



Chinese-Russian collaboration in debris flow research in 2008-2012: review of results

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Before

Prof. S. Fleishman (1912-1984), MSU.

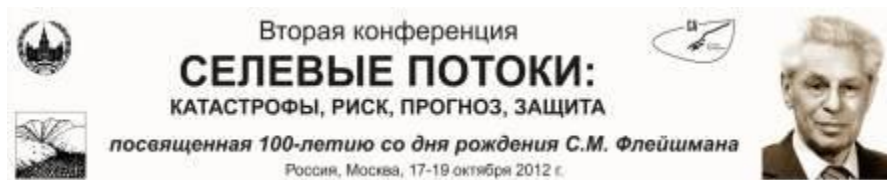


Two his books translated to Chinese in IMHE, CAS:

- *Debris Flows and Design of Roads in Areas Affected by Them, 1955*
- *Debris Flows, 1978*



Now we celebrate his 100th anniversary.



Before

Meetings on debris-flow conferences:

- First International Conference on Monitoring, Simulation, Prevention and Remediation of Dense and Debris Flow (Rhodes, Greece, 2006)
- 4th International Conference on Debris-Flow Hazards Mitigation: Mechanics, Prediction, and Assessment (Chengdu, China, 2007), and field trip to Dongchuan Station



Collaboration Agreement

Prepared during the visit of F. Wei and
K. Hu to Moscow in January-February 2008



罗蒙诺索夫莫斯科国立大学地理系主任
俄罗斯科学院通讯院士

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中国科学院水利部成都山地灾害与环境研究所所长, 教授

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科学研究合作协议

中国科学院水利部成都山地灾害与环境研究所所长邓伟教授代表中国科学院水利部成都山地灾害与环境研究所(下面简称IMHE)基于研究所的规章,与罗蒙诺索夫莫斯科国立大学地理学系主任、俄罗斯科学院通讯院士Kasimov Nikolay Sergeevich代表罗蒙诺索夫莫斯科国立大学地理学系(下面简称FG MSU)基于系的法规,共同达成以下协议。

1. 协议的目的

本协议的目的是在IMHE和FG MSU间开展合作研究,合作解决双方专家共同关注的重基础和应用性科学问题。双方主要致力于中国和俄罗斯的泥石流灾害评估、泥石流性质和动力学行为的研究,开展冰川泥石流预测、预警和危险分区的方法研究,研发泥石流、滑坡、洪水和其他山地灾害的减灾与防护技术。FG MSU在研的与未来研究相关的项目包括“自然和人为灾变过程的分析、评估和建模”。IMHE在研的与未来研究相关的项目包括“泥石流垂直流速观测和实验研究”、“泥石流预报系统研制”。

2. 双方的义务

- 2.1 在本协议中,双方一致表达了下列意向:
 - 2.1.1 开展与本协议第1部分指定内容相关的野外联合考察、实验研究和学术讨论会。
 - 2.1.2 在泥石流研究方面举行双方的咨询、研究生和研究人员的培训。
 - 2.1.3 在双方同意的基础上,发表共同合作的出版物。
 - 2.1.4 交换泥石流的资料和信息,包括在俄罗斯和中国出版的定期科学期刊上发表的论文。
 - 2.1.5 若未经双方事先同意,IMHE和FG MSU均不得将合作研究期间从对方获得的资料进行出版、分发或转交给第三方。
- 2.2 本协议中双方的合作不是商业性活动,也不从中索取获利并将其在双方中进行分配。

Projects



- Hazard assessment and risk zoning for debris flows in Russia and China (2008-2010)

The project goal is to study evolution of debris flow activity, assess debris flow hazard and risk in stage of modern climate change in different environment in the Central Caucasus (Russia) and in mountains in Southern China. We conducted joint field investigations in Mt.Elbrus area and Mt.Gongga area (Hengduanshan, Sichuan Province) to study glacial debris flows, in Longmenshan Mts. (Sichuan Province) to study rain and barrier lake induced debris flows. We have investigated phenomena of simultaneous formation of debris flows in Longmenshan Mts. after the Wenchuan earthquake and found that a lower precipitation threshold is required to trigger the debris flows. We noticed that mobility of debris flows in this region is significantly lower than in other parts of Southern China and the Caucasus. We conducted surveys and compiled DEMs for key areas in Adyl-su and Gerkhozhan-su valleys in the Central Caucasus, Moxi, Mozigou and Tongkou valleys in China. Bathymetric survey of Tangjiashan barrier lake formed after the Wenchuan earthquake 12.05.2008 was conducted first time. For these areas we obtained data required for further debris flow modeling, hazard assessment and risk zoning. To compare debris flow activity in different environment we have analyzed morphometry of 3 debris flow catchments: Baksan, Chapinghe and Shitingjiang. Shear force-based measurement for internal velocity of debris flow were organized at Dongchuan research station. We continued monitoring of glacial debris flow initiation zones (outburst type – Bashkara lakes, proglacial lakes on Mt. Elbrus slopes, non-outburst type – Gerkhozhan-su) in the Central Caucasus. We have developed a new 3D model for debris flows and slope failures, called DEBRIS (Digital Elementary Balls & Relief Interaction Simulation). Using this software we simulated debris flows in Gerkhozhan-su (Russia) and Moxi (China) valleys, and Yigong landslide in Tibet (China). Possible glacier lake outburst flood in Adyl-su valley (Russia) was simulated using FLO-2D software. Basing on hydrodynamic modeling we obtained flow depth, velocity, area and conducted a hazard assessment for Adyl-su valley. A method for regional forecast of debris flow activity in a region with uniform debris flow formation conditions has been proposed on the basis of the experience of long-term debris flow monitoring. We have compiled results of research of glacio-volcanic and nival-volcanic lahars in Kamchatka peninsula.

Projects



- Mountain disasters assessment and forecast in the region influenced by the Wenchuan earthquake (2008-2009)



- Examination of key parameters for large-scale debris flows induced by earthquakes and volcanism: implications for hazard assessment (2012-2013)



- Bilateral seminar on Debris Flows: Movement Behaviour, Numerical Simulation and Hazard Assessment (2012)

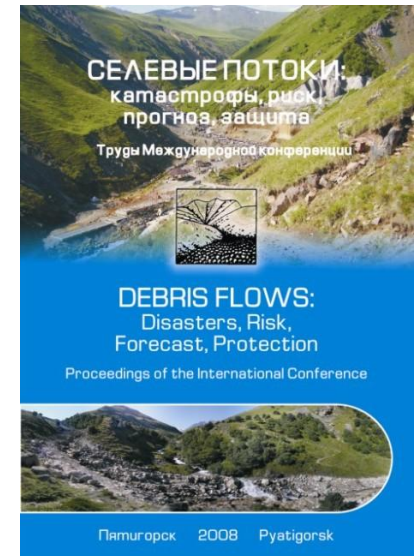
Visits, expeditions, workshops

- 2008, Moscow, preparation of agreement, F. Wei and K. Hu
- 2008, Pyatigorsk and Mt. Elbrus (Caucasus), Intl. Conf. on Debris Flows: Disasters, Risk, Forecast, Protection, F. Wei, K. Hu, H. Xie, Y. Zhang, S. Wang
- 2008. Kolka Glacier, Caucasus (expedition), F. Wei and K. Hu
- 2008, Chengdu, Wenchuan earthquake zone and Mt. Gongga, S. Chernomorets, K. Aristov
- 2009, Moscow and Vladimir (workshop), F. Wei and Z. Cheng
- 2009, Chengdu, Beichuan, Yingxiu (fieldwork), S. Chernomorets, A. Petrasov
- 2009, Caucasus (expedition), K. Hu, X. Chen, P. Su, Y. Jiang
- 2010, Moscow (modelling workshop). K. Hu, H. Yang, G. Zhou

Visits, expeditions, workshops

- 2010, Wenchuan earthquake zone (fieldwork), D. Petrakov, I. Seynova, I. Krylenko, V. Mikhailov, V. Kidyaeva
- 2011, Chengdu (preparation of project proposals), S. Chernomorets and D. Petrakov
- 2012, Chengdu and Wenchuan earthquake zone (observation of debris flow control measures), S. Chernomorets and V. Karavaev
- 2012, Dujiangyan (bilateral workshop), S. Chernomorets, D. Petrakov, I. Seynova, I. Krylenko, E. Zaporozhchenko, N. Kazakov

Pyatigorsk: debris flow conference (2008)



Caucasus: post-conference field trip (2008)



The 2002 Kolka Glacier disaster site, Caucasus (2008)



Fieldwork in Beichuan (2008)



Workshop in Moscow and Vladimir (2009)



Wenchuan earthquake zone (2009)



Wenchuan earthquake zone (2009)



Moxi River basin and Tangjiashan, 2009



Kabardino-Balkariya, Caucasus (2009)



Kabardino-Balkariya, Caucasus (2009)



Gerkhozhan valley, Caucasus (2009)



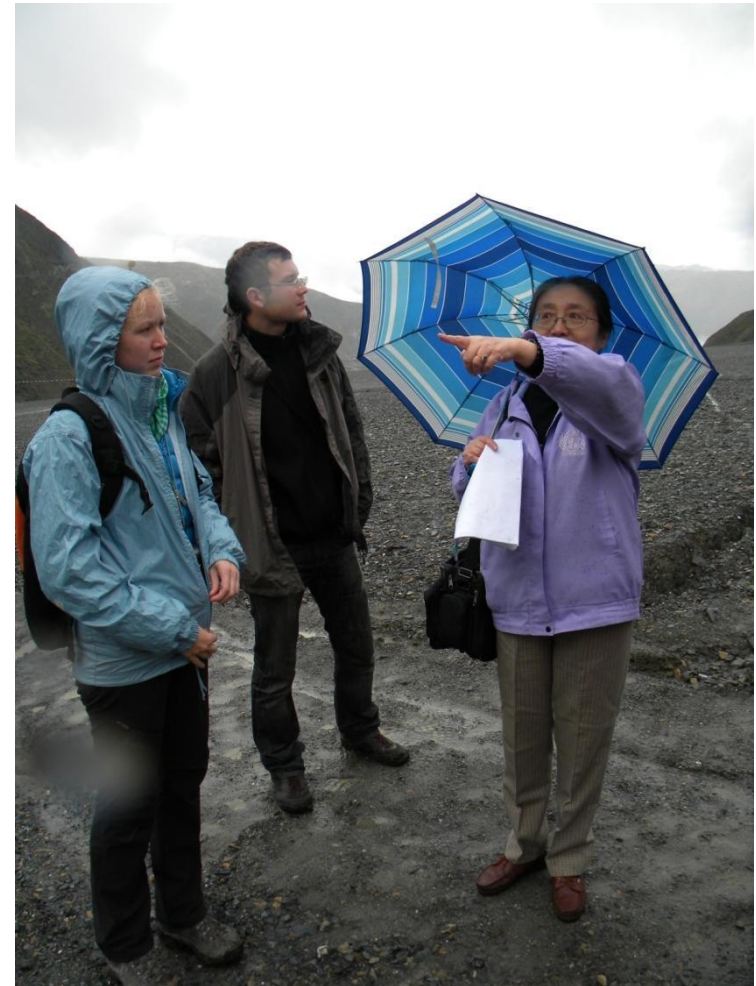
Moscow University: presentation about 2010 Zhouqu disaster (2010)



Project meetings in Moscow (2009-2010)



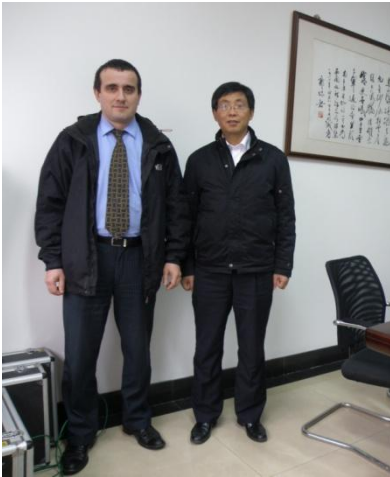
Earthquake zone (2010)



Bathymetry of Tangjiashan Lake (2010)



Chengdu and Longxi (2011)

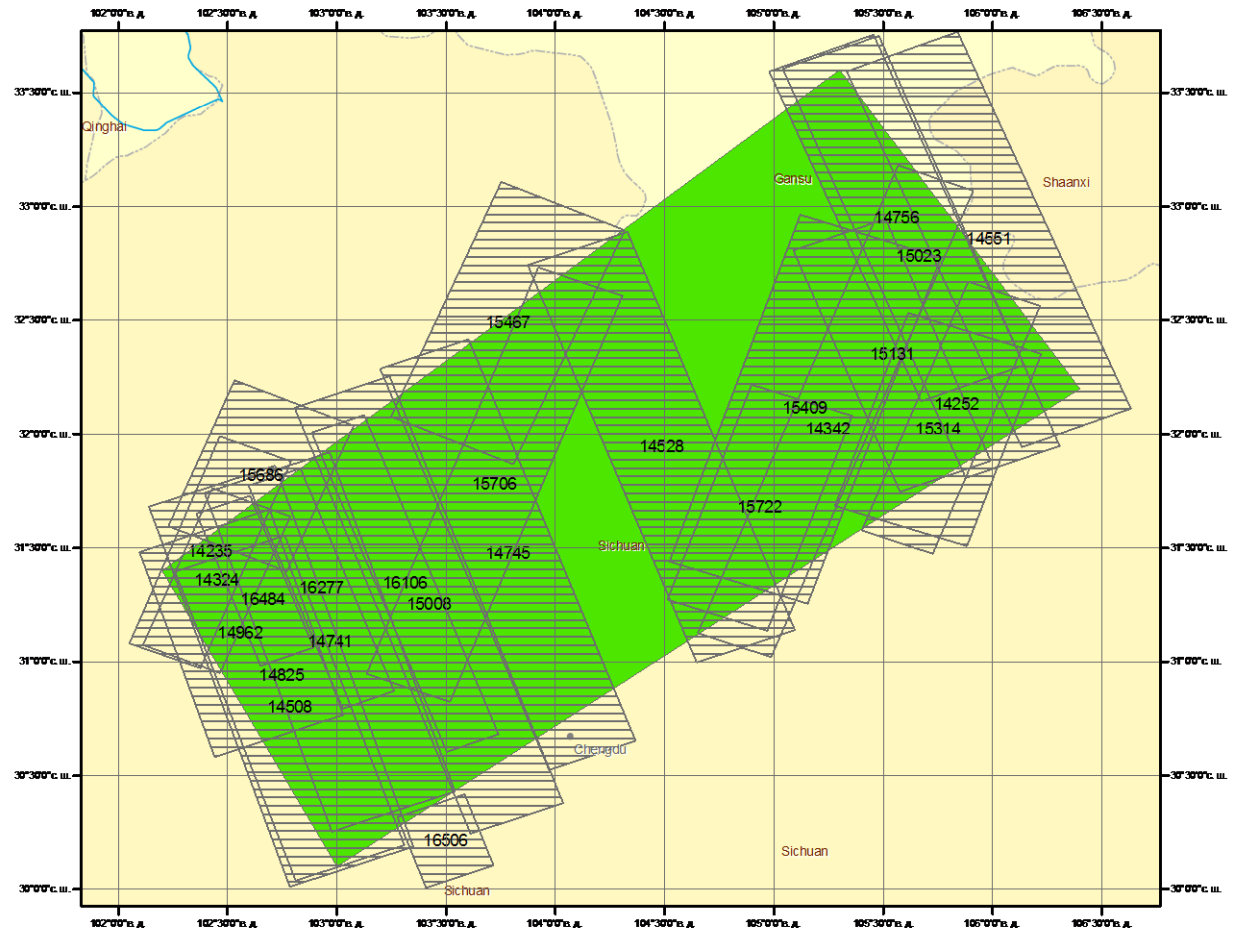


Observation of debris flow control measures in Zhouqu and Qinping (2012)

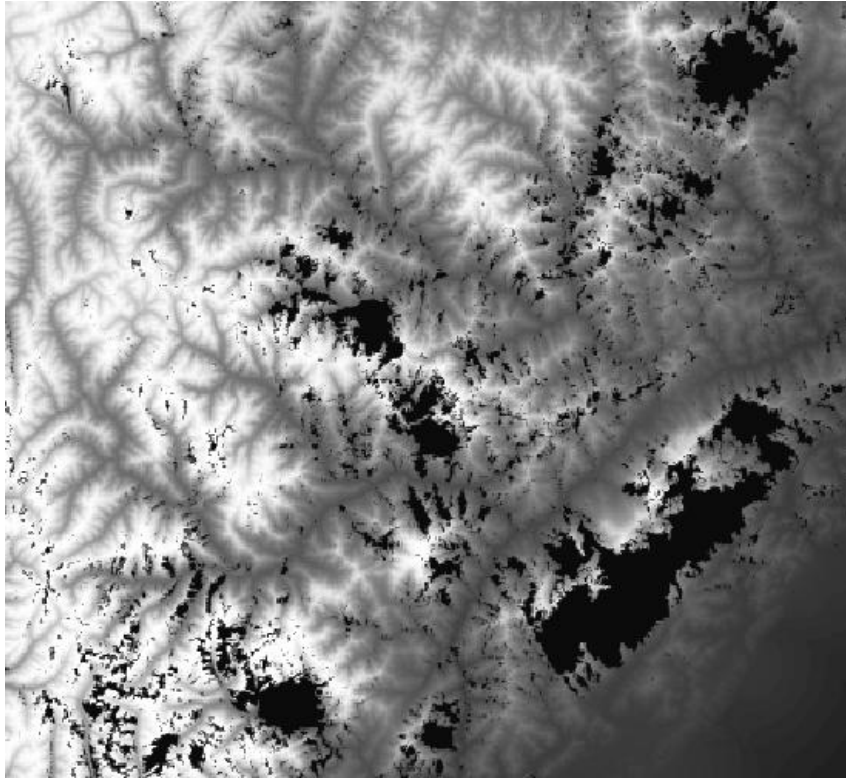


Selected results

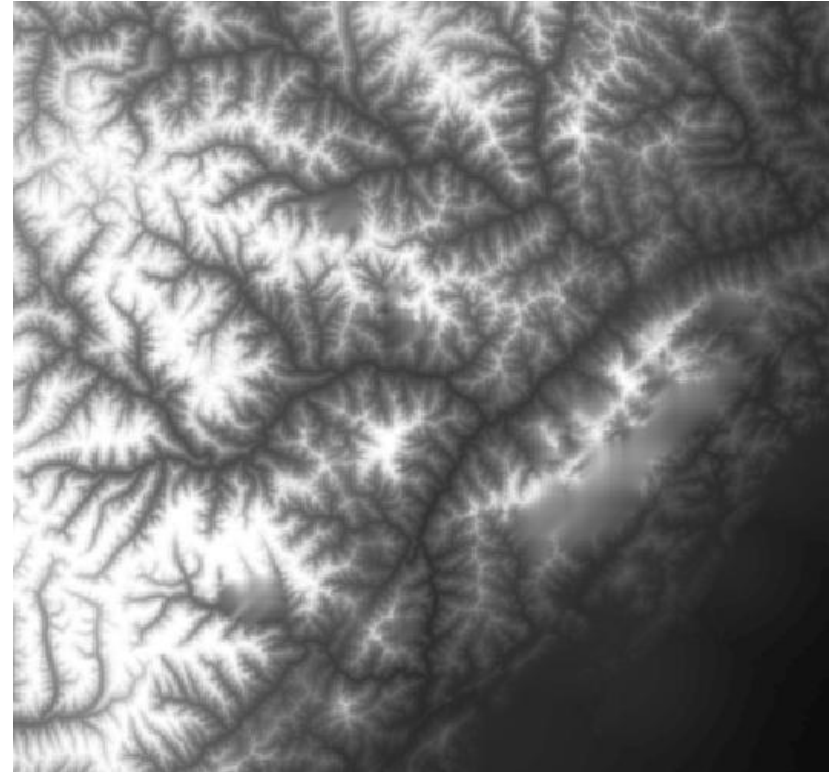
Remote sensing: Resurs-DK satellite survey of Wenchuan earthquake zone



Remote sensing: patching holes in SRTM DEM



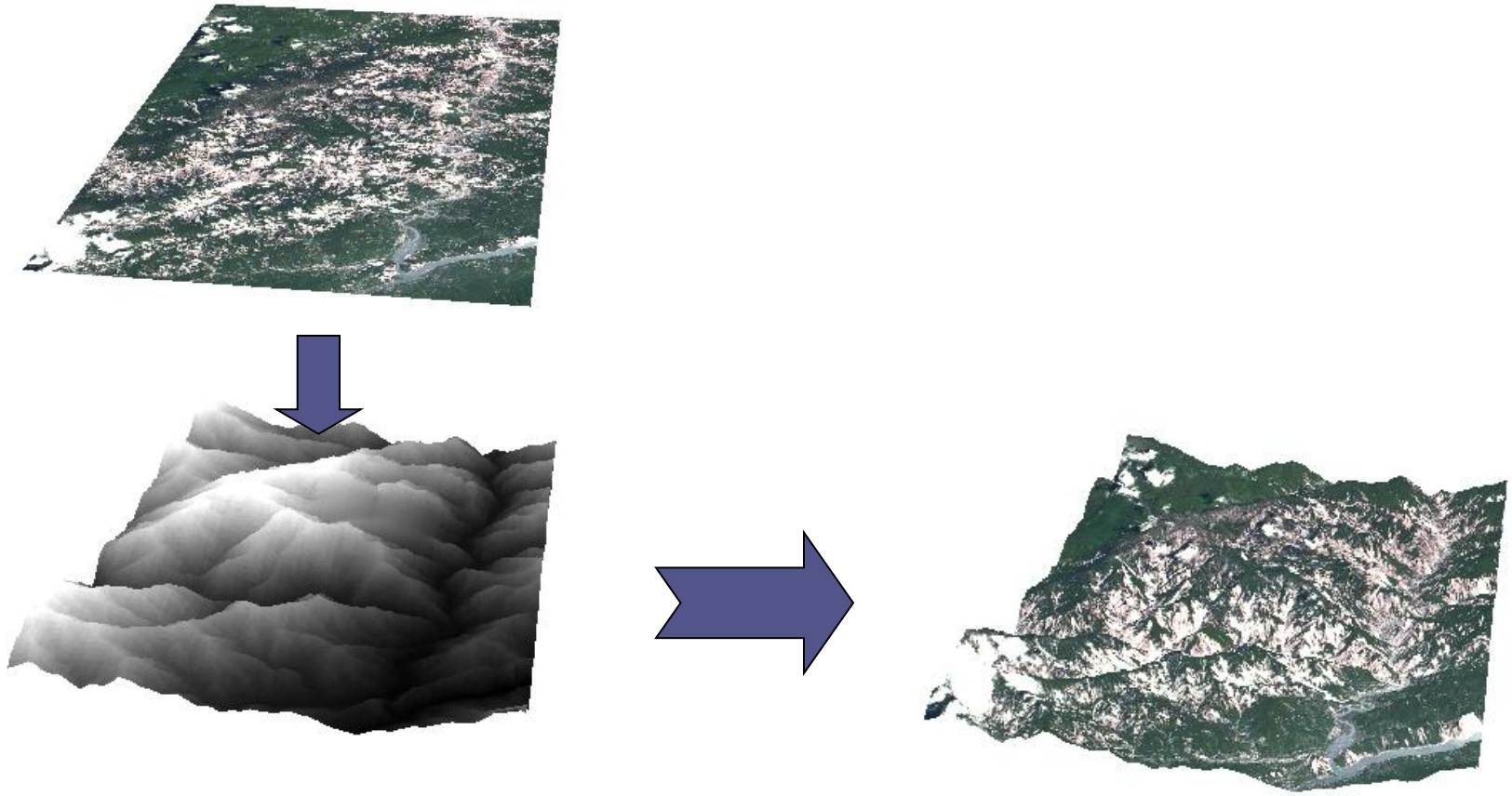
BEFORE



AFTER

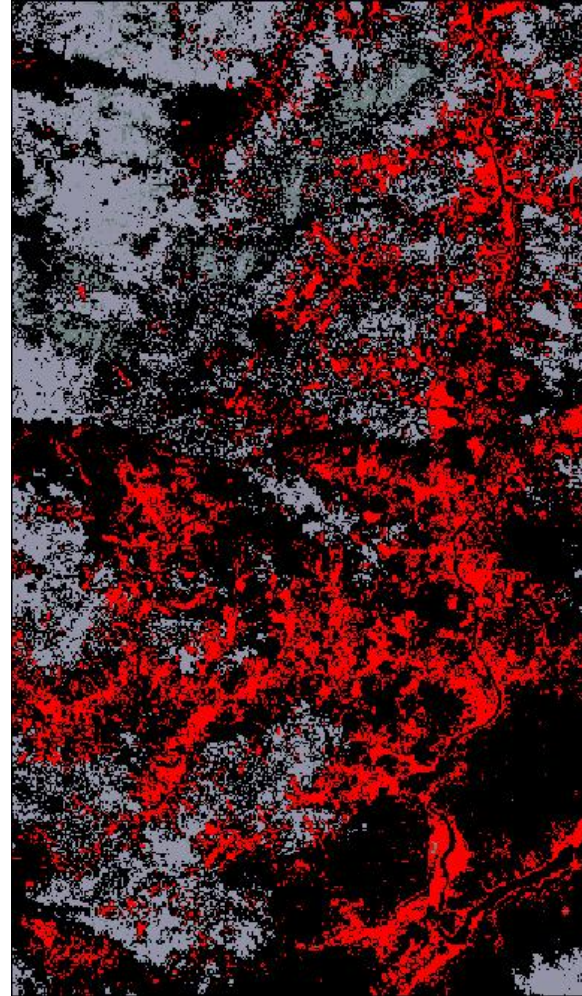
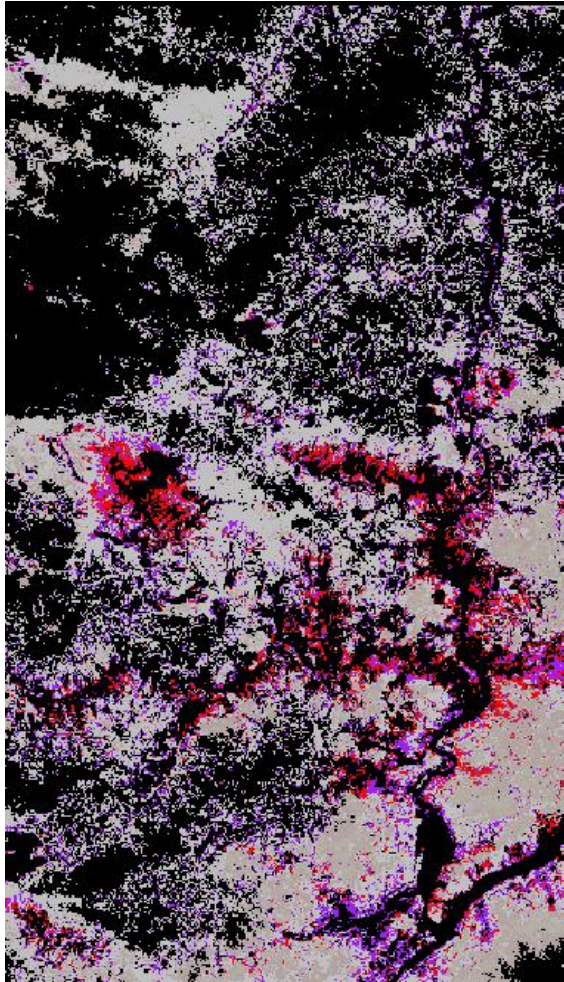
* Executed in 3 DEM (Visualization Software LLC)

Remote sensing: orthorectification

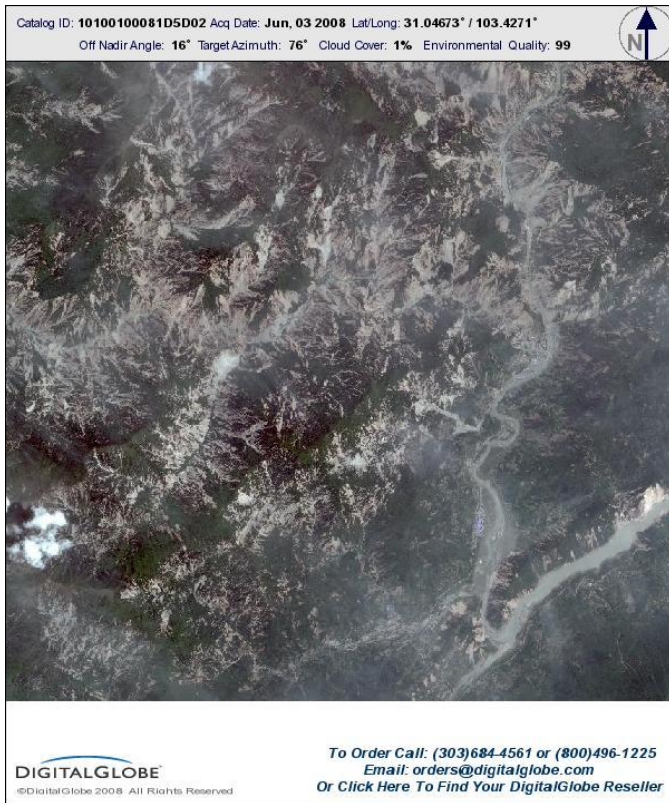


Orthorectification process helps to eliminate terrain distortion

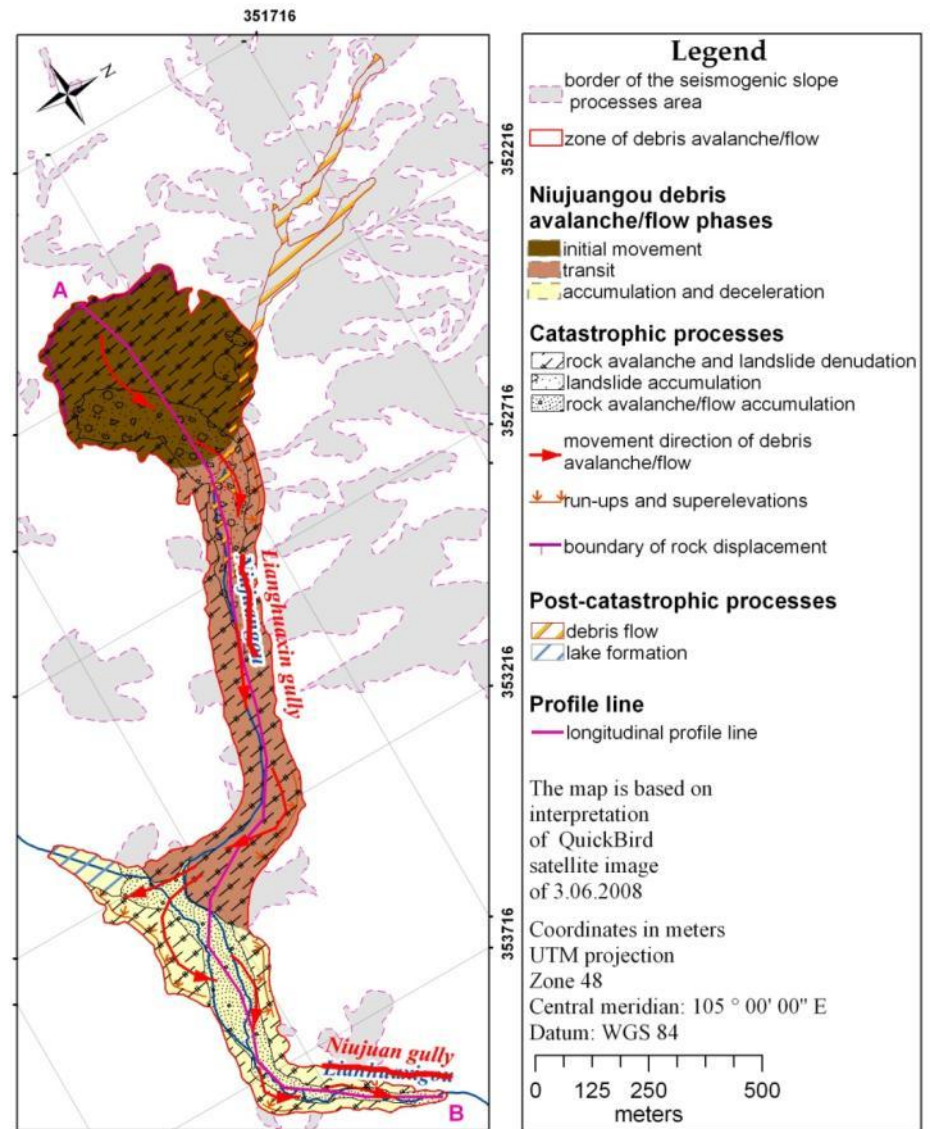
Satellite image interpretation



3D modelling

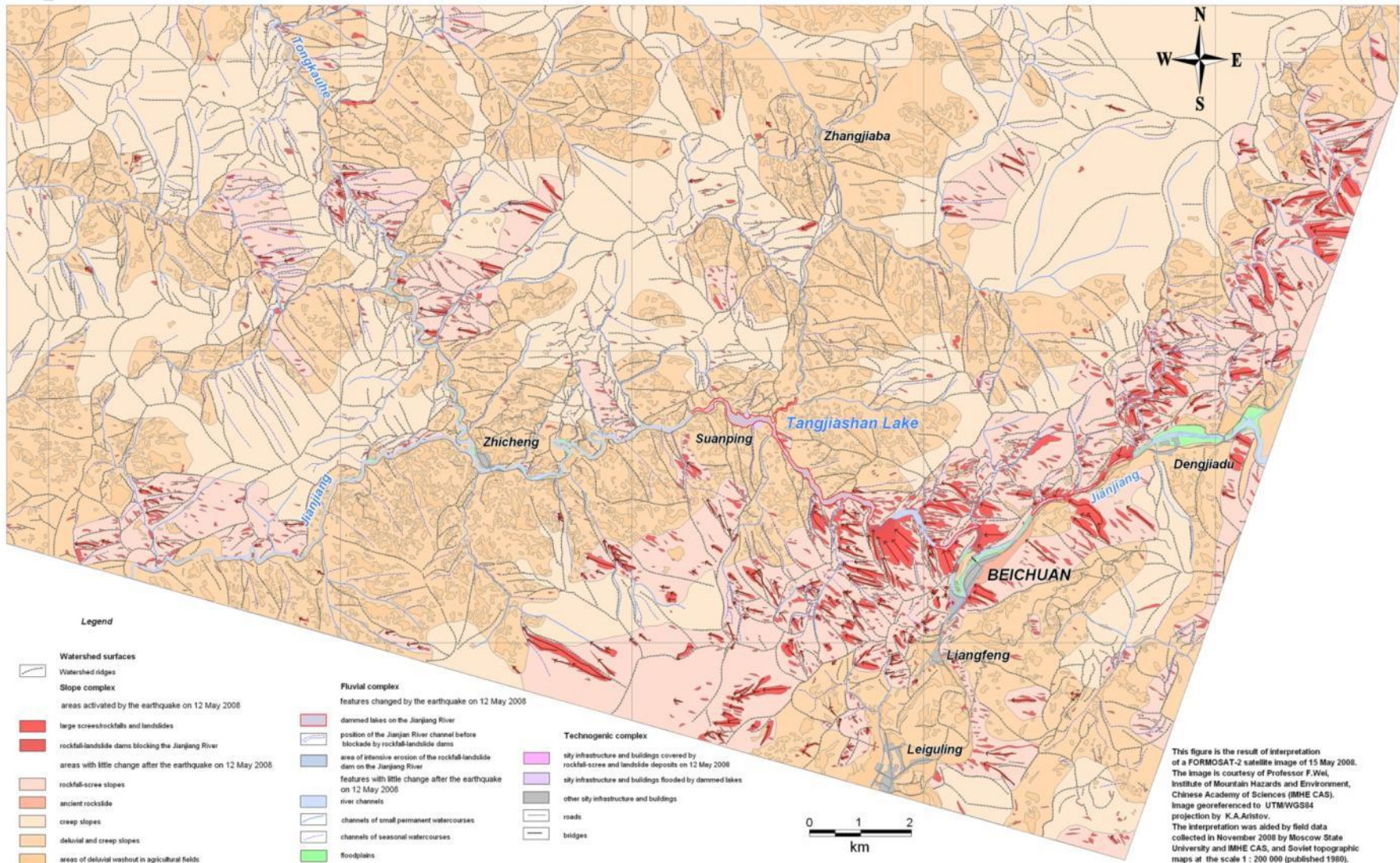


Mapping: Niujuan



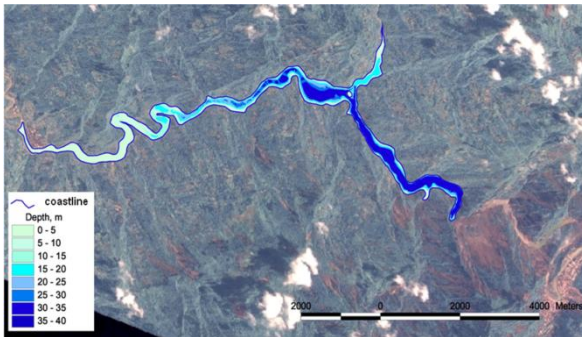
Mapping: Beichuan

MORPHODYNAMIC SETTING AROUND BEICHUAN CITY AFTER THE EARTHQUAKE ON 12 MAY 2008

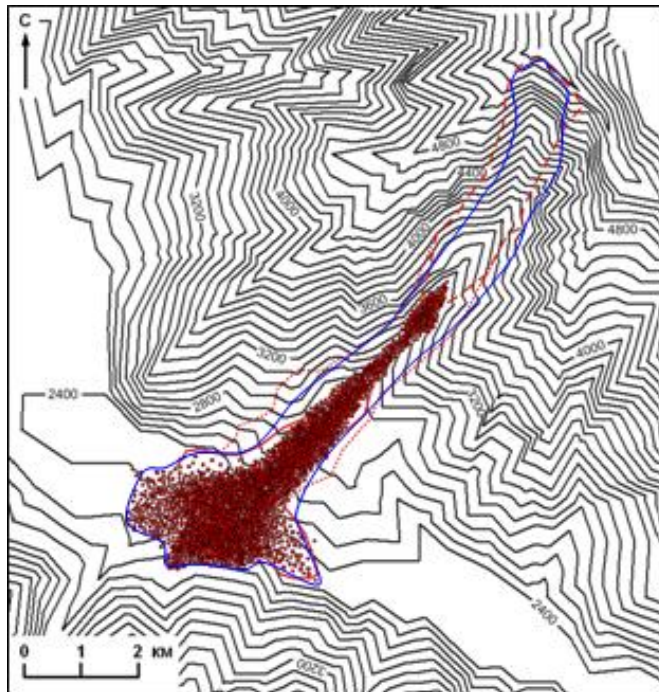


This figure is the result of interpretation of a FORMOSAT-2 satellite image of 15 May 2008. The image is courtesy of Professor F. Wei, Institute of Mountain Hazards and Environment, Chinese Academy of Sciences (IMHE CAS). Image georeferenced to UTMWGS84 projection by K.A. Aristov. The interpretation was aided by field data collected in November 2008 by Moscow State University and IMHE CAS, and Soviet topographic maps at the scale 1 : 200 000 (published 1980).

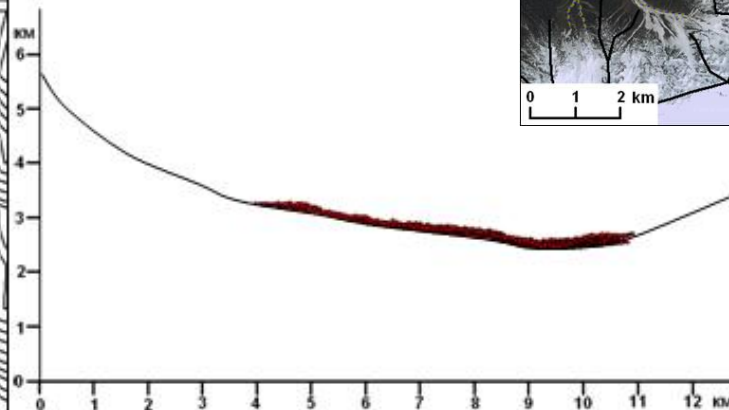
Tangjiashan Lake: bathymetry and potential outburst modelling



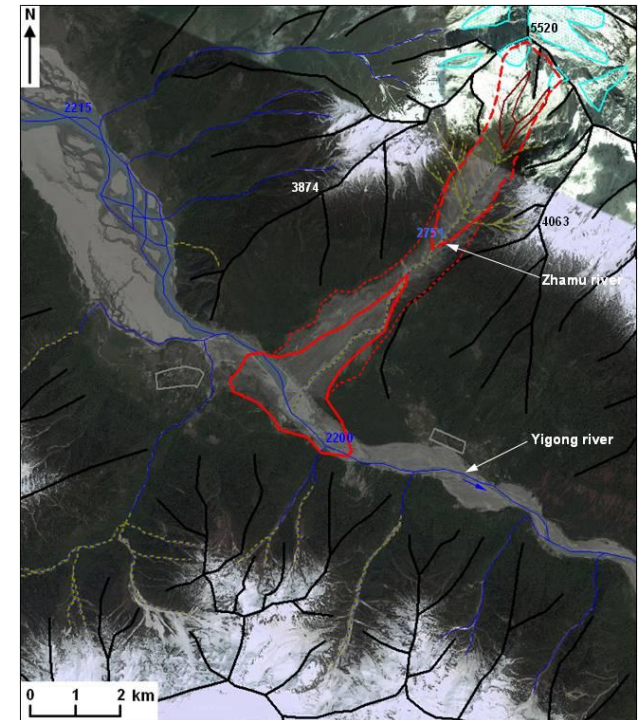
Numerical modelling: Yigong landslide



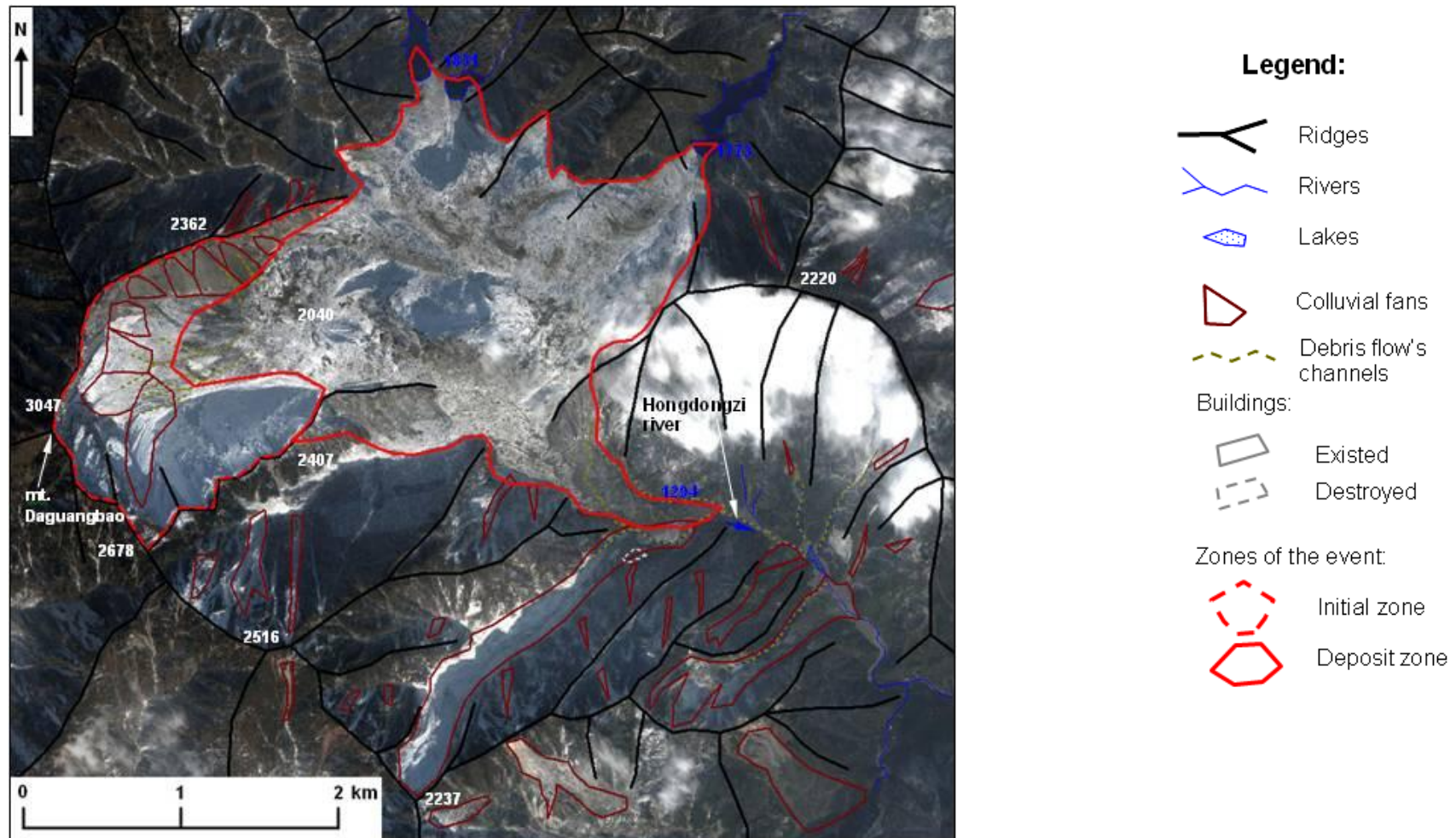
T = 150 s
Deposition



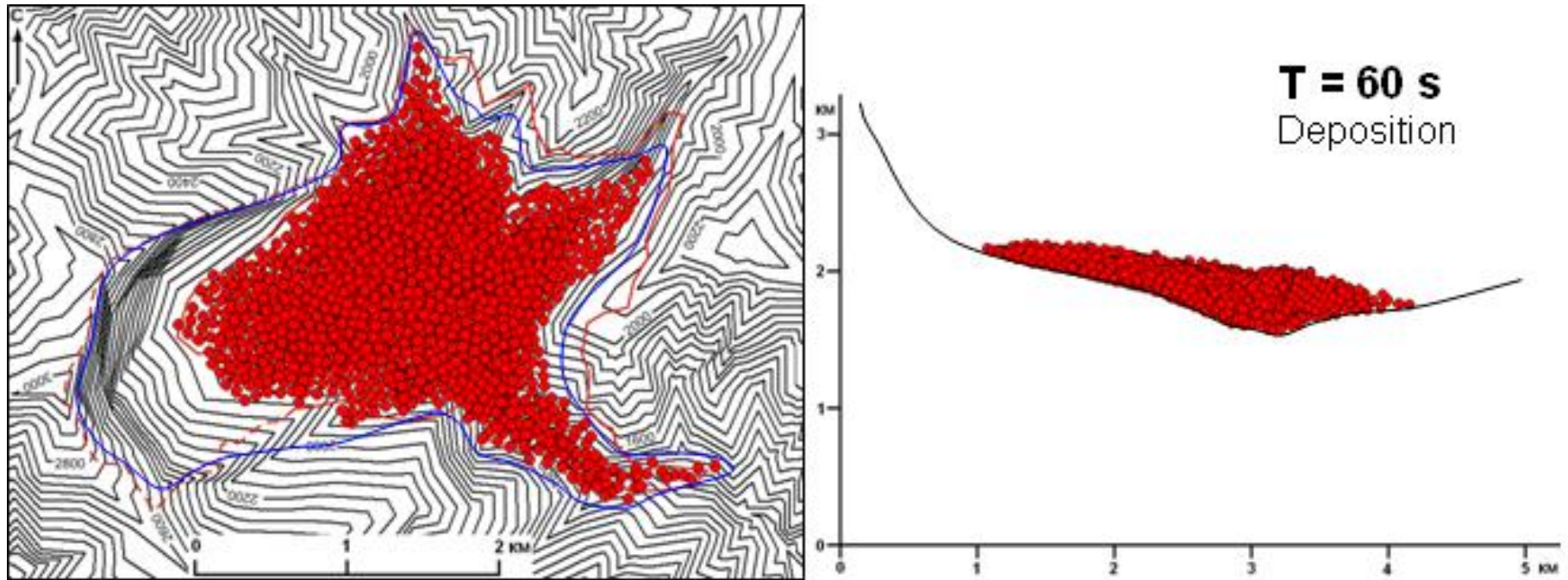
- Legend:**
- Ridges
 - Rivers
 - Glaciers
 - Colluvial fans
 - Debris flow's channels
 - Buildings:**
 - Existed
 - Destroyed
 - Zones of the event:**
 - Initial zone
 - Transit zone
 - Deposit zone



Map of the Daguangbao landslide



Simulation of the Daguangbao landslide



Particle (landslide) parameters: radius $R=20$ m, density $\rho=2500$ kg/m³, elasticity Young's module $E=40$ GPa, dry friction coefficient $\mu=0.17$, viscous friction coefficient $\eta=0$ kPa·s²

Publications

Journal of Earth Science, Vol. 23, No. 3, p. 373–380, June 2012
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DOI: 10.1007/s12583-012-0258-1

ISSN 1674-487X

A Seismically Triggered Landslide in the Niujuan Valley near the Epicenter of the 2008 Wenchuan Earthquake

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ABSTRACT: The Wenchuan (汶川) earthquake on 12 May 2008 induced a large number of landslides, collapses, and rockfalls along the Longmenshan (龙门山) fault. The landslide in Niujuan (牛圈) Valley (named Niujuan landslide), close to the epicenter, is one that travelled a long distance with damaging consequences. Using QuickBird satellite images and GPS data, the seismogenic mass movement area was analyzed, and the movement phases, travel path, and post-seismic processes of Niujuan landslide are described and discussed. Image interpretation and a GPS survey showed that the mass movement damaged 37% of the research area. The Niujuan landslide moved 1.95 m along the Longmenshan (龙门山) system, transformed to a debris avalanche, and accumulated in the downstream bed of Niujuan Valley, where they formed a dome 30 m in height, blocking the Niujuan stream and creating a barrier lake basin with 0.12 million m³ storage capacity. Subsequent to the Niujuan landslide, debris flows have been more active in Linshuixing and Niujuan valleys because of the accumulated mass of debris.

KEY WORDS: Wenchuan earthquake, landslide, debris flow, debris avalanche.

INTRODUCTION

The 2008 Wenchuan earthquake induced many landslides, rockfalls, and debris flows. According to the systematic investigation by the Ministry of Land and Resources of China, landslides, rockfalls, and debris flows induced by the earthquake were observed in 15 000 sites (Yin et al., 2009). The landslide in the Niujuan Valley, near the earthquake epicenter, is an

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Measuring Internal Velocity of Debris Flows by Temporally Correlated Shear Forces

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ABSTRACT: Debris flow is a kind of geological hazard occurring in mountain areas. Its velocity is very important for debris flow dynamics research and designing debris flow control works. However, most of past researches focused on surface velocity and mean velocity of debris flow, while few researches involve its internal velocity because there is no available method for measuring the internal velocity for its destructive power. In this paper, a method of temporally correlated shear forces (TCSP) for measuring the internal velocity of debris flows is proposed. The principle of this method is to calculate the internal velocity of a debris flow using the distance between two detecting sections and the time difference between the two overflows of shear forces measured at both sections. This measuring method has been tested in 14-bed flume experiments.

KEY WORDS: debris flow, internal velocity, velocity measuring, shear force, flume experiment.

INTRODUCTION

Debris flow is a kind of geological hazard occurring in mountain areas. Its velocity is a key part of debris flow kinematics and is one of the key parameters in the design of debris flow control structures. However, it is difficult to measure debris flow movement because this kind of fluid is nontransparent and heterogeneous. It is more difficult to measure its internal

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velocity because conventional current meters would be destroyed by impact force of this heterogeneous fluid containing debris and boulders. Some methods have been developed for measuring the surface velocity and surge velocity of debris flows. The method using stopwatches and floats is the simplest (Kang and Hu, 1990). Ultrasonic sensors or ground vibration sensors (geophones) have been used to detect the times a debris flow arrives at two observing sections and velocity is calculated using the arrival time difference and the distance between the sections (Aristov and Marchi, 2005; Berti et al., 2000; Arattano et al., 1997; Isakura et al., 1997; Pierson, 1986). Theory of movement for the core part and for the gradient layer of debris flow and equations of velocity curve were developed (Nadaiyev et al., 1963). Pressure of debris flow at different depths has been studied (Khokhleshidze, 1984; Gogushidze, 1978). Doppler

J. Mt. Sci. (2011) 8: 109–116
DOI: 10.1007/s11629-011-0083-4

Measuring the Internal Velocity of Debris Flows Using Impact Pressure Detecting in the Flume Experiment

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Abstract: Measuring the internal velocity of debris flows is very important for debris flow dynamics research and designing debris flow control works. However, there is no appropriate method for measuring the internal velocity because of the destructive power of debris flow process. In this paper, we address this problem by using the relationship between velocity and kinetic pressure, as described by surface velocity and surface kinetic pressure data. Kinetic pressure is the difference of impact pressure and static pressure. The former is detected by force sensors installed in the flow direction at the sampling section. Observations show that static pressure can be computed using the formula for static water pressure by simply substituting water density for debris flow density. We describe the relationship between surface velocity and surface kinetic pressure using data from seven laboratory flume experiments. It is consistent with the relationship for single phase flow, which is the measurement principle of the Pitot tube.

Keywords: Internal velocity; Measurement; Debris flow; Impact pressure

Introduction

Debris flow velocity is not only a key part of

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debris flow kinematics but also one of the key parameters in designing debris flow control works. However, it is difficult to measure debris flow movement because this kind of fluid is nontransparent and heterogeneous. Furthermore, it is difficult to measure its internal velocity because conventional current meters would be destroyed by the impact force of this heterogeneous fluid which contains gravels and boulders. Some methods have been developed for measuring the surface velocity and surge velocity of debris flows. Using a stopwatch and floats is the simplest way (Kang and Hu 1990). Ultrasonic sensors and ground vibration sensors (geophones) have been used to detect the times a debris flow passes two observing sections and the velocity can be calculated using the arrival time difference and the distance between the two sections (Pierson 1986; Arattano et al. 1997; Isakura et al. 1997; Berti et al. 2000; Arattano and Marchi 2005). Surface and mean velocities have been estimated through measurements of debris flow discharge in flume experiments (Boyarisky et al. 1970). A theory of movement for the core and gradient layer of debris flows, and equations of velocity curve have been developed (Nadaiyev et al. 1963). The pressure of a debris flow at different depths has been studied (Gogushidze 1970; Khokhleshidze 1984). Doppler

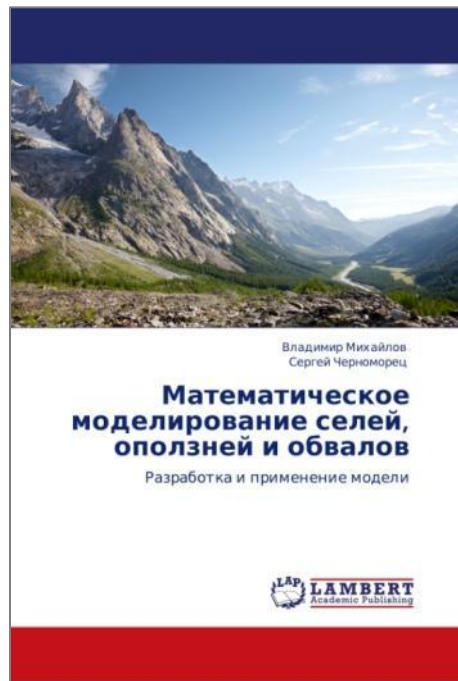
109

Wei F., Yang H., Hu K., Chernomoretz S. Measuring internal velocity of debris flows by temporally correlated shear forces. // *Journal of Earth Science*, 2012, Vol. 23, No. 3, p. 373–380. DOI: 10.1007/s12583-012-0258-1

Wei F., Chernomoretz S., Aristov K., Petrasov D., Tutubalina O., P. Su, Y. Jiang, Xu A., Petrasov A. A seismically triggered landslide in the Niujuan valley near the epicenter of the 2008 Wenchuan earthquake. - *Journal of Earth Science*, 2010, Vol. 21, No. 6, p. 901–909. DOI: 10.1007/s12583-010-0143-8

Yang H., Wei F., Hu K., Chernomoretz S., Hong Y., Li X., Xie T. Measuring the internal velocity of debris flows using impact pressure detecting in the flume experiment. // *Journal of Mountain Science*, 2011, Vol. 8, No. 2, p. 109–116. DOI: 10.1007/s11629-011-0083-x

Publications (in Russian)



Михайлов В.О., Черноморец С.С. Математическое моделирование селей, обвалов и оползней. 2011. LAP Lambert, 131 с. ISBN 978-3-8465-5660-3



Черноморец С.С., Михайлов В.О. Численное моделирование катастрофических селей, обвалов и оползней с применением трехмерной дискретной модели. // Геотехника, №1, 2012, с. 16-27.

Perspectives

- Study of volcano-induced debris flows in Kamchatka, Russia
- Study of glacial hazards in Tibet, China



Thank you for your attention!



We used information and materials prepared by all project participants.