Date of Submission	May 25 2026

IPL Project (IPL-282) Annual Report Form

Period of activity under report
from 1 January 2024 to 31 December 2026

1. **Project Number and Title:**

   IPL-282 Project Title: Intelligent Debris Flow Monitoring System

2. **Main Project Fields**

   (1) Technology Development

   A. Monitoring and Early Warning,

3. **Name of Project Leader**

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Core members of the Project

Louis Ge: Professor, Chairman, department of Civil Engineering, National Taiwan University

Shih-Chao Wei: Assistant professor, Depart of water and soil conservation, Chung-Hsing University

4. **Objectives** (5 lines maximum)

   To have an intelligent debris flow system which can automatically identify debris flow and flood, automatically issue warning through various channel to authorities and affected region. The warning message contains the degree of threat and estimated arrival time and affected region. The system must be mobile enough so it won't take more than one hour to setup everything. This will be a useful tool for any future disaster reduction in regional or watershed scale.

5. **Study Area**

   Yu-Shui River in Kaohsiung County, central Taiwan

6. **Project Duration**

   Three years

7. **Report**

1) Progress in the project (30 lines maximum)

   A debris flow monitoring and warning system was installed on midstream Yu-Sui Stream,

Taiwan. Two mobile system combines CCD and lighting are also established. Mobile system uses 4G as signal transmitting solution. All systems are fully automatic monitoring and warning stations. The cost of each system is less than 20000 USD. All cables are PoE and small electrical car battery is used as power blackout solution or mobile system power. All system can last for more than 6 days without regular electric power supply.

The arrival of debris flow is detected using grey level method with video images. The region of interest for analysis is chosen automatically through program. The arrival of debris flow is detected using energy method for ground vibration signal. Detection time error is less than 2 second.

Flow depth and surface velocity can be determined through image and is calculated using ROI deduction method. Flow depth module is proved to have error less than 2% and surface flow velocity module is tested to have error less than 12%. Tested cases include indoor experiments and real events in the field.

The influence area is determined through DEBRIS-2D numerical simulation of the given river for different amounts of landslides in upstream area. Once debris flow is detected, the affected area according to pre-simulation result can be known and effective warning will be issued.

The system had no fault warning within last three years. There are two successful records. One is in the July 24th, 2024, Typhoon Gaemi debris flows in Yu-Sui River. Successful automatic warning is released for three consecutive debris flow waves. The other successful records are in Chi-Lai River in the August 6th, 2025. Debris flow warning is issued through mobile system.

2) Planned future activities or statement of completion of the Project (15 lines maximum)

This project is completed and the goal of the project is fully achieved.

In the future, this automatic monitoring and warning will be the backbone of a centralized system for all mountain streams and potential debris flow hazardous area in Taiwan. Intelligent monitoring system can be installed in one location within 30min. Once installed, all signals can be viewed through hazard monitoring center hundred kilometers away from monitoring site.

3) Beneficiaries of Project for Science, Education and/or Society (15 lines maximum)

High way in Yu-Shui river mouth and all transportation.

Two elementary school students.

Official debris flow prevention team

If this precision warning system works fine, it will change the future of debris flow prevention work

4) Results (15 line maximum, e.g. publications)

The developed intelligent automatic debris flow warning system uses MEMS sensors and webcams. The system can detect flow depth and surface velocity real-time, and once debris flow is detected automatic timely warnings can be released through different channels.

The system was able to detect debris flow events with a detection time error of less than 1.3 seconds, while flow velocity measurements showed an average error of 7%. The estimation of flow depth achieved an accuracy within 5% of the manually traced values.

This system is installed in Yu-Shui stream and other mobile locations according to rainfall weather forecast. There are two successfully detecting and warning event on 2025 with no false warning issued.

1. Liu KF, Wei SC (2024) Real-Time Debris Flow Monitoring and Automated Warning System. J. Mt. Sci. (2024) 21. https://doi.org/10.1007/s11629-024-9269-5
2. Regmi, S., Liu, K-F and Dahal, K.D. (2024) Rock and Debris Fall Detection Using Total Gray Level Method, Asian Journal of Engineering Geology, 2024, SI-1, 5-6
3. Liu KF, Hsu YC and Chen YC (2025) Deep Sea water pumping pipe destruction due to Undersea debris flows, Geoenvironmental Disasters 12(14) https://doi.org/10.1186/s40677-025-00319-7
4. Yi Jun Huang; Po-Hsu Tsai; C. C. Sung; K. F. Liu (2025) Calibration Technology for a Radar Surface Velocimeter ASCE's J. Hydraulic Engineering. 151 (4) https://doi.org/10.1061/JHEND8.HYENG-14030
5. Liu, K-F and Wei, S. C. (2025) Point monitoring automatic geohazard warning system, Asian Journal of Engineering Geology, special issue, SI-2, 1-4

Note:

1) If you will change items 2-6 from the proposal, please write the revised content in Red.
2) Please fill and submit this form to ICL Network <icl-network@landslides.org>
3) Reporting year must be one or two years (Maximum).