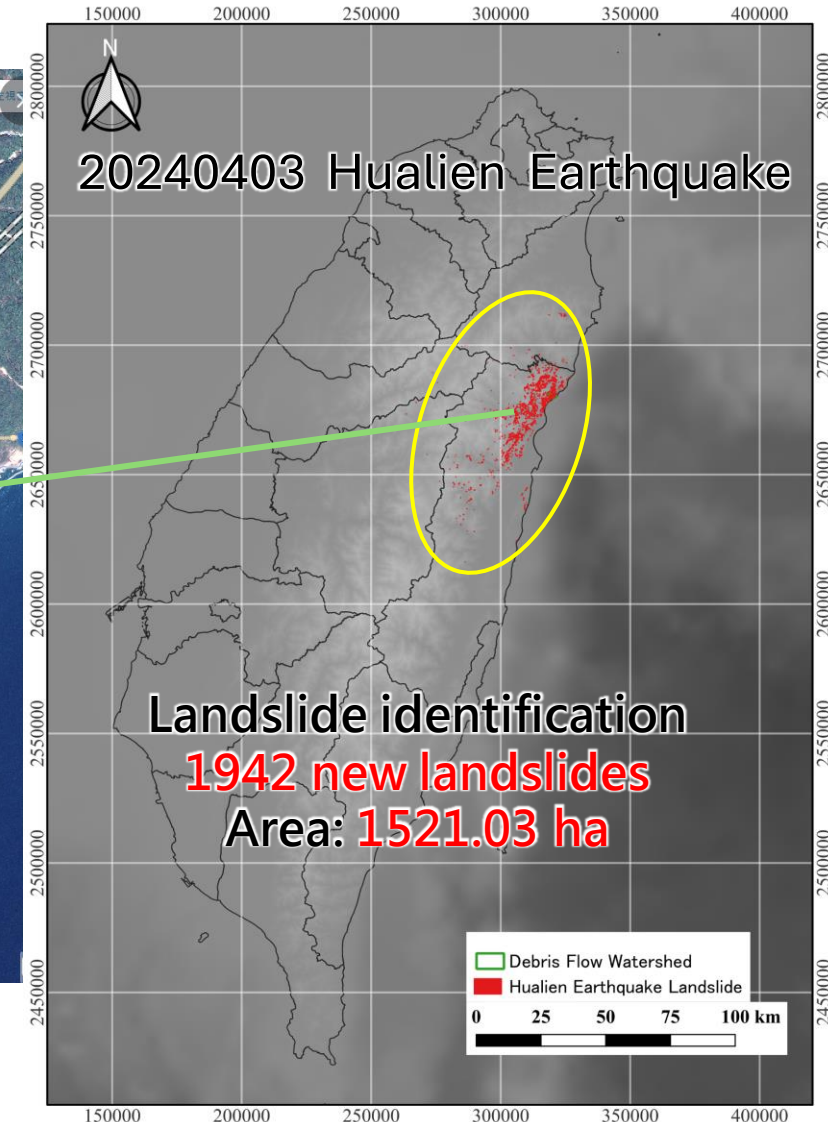
The Hualien Earthquake Event

Landslide Identification

- **Hualien County** (HSIU-LIN、WAN-RONG、FENG-PIN、SHOU-FENG、CHI-AN);
- **Yilan County** (NAN-AO、TA-TUNG、SU-AO);
- **Nantou County** (JEN-AI);
- **Taichung City** (HE-PING)
- **1,942** New Landslides
- **Landslide Area: 1521.03 ha**



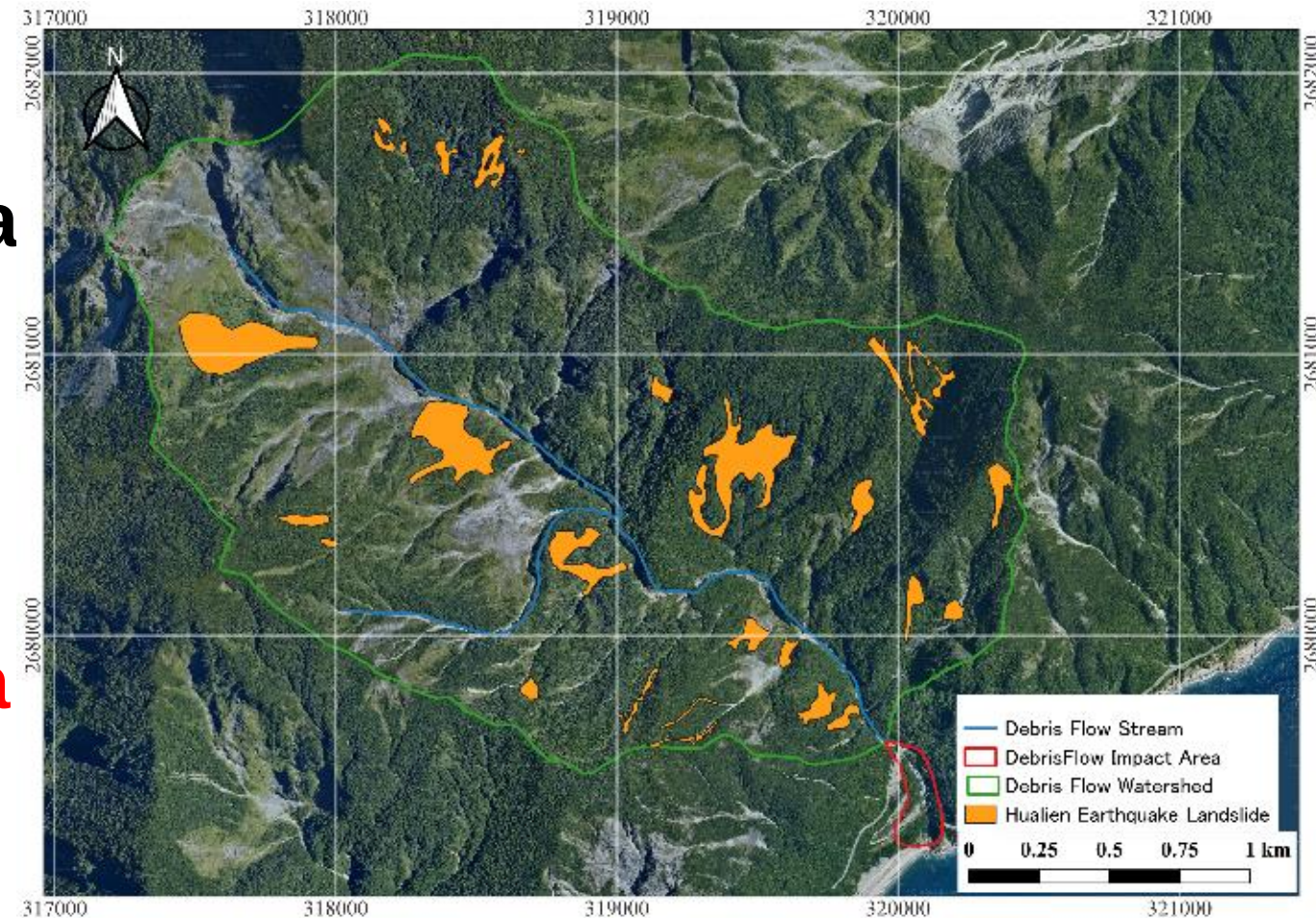
Hualien Debris Flow No.024



Study Area

- Location: Hsiulin district, Hualien County
- Debris Flow Catchment Area 5.29 km²
- Debris Flow Impact Area: 43.9 ha
- **25 New Landslides**
- New Landslide Area: **31.7 ha**
- New Landslide ratio: **6%**
- Average slope: 50%

Hualien Debris Flow No.024



Hualien Daqingshuishi Creek (DF024)



Event Narrative

- Taiwan Express Train Derailment
- Debris Flow outburst:
 - 2024/06/21 16:30
- Train Derailment
 - 2024/06/21 16:50
- Location: The Hualien Daqingshuishi Creek
- Casualty: 9 People Injured and train damage

2024/06/21



Source : SETN.com



Rainfall

Gauge	District	10 mins	1hour	3hour	6hour	12hour	24hour
大農 (C1T97)	KuangFu	-	-	-	12.0	12.0	12.5
清水斷崖 (C0Z31)	HsiuLin	-	-	5.0	12.0	12.0	12.0

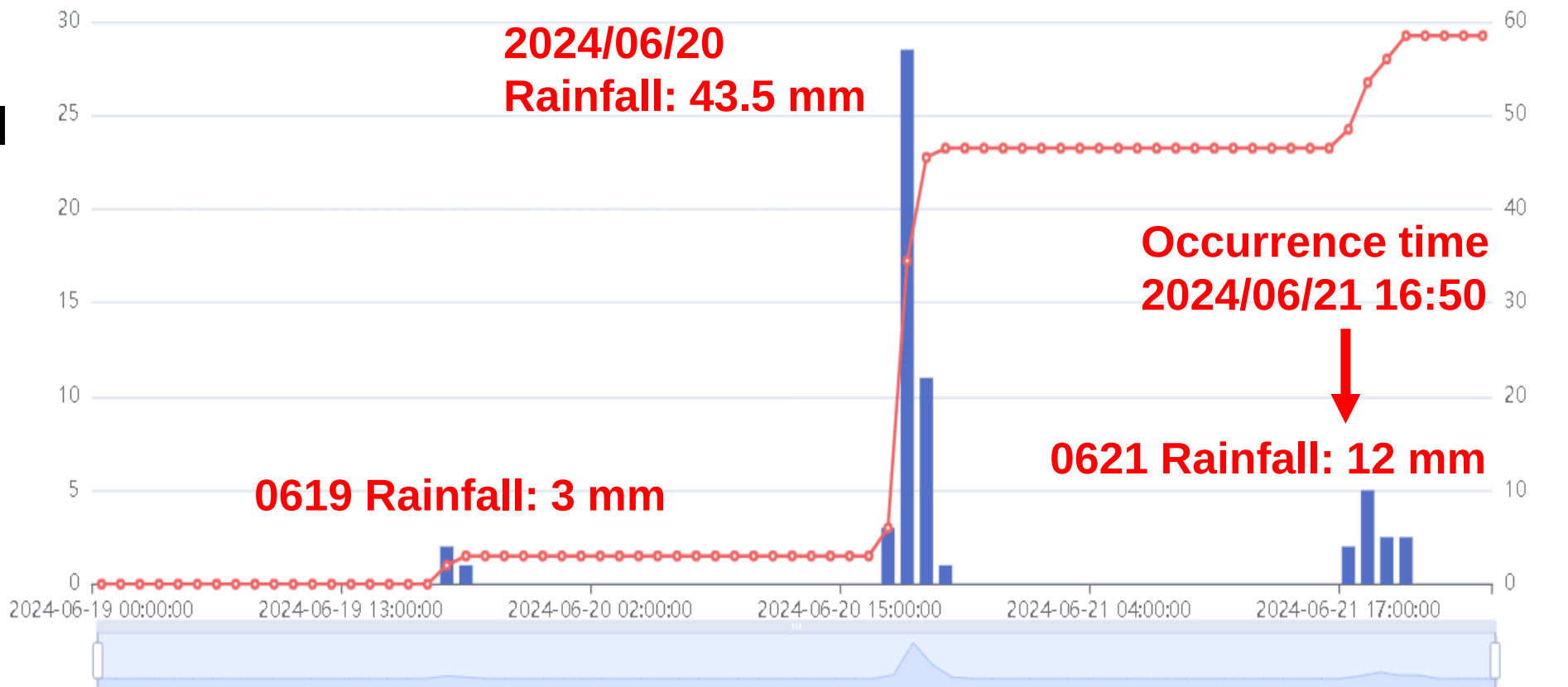
■ 時雨量 ○ ETR2 ○ ETR1 ○ 總累積雨量

QingShuiTuanYai Rain Gauge (C0Z31)

時間區間: 2024-06-19 ~ 2024-06-21

Rainfall Intensity (mm/hr)

Cumulated Rainfall (mm)



✓ 2024/06/20 Rainfall
= 43.5 mm

✓ 2024/06/21 Rainfall
= 12 mm and **Train
derail at 16:50**

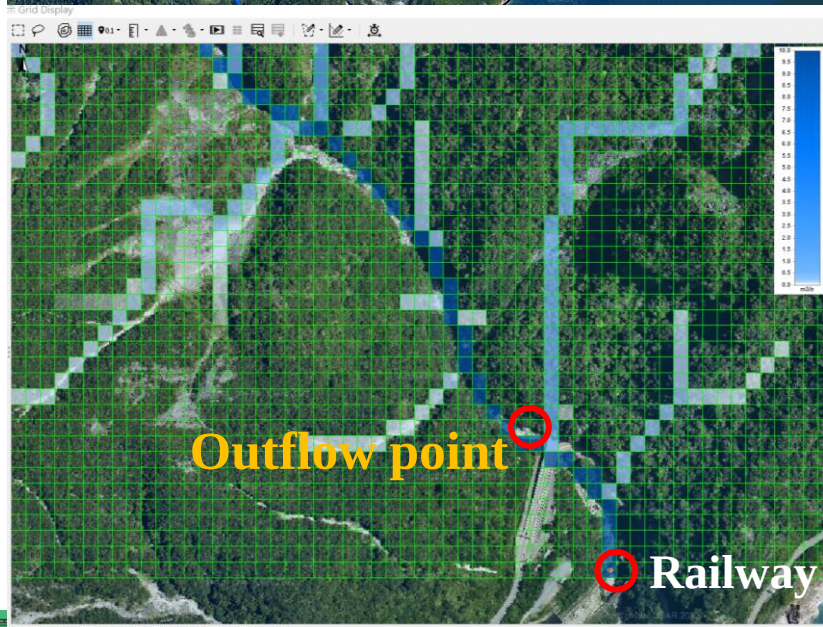
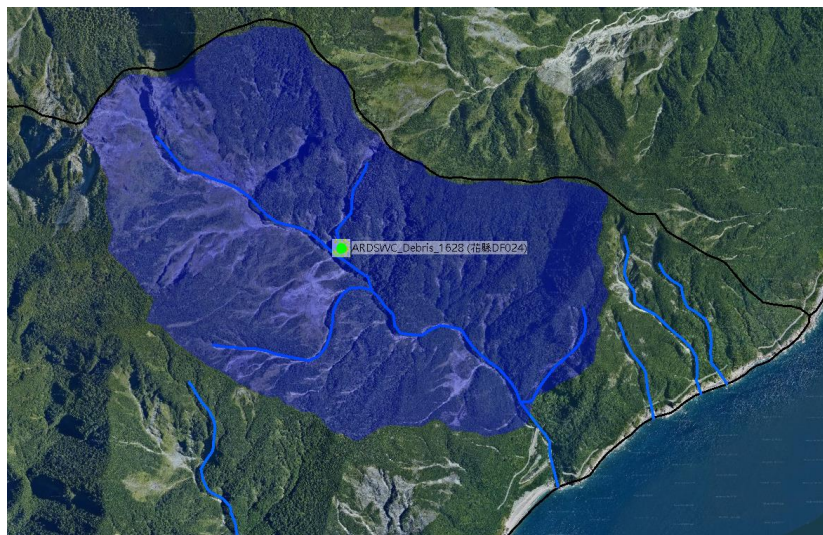
✓ Debris Flow
**Warning Criteria =
300mm**

✓ 20240619 to 0621
Cumulated
Rainfall = **58.5mm**

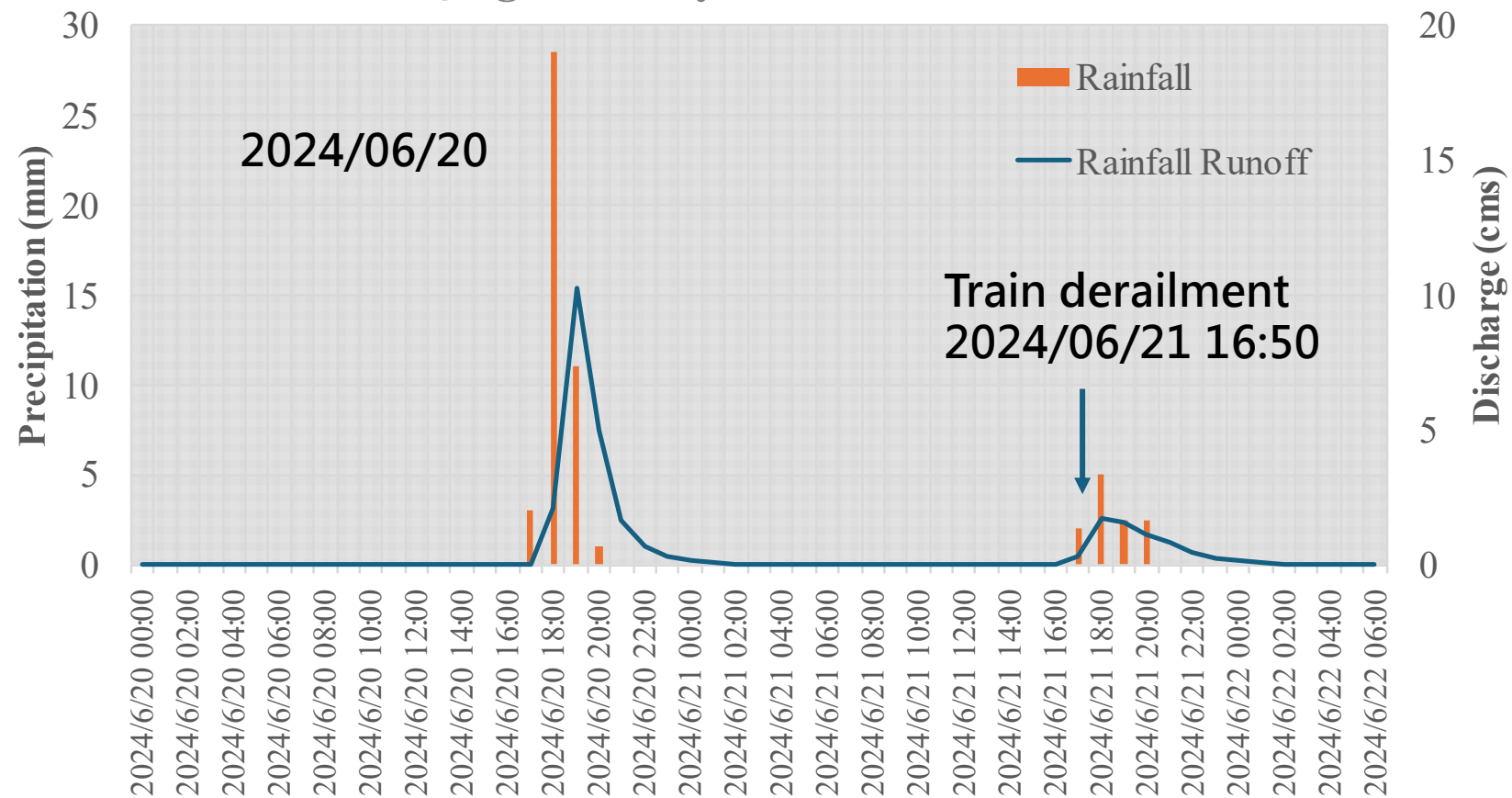


Rainfall Runoff

Based on rainfall data and Wflow rainfall runoff model, the **maximum rainfall was 28.5 mm** on June 20, and estimated **river flow was 10.24 cms.**



Qingshuituanyai Rainfall Runoff



Satellite Image Comparison

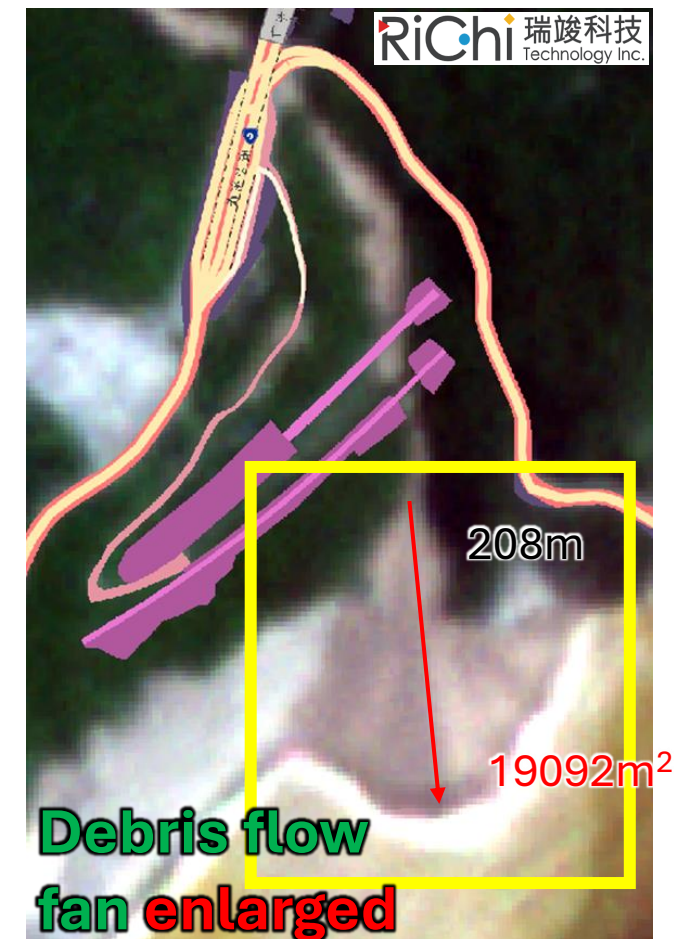
- ✓ The **riverbed was lifted** by a debris flow occurred on **June 20 at 17:00~20:00** ;
- ✓ The **debris flow surged onto the railway tracks** on **June 21 at 16:30**



2024/06/20 10:37 Planet



2024/06/21 10:02 Planet



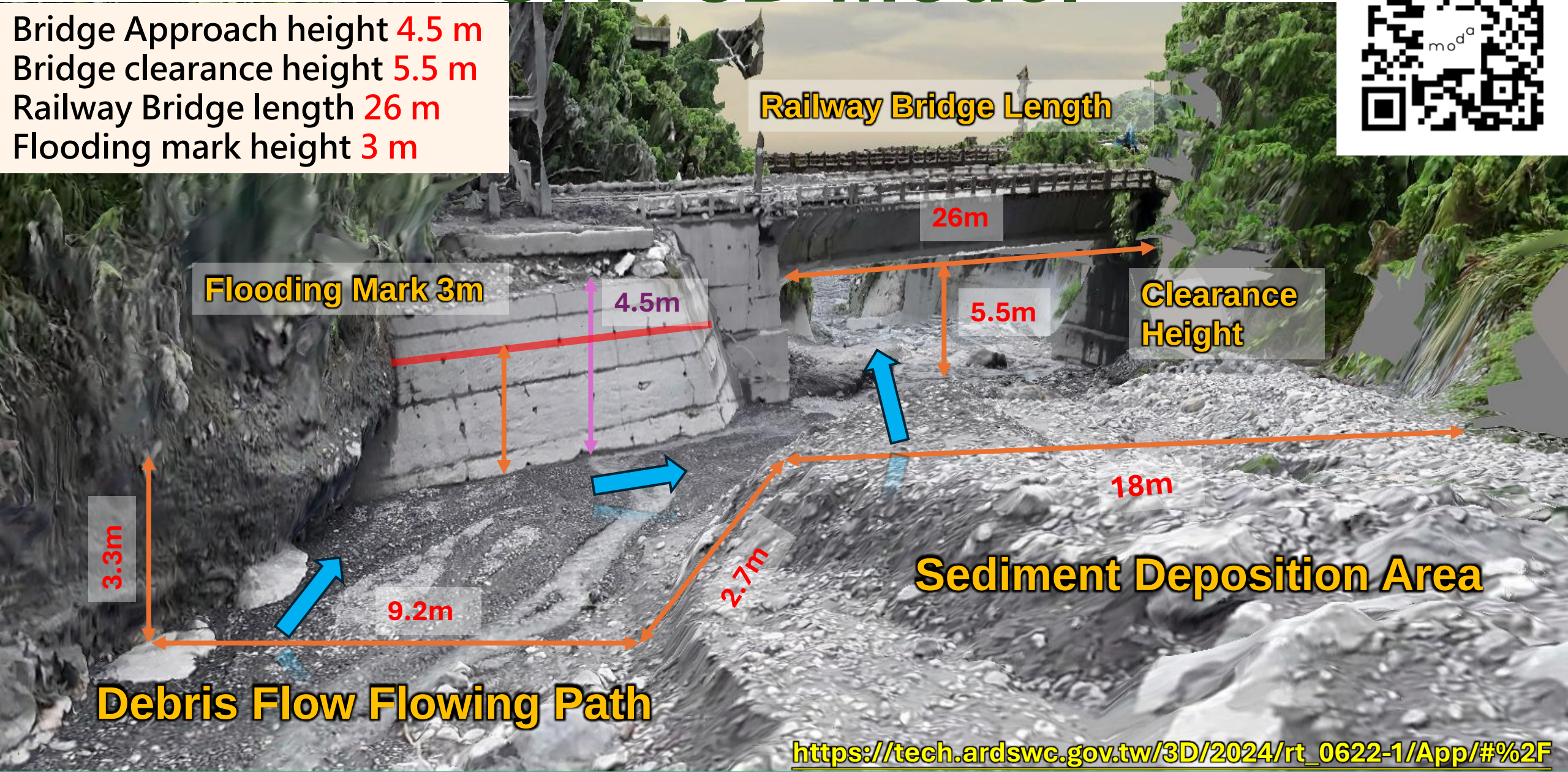
2024/06/22 09:50 Planet



UAV-3D Model



Bridge Approach height **4.5 m**
Bridge clearance height **5.5 m**
Railway Bridge length **26 m**
Flooding mark height **3 m**





Debris Flow Event

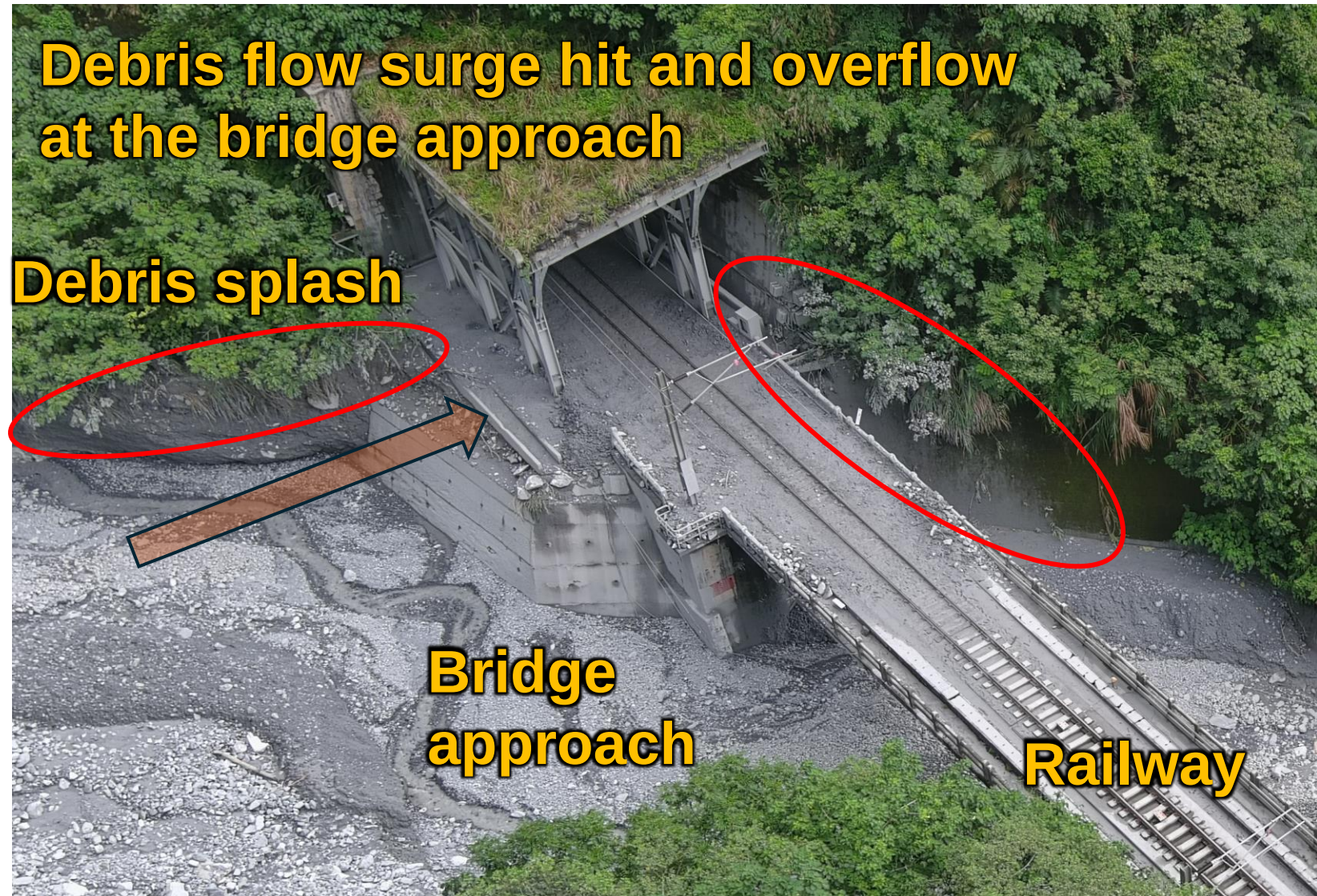
Debris Flow outburst: 2024/06/21 **16:30**
Train Derailment: 2024/06/21 **16:50**

- ✓ Debris flow surge hit bridge approach.
- ✓ Debris splash onto the railway tracks.
- ✓ Debris flow affected the railway on June 21 at 16:30.
- ✓ Taiwan Railway Express Train derailed on June 21 at 16:50.
- ✓ There was a **20-minute loss** in warning time.



Field Survey Result

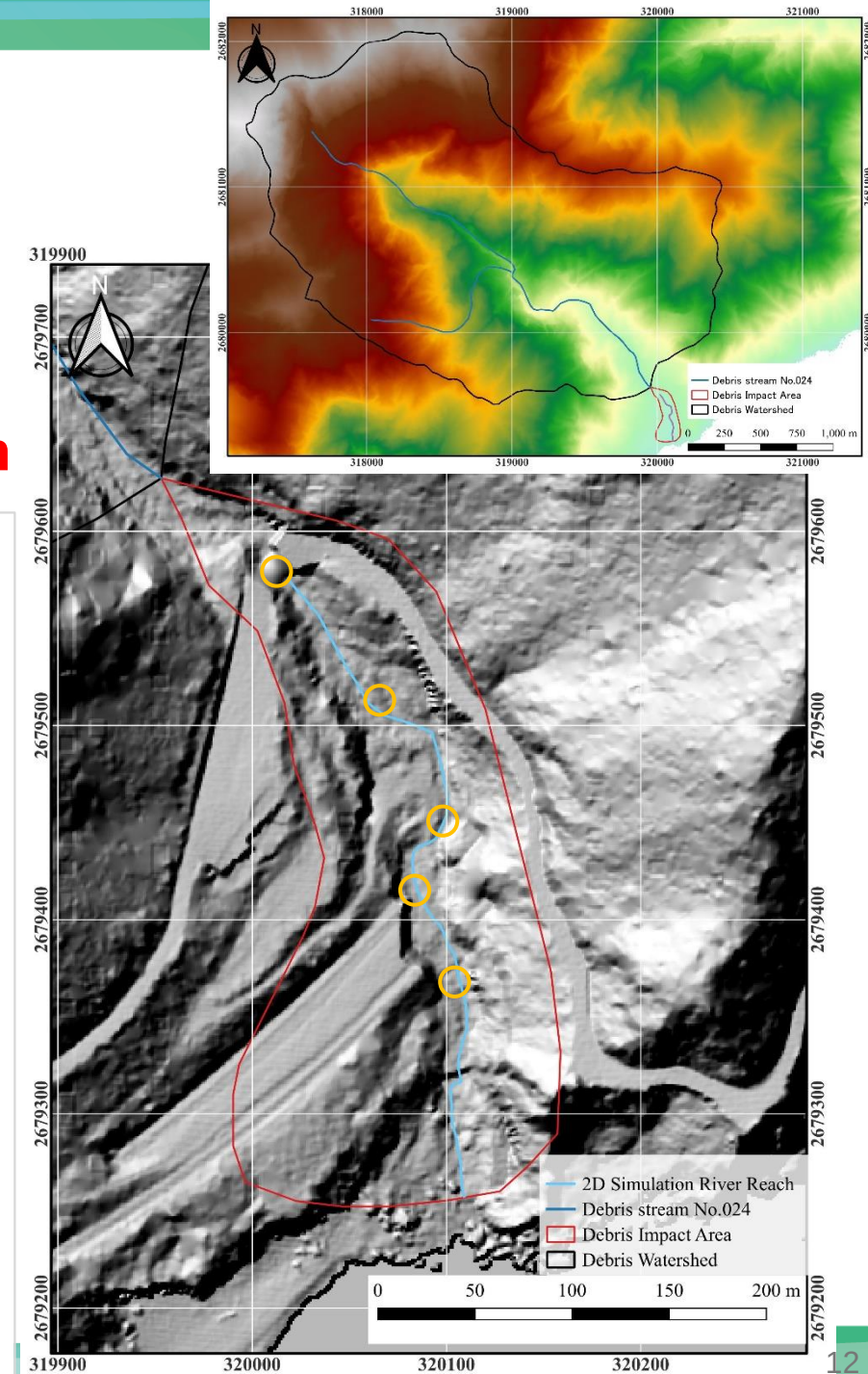
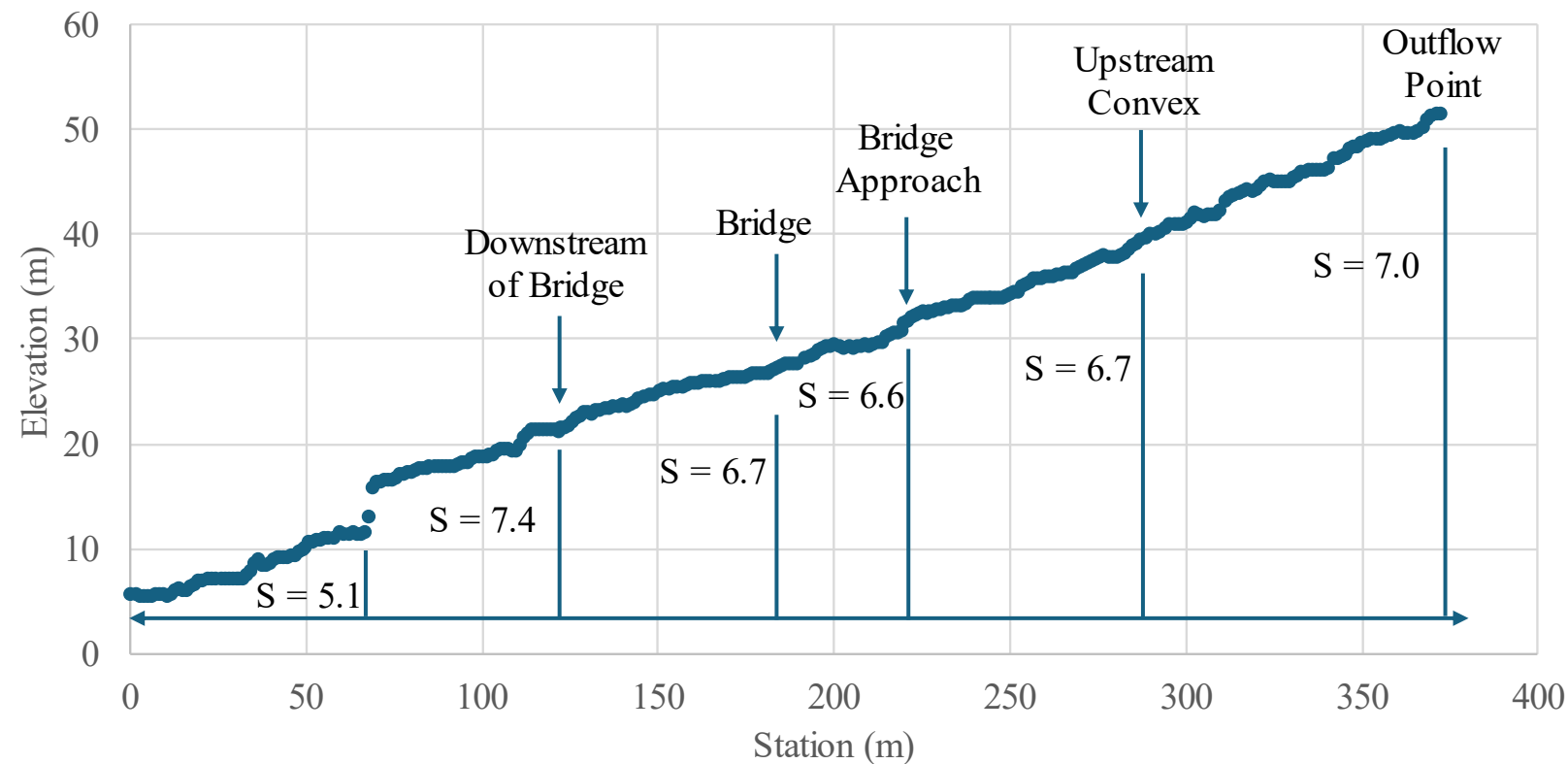
- ✓ The leaves, marked by splashes, showed that the **debris flow had rushed onto the railway.**
- ✓ Influenced by the **convex bank** the debris flow path is concentrated on the **left bank.**
- ✓ The debris flow **deposited lots of sediment** in the riverbed on June 20.
- ✓ The debris flow caused **a surge that overtopped the bridge approach** on June 21.



Longitudinal Profile

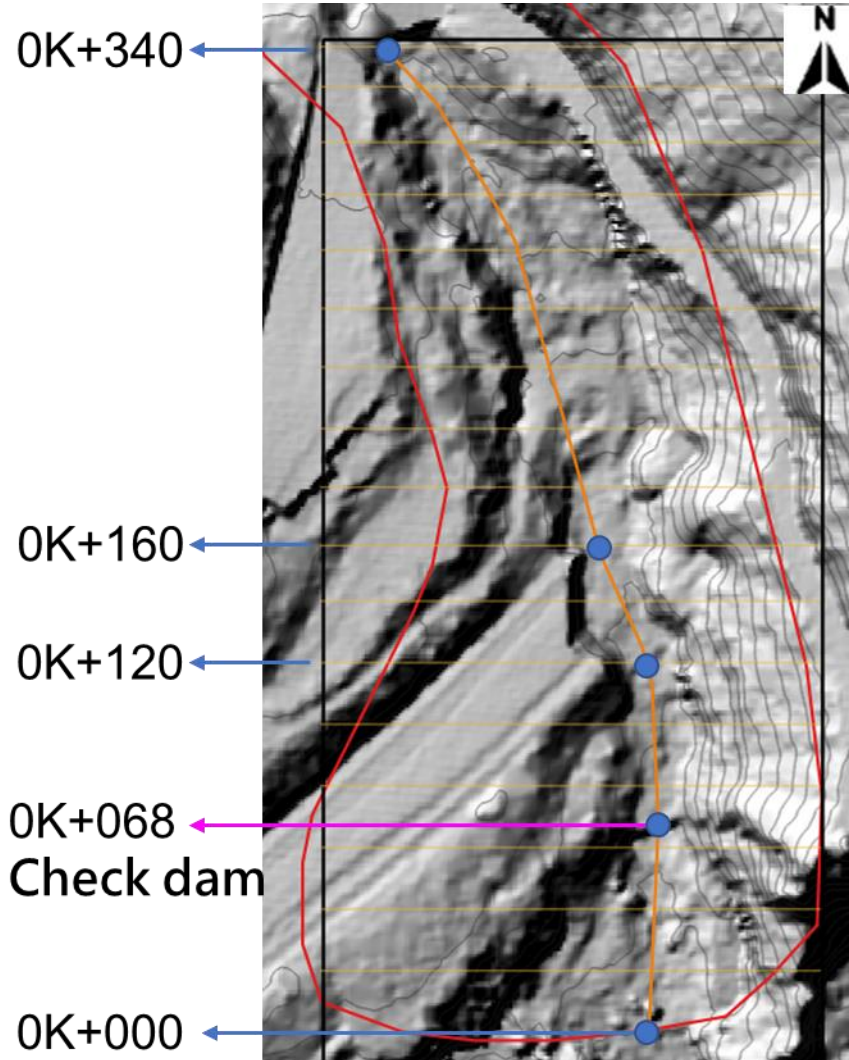
1. Part of sediment affected by upstream Convex Reach
2. The bridge contraction can affect sediment deposition

Debris flow Stream Longitudinal Profile





Numerical Setup



Hydrograph Data :

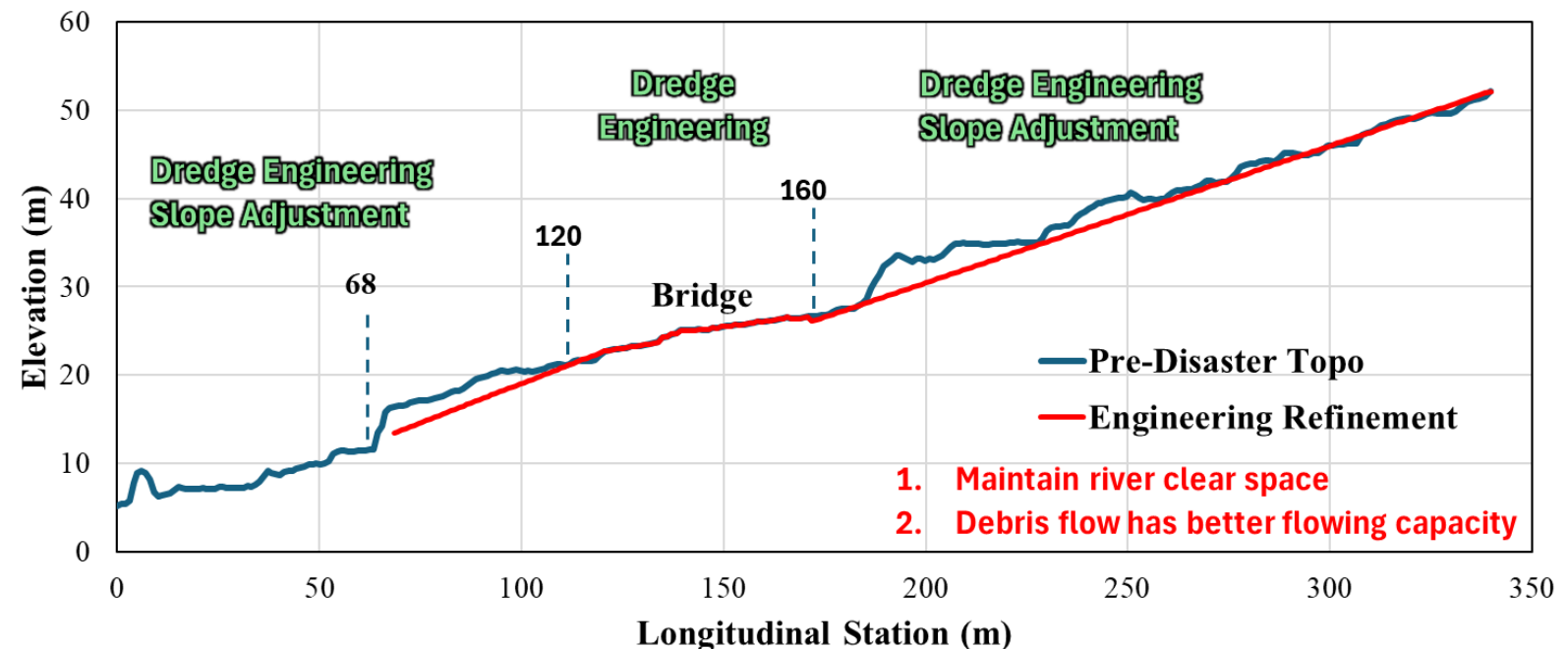
Time: 18000sec

- Total Cumulated rainfall 43.5 mm
- Max. Rainfall intensity 28 mm/hr

Geometric Data :

- Pre-Event: 2015 DEM (Resolution 1 m*1 m)
- Computation mesh: 2 m
- Post-Event: 2024/06/22 UAV-3D Model

Debris Flow Stream Longitudinal Profile



Numerical Simulation

Table - Parameters and values used in the KANAKO-2D

Case	Qp (cms)	Particle size (m)	Cv [%]	Protection work	Note
Run 1	10	0.1	30	Non	-
Run 2	135	0.1	30	Non	50-year return period
Run 3	135	0.1	30	Riverbed Dredge	50-year return period
Run 4	135	0.1	30	Riverbed Dredge + Embankment	50-year return period

Numerical

Run 1

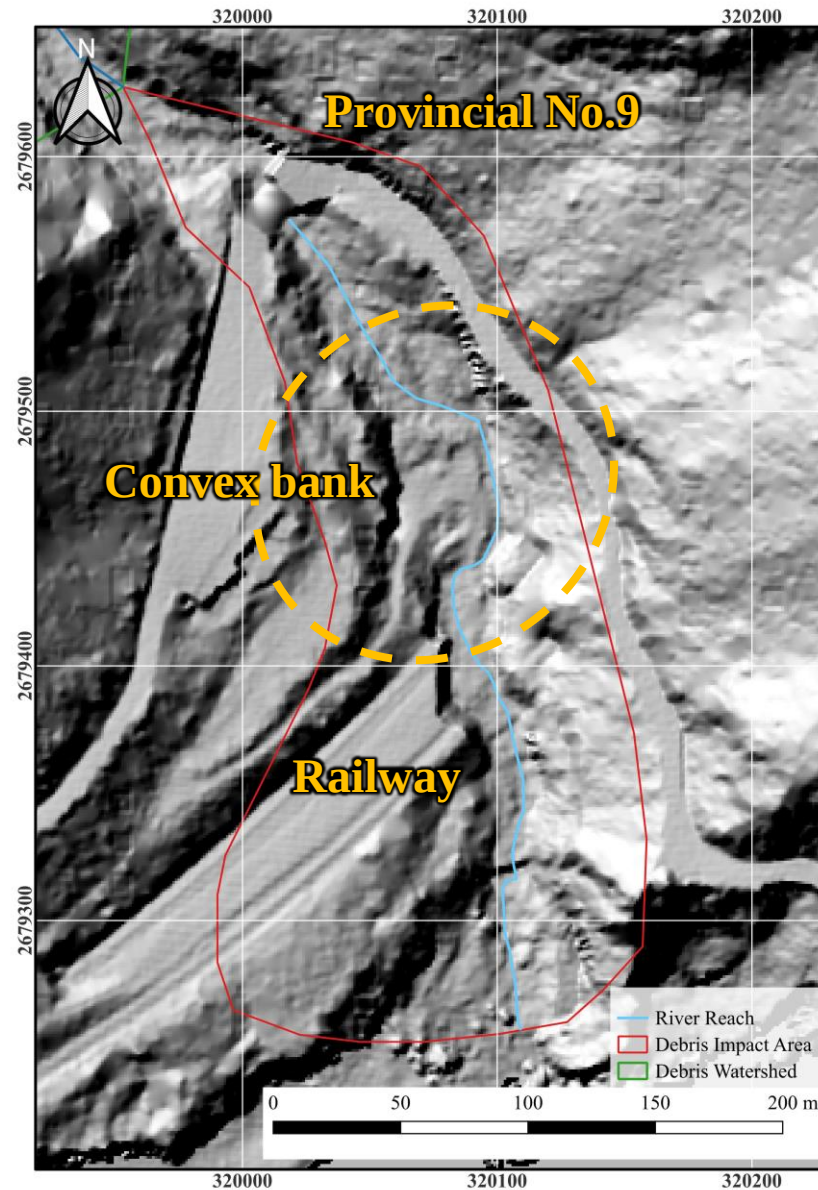
Concentration: 30%

Q_{peak}: 10.24 cms

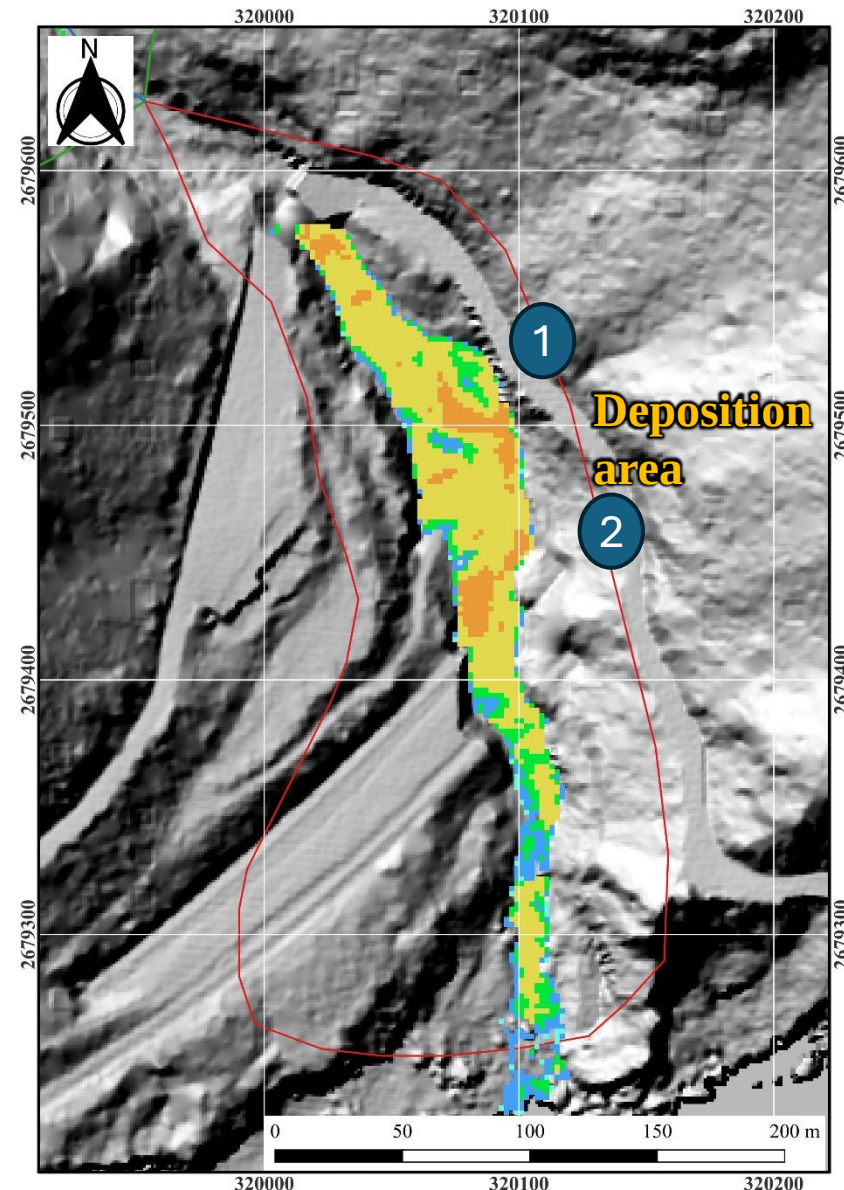
Geometric Mesh: 2m

The river bend influence the **flow path toward left bank.**

Debris mostly deposited in the upper part of **convex bank and bridge.**



Flow path toward left bank



Numerical

Run 2

Concentration: 30%

Q_{peak}: 135 cms

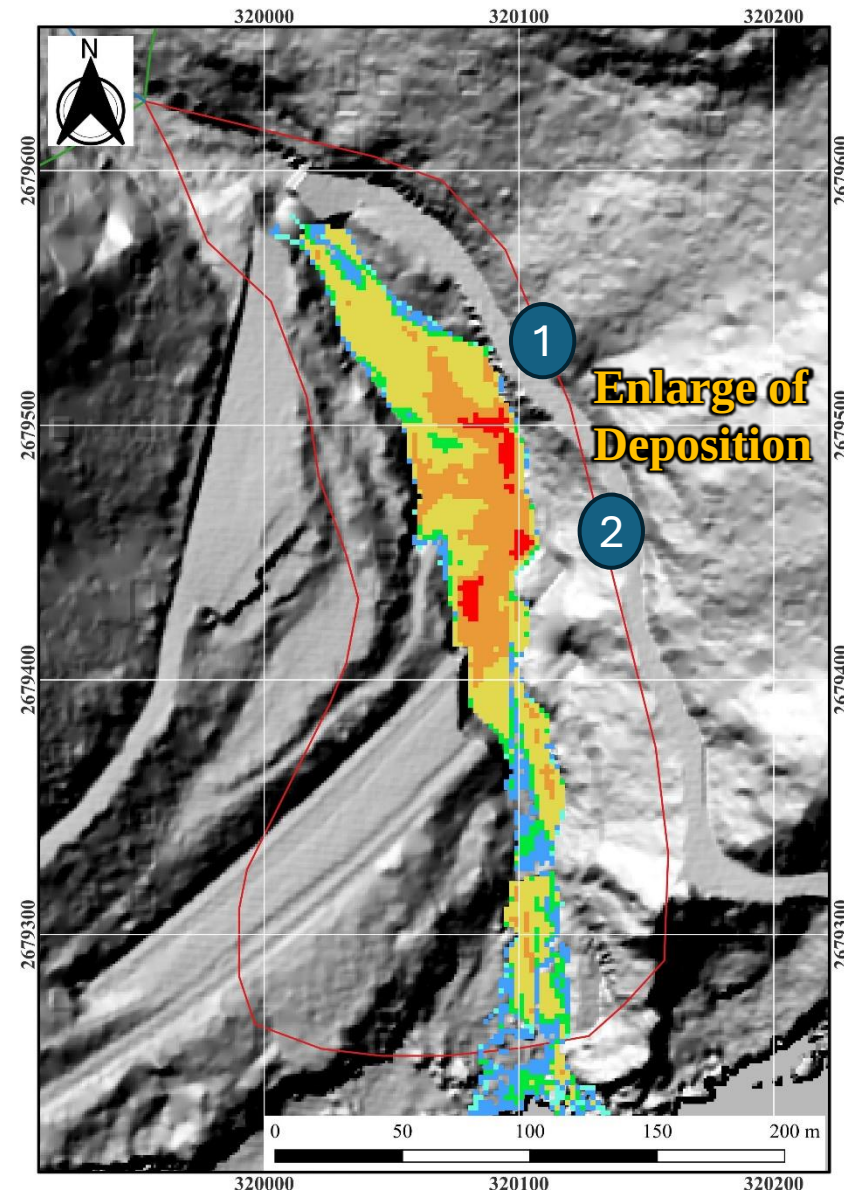
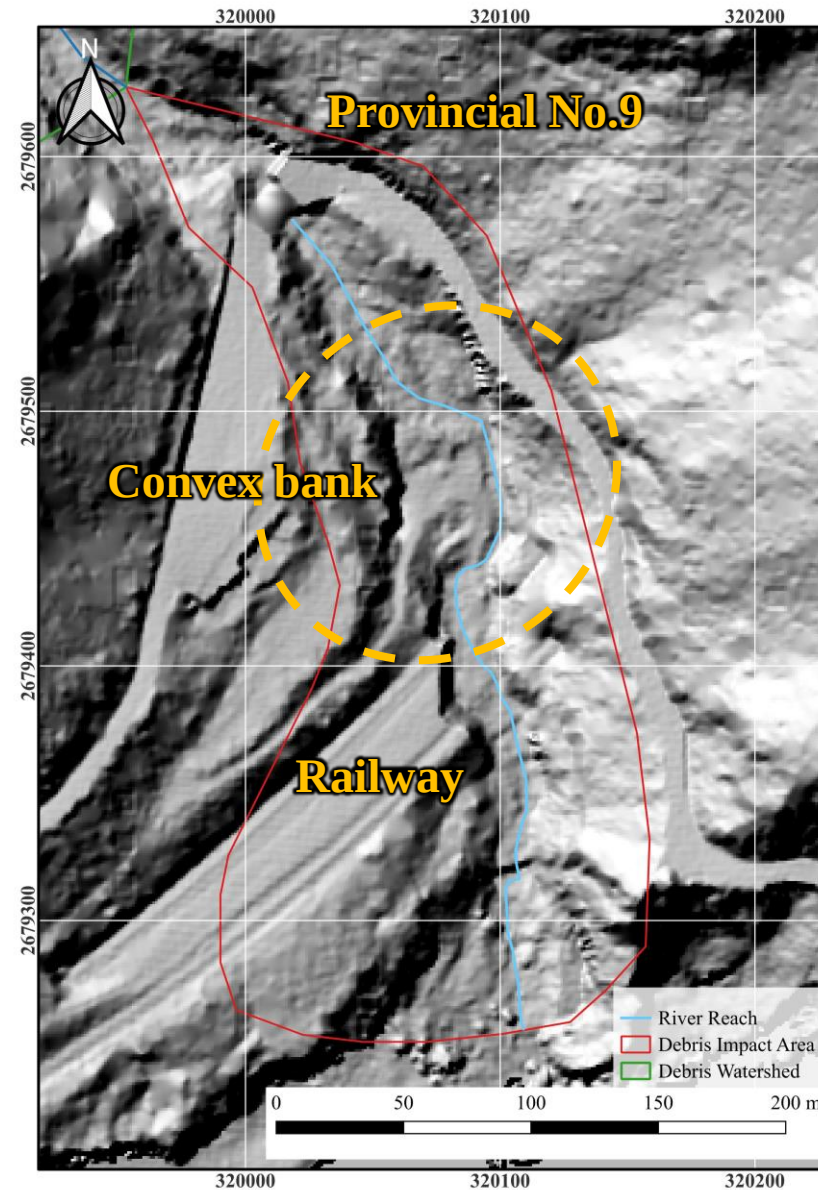
Geometric Mesh: 2m

Condition : Q50YR

River bend let the flow path toward left bank.

Bridge contraction effect influence debris mostly deposited in the upstream of bridge.

Sediment mostly deposit in the left bank



Debris mostly deposited in original convex bank

Numerical

Run 3

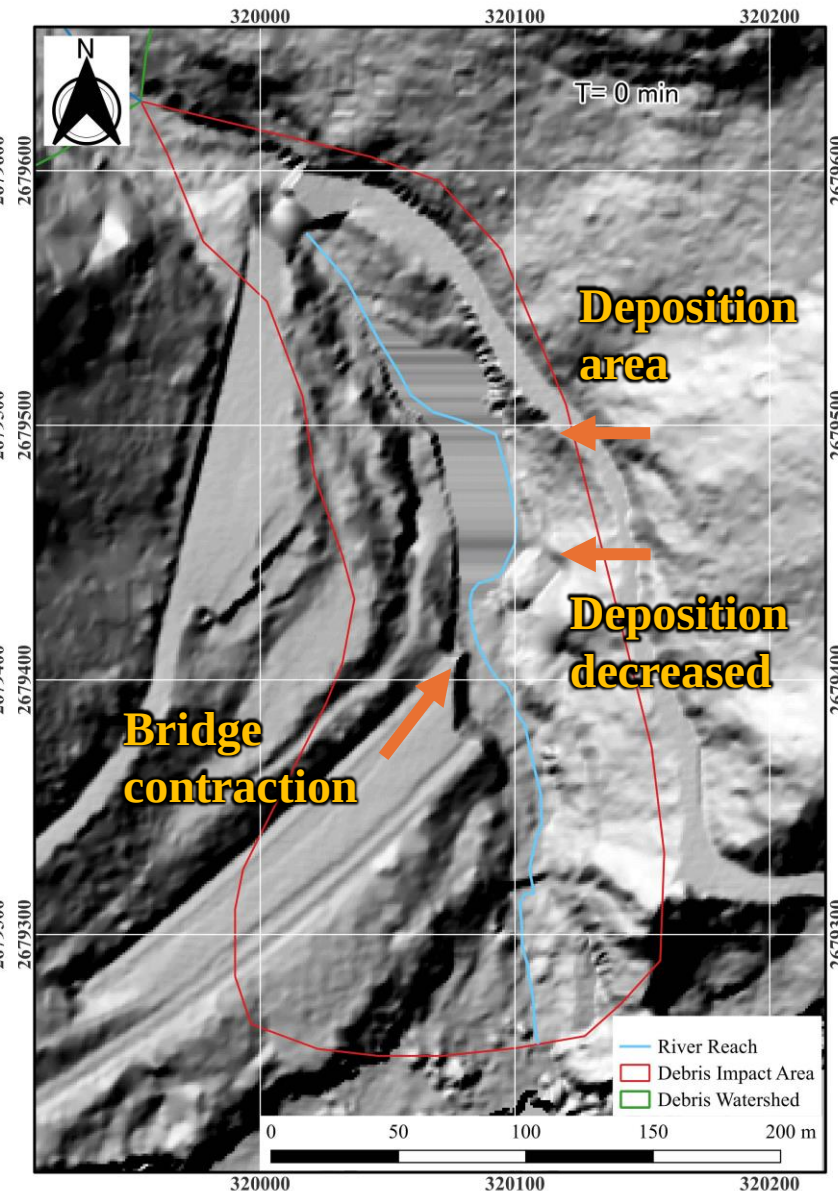
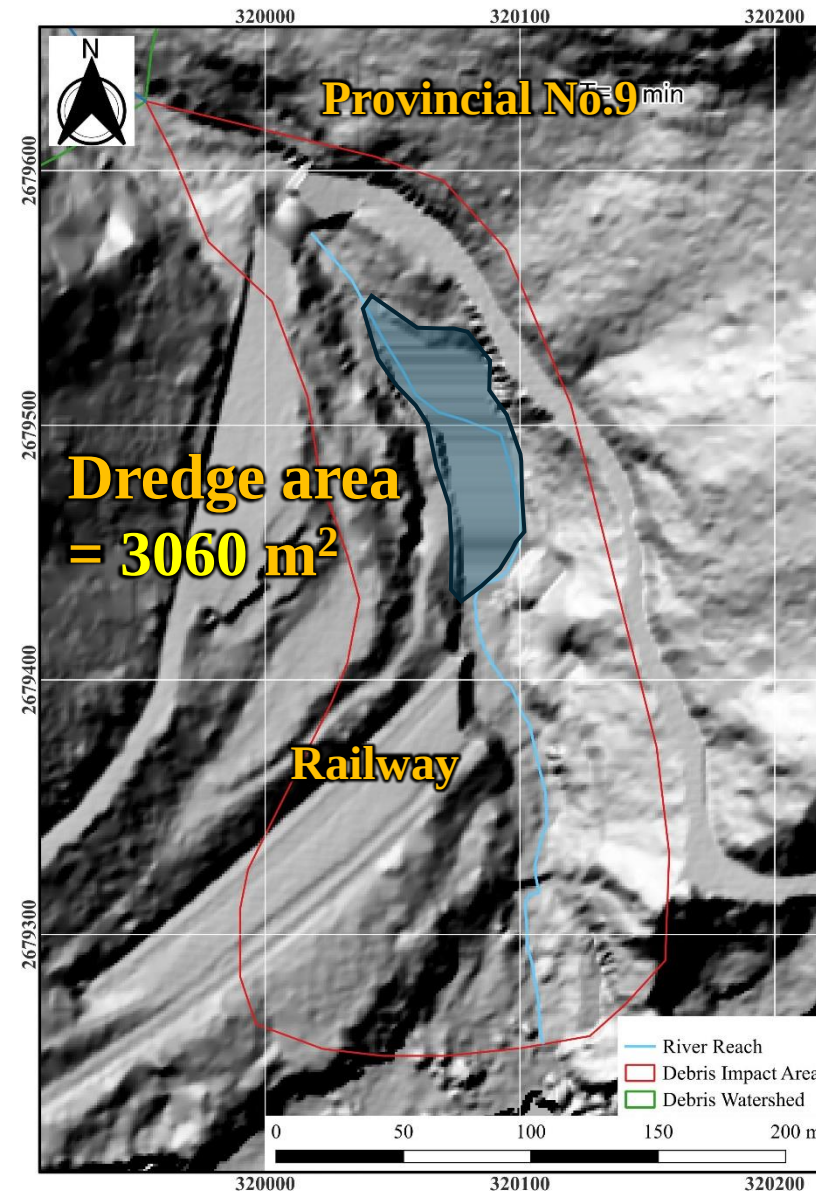
Concentration: 30%

Qpeak: 135 cms

Geometric Mesh: 2m

Condition : riverbed
dredge.

The debris mostly
deposited in original
convex bank and
lowdown the impact.



Numerical

Run 4

Concentration: 30%

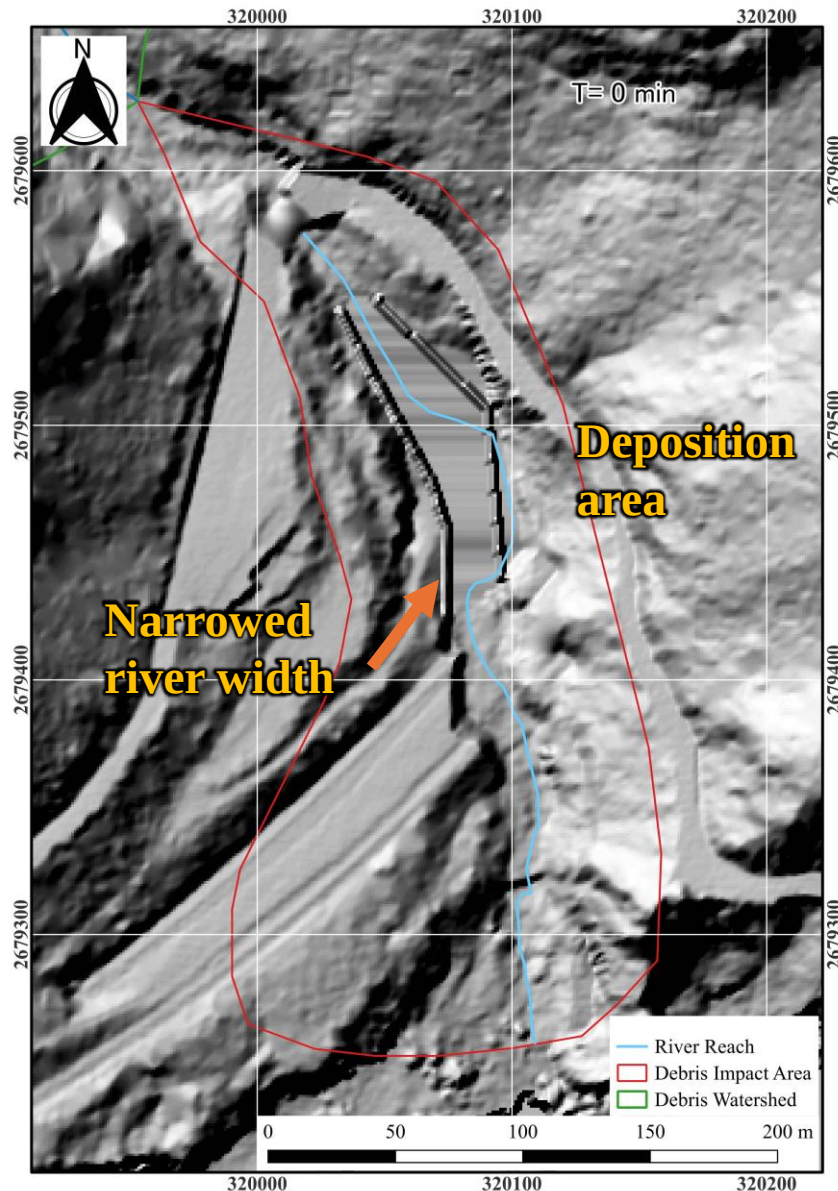
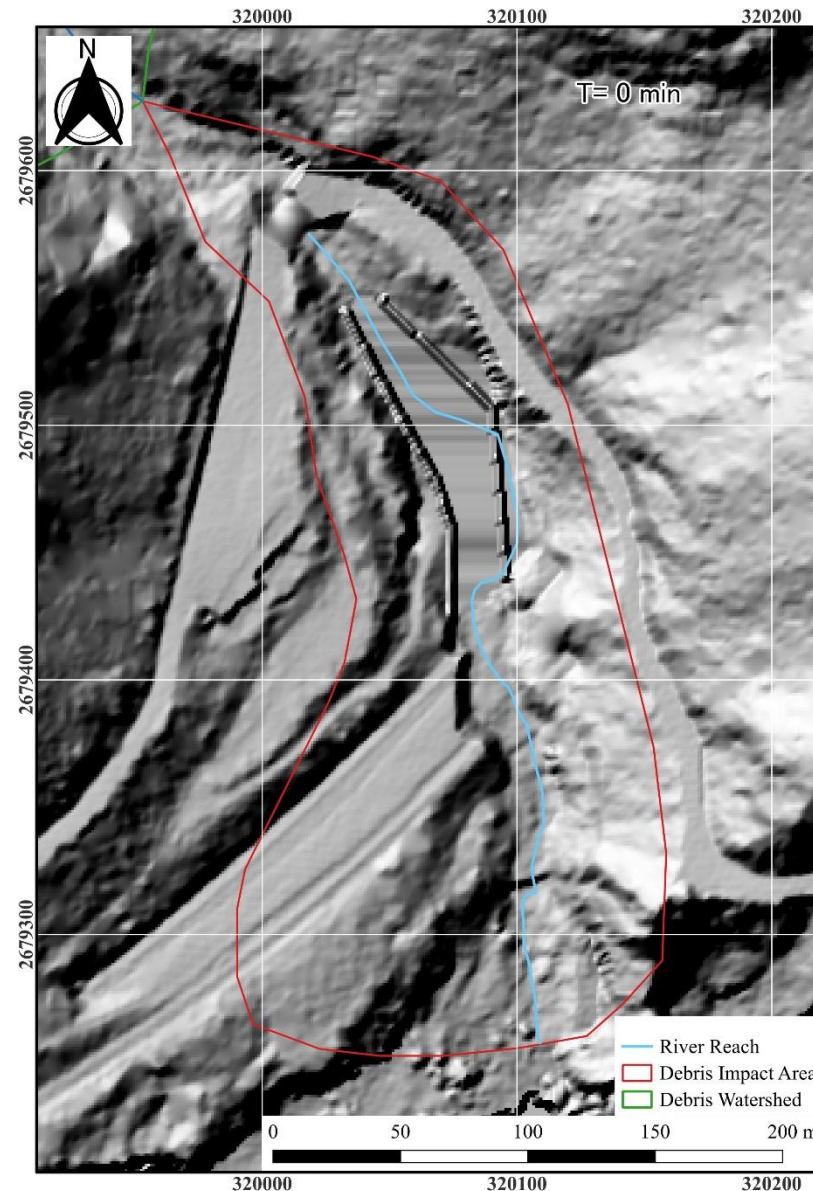
Q_{peak}: 135 cms

Geometric Mesh: 2m

Condition : **embankment**
+ dredge.

The debris deposited in
front of bridge.

The embankment narrow
river width and lead to
deposition increase.





Conclusions

1. Field data indicated that large earthquakes **significantly lower the rainfall threshold** required to trigger **debris flow**.
2. The debris flow is **primarily along the left river bank** due to the **river bend characteristics**.
3. Due to the **narrowed flow width**, the simulation results indicated that sediment was **preferentially deposited upstream of the bridge**.
4. The engineering measures can reduce the debris flow impact but need a **long-term maintenance**.
5. Further research is needed to address the problems of **narrowed flow width, river bend characteristics, and concave erosion**.

Discussion - Further Research

1. In upland area has **lots of new landslides** and that may occur sediment-related disasters in later years.
2. **The hyper-concentrated flow** that may adjust the debris flow **deposits/erodes with flowing sediments**.
3. The concave bank eroded severe than convex bank, which **forced the flow path along left bank**.
4. The **sediment transport capacity reduced** by the **narrowed flow width of bridge**, which result sediment deposits.

報告完畢
敬請指教

Thank you for your listening



農業部農村發展及水土保持署
與您一起打拼



Disaster prevention operation Information



Debris flow and Large-scale landslide

土石流及大規模崩塌防災資訊 <https://246.ardswc.gov.tw>

提供社會大眾土石流及大規模崩塌警戒發布、疏散避難、自主防災社區、重大坡地災害事件、颱風及雨量資訊等相關知識與防災資訊。

BigGIS_巨量空間資訊系統

<https://gis.ardswc.gov.tw>

BigGIS整合全臺範圍之歷年開源衛星、商用衛星、航空照片與UAV正射影像，發布本署與各單位核心圖資，輔助水保業務、災害事件、歷史變遷、地貌描述、科學研究、環境評估等應用，提供其他單位與民眾線上立即使用，達成政府資源開放共享之目標。



Slope Land Info Express 行動水保 <https://serv.ardswc.gov.tw>

提供民眾以地號或是地圖方式查詢土地是否位於山坡地、特定水土保持區、土石流潛勢溪流；同時提供臺灣地區山坡地之降雨沖蝕指數(R)與土壤沖蝕指數(K)之查詢，作為水土保持相關從業人員以水土保持技術規範之通用土壤流失公式(USLE)估算土壤流失量或泥砂生產量之參據。



Disaster Prevention Technology Information

History Photo Platform



歷史影像平臺

<https://photo.ardswc.gov.tw>



整合地圖、影像等技術，透過政府與民間提供影像記錄這片土地。

Research and Technology Development Platform



技術研究發展平臺

<https://tech.ardswc.gov.tw>



推動產官學研跨域技術整合，增進實務經驗及技術支援能力。

Data Platform 資料管理平臺

<https://data.ardswc.gov.tw>



整合本署各項資料對內及對外資料流通供應之單一窗口。



FB社團－水土保持與防災資訊交流



分享水土保持、農村發展、土木、大地、地質及防災等資訊。

