Cutting-Edge Technologies Aiming for Better Outcomes of Landslide Disaster Mitigation

Kazuo Konagai

The International Consortium on Landslides (ICL) and The Global Promotion Committee of the International Programme on Landslides (GPC/IPL) have been responsible for organizing the World Landslide Forums (WLFs) every three years since 2008. Ever since the 1st WLF, the forums have long been the arena for landslide researchers and practitioners to exchange up-to-date information of recent devastations caused by landslides, cutting-edge technologies for landslide disaster mitigations and early warnings etc. to establish synergies among all participants worldwide.

Though the upcoming WLF5 has officially been postponed by one year to 2–6 November 2021 due to the global disruption caused by the coronavirus pandemic, the WLF5 will be all the more important with the Kyoto Landslide Commitment 2020 (KLC2020) to be launched as planned in the final online signatory meeting on 5 November 2020; the KLC 2020 is intended to be our action goals as the further advanced successor of the ‘Sendai Landslide Partnerships 2015–2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk’ in line with some of 17 Sustainable Development Goals (SDGs), particularly SDG 11, “Make cities and human settlements inclusive, safe, resilient and sustainable,” of the United Nations.

For these important goals, the ICL has been inviting sponsorship from industries, businesses, and government agencies; all leading players in landslide science and technologies. They have been supporting a variety of the ICL/IPL activities such as publishing the International full-color journal “Landslides (Journal of the International Consortium on Landslides)”, full-color books for WLFs, exhibiting their cutting-edge technologies in WLFs, etc. Here follow short introductions of their activities with their names, addresses and contact information.

Marui & Co. Ltd.
1-9-17 Goryo, Daito City, Osaka 574-0064, Japan
URL: https://marui-group.co.jp/en/index.html
Contact: hp-mail@marui-group.co.jp

Marui & Co. Ltd. celebrates its 100th anniversary in 2020. Marui, as one of the leading manufacturers of testing apparatuses in Japan, has been constantly striving to further improve its service since its foundation in 1920, thus contributing to the sustainable development of our nation and society. Our main products cover a wide variety of destructive and non-destructive testing apparatuses in the fields of geotechnical engineering, concrete engineering (mortar, aggregates, etc.), and ceramic engineering. Of special note is that Marui has been helping manufacture ring-shear apparatuses half-century long based on the leading-edge idea of Dr. Kyoji Sassa, Professor Emeritus at the Kyoto University. Marui has delivered total 7 ring-shear apparatuses to the Disaster Prevention Research Institute, Kyoto University, and 2 to the International Consortium on Landslides. Also the apparatuses were exported to the United States of America, China, Croatia and Vietnam.

Marui & Co. Ltd. takes great pleasure in developing, manufacturing, and providing new products of high value sharing the delight of achievement with our customers, and thus contributing to the social development. The whole staff of Marui & Co. Ltd. are determined to devote ceaseless effort to keep its organization optimized for its speedy and high-quality services, by the motto “Creativity and Revolution”, and strive hard to take a step further, as a leading
manufacturer of testing apparatuses, to answer our customer’s expectations for the twenty-second century to come.

**Nippon Koei Co., Ltd.**

5-4 Kojimachi, Chiyoda-ku, Tokyo 102-8539, Japan  
URL: [https://www.n-koei.co.jp/english/](https://www.n-koei.co.jp/english/)  
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Nippon Koei Co., Ltd. and its group companies conduct many projects to support the growth of developing countries in Asia, Africa, the Middle and Near East, Latin America and other regions. Examples of their efforts include environmental measures to combat global warming, development of regional transportation infrastructure to support the rapid growth of emerging economies, and reconstruction assistance for regions affected by conflict and/or natural disasters.

**OSASI Technos, Inc.**

65-3 Hongu-cho, Kochi City, Kochi 780-0945, Japan  
URL: [https://www.osasi.co.jp/en/](https://www.osasi.co.jp/en/)  
Contact: cs@osasi.co.jp

OSASI Technos, Inc. has been making its best efforts to develop its cutting-edge technologies for landslide early warning. Its unique compact and lightweight sensors making up the Landslide Early Warning System enable long-term monitoring of unstable landslide mass movements, precipitations, porewater pressure buildups, etc., in a remote mountainous area where commercial power is often unavailable. OSASI Technos, Inc. is also proud of its advanced technology to transfer observed data even in areas with poor telecom environments as proven in the successful implementations in South Asia.

All stuff members of OSASI Technos work together for mitigation of landslide disasters worldwide.

**Godai Corporation**

1-35 Kuroda, Kanazawa, Ishikawa 921-8051, Japan  
URL: [https://soft.godai.co.jp/En/Soft/Product/](https://soft.godai.co.jp/En/Soft/Product/)  
Products/LS-RAPID/  
Contact: pp-sales@godai.co.jp

Ever since its foundation in 1965, Godai Kaihatsu Co., Ltd., a civil engineering consulting firm, has long been providing a variety of software and measures particularly for natural disaster mitigation. With its rich expertise in both civil engineering and information technology (IT), the company has its primary goal to address real world needs of disaster mitigation. All the staff of Godai Kaihatsu Co., Ltd. feel it more than happy that their cutting-edge technologies help mitigate natural disasters.

**Japan Conservation Engineers & Co., Ltd.**

3-18-5 Toranomon, Minato-ku, Tokyo 105-001, Japan  
URL: [https://www.jce.co.jp/en/](https://www.jce.co.jp/en/)  
Contact: go_info@jce.jp

Japan Conservation Engineers & Co., Ltd. (JCE) is a general consulting firm working on landslide prevention research and consulting. JCE provides various disaster prevention technologies for debris flows, landslides, slope failures, rockfalls, etc. In addition, JCE is proud of its expertise having been conducting surveys and consulting works on coastal erosions and tsunami countermeasures for about 20 years. JCE contributes to the world through its activities in the realm of both structural and non-structural measures to build a resilient society.

**OYO Corporation**

7 Kanda-Mitoshiro-cho, Chiyoda-ku, Tokyo 101-8486, Japan  
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Contact: [https://www.oyo.co.jp/english/contacts/](https://www.oyo.co.jp/english/contacts/)

OYO Corporation, the top geological survey company in Japan established in Tokyo in 1957, is well known as one of leading companies providing cutting-edge technologies and measures for natural disasters such as landslides, earthquakes, tsunamis, and floods. Not just developing and selling measuring instruments related to disaster prevention, OYO also delivers a market-leading services in 3D ground/geological modeling and 3D exploration technologies.

**Kokusai Kogyo Co., Ltd.**

2 Rokubancho, Chiyoda-ku, Tokyo 102-0085, Japan  
URL: [https://www.kkc.co.jp/english/index.html](https://www.kkc.co.jp/english/index.html)  
Contact: overseas@kk-grp.jp

Kokusai Kogyo Co., Ltd. as a leading company of geospatial information technologies, has long been providing public services with its comprehensive expertise to
address real world needs and cutting-edge measurement technologies. Kokusai Kogyo Co., Ltd. helps rebuild “Green Communities,” which has been of our great concern in terms of “environment and energy,” “disaster risk reduction” and “asset management”. Kokusai Kogyo Co., Ltd. offers the advanced and comprehensive analyses of geospatial information for developing new government policies, maintaining and operating social infrastructures safe and secure, and implementing low-carbon measures in cities.

Influenced by the recent global climate change, extreme rainfall events have become more frequent worldwide and resultant hydro-meteorological hazards are creating more deaths and devastations particularly in many developing countries where effective advanced countermeasures are not readily available. Kokusai Kogyo Co., Ltd. is proud of its achievements in establishing resilient infrastructure systems and implementing effective monitoring/early warning systems in developing countries, which have long been helping reduce the risks from natural hazards.

**Geobrugg AG**

Aachstrasse 11, 8590 Romanshorn, Switzerland

URL: [www.geobrugg.com](http://www.geobrugg.com)

Contact: info@geobrugg.com

Swiss company Geobrugg is the global leader in the supply of high-tensile steel wire safety nets and meshes—with production facilities on four continents, as well as branches and partners in over 50 countries. True to the philosophy “Safety is our nature” the company develops and manufactures protection systems made of high-tensile steel wire. These systems protect against natural hazards such as rockfall, landslides, debris flow and avalanches. They ensure safety in mining and tunneling, as well as on motorsport tracks and stop other impacts from falling or flying objects. More than 65 years of experience and close collaboration with research institutes and universities make Geobrugg a pioneer in these fields.

**Ellegi srl**

Via Petrarca, 55 1-22070 Rovello Porro (CO) Italy

URL: [https://www.lisalab.com/engl/?seze=1](https://www.lisalab.com/engl/?seze=1)

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Ellegi srl provides worldwide monitoring services and produces Ground Based synthetic aperture radar (GBInSAR) for remote measurement of displacements and deformations on natural hazards and manmade buildings using its own designed and patented LiSALab system.

Its activities started in 2003 as a spin off project to exploit commercially the Ground Based Linear Synthetic Aperture Radars technology developed by European Commission’s Ispra Joint Research Centre and based on the results of more than 10 years of research. Since then Ellegi has industrialized and developed the core technology of the LiSALab system and latest LiSAMobile system represents the 5th generation of development.

In 2003 it was the first commercial company in the world to provide GBInSAR measurements of natural hazards and structure.

Ellegi srl offers:

- Displacement fields measurement, control and monitoring of the deformation caused by natural hazards, like landslides, rockslides, sinkhole, volcanic deformation in every operative condition, including emergencies.
- Structural strain fields measurement, control, monitoring and diagnosis of the deformation affecting buildings, bridges, viaducts, dams.
- GBInSAR monitoring systems, installation, management and maintenance in order to provide information about natural hazards or anthropic activity, that can generate or cause slopes failures or buildings instabilities.

In all the above-mentioned activities Ellegi srl uses the GBInSAR LiSALab technology that represents a real “break-through”.

**Chuo Kaihatsu Corporation**

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Chuo Kaihatsu Corporation (CKC) was founded in 1946, and has been aiming to become the “Only One” consultant for our customers. We engage in the hands-on work that will “Remain with the earth, Remain in people’s hearts, and Lead to a prosperous future”. We focus on road, river and dam engineering to flesh out industrial infrastructures specifically by means of geophysical/geotechnical/geological investigations, civil engineering surveys and project implementations. In recent years, we make significant efforts on earthquake disaster mitigation, sediment disaster prevention/mitigation and ICT information services. Many achievements of ours have already contributed to mitigation of natural disasters such as landslides, earthquakes and slope failures in Japan, Asia and the Pacific Region.
IDS GeoRadar s.r.l.

IDS GeoRadar, part of Hexagon, provides products and solutions, based on radar technology, for monitoring applications including landslides, rockfalls, complex structures, mining and civil engineering. The company is a leading provider of Ground Penetrating Radar (GPR) and Interferometric Radar solutions worldwide. IDS GeoRadar is committed to delivering best-in-class performance solutions and to the pursuit of product excellence, through the creation of application-specific, innovative and cost-efficient systems for a wide range of applications.

METER Group, Inc.

METER Group provides accurate, rugged, and dependable instrumentation to monitor moisture in all its phases within an unstable slope. METER specializes in instrumentation for near real-time monitoring of incoming moisture in the form of rain and weather. In addition, we provide real-time below-surface monitoring of existing moisture conditions like moisture content and soil suction which show how the soil profile is filling with water to saturation, including the transition to positive pore water pressure.

The ZL6 advanced cloud data logger works together with ZENTRA Cloud data software to simplify and speed up data collection, management, visualization, and alerting. Our well-published instrumentation is used worldwide in universities, research and testing labs, government agencies, and industrial applications.

For almost four decades, scientists and engineers have relied on our instrumentation to understand critical moisture parameters. We’ve even partnered with NASA to measure soil (regolith) moisture on Mars. Wherever you measure, and whatever you’re measuring, rely on METER for accuracy, affordability, and simplicity that will make your job easier.

Asia Air Survey Co., Ltd.

Asia Air Survey (AAS), as one of the leading engineering and consulting companies, has long been providing disaster prevention and mitigation services for over 65 years, particularly in the fields of landslide, debris flow, erosion control, etc. AAS is proud of being the inventor of Red Relief Image Map (RRIM), which is a cutting-edge 3D terrain visualization method allowing great geomorphological details to be visualized in one glance, thus has been used in various facets of disaster prevention and mitigation.

Kiso-Jiban Consultants Co., Ltd.

Kiso-Jiban Consultants, established in 1953, is an engineering consulting firm especially well known in the field of geotechnical engineering. The areas of its comprehensive services are listed below:

- Geological and Geotechnical Survey
- Geotechnical Analysis and Design
- Disaster Prevention and Management
- Geographic Information Systems (GIS)
- Soil and Rock Laboratory Tests
- Instrumentation and Monitoring
- Geophysical Exploration and Logging
- Distribution of Geosynthetics Products

Much-talked-about new service is Kiso-SAR System allowing accurate estimation of both extent and rate of landslide movements based upon a comprehensive interpretation of InSAR results from geotechnical and landslide engineering viewpoint (see the one-page introduction of Kiso-Jiban Consultants Co., Ltd.). With Kiso-SAR system,
the following pieces of important geotechnical information can be provided:

(1) Extent of a deforming landslide mass (and the rate of its movement)
(2) Consolidation buildup in soft clay underlying a fill
(3) Deformation buildups induced by slope cutting.

Okuyama Boring Co., Ltd.

10-39 Shimei-cho, Yokote City, Akita 013-0046, Japan
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Contact: info@okuyama.co.jp

Okuyama Boring Co., Ltd. is proud of its achievements in various projects to help solve many landslide problems. The company has been offering services in geological surveys and analyses, developing rational countermeasures against various geotechnical problems as well as safe workflow diagrams, and providing necessary pieces of advice for ensuring safety during landslide countermeasure works. For this purpose, Okuyama Boring Co., Ltd. works on monitoring, observations, field surveys, numerical analyses, countermeasure works, etc. of landslides.

Kawasaki Geological Engineering Co. Ltd.

Mita-Kawasaki Bldg., 2-11-15 Mita, Minato-ku, Tokyo 108-8337, Japan
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Contact: post-master@kge.co.jp

Kawasaki Geological Engineering Co., Ltd. as one of the leading members of SAAM Research Group, has proactively been involved in developing “Sustainable Asset Anchor Maintenance (SAAM, hereafter) System,” enabling easy maintenance of ground anchors. Its unique jack, weighing about half the weight of a conventional jack, together with a newly developed jig, can be applied to any type of anchor even with a short extra length, thus allowing for in-situ lift-off tests on these anchors. The SAAM system also has an optional weight meter that can be installed after performing a lift-off test.

Nissaku Co., Ltd.

4-199-3 Sakuragi-cho, Omiya-ku, Saitama 330-0854, Japan
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Nissaku Co., Ltd., founded in 1912 as a well drilling company, provides services for far-flung fields of not only groundwater exploitation but also measures for landslides. Having its rich expertise in these fields, Nissaku Co., Ltd. offers general reliable one-stop technical services including designs, investigations, analyses, constructions, and maintenances.

Full-color presentations from the above seventeen exhibitors focusing on their landslide technologies are shown on the following pages. Their cutting-edge technologies have of course been instrumental in the progress that we have made in landslide risk-reduction worldwide, and we want to exert even greater effort to aim high given the KLC 2020 as our new action goals. The International Consortium on Landslides seeks volunteers willing to support our activities introducing their brand-new technologies for landslide disaster mitigation in our international journal “Landslides,” full color books for WLFs, exhibitions at WLFs, etc. If you are interested in being engaged in supporting ICL activities, please contact the ICL secretariat. secretariat@iclhq.org.
Stress / Speed Dual Control
Ring Shear Apparatus

ICL-2 type: High-Stress Landslide Simulator

Web site: https://www.marui-group.co.jp/en/
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574-0064, Japan
Phone: 81-72-869-3201
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Geohazard Management
Response to natural disasters with various technologies from space to the surface

Remote Sensing Technology
Potential hazards around the globe are assessed by optical remote sensing and InSAR which can detect land-resources, topographic features, and ground deformation. Example of InSAR, shown below, is a new effective way to detect deformation of slopes along infrastructures such as roads and railways.

A team of 5,497 multidisciplinary experts
Excellent teams, covering advanced and wide range of technologies based on long-standing experiences, are formed to provide optimum solutions customized for each condition and needs.

AI Technology
Our AI technology helps quickly identify morphological features of past and current landslides.

Numerical simulation
We can predict the extent of damage in the event of a disaster and the effectiveness of countermeasure works by numerical analysis.

R&D center
State-of-the-Art Nippon Koei’s R&D Center

NIPON KOEI
Global Consulting Engineering Firm
Head Office: 5-4 Kajimachi, Chiyoda-ku, Tokyo 102-8539, Japan
TEL: +81 3 3238 8030
Website: www.n-koei.co.jp/eng
We have developed a variety of software related to the slope disaster prevention and social infrastructure, analysis, simulation, and monitoring.
Japan Conservation Engineers is a consulting firm that specializes in disaster prevention and mitigation for the conservation of land and the environment.

We aim to establish a sustainable country by various technology related to earth, water, and vegetation.

**Consulting Services**
Slope Disaster Management/
Forest Conservation and Afforestation/
Community Based Disaster Risk Reduction/
Disaster Risk Assessment Technology Transfer

**Construction and Supervision**
Construction of Landslide and Slope Disaster Prevention Measures/
Countermeasures Against Aging Infrastructure

**Research and Development**
Slope Protection Technology/
Afforestation Technology/
Geospatial Information Technology/
3D Simulation Technology/
Laboratory Testing of Soil and Rocks
Find the best answer to the future of people and the earth. To realize a sustainable society.

3D Geological Modeling

GEO-CRE® / GEO-CRE® PRO
OCTAS® Modeler
OCTAS Modeler is a system to support the utilization of subsurface information. It helps to grasp the positional relationship of the borehole logs and create various 3D models including borehole, soil bearing layer, and terrain.

Inclinometer

Clino-pole

Tilt sensor for Sediment disaster

3D Geophysical Survey

McSEIS-AT

McSEIS-AT is an epoch-making microtremor exploration system that can measure S-wave velocity structures in three dimensions.

oyo corporation

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Kokusai Kogyo as a leading company of geospatial information technologies, has been contributing to the improvement of public services with advanced measurement technologies and a wide range of consulting technologies. Kokusai Kogyo supports the development of "Green Communities" representing the new era public concerns on "environment and energy," "disaster risk reduction" and "asset management". Kokusai Kogyo offers the advanced analysis of geospatial information consultancy for developing new government policies, maintaining and operating social infrastructures with safe and secure city planning, and building low-carbon cities.

3D-GIV can help grasp the ground surface displacements caused by natural phenomena such as landslides by analyzing differences between digital geographic images obtained through ad hoc Airborne Laser Surveys.

ELSAMAP is our cutting-edge 3D terrain visualization method allowing great geomorphological details to be visualized in one glance with gray-scaled slope inclinations and colored altitudes. ELSAMAP has been used to interpret micro-topographies, landslides and some other things.

Our Realtime Hazard Map reflects up-to-date information of soil nature and precipitations at landslide hazard sites, etc. that can constantly be changing, and evaluates area-wide hazard risk in real time.

"Shamen-net" is a total monitoring system integrating GNSS and other monitoring devices (Measurement precision: +/-1mm, on a real time basis).
Cutting-Edge Technologies Aiming for Better Outcomes

GEOBRUGG
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Free dimensioning tool
www.mygeobrugg.com

Ring net barriers made of high-tensile steel wire
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Geobrugg AG | CH-8590 Romanshorn | www.geobrugg.com
... A step ahead in monitoring structures and natural hazards ....

by Ground Based Interferometric Synthetic Aperture Radar LiSALab technology

Ellegi's provides services and products for remote sensing measurement of displacements and deformations of natural hazards and manmade buildings using a ground based SAR system, known as LiSALab system, in software production and system integration, production and developments of data acquisition, visualization and data-analysis systems.

LiSALab system at present is at its 6th generation of development since 2003.

One of the biggest points of strength of Ellegi is based on its high vertical integration. It can internally design, produce, sell, maintains and provide services and products using GBinSAR LiSALab technology, the customer can have all the answers.

Ellegi srl offers:

- displacement fields measurement, control and monitoring of the deformation caused by natural hazards, in every operative conditions, including emergencies;
- structural strain fields measurement, control, monitoring and diagnosis of the deformation affecting buildings, bridges, viaducts, dams, etc. etc.;
- integrated monitoring systems design, installation, management and maintenance in order to provide information about natural hazards or anthropic activity, that can generate or cause slopes or buildings instabilities.

Since 2003 Ellegi has provided services, systems and technologies in the world to the most important players in the monitoring sector.
Cutting-Edge Technologies Aiming for Better Outcomes

Early Warning Monitoring System of Slope Failure using Multi-point Tilt Change and Volumetric Water Content - CHUO KAIHATSU CORPORATION -

Objectives and Subjects

Research and develop a highly accurate, multi-point early-warning system for slope failure using low-cost tilt sensors.

- Low-cost, easy-to-install tilt sensors.
- Realized low-cost multi-point measurement.
- Prediction of slope deformation by multi-point measurements.
- Realized high-precision, stable, slope failure early warning system.

Accomplishments

Effective, rapid, and convenient installation of sensors by inserting a steel pole into the slope and affixing the sensor module.

Utilization example

At other sites, there were gradual tilt rate increases within a relatively short time before slope failures occurred, the rate increase, in a way, was inversely proportional to the remaining time before failure.

International Support

- Support pilot projects
- Promote an international standard
- Export of technology packages

Technical Services

- Early warning of slope failure
- Prevention of secondary disasters
- Assess pre-failure phenomena of slopes
- Dynamic monitoring of landslides in mountainous areas
- Application to Internet of Things and trends in Big data

Joint Research by Local Autonomies and Private Enterprise

- Secondary disaster prevention of critical slope works
- Slope monitoring in densely populated areas
- Community participation in disaster information education

Users

JICA, Local autonomies, Regional Bureaus of MLIT, General construction company etc.
International: Taiwan, China, India, Australia, Sri Lanka, Pakistan, Bhutan etc.

Achievement (-2019)

- Over 900 sets in Japan
- Over 300 sets abroad

Cooperation with Regional Bureau of MLIT to develop research results

- Monitoring of natural slopes
- Monitoring of dams and wall slopes
- Monitoring of drainage systems

Places of use

To fulfill a role of early warning for disaster prevention by using the results of research and development for natural slope, road works, cutting slope works, and rock fall.

High-precision and stable early-warning system for slope failure.

---Realized early-warning system based on spatial and temporal analysis of entire slope behavior.
IDS GeoRadar is nowadays the leader company in the Radar monitoring solutions applied to landslide monitoring, thanks to the combination of the highest performance radar technology with the most advanced data processing algorithm for the removal of atmospheric artifacts integral part of Guardian Software.

The unique IBIS-FM radar system accurately monitors multiple scales of displacements in real time, from early detection of slow movements to fast accelerations associated with slope collapse. The great operative range, up to 4500 m, allows to safely deploying the system in comfortably accessible areas, without exposing people and equipment to hazardous zones.

**Fully automatic**

The atmospheric correction procedure does not require any input from the user (does not need any stable area selection). It is a completely automatic software processing, requiring advanced knowledge to the user. The atmospheric compensation algorithm is based on hundreds of thousands of pixels automatically selected by the software and updated at each radar scan. It permits to achieve the best performances even in case of extreme or unstable atmospheric conditions.

**Advanced 3D atmospheric effects modelling**

IDS GeoRadar algorithm for atmospheric correction offers unique capability able to model and remove complex atmospheric effects in extensive areas overcoming the limits of the standard linear model algorithms, providing very clean displacement map in the most extreme atmospheric conditions environment.

**Slow and fast movement detection**

IDS GeoRadar algorithm is able to distinguish very slow movement together with faster ones providing the capability to measure in real time movements across four orders of magnitudes from very fast movements (up to 350 mm/ hour) to extremely low displacements (few mm/month).
METER ENVIRONMENT

LANDSLIDE PREDICTION AND ALERTS
POSITIVE & NEGATIVE PORE WATER PRESSURE MONITORING

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metergroup.com/wlf5
A novel 3D visualization technique

**Red Relief Image Map (RRIM)**

Developed by AAS, RRIM is a simple and effective tool for representing and interpreting ground surface features. The RRIM allows great geomorphological details to be visualized in one glance with a single map without any device, at any map scale, from any viewing angles without shades.

**AAS provides one-stop services of RRIM.**

![RRIM of Mt.Usu, Japan, from 1m mesh Lidar data.](image)

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Cutting-Edge Technologies Aiming for Better Outcomes

Monitoring Service for Landslide by Kiso-SAR System

What’s SAR?

SAR (Synthetic Aperture Radar) is a technique that utilizes interference of radio waves for precise determination of distance. InSAR (interferometric SAR), the phase of the received backscattered signal from two images of the same scene are used to measure path length differences with an accuracy of a few millimeters.

Ground Deformation Estimation in Landslides

Ground Deformation of Landslide Observed by Kiso-SAR System

Kiso-Jiban Consultants Co., Ltd.
Kinshicho Prime Tower 12 Floor, 1-5-7 Kameido, Koto-ku, Tokyo 136-8577, Japan
Tel.: +81-3-6861-8800
**Small & simple water drainage drilling system** for landslide disaster prevention

### Simple & Small

- Simple structure.
- At a narrow space (0.3m×1.5m for guide rail, 0.8m×2.0m for drilling machine base).
- Lightweight equipment (Max. weight of drilling machine: 25kg).
- Easy installation of one operational well requires only 2 persons.

### Quick & Short-term construction

- All pieces of equipment are man-portable.
- Preparation time for starting drilling is only 30 min.
- 50% reduction in construction time compared with conventional construction method.

### Low cost & High effectivity

- Additional works (ex. scaffold or construction road) are not required.
- 50% reduction in construction cost compared with conventional construction method.
- About 30m long water drainage hole can be drilled in clayey and/or soft rock layers.

### Safety & Environmentally friendly

- Small sound and low vibration.
- Construction yard is not required.

*Japanese utility model registration No.3186011

[Okuyama Boring Co., Ltd.](https://okuyama.co.jp/en/)

10-39 Shinmei-cho, Yokote-City, AKITA Pref. 013-0046, JAPAN
Sustainable Asset Anchor Maintenance System

■ What’s “SAAM System”?

SAAM stands for "Sustainable Asset Anchor Maintenance".

SAAM Jack, only half the weight of a conventional jack, enables lift-off tests in various onsite conditions.

SAAM, thus, allows for easy maintenance of ground anchors.

■ SAAM-A (PAT No. 5971596)

Lift-off tests on anchors with a short extra length can be performed with a newly developed jig.

■ SAAM-L (PAT No. 5440772)

SAAM load cell can be attached to any anchors without loosening them.

■ Planar Distribution of Anchor’s Tensioning Force

| Evaluation | Status                         | Coping example                     |
|------------|--------------------------------|------------------------------------|
| 0.9 Tons   | Risk of Breakage               | Emergency measures                 |
| 1.1 Tons   | Risk of Damage                 | implementation of countermeasure work |
| C+         | Exceeds the allowable value    | Follow up                          |
| B+         | Good                           | Follow up                          |
| A+         | Dysfunction                    | Implementation of countermeasure work |

Kawasaki Geological Engineering Co., Ltd.
Marketing & Sales Department
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