SATLAB® GEOSOLUTIONS

Case Study

Apus-MX LiDAR
Empowering Debris Flow Disaster Investigation

Introduction

Debris flows are most frequent in summer and autumn. During this period, increased rainfall, heavy storms, and prolonged precipitation provide abundant water, triggering debris flow events.

In mountainous areas, ice and snow melt further contribute to the risk. Warmer temperatures lead to increased runoff, which destabilizes slopes and increases the likelihood of debris flows.

These events cause significant economic losses and pose serious threats to human safety and the environment. Conducting debris flow investigations helps understand their formation conditions, assess potential risks, determine suitable locations for mitigation projects, and protect local ecosystems.

Project Background

Chengdu, Sichuan Province, China, the flood season brought multiple rounds of heavy rainfall. As a result, several geological hazard-prone areas were hit by debris flows.

Following local authorities' requirements, a survey was conducted. The goal was to assess geomorphology, surface deformation, vegetation coverage, and hydrological features. This would help evaluate disaster risks, predict future changes, and support early warning and prevention efforts.

This project covers two survey areas:

- Area 1: 0.5 km², elevation ranging from 1,400 to 2,300 meters.
- Area 2: 0.35 km², elevation ranging from 1,150 to 1,450 meters.

Both survey areas are predominantly covered by dense primary forests with multi-layered vegetation, including thick undergrowth and low-lying shrubs.

Figure1 Areas to be surveyed

Challenge

Debris flows often occur in mountainous and canyon regions with complex terrain and unpredictable weather. These areas have poor accessibility and harsh environments, making traditional on-site surveys both risky and prone to errors.

The survey area consists of high-altitude forested mountains with dense vegetation. Data transmission may be affected by terrain constraints and interference, requiring advanced technical solutions and high-performance survey equipment.

The available takeoff points have a significant elevation difference of nearly 1,000 meters from the highest point of the survey area. A multi-rotor UAV carrying LiDAR must ascend at least 1,000 meters in a single flight to capture complete survey data.

Solution

To meet the requirements, we deployed the drone and LiDAR technology. The equipment used included the SatLab Apus-MX UAV LiDAR system and a DJI Matrice 350 RTK drone. These were chosen for their ability to cover large areas quickly and operate safely. A ground-proximity flight strategy was employed, with a total of three flight missions to complete the data acquisition for the entire survey area.

Figure2 SatLab Apus-MX mounted on the DJI M350

Figure3 Flight plan of the acquisition

Project Parameters

1. Equipment

Apus-MX UAV LiDAR

DJI M350 RTK

CORS Network

2. Software

Sat-LiDAR

Specification

Unit	System Accuracy	H: 5cm@300m V : 5cm@300m
	Range Accuracy	1.5cm/0.5cm@150m
	Measuring Range	1200 m@60% ref
	Field of View(FOV)	80°
	Returns	Up to 8
POS Unit	Position Accuracy(pp)	0.01 m RMS Horizontal 0.02 m RMS Vertical
	Attitude Accuracy(pp)	0.019° Heading 0.006° Roll/Pitch
	IMU Frequency	500 Hz
Camera Unit	Effective Pixel	45 Mega Pixels (8129*5468)
	Focal Length	18mm
System	Weight	1.55kg
	Temperature Range	-20℃~+50℃(operation) -20℃~+65℃(storage)
	Protection Class	IP64
	Data Storage	SSD 1 TByte (expandable 512 GByte SD Card)
	Data Transmission Mode	Type-C, up to 160M/S
	Mounting Interface	DJI SKYPORT
	UAVS	Designed for DJI M300/M350

Table 1 Apus-MX UAV LiDAR Specification

Technical route

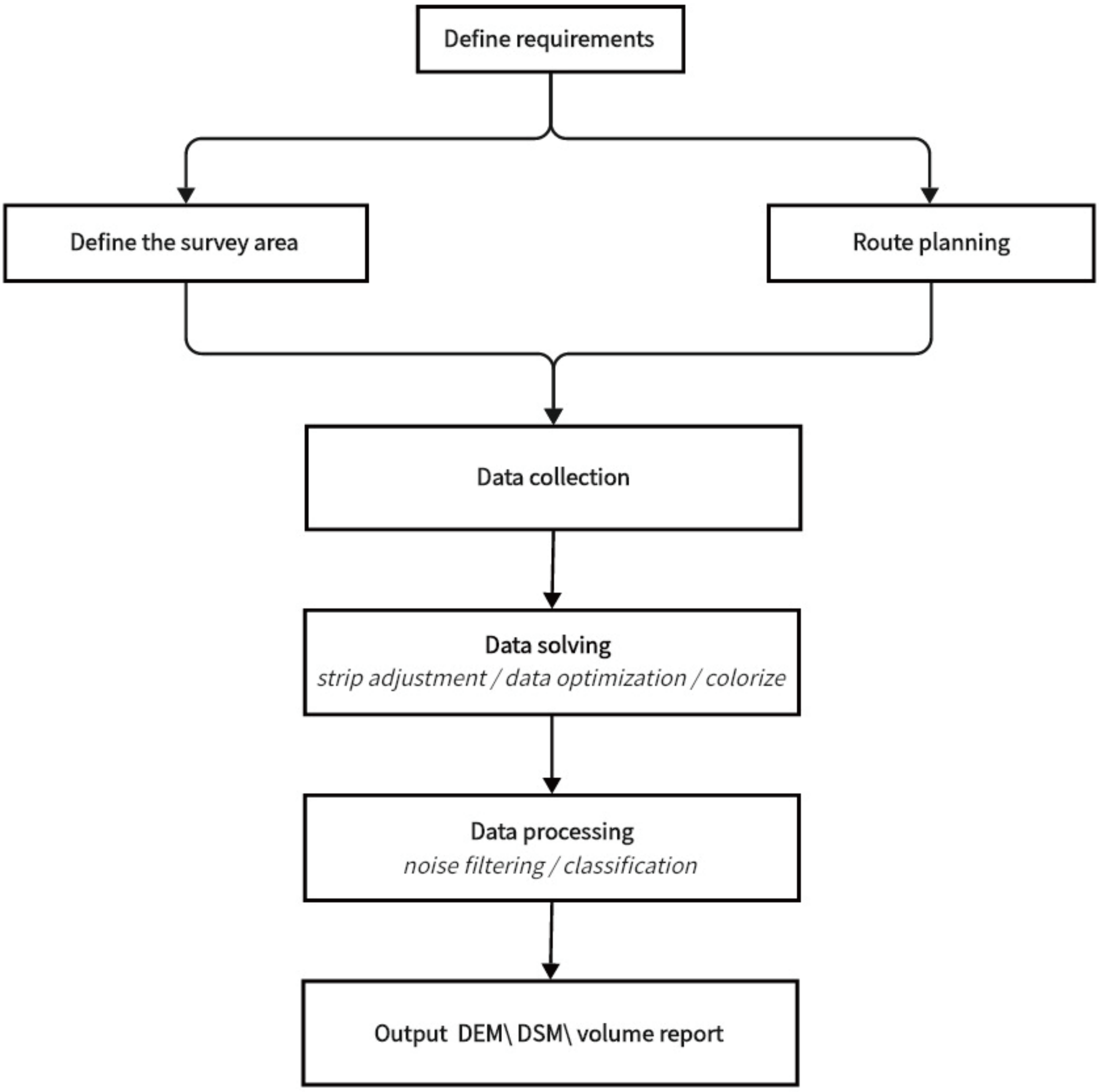

Figure4 Technical route

Sat-LiDAR software can automatically solve the collected point cloud data, outputting high-precision color point clouds. By filtering the point cloud data, ground points and their terrain feature classification data in the mining area can be obtained, which can then be used to produce DEM, DSM, contour lines, and other results. Additionally, the software supports multi-phase volume calculation of the mine using TIN grid. It also includes features such as data accuracy inspection, strip adjustment, noise filtering, classification, and point cloud tiling processing.

Results

The project results data: overall point cloud density: **an average of 127 points/square meter**, ground points under vegetation are continuous and dense, and the **point cloud accuracy is better than 2cm, meeting the needs of this customer project.**

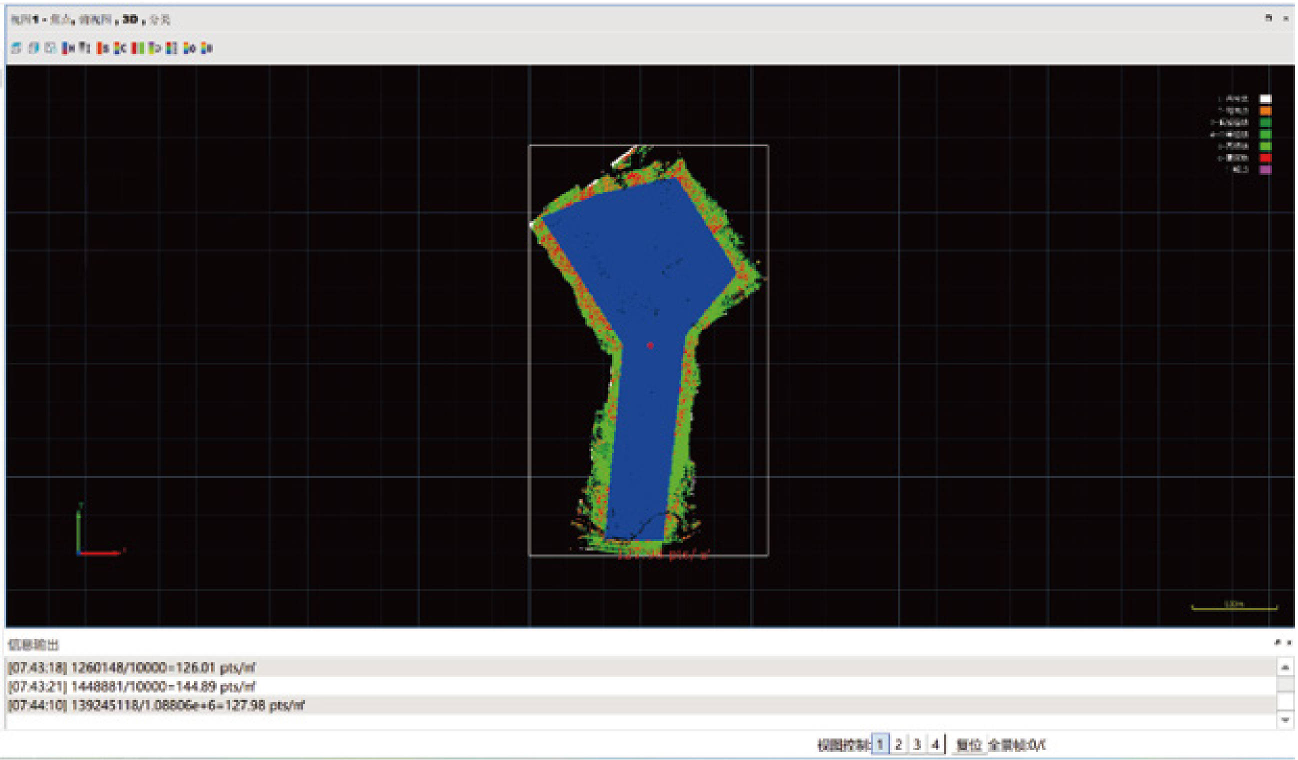

Figure5 Point cloud density

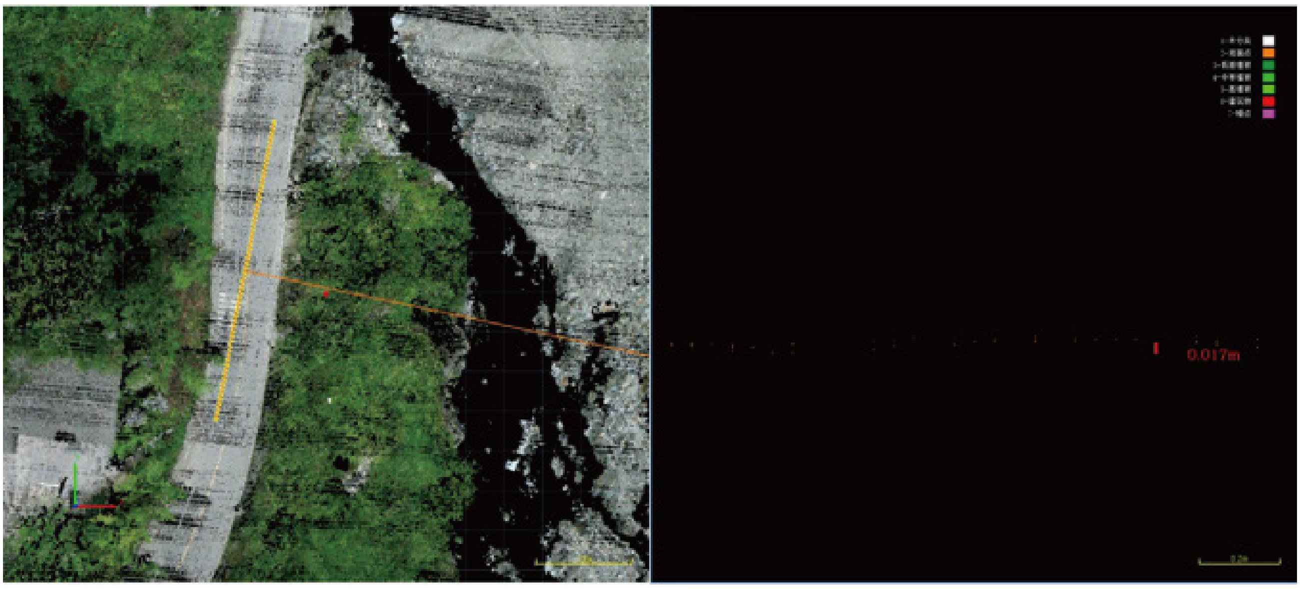

Figure6 Point cloud thickness

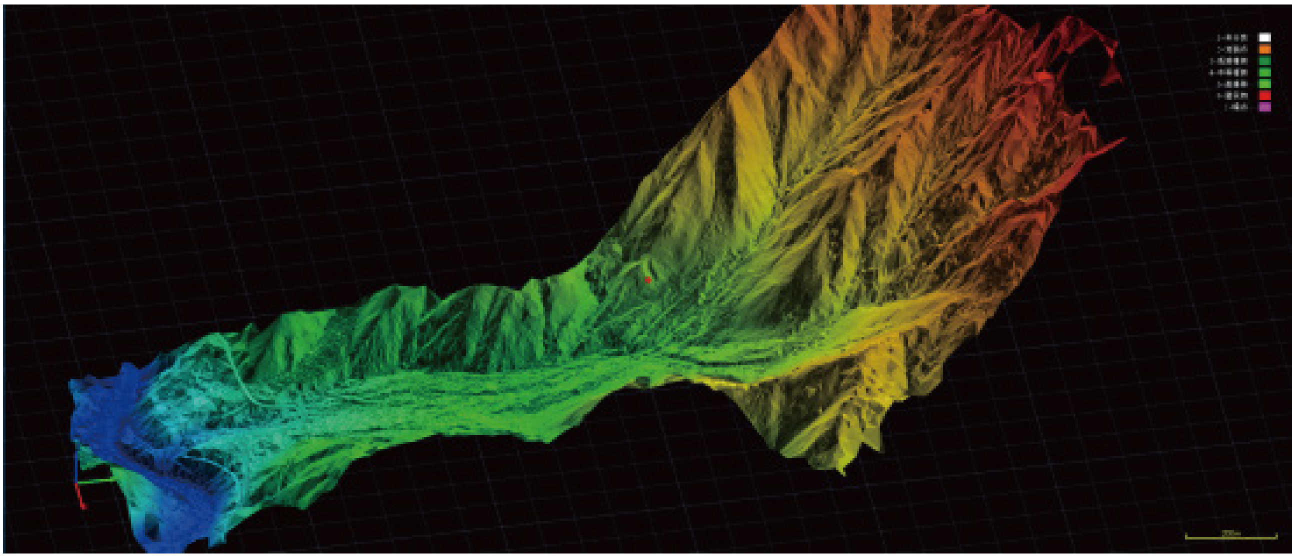

Figure7 Point cloud result

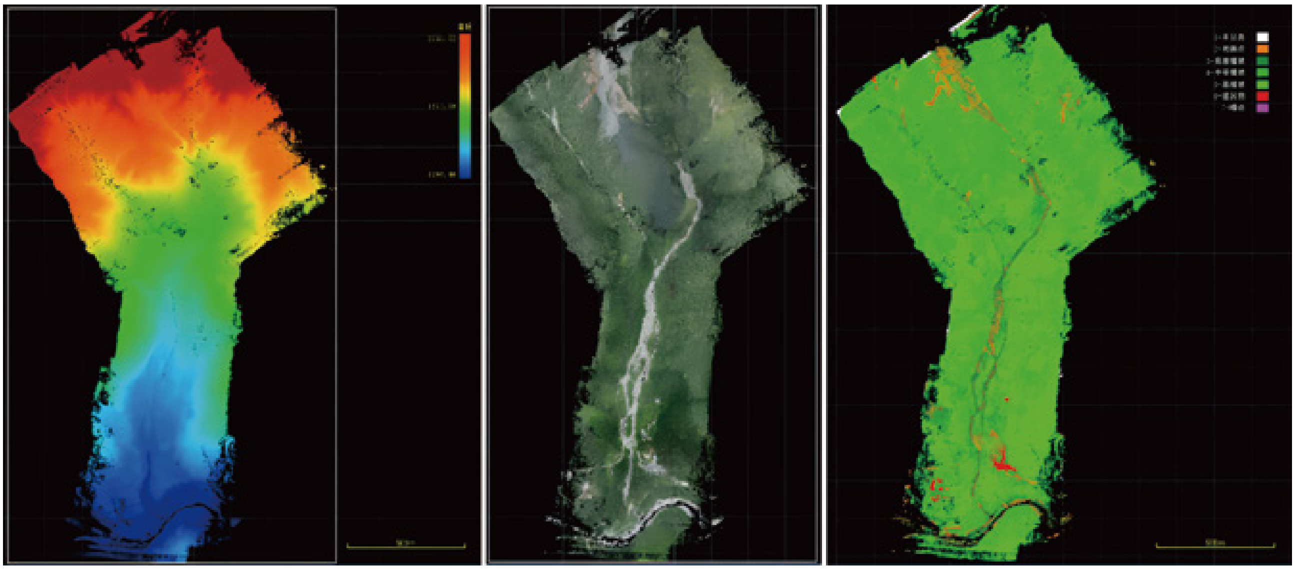

Figure8 DEM result

Figure9 DOM result

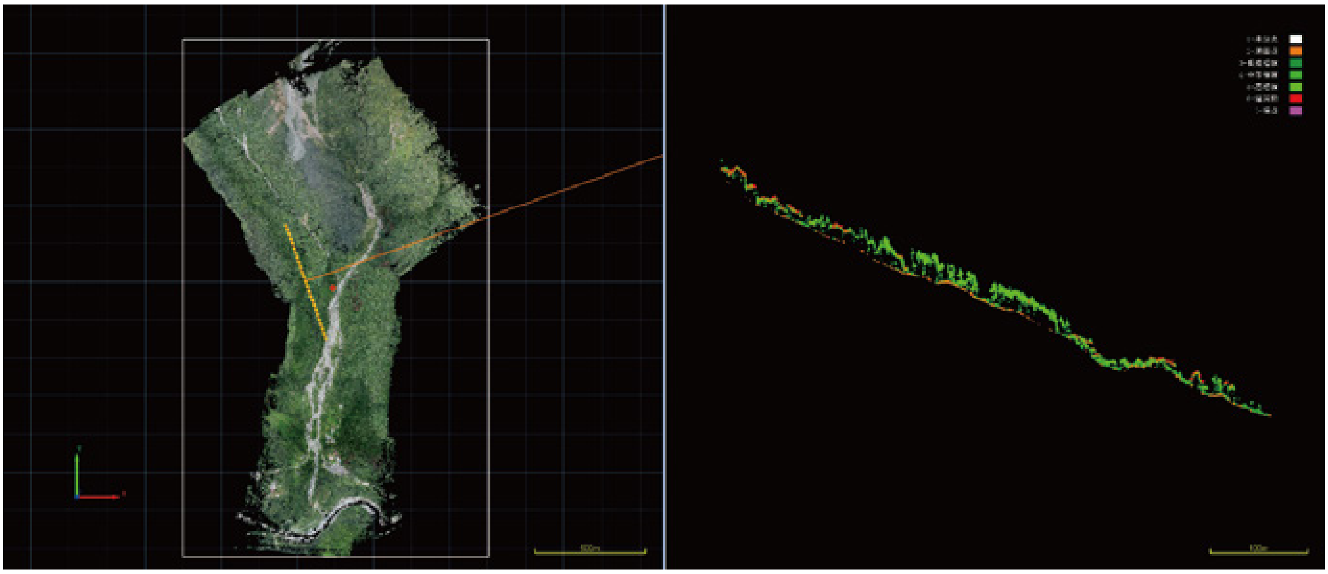

Figure10 Vegetation penetration effect

Conclusion

The Apus-MX UAV LiDAR System used in this project is compatible with the DJI drone system. It collects data in the debris flow disaster area efficiently and without contact. **The system can measure up to 1200 meters at a 60% reflectivity and has a laser pulse rate of 550,000 shots per second.** This improves work efficiency and ensures complete coverage of the survey area with high point cloud density. Even in dense vegetation, it accurately captures ground points.

With SatLab Sat-LiDAR full-process data processing software, the system can generate various terrain results with a single click. It provides customers with one-stop data services. The data analysis offers accurate and reliable support for investigating geomorphic features, surface deformation, vegetation coverage, and hydrological characteristics in the debris flow disaster area.