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Advancing Culture of Living with Landslides

Volume 1
ISDR-ICL Sendai Partnerships 2015–2025

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Hiroshima landslide disasters in August 2014, Hiroshima, Japan (PASCO Corporation—Kokusai Kogyo Co., Ltd. All Rights Reserved)

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Foreword By Irina Bokova

Every year, disasters induced by natural hazards affect millions of people across the world. The loss of life is tragic, impacting on communities for the long term.

The costs are also economic, as disasters are responsible for estimated annual economic losses of around USD 300 billion. With the rising pressures of climate change, overpopulation, and urbanization, we can expect costs to increase ever more.

We cannot prevent disasters, but we can prepare for them better. This is the importance of the *International Consortium on Landslides*, supported actively by UNESCO, to advance research and build capacities for mitigating the risks of landslides. Led by Prof. Kyoji Sassa, the Consortium has become a success story of international scientific cooperation at a time when this has never been so vital.

This is especially important as the world implements the *2030 Agenda for Sustainable Development* and the Paris Agreement on Climate Change, as well as the *Sendai Framework for Disaster Risk Reduction 2015–2030*—adopted in Sendai, Japan, to assess global progress on disaster risk reduction and set the priority actions.

The International Strategy for *Disaster Risk Reduction—International Consortium on Landslides Sendai Partnerships 2015–2025* is the key outcome relating to landslides from the 3rd World Conference on Disaster Risk Reduction, held in Sendai. On this basis, every member of the *International Consortium of Landslides* is redoubling efforts to understand, foresee, and reduce landslide disaster risk across the world.

Led by the Consortium, the Landslide Forum is a triennial milestone event that brings together scientists, engineers, practitioners, and policy makers from across the world—all working in the area of landslide technology, landslide disaster investigation, and landslide remediation. Meeting in Slovenia, the 4th Landslide Forum will explore the theme, "Landslide Research and Risk Reduction for Advancing Culture of Living with Natural Hazards," focusing on the multidisciplinary implementation of the Sendai Framework to build a global culture of resilient communities.

Against this backdrop, this report includes state-of-the-art research on landslides, integrating knowledge on multiple aspects of such hazards and highlighting good practices and recommendations on reducing risks. Today, more than ever, we need sharper research and

stronger scientific cooperation. In this spirit, I thank all of the contributors to this publication and I pledge UNESCO's continuing support to deepening partnerships for innovation and resilience in societies across the world.

January 2017

Irina Bokova
Director-General of UNESCO

Foreword By Robert Glasser

Landslides are a serious geological hazard. Among the host of natural triggers are intense rainfall, flooding, earthquakes or volcanic eruption, and coastal erosion caused by storms that are all too often tied to the El Niño phenomenon. Human triggers including deforestation, irrigation or pipe leakage, and mining spoil piles, or stream and ocean current alteration can also spark landslides.

Landslides occur worldwide but certain regions are particularly susceptible. The UN's Food and Agriculture Organization underlines that steep terrain, vulnerable soils, heavy rainfall, and earthquake activity make large parts of Asia highly susceptible to landslides. Other hotspots include Central, South, and Northwestern America.

Landslides have devastating impact. They can generate tsunamis, for example. They can bring high economic costs, although estimating losses is difficult, particularly so when it comes to indirect losses. The latter are often confused with losses due to earthquakes or flooding.

Globally, landslides cause hundreds of billions of dollars in damages and hundreds of thousands of deaths and injuries each year. In the US alone, it has been estimated that landslides cause in excess of US$1 billion in damages on average per year, though that is considered a conservative figure and the real level could be at least double.

Given this, it is important to understand the science of landslides: why they occur, what factors trigger them, the geology associated with them, and where they are likely to happen.

Geological investigations, good engineering practices, and effective enforcement of land use management regulations can reduce landslide hazards. Early warning systems can also be very effective, with the integration between ground-based and satellite data in landslide mapping essential to identify landslide-prone areas.

Given that human activities can be a contributing factor in causing landslides, there are a host of measures that can help to reduce risks, and losses if they do occur. Methods to avoid or mitigate landslides range from better building codes and standards in engineering of new construction and infrastructure, to better land use and proper planned alteration of drainage patterns, as well as tackling lingering risks on old landslide sites.

Understanding the interrelationships between earth surface processes, ecological systems, and human activities is the key to reducing landslides disaster risks.

The Sendai Framework for Disaster Risk Reduction, a 15-year international agreement adopted in March 2015, calls for more dedicated action on tackling underlying disaster risk drivers. It points to factors such as the consequences of poverty and inequality, climate change and variability, unplanned and rapid urbanization, poor land management, and compounding factors such as demographic change, weak institutional arrangements, and non-risk-informed policies. It also flags a lack of regulation and incentives for private disaster risk reduction investment, complex supply chains, limited availability of technology, and unsustainable uses of natural resources, declining ecosystems, pandemics and epidemics.

The Sendai Framework also calls for better risk-informed sectoral laws and regulations, including those addressing land use and urban planning, building codes, environmental and

resource management and health and safety standards, and underlines that they should be updated, where needed, to ensure an adequate focus on disaster risk management.

The UN Office for Disaster Risk Reduction (UNISDR) has an important role in reinforcing a culture of prevention and preparedness in relevant stakeholders. This is done by supporting the development of standards by experts and technical organizations, advocacy initiatives, and the dissemination of disaster risk information, policies, and practices. UNISDR also provides education and training on disaster risk reduction through affiliated organizations, and supports countries, including through national platforms for disaster risk reduction or their equivalent, in the development of national plans and monitoring trends and patterns in disaster risk, loss, and impacts.

The International Consortium on Landslides (ICL) hosts the Sendai Partnerships 2015–2025 for the global promotion of understanding and reducing landslide disaster risk. This is part of 2015–2025, a voluntary commitment made at the Third UN World Conference on Disaster Risk Reduction, held in 2015 in Sendai, Japan, where the international community adopted the Sendai Framework.

The Sendai Partnerships will help to provide practical solutions and tools, education and capacity building, and communication and public outreach to reduce landslides risks. As such, they will contribute to the implementation of the goals and targets of the Sendai Framework, particularly on understanding disaster risks including vulnerability and exposure to integrated landslide-tsunami risk.

The work done by the Sendai Partnerships can be of value to many stakeholders including civil protection, planning, development and transportation authorities, utility managers, agricultural and forest agencies, and the scientific community.

UNISDR fully support the work of the Sendai Partnerships and the community of practice on landslides risks, and welcomes the 4th World Landslide Forum to be held in 2017 in Slovenia, which aims to strengthen intergovernmental networks and the international programme on landslides.

Robert Glasser
Special Representative of the Secretary-General
for Disaster Risk Reduction and head of UNISDR

Preface

The International Consortium on Landslides (ICL) organized the ICL-IPL Conference in Kyoto, Japan in 2013, and discussed and prepared the 2014 Beijing Declaration to be adopted at the World Landslide Forum 3 in Beijing, China in June 2014. ICL wrote the draft of ICL-IPL Sendai Partnerships 2015–2025—Landslide disaster risk reduction for a safer geo-environment to be examined in Sendai, Japan, in March 2015. **The 2004 Beijing Declaration**—Landslide mitigation toward a safer Geo-environment was examined at a high-level panel discussion with the participation of the Director-General of UNESCO, Ms, Irina Bokova and was adopted at the end of WLF3 in Beijing, China, which was held on June 2–6, 2014 (Sassa et al. 2015).

ICL organized the Steering Committee meeting in Kyoto on October 7–9 , 2014, together with the International Forum "Urbanization and Landslide Disaster"—Hiroshima landslide disaster, in August, 2014 and Japan's contribution to the post-2015 framework for Disaster Risk Reduction. This forum was planned as a preparatory meeting of the ICL-IPL Sendai Partnerships Conference on March 11–15, 2015. Key members of ICL, UNESCO, UNISDR, MEXT, and the Cabinet Office and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Government of Japan attended and discussed the global collaborative framework contributing to the Third World Conference on Disaster Risk Reduction.

Establishment of the ISDR-ICL Sendai Partnerships 2015–2025

ICL initially proposed a thematic session "Urbanization and Geodisasters" to be considered as part of the Third UN World Conference on Disaster Risk Reduction (WCDRR). This topic was not retained among the topics of the Conference. Thereafter, ICL became a co-organizer of Working Session No. 4 (WS 4) "Underlying Risk Factors" (Priority No. 4 of the Hyogo Framework for Action), together with MLIT, UNESCO and other organizations under the initiative of ISDR. ICL proposed a Sendai Partnership on Landslides to the session. It was changed from the initial proposal of "ICL-IPL Sendai Partnerships 2015–2024—Landslide disaster risk reduction for a safer geo-environment" to the "Sendai Partnerships for the Global Promotion of Understanding Disaster Risk" (Priority 1 of the Sendai Framework for Disaster Risk Reduction 2015–2030) to widen the scope beyond just landslides. However, an opinion was expressed that it was too broad, and the session should focus on specific disasters within the interest of organizers of the Working Session No. 4. It was then changed to the "ISDR-ICL: Sendai Partnerships 2015–2024 for Global Promotion of Understanding and Reducing Landslide, Flood and Tsunami Disaster Risk—Tools for Implementing and Monitoring the Post-2015 Framework for Disaster Risk Reduction and the Sustainable Development Goals." This version was circulated to the expected intergovernmental, international and national organizations on 21 January 2015. However, it was suggested that because this partnership is under the initiative of the International Consortium on Landslides, it is better to focus on landslides. As a result, it was finally returned to only landslides (Sassa 2015; Wahlström 2015)

The revised title of the finally agreed Sendai Partnerships was:

Header: Voluntary commitment to the World Conference on Disaster Risk Reduction, Sendai, Japan, 2015

Title: ISDR-ICL Sendai Partnerships 2015–2025 for global promotion of understanding and reducing landslide disaster risk

Subtitle: *Tools for Implementing and Monitoring the Post-2015 Framework for Disaster Risk Reduction and the Sustainable Development Goals*

Based on this frame for the Sendai Partnerships, ICL members and ICL advisory members discussed its main contents before and during the ICL-IPL Sendai Partnerships Conference on March 11–15, 2015 in Sendai.

ISDR-ICL Sendai Partnerships 2015–2025 was adopted at a session "Underlying risk factors" of 3rd WCDRR in the morning of 16 March 2015 and it was signed by 16 signatory organizations in the afternoon of the same day in Sendai, Japan. The WCDRR Conference hall was constructed in front of Sendai Castle (*left*) build by Mr. Masamune Date (*right*) in 1601. He sent a mission of 180 people lead by Mr. Tsunenaga Hasekura on a mission to Spain and Rome for international trade and cooperation from 1613 to 1620.

The above is the poster displayed at the preparatory meeting and also the signing ceremony. It has the logos of ICL and ISDR, as well as the logo of the Third UN Conference on Disaster Risk Reduction. The agreed major content is presented below.

We acknowledgee that:

- Landslide disasters are caused by exposure to hazardous motions of soil and rock that threaten vulnerable human settlements in mountains, cities, coasts, and islands.
- Climate change will intensify the risk of landslides in some landslide-prone areas through an increase in the frequency and/or magnitude of heavy rainfall, and shifts in the location and periodicity of heavy rainfall.
- Developments in mountains and coastal areas, including construction of roads and railways and expansion of urban areas due to population shifts, increase exposure to hazards of landslides.
- Although they are not frequent, strong earthquakes have potential to trigger rapid and long-runout landslides and liquefaction. Earthquake-induced coastal or submarine large-scale landslides or megaslides (with depths on the order of hundreds of meters to one thousand meters) in the ocean floor can trigger large tsunami waves. These hazardous motions of soil and water impacting on exposed and vulnerable population can result into very damaging effects.
- The combined effects of triggering factors, including rainfall, earthquakes, and volcanic eruptions, can lead to greater impacts through disastrous landslides such as lahars, debris flows, rock falls, and megaslides.
- Understanding landslide disaster risk requires a multi-hazard approach and a focus on social and institutional vulnerability. The study of social and institutional as well as physical vulnerability is needed to assess the extent and magnitude of landslide disasters and to guide formulation of effective policy responses.
- Human intervention can make a greater impact on exposure and vulnerability through, among other factors, land use and urban planning, building codes, risk assessments, early

warning systems, legal and policy development, integrated research, insurance, and, above all, substantive educational and awareness-raising efforts by relevant stakeholders.

- The understanding of landslide disaster risk, including risk identification, vulnerability assessment, time prediction, and disaster assessment, using the most up-to-date and advanced knowledge, is a challenging task. The effectiveness of landslide disaster risk reduction measures depends on scientific and technological developments for understanding disaster risk (natural hazards or events and social vulnerability), political "buy-in", and on increased public awareness and education.
- At a higher level, social and financial investment is vital for understanding and reducing landslide disaster risk, in particular social and institutional vulnerability through coordination of policies, planning, research, capacity development, and the production of publications and tools that are accessible, available free of charge and are easy to use for everyone in both developing and developed countries.

We agree on the following initial fields of cooperation in research and capacity building, coupled with social and financial investment:

- Development of people-centered early warning technology for landslides with increased precision and reliable prediction both in time and location, especially in a changing climate context.
- Development of hazard and vulnerability mapping, vulnerability and risk assessment with increased precision and reliability, as part of multi-hazard risk identification and management.
- Development of improved technologies for monitoring, testing, analyzing, simulating, and effective early warning for landslides.
- Development of international teaching tools that are always updated and may be used free of charge by national and local leaders and practitioners, in developed and developing countries through the Sendai Partnerships 2015–2025.
- Open communication with society through integrated research, capacity building, knowledge transfer, awareness-raising, training, and educational activities to enable societies to develop effective policies and strategies for reducing landslide disaster risk, to strengthen their capacities for preventing hazards from developing into major disasters, and to enhance the effectiveness and efficiency of relief programs.
- Development of new initiatives to study research frontiers in understanding landslide disaster risk, such as the effect of climate change on large-scale landslides and debris flows, the effective prediction of localized rainfall to provide earlier warning and evacuation, especially in developing countries, the mechanism and dynamics of submarine landslides during earthquakes that may cause or enhance tsunamis, and geotechnical studies of catastrophic megaslides for prediction and hazard assessment.

All of the items above came from the discussions of ICL and its partners. Within those items, one of the most discussed parts are the effects of climate change on landslides. It was mentioned in two places as a high priority. Climate changes are studied by meteorologists, but not studied by landslide scientists and engineers. It is not easy to prove the effects of climate change on landslides in a decisive and a quantitative way. However, all agreed, in the following sentence, to add "in some landslide prone areas."

Climate change will intensify the risk of landslides in some landslide-prone areas through an increase in the frequency and/or magnitude of heavy rainfall, and shifts in the location and periodicity of heavy rainfall.

Figure 1 presents a comparison of extreme rainfalls in Japan of over 100 mm/day and extreme rainfalls in Vietnam of over 51 mm/day. One is the number of days and another is the number of events, and the monitoring period is different. However, both present an increasing

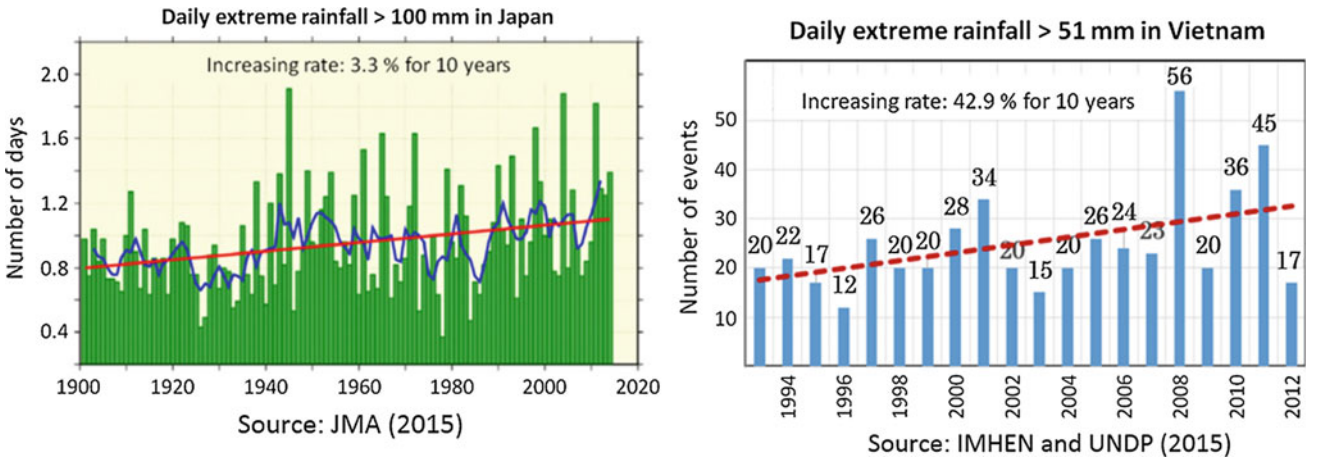

Fig. 1 Comparison of extreme rainfalls in Japan of over 100 mm/day and extreme rainfalls in Vietnam of over 51 mm/day. *Source 1* Japanese Meteorological Agency (JMA) (2015) Climate Change Monitoring Report 2014. *Source 2* IMHEN (Institute of Meteorology, Hydrology and Climate Change, Vietnam) and UNDP (United Nations Development Program) (2015) Viet Nam Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

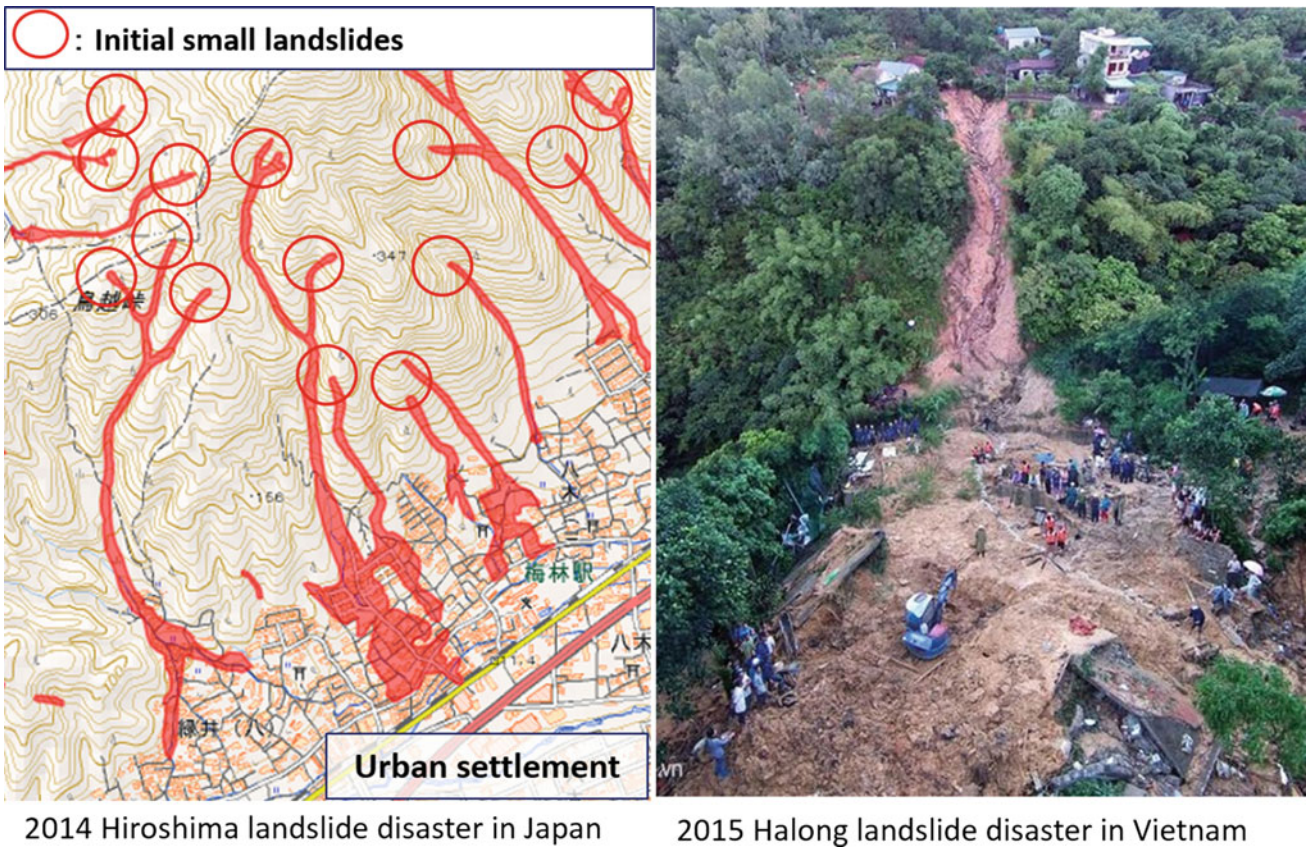

Fig. 2 Two examples of small-scale landslides due to extreme rainfall that destroyed human settlements at the toe of slopes in Japan and in Vietnam. Source of Landslide distribution: Geospatial Information Authority of Japan (GSI) Red circles showing the locations of the initial small landslides are added by K. Sassa. Source of UAV photo of Ha Long landslide: Vietnamese news company "Zing. vn"

trend of frequency of extreme rainfall, and the rate in Vietnam is one order higher than that in Japan. Climate change effects will be different in countries or regions.

Figure 2 presents recent typical landslide disasters in Japan and Vietnam in 2014 and in 2015. Local heavy rainfall (the maximum rainfall was 121 mm/h, and 217 mm for 3 h) deluged urban areas of Hiroshima city. Many small-scale shallow landslides occurred in the mountains (shown by red circles in the left figure). As they flowed down they increased in volume, and destroyed urban settlements and killed 66 persons in this area. A shallow landslide triggered by heavy rainfall (the maximum rainfall was 87 mm/h, 277 mm for 5 h) in Ha Long city and the landslide debris destroyed three houses and killed eight people as shown in the right figure.

Global Promotion of Understanding and Reducing Landslide Disaster Risk

The ICL and signatory organizations of the Sendai Partnerships 2015–2025 wish to voluntarily commit to the Sendai framework for disaster risk reduction 2015–2030 and the United Nations Sustainable Development Goals No.11 *"Make cities and human settlements inclusive, safe, resilient and sustainable."*

The successful result of each item proposed in the Sendai Partnership cannot be achieved without close cooperation with the signatory organizations and other related organizations. In order to plan the milestones of the Sendai Partnership, ICL and Sendai Partnership groups are organizing a High-Level Panel Discussion on May 30, 2017 as a Plenary session of the Fourth World Landslide Forum in Ljubljana, Slovenia:

High-Level Panel Discussion "Strengthening Intergovernmental Network and the International Programme on Landslides (IPL) for *"ISDR-ICL SENDAI PARTNERSHIPS 2015–2025 for global promotion of understanding and reducing landslide disaster risk"*

Objectives: The International Programme on Landslides (IPL) is a programme of the International Consortium on Landslides (ICL). ICL proposed the IPL in a thematic session of the Second World Conference on Disaster Reduction (WCDR) in Kobe, 2005. The activities of IPL were defined in the 2006 Tokyo Action Plan "Strengthening research and learning on landslides and related earth system disasters for global risk preparedness" at the Round Table Discussion held in Tokyo, 2006. IPL was supported by seven global stakeholders—UNESCO, WMO, FAO, UNISDR, UNU, ICSU, and WFEO, and ICL exchanged Memorandums of Understanding to promote the Tokyo Action Plan with each of them in 2006.

The activities of IPL include the triennial organization of the World Landslide Forum, the implementation of various IPL Projects, identification of World Centres of Excellence on Landslide Risk Reduction (WCoE), and the publication of the ICL bimonthly journal Landslides. Based on this background, ICL proposed the ISDR-ICL Sendai Partnerships 2015–2025 for global promotion of understanding and reducing landslide disaster risk at the 3rd WCDRR in Sendai, 2015 which was accepted and signed by 17 global and national stakeholders, including the governments of Croatia, Italy and Japan. This high-level panel discussion aims to strengthen networking with governments in landslide-prone countries and governments supporting landslide disaster risk reduction efforts in developing countries. The close cooperation within governments, United Nation Organizations and International NGOs is necessary and effective to implement the ISDR-ICL Sendai Partnerships 2015–2025 and the International Programme on Landslides (IPL) in its infrastructure.

Following the discussion result in the high-level panel discussion, a **Round Table Discussion on the follow-up of the high-level panel discussion and implementation planning** will be held at 13:30–17:30 on May 31, 2017 at Club CD as a parallel session. Representatives of 17 signatory organizations, ICL-IPL members, and potential new members of the Sendai Partnerships are invited. All participants will examine an action plan/road map/Addendum to

the Partnerships to implement and further develop the Sendai Partnerships, effectively contributing to the SENDAI Framework for Disaster Risk Reduction. At the end of the session, signing to the Sendai Partnerships by new members may be organized. To strengthen the Sendai Partnerships cooperation network, we wish to invite new signatory organizations and also the new members of ICL. Those organizations are invited to the high-level panel discussion and also the round-table discussion.

The WLF4 will publish five volumes of books. Volumes 2–5 are the proceedings of technical papers presented at the forum. Volume 1 includes **Part 1 ISDR-ICL Sendai Partnerships**: (1) three forum lectures (Rupestrian world heritage sites at landslide risk, Subaerial landslide-generated (tsunami) waves, Rock fall occurrence and fragmentation) to present leading landslide issues, (2) Contribution of signatory organizations to provide basic information for the high-level panel discussion, (3) a planning initiative from ICL to Sendai Partnerships to create "Landslide Dynamics-ISDR-ICL Landslide Interactive Teaching Tools (LITT)" to broaden the availability of landslide technologies for landslide risk reduction for capacity development, and to examine the initial stage of "ICL World Report on Landslides" to share landslide information and technologies within WRL contributors and users. **Part 2 International Programme on Landslides (IPL)** is a programme of ICL contributing to ISDR with support from seven global stakeholders. IPL consists of IPL projects proposed and implemented by ICL member organizations, and the activities of World Centres of Excellence on Landslide Risk Reduction (WCoEs), which are updated at the triannual world landslide forum. **Part 3** includes papers from the Session 3 Landslides and Society.

Vol. 1 Sendai Partnerships 2015–2025 will be published initially as a free online access book and then as a printed book distributed to all participants in the Fourth World Landslide Forum. We would like to ask the readers of this volume to join this voluntary commitment to the Sendai Framework for Disaster Risk Reduction. Such support shall promote and enable the realization of many of the difficult tasks proposed in the Sendai Partnerships.

Call for Cooperation

ICL acknowledges the dedicated support from ICL's many supporting organizations and cooperating individuals for the International Programme on Landslides (IPL) including the editing and publication of an international journal "Landslides: Journal of International Consortium on Landslides," and we request further support for ICL and IPL and the activities of the Sendai Partnerships. Those organizations and individuals are invited to the Fourth World Landslide Forum and the high-level panel discussion on May 30, 2017 and the round-table discussion to follow on May 31, 2017, to join this global initiative 2015–2025. Information on the Fourth World Landslide Forum is uploaded at the WLF4 website: https://www.wlf4.org/. Inquiries and cooperation for the Sendai Partnerships 2015–2025 should be addressed to the ICL Secretariat secretariat@iclhq.org.

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