International Forum
“Japanese contribution to Landslide Disaster Risk Reduction”

Sendai Partnership 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk
Science and Technology Research Partnership for Sustainable Development (SATREPS)

24 November 2016, Tokyo, Japan

Organized by
International Consortium on Landslides (ICL) and Japan Landslide Society (JLS)

Supported by
Japan Science and Technology Agency (JST) and United Nations Educational, Scientific and Cultural Organization (UNESCO)
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Programme

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Organized by
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the Japan Landslide Society (JLS)

Supported by
the Japan Science and Technology Agency (JST) and
the United Nations Educational, Scientific and Cultural Organization (UNESCO)

Date: 9:00-18:00 on 24 Nov 2016
Venue: 22nd at TKP Tokyo Otemachi Conference Center in the KDD building in Tokyo, Japan (http://www.kashikaigishitsu.net/facilitys/cc-tokyo-otemachi/access/)

Aim of the Conference:

The International Consortium on Landslides (ICL) proposed the “Sendai Partnerships 2015–2025 for global promotion of understanding and reducing landslide disaster risk” in contribution to the Third UN World Conference on Disaster Risk Reduction. The proposal goes into effect by the signature of ICL, Special Representative of Secretary General of the United Nations, UNESCO, Cabinet office and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of the Government of Japan and other 17 organizations in Japan and overseas. This partnership was significantly gained from the implementation of JICA and JST Joint funded SATREPS projects.

At this conference, we will introduce the results of SATREPS project in Croatia (2009-2014) and in Vietnam (2011-2017), and other SATREPS and JICA projects in Malaysia, Butan and Honduras. Then, we will examine further Japan’s international contribution for the landslide disaster reduction as a part of Sendai Partnerships 2015-2025.

ICL and UNESCO, UNISDR, and other ICL supporting organization will organize the Fifth World Landslide Forum (WLF5) in Kyoto, Japan. This conference is the mid-term milestone of

### Programme of Tokyo Forum

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
</table>
| 9:00-9:20  | **Opening session**  
Collaboration Between UNESCO and ICL by Mr. Qunli Han, Director of the Division of Ecological and Earth Sciences of UNESCO  
Objective of the Forum by Prof. Kyoji Sassa, Executive Director of ICL |
| 9:20-9:40  | JST - JICA International Scientific and Technical Cooperation SATREPS Projects |
| 9:40-10:00 |Achievements of Vietnam-Japan SATREPS Project (2011.11-2017.3)  
*Prof. Kyoji Sassa (Project Leader, ICL)* |
| 10:00-10:15|Impact of the Project to the Vietnam Society and Output of Mapping Group  
*Dr. Dinh Van Tien (Project Manager, Vietnam Institute of Transport Science and Technology)* |
| 10:15-10:30|Output of Monitoring Group  
*Dr. Hirotaka Ochiai, Dr. Shiho Asano* |
| 10:30-10:45|2. Risk identification and land-use planning for disaster mitigation of landslides and floods in Croatia  
Output of Croatia Project  
*Prof. Hideaki Marui* |
| 10:45-11:00|Report from Croatia Landslide Group  
*Prof. Zeljko Arbanas (Rijeka University)* |
| 11:00-11:15|Report from Hazard Mapping Group  
*Prof. Snjezana Mihalic-Arbanas (Zagreb University)* |
### 3. Research on Disaster Reduction by Landslides and Floods in Malaysia

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:15-11:30</td>
<td>Outline of the Project&lt;br&gt;Prof. Hiroshi Fukuoka</td>
</tr>
</tbody>
</table>

### 4. Study on GLOFs (Glacial Lake Outburst Floods) in the Bhutan Himalayas

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:30-11:45</td>
<td>Outline of the Project&lt;br&gt;Prof. Dasuke Higakii</td>
</tr>
</tbody>
</table>

### Another International Landslide Projects

#### 5. Research on Landslide Hazard Map in Honduras

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:45-12:00</td>
<td>Report on Hazard Map Training.&lt;br&gt;Dr. Kiyoharu Hirotao</td>
</tr>
</tbody>
</table>

#### 6. UNESCO ENHANS project in Peru, Ecuador and Chile (GIS landslide mapping)

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00-12:15</td>
<td>Report on training of the hazard mapping&lt;br&gt;Prof Hiromitsu Yamagishi</td>
</tr>
</tbody>
</table>

### Comment on Future Activities on SATREPS and Landslide Activities

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:15-12:30</td>
<td>Giuseppe Arduino&lt;br&gt;Division of Water Sciences, International Hydrological Programme (IHP), UNESCO</td>
</tr>
<tr>
<td>12:30-14:00</td>
<td>Working Lunch (UNESCO and other Invited foreign Researchers and officers from Croatia and Vietnam Embassy) in Room 22 C (next door)</td>
</tr>
</tbody>
</table>

### Round Table Meeting on Sendai Partnerships

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00-14:20</td>
<td>- Greeting from Ministry of Land, Infrastructure, Transport and Tourism of Japan (Mr. Shinichi Kusano)&lt;br&gt;- Greeting from Ministry of Education, Culture, Sports, Science and Technology (Mr. Yamato Tanaka)&lt;br&gt;- Greeting from Vietnam Institute of GeoSciences and Mineral Resources (Mr. Le Quoc Hung)</td>
</tr>
</tbody>
</table>

### Introduction of Internationally Acknowledged Techniques and Practices (Private Sectors and Researchers)

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:20-14:35</td>
<td>World Landslide Forum 4 and Introduction of 8 Japanese Landslide Techniques&lt;br&gt;Prof. Kyoji Sassa</td>
</tr>
<tr>
<td>14:35–15:35</td>
<td>Private companies working on landslide (technical)</td>
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<tr>
<td>15:35-15:50</td>
<td>Break</td>
</tr>
<tr>
<td>Time</td>
<td>Session</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>15:50-17:40</td>
<td>Panel discussion (Japanese contribution on landslide DRR)</td>
</tr>
<tr>
<td></td>
<td>Chairs: Prof. Kaoru Takara, Mr. Qunli Han, Prof. Yamagishi</td>
</tr>
<tr>
<td></td>
<td>1. Activities of ICL for implementation of Sendai partnership, increasing</td>
</tr>
<tr>
<td></td>
<td>signatures; Landslide Dynamics: ISDR-ICL Interactive Teaching Tools;</td>
</tr>
<tr>
<td></td>
<td>ICL World Reports on Landslides</td>
</tr>
<tr>
<td></td>
<td>Prof. Kyoji Sassa</td>
</tr>
<tr>
<td></td>
<td>2. UNESCO’s activities to implement Sendai Partnership</td>
</tr>
<tr>
<td></td>
<td>Mr. Qunli Han/Mr. Giuseppe Arduino</td>
</tr>
<tr>
<td></td>
<td>3. Proposal for new joint research between Japan and Viet Nam</td>
</tr>
<tr>
<td></td>
<td>Dr. Hung Le Quoc (VIGMR)</td>
</tr>
<tr>
<td></td>
<td>4. Planning on the 5th world landslide forum in Japan in 2020</td>
</tr>
<tr>
<td></td>
<td>5. World Bosai Forum in Sendai 2017 by Prof. Ono</td>
</tr>
<tr>
<td></td>
<td>6. Prof. Snjezana Mihalic-Arbanas (ICL Adria Balkan Network Coordinator)</td>
</tr>
<tr>
<td></td>
<td>7. Free discussion time</td>
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<tr>
<td>17:40-18:00</td>
<td>Closing: Toward further development of the Japanese contribution to</td>
</tr>
<tr>
<td></td>
<td>Landslide Disaster Risk Reduction</td>
</tr>
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<td></td>
<td>Prof. Kaoru Takara, Mr. Qunli Han and Prof. Hiromitsu Yamagishi</td>
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</tbody>
</table>

Contact on the Tokyo Forum

ICL Secretariat <secretariat@iclhq.org>  Tel: 075-723-0640
Kyoji Sassa <sassa@iclhq.org>  Tel: 090-8758-1405
ICL WEB: http://icl.iplhq.org/category/home-icl/
IPL WEB: http://iplhq.org/
国際フォーラム「地すべり災害リスク軽減への日本の貢献」

地すべり災害の理解と軽減のための仙台パートナーシップ 2015-2025と
地球規模課題対応国際科学技術協力 SATREPS）プログラム

主催：国際斜面災害研究機構、日本地すべり学会
後援：科学技術振興機構、ユネスコ
日時：平成28年11月24日 9:00-18:00
場所：TKP 東京大手町コンファレンスセンター（KDDI大手町ビル22階）

目的：ICL グループでは、第3回国連防災世界会議への自発的貢献として「地すべり災害リスクの理解と軽減を
推進するための仙台パートナーシップ 2015-2025」を提案し、採択された。ICL、ユネスコ、国際防災戦略事務局、
内閣府、文部科学省ほか国内外の17機関の署名を得て、発効している。このパートナーシップの成立は、地す
べりに関する SATREPS プログラムの実施によるところが大きい。今回の会議では、過去の SATREPS プロジェクト、
今後のプロジェクト、JICA-JST その他の fund を得た国際地すべり協力プログラム、今後の日本の地すべり災害危
険度軽減分野での国際貢献・推進方策を検討する。特に 2020 年 9 月に、新潟市において第5回斜面防災世界
フォーラム(WLF5)を実施することが決まっている。

国内外の研究者・アドバイザーとともに仙台パートナーシップの中間年(2020年)と同年に開催する第5回斜面防
災世界フォーラム(WLF5)において、日本において発達してきた地すべり災害予測・軽減技術に基づいて、地す
べり災害軽減分野での日本の国際貢献と日本の研究者・研究機関・民間企業と個人の世界展開の推進策につ
いての枠組みを検討する。

プログラム

国際フォーラム「地すべり災害リスク軽減への日本の貢献」

オープニング・セッション

| 9:00-9:20 | 国際フォーラム来賓挨拶 | UNESCO と ICL の協力
                      | 国際フォーラム開会・趣旨説明 | ユネスコ生態学・地球科学部長 Quinli Han
                      |                               | 仙台パートナーシップと SATREPS プロジェクト
                      |                               | 国際斜面災害研究機構理事長・佐々恭二

JST-JICA 地球規模課題対応国際科学技術協力 SATREPS プロジェクト (スクール形式)

| 9:20-9:40 | SATREPS 採択
            | + JST SATREPS 防災領域座長・實 蒟（京都大学防災研究所長）
            | + JICA 地球環境部防災第一課長 植木雅浩
            | 駐日クロアチア共和国大使館 大使 Dražen Hrastić
            | 駐日ベトナム社会主義共和国大使館 参事官（科学技術担当）Bui Viet Khoi

1 | ベトナムにおける幹線交通網沿いの斜面災害危険度評価技術の開発

| 9:40-10:00 | 佐々恭二（プロジェクトリーダー：ICL）：ベトナムプロジェクト 2011.11-2017.3 の成果

| 10:00-10:15 | Dinh van Tien（プロジェクト・マネージャー・地形班リーダー、ベトナム交通科学研究所）：
                      | ベトナム側からみたプロジェクトの成果と地形班の成果

| 10:15-10:30 | 落合博貴・浅野志穂（計測班リーダー/副リーダー・森林総合研究所）：計測班の成果

2 | クロアチア土砂・洪水災害軽減基本計画構築
<table>
<thead>
<tr>
<th>時間</th>
<th>トピック</th>
</tr>
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<tbody>
<tr>
<td>10:30-10:45</td>
<td>丸井英明（プロジェクトリーダー:新潟大学）:クロアチアプロジェクト2009.3-2014.3の成果</td>
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<td>10:45-11:00</td>
<td>Zeljko Arbanas (地すべりグループリーダー・リエカ大学):地すべり班の成果</td>
</tr>
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<td>11:00-11:15</td>
<td>Snejzana Mihalic-Arbanas (災害危険地図リーダー・ザグレブ大学):災害危険地図班の成果</td>
</tr>
<tr>
<td>11:15-11:30</td>
<td>福岡浩 (地すべり班:新潟大学):マレーシアプロジェクトにおける地すべり研究</td>
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<tr>
<td>11:30-11:45</td>
<td>桧垣大介 (不安定斜面班:弘前大学):SATREPS ブータンプロジェクトにおける地すべり研究</td>
</tr>
<tr>
<td>11:45-12:00</td>
<td>广田清治 (国斜面災害研究機構):ホンジュラスプロジェクトにおける地すべりハザードマップ指導</td>
</tr>
<tr>
<td>12:00-12:15</td>
<td>国土交通省砂防計画課砂防計画調整官・草野愼一:日本の地すべり技術の世界展開を推進するための新技術・国際貢献可能な確立された技術・事例紹介 - 地すべり関連企業・研究者</td>
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<tr>
<td>12:15-12:30</td>
<td>Giuseppe Arduino (ユネスコ水科学部生態水文学・水質・水教育課長):ISDR-ICL 仙台パートナーシップの推進 2015-2025 (円卓会議形式)</td>
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<tr>
<td>12:30-14:00</td>
<td>ウィニングランチ (会議室22C)</td>
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<tr>
<td>14:00-14:20</td>
<td>国土交通省砂防計画課砂防計画調整官・草野愼一:日本の地すべり技術の世界展開を推進するための新技術・国際貢献可能な確立された技術・事例紹介 - 地すべり関連企業・研究者</td>
</tr>
<tr>
<td>14:20-14:35</td>
<td>佐々恭二:第4回斜面防災世界フォーラム (2017年5月29日～6月2日 スロベニア国リブリアナ市)開催とそのProceedingへの日本の地すべり技術紹介 8社の紹介</td>
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<td>14:35-15:35</td>
<td>(株)マルイ:リングせん断試験機(圆井健敏:代表取締役、碇祐次)</td>
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<td>15:35-15:50</td>
<td>休憩</td>
</tr>
<tr>
<td>15:50-17:40</td>
<td>パネル討論「地すべり災害軽減への日本の貢献」</td>
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<td>司会:寶馨、Qunli Han、山岸宏光</td>
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</tbody>
</table>

1. 佐々恭二: 仙台パートナーシップ 2015-2025 の推進に向けた ICL の取り組み
- 第4回斜面防災世界フォーラムにおける仙台パートナーシップ (SP) の推進のためのハイレベルパネル討論と強化のための追加署名
- 地すべり技術の世界標準化と普及に向けた地すべり教材 (Landslide Dynamics: ISDR-ICL Interactive Teaching Tools) (テキスト＋PPT＋PDF) の作成
- 世界地すべりレポート (WEB: ICL World Reports on Landslides) の構築

2. Qunli Han/Giuseppe Arduino: 仙台パートナーシップ 2015-2025 の推進に向けたユネスコの取り組み

3. 仙台パートナーシップの一環としての豪雨時表層すべりの災害軽減に向けた日越共同研究の提案
   Hung Le Quoc (VIGMR): ベトナムの地すべりと日越共同研究プロジェクトの提案

4. 第5回斜面防災世界フォーラム (2020年11月、京都市) の組織: 12年ぶりの日本開催、仙台パートナーシップ 2015-2025 中間年、仙台防災枠組 2015-2030 のレビュー年における日本のプレゼンスの増大に向けた取り組み
   （会議組織に参画する機関と個人のネットワークの構築）

5. 小野裕一（東北大学災害科学国際研究所・所長補佐）: 仙台市における隔年開催の世界防災フォーラムの準備について

6. Snjezana Mihalic-Arbanas (ICL Adria Balkan Network Coordinator): クロアチプロジェクトと外務省主催の「防災分野（斜面災害）における南東欧地域の協力促進に向けたワークショップ」 (2010年12月14-17日、於: 外務省三田共用会議所) を受けて、設立された ICL のアドリア・バルカンネットワーク（スロベニア3機関、クロアチア2機関、セルビア1機関、アルバニア1機関、ボスニア・ヘルツェゴビナ1機関の8機関が加盟）について

7. 会議は円卓会議方式です。討論では、時間の範囲で自由に話してください。
   ICL 会議、クロアチア、ベトナム SATREPS プロジェクト研究に参加して（飯塚昌、木村直子、藤田久美子、永井修、Pham Tien、Hendy Setiawan、Nguyen Duc Ha）、参加者からのその他のコメント、「地すべり災害軽減への日本の貢献」、「第5回斜面防災世界フォーラム」組織への協力表明など

<table>
<thead>
<tr>
<th>17:40-18:00</th>
<th>「地すべり災害軽減への日本の貢献」の増大に向けて</th>
</tr>
</thead>
<tbody>
<tr>
<td>寶馨、Qunli Han、山岸宏光</td>
<td></td>
</tr>
</tbody>
</table>
## Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISDR-ICL Sendai Partnerships 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>International Forum “Japanese contribution to Landslide Disaster Risk Reduction”</td>
<td>Kyoji Sassa</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Science and Technology Research Partnership for Sustainable Development (SATREPS)</td>
<td>Kaoru Takara</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Greeting from Embassy of the Socialist Republic of Vietnam</td>
<td>Bui Viet Khoi</td>
<td>31</td>
</tr>
<tr>
<td>5</td>
<td>Objectives and Achievements of Vietnam-Japan SATREPS Project</td>
<td>Kyoji Sassa</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>Impact of the Project to the Vietnam Society and Output of Mapping Group</td>
<td>Dinh Van Tien</td>
<td>43</td>
</tr>
<tr>
<td>7</td>
<td>Monitoring system in Hai Van and landslide flume construction in ITST, Vietnam</td>
<td>Hirota Ochiai, Shiho Asano</td>
<td>51</td>
</tr>
<tr>
<td>8</td>
<td>Instruction and Essential Outputs of the Croatian-Japanese Research Project on Landslides</td>
<td>Hideaki Marui</td>
<td>63</td>
</tr>
<tr>
<td>10</td>
<td>Japanese - Croatian satreps FY2008 project 2009-2014 ‘Hazard maps and land-use guidelines’ (Working group 3)</td>
<td>Snjezana Mihalic-Arbanas</td>
<td>103</td>
</tr>
<tr>
<td>11</td>
<td>SATREPS Project for “Research and Development for Reducing Geo-Hazard Damage in Malaysia Caused by Landslide and Flood” 2011 – 2016</td>
<td>Hiroshi Fukuoka</td>
<td>120</td>
</tr>
<tr>
<td>12</td>
<td>Study on Glacial Lake Outburst Floods in the Bhutan Himalayas</td>
<td>Dasuke Higaki</td>
<td>144</td>
</tr>
<tr>
<td>14</td>
<td>Landslide Mapping Education Programs in Latin America-CEPEIGE (ECUADOR) and UNESCO ENHANS PROJECT(PERU)</td>
<td>Hiromitsu Yamagishi</td>
<td>166</td>
</tr>
<tr>
<td>15</td>
<td>World Landslide Forum 4 and Introduction of 8 Japanese Landslide Techniques</td>
<td>Kyoji Sassa</td>
<td>178</td>
</tr>
<tr>
<td>No</td>
<td>Company Name</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>MARUI &amp; Co., LTD</td>
<td>181</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Okuyama Boring Co., LTD</td>
<td>190</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Japan Conservation Engineers &amp; Co., LTD</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>GODAI Development Corporation</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>OSASI Technos INC.</td>
<td>207</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>OYO Corporation Instruments &amp; Solution Division</td>
<td>211</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>PROTEC Engineering, INC.</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>SABO &amp; Landslide Technical Center</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Hazama Ando Corporation</td>
<td>224</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>ASIA Air Survey Co., LTD</td>
<td>228</td>
<td></td>
</tr>
</tbody>
</table>
| 26 | Activities of ICL for implementation of Sendai partnership, increasing signatures; Landslide Dynamics : ISDR-ICL Interactive Teaching Tools; ICL World Reports on Landslides  
  *Kyoji Sassa* | 237  |
| 27 | Landslides in Vietnam and the needs to develop the landslide risk assessment technology  
  *Hung Le Quoc* | 246  |
| 28 | World Bosai Forum in Sendai 2017  
  *Yuichi Ono* | 258  |
| 29 | List of Participants                              | 268  |
At the 2nd United Nations World Conference on Disaster Reduction, which was held in Kobe, Japan, on 18-22 January 2005, the International Consortium on Landslides (ICL) co-organized a session which resulted in a global partnership and platform taking a holistic approach to research and learning on 'Integrated Earth system risk analysis and sustainable disaster management'. This partnership was forged through a “Letter of Intent”, that was signed by UNESCO, UNISDR, WMO, FAO, UNU, ICSU, and WFEO. It further led to the adoption and implementation of the 2006 Tokyo Action Plan, thus creating a global partnership on Landslides, i.e., the current International Programme on Landslides (IPL) of ICL.

At the 3rd World Conference on Disaster Risk Reduction (WCDRR), which was convened by the United Nations and hosted by Japan in Sendai from 14 to 18 March 2015, the ICL and its IPL contributed further to the UN International Strategy for Disaster Reduction (ISDR) and co-organized the Working Session “Underlying Risk Factors” together with UNESCO, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and other pertinent organizations.

At the Working Session, the causes that create risk and their cumulative effects, as well as the relevant achievements of the Hyogo Framework for Action 2005-2015, were reviewed. Steps to address the principal drivers of vulnerability and exposure and to support hazard and risk assessment were suggested. In addition, the participating scientific and academic institutions and governmental and non-governmental organizations proposed that the Sendai Partnerships 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk be established. This sound global platform will be mobilized in the coming decade to pursue prevention, to provide practical solutions, education, communication, and public outreach to reduce landslide disaster risk. These Partnerships will engage all significant stakeholders concerned with the challenge of understanding and reducing disaster risk, including relevant international, national, local, governmental, and non-governmental institutions, programmes and initiatives. The Partnerships will focus on delivering tangible and practical results that are directly related to the implementation of the goals and targets of the post-2015 Framework for Disaster Risk Reduction.

The Sendai Partnerships 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk are hereby established. They represent Tools for Implementing and Monitoring the Post-2015 Framework for Disaster Risk Reduction and the Sustainable Development Goals.

Partners in the “Partnerships” adopt the following Resolution:

We acknowledge 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 to develop 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.

We further agree to advocate that activities should be balanced at regional, national, and community levels in order to empower and engage more professionals, practitioners and decision-makers in formulating policies and establishing programmes for the benefit of disaster risk reduction efforts.

We further agree that progress made in the contribution of the Sendai Partnerships 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk toward the implementation of the Post-2015 Framework for Disaster Risk Reduction will be reported and emerging challenges will be discussed every two years at the Global Platform for Disaster Risk Reduction in Geneva.

A Call for joining the Partnerships
Competent global, regional, national, and local institutions participating in the 3rd WCDRR and in the implementation of the Post-2015 Framework for Disaster Risk Reduction are invited to support this initiative by joining and signing these Partnerships through participation in clearly defined projects related to the issues and objectives of these Partnerships. The potential partners are requested to be in contact with the secretariat of the host organization.

Host Organization and Secretariat

The International Consortium on Landslides (ICL) hosts the Sendai Partnerships 2015-2025 as a voluntary commitment to the United Nations World Conference on Disaster Risk Reduction, Sendai, Japan. The ICL Secretariat in Kyoto, Japan, serves as the Secretariat of the Sendai Partnerships.

Signatories:

Mr. Kyoji Sasa
Executive Director
International Consortium on Landslides
Host organization of the Partnerships

Ms. Margareta Wahlström
Special Representative of the UN Secretary-General for Disaster Risk Reduction
Chief of UNISDR

Date 16 March 2015 in Sendai
Voluntary commitment to the World Conference on Disaster Risk Reduction
Sendai, Japan, 2015

Mr. Qunli Han
Director
Division of Ecological and Earth Sciences
United Nations Educational, Scientific and Cultural Organization
16 March 2015

Mr. Dominique Burgeon
Resilience Coordinator, Director
Emergency and Rehabilitation Division
Food and Agriculture Organization of the United Nations
16 March 2015

Mr. Kazuhiko Takeuchi
Senior Vice-Rector
United Nations University
16 March 2015

Mr. Petteri Taalas
Secretary-General
World Meteorological Organization
15.4.15

Mr. Gordon McBean
President
International Council for Science
16/03/2015

Mr. Toshimitsu Komatsu
Vice President
World Federation of Engineering Organizations
March 16, 2015

Mr. Roland Oberhansli
President
International Union of Geological Sciences
16/03/2015

Mr. Alik Imaïl-Zadeh
Secretary-General
International Union of Geodesy and Geophysics
16 March 2015, Sendai, Japan

Date

Date

Date

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

Mr. Kaoru Saito
Director
Disaster Preparedness and
International Cooperation Division
Disaster Management Bureau
Cabinet Office, Government of Japan

Date 16/03/2015

Mr. Hideaki Maruyama
Director
Office for Disaster Reduction Research
Ministry of Education, Culture, Sports,
Science and Technology, Japan

Date 16.03.2015.

Mr. Takashi Onishi
President
Science Council of Japan

Date March 16, 2015

Ms. Kayo Inaba
Executive Vice President for Gender
Equality, International Affairs, and
Public Relations
Kyoto University

Date 16.03.15

Mr. Prefetto Franco Gabrielli
Head
National Civil Protection Department
Italian Presidency of the Council of
Ministers
Government of Italy

Date 16.03.2015

Mr. Jadran Perinic
Director General
National Protection and Rescue Directorate
Republic of Croatia

Date 16.03.2015.

Mr. Walter Ammann
President/CEO
Global Risk Forum GRF Davos

Date 16 March 2015
ICL member organizations (as of 10 November 2016)

1. Albanian Geological Survey, ALBANIA
2. The Geotechnical Society of Bosnia and Herzegovina, BOSNIA AND HERZEGOVINA
4. China Geological Survey, CHINA P.R.
5. Institute of Cold Regions Science and Engineering, Northeast Forestry University, CHINA P.R.
6. Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, CHINA P.R.
7. Bureau of Land and Resources of Xi’an, China P.R.
8. Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, CHINA P.R.
9. Tongji University, College of Surveying and Geo-Informatics, CHINA P.R.
10. Universidad Nacional de Colombia, Colombia
11. Croatian Landslide Group from University of Rijeka and University of Zagreb, CROATIA
12. City of Zagreb, Emergency Management Office, CROATIA
13. Charles University, Faculty of Science, CZECH REPUBLIC
14. Institute of Rock Structure and Mechanics, Czech Academy of Sciences, Department of Engineering Geology, CZECH REPUBLIC
15. Joint Research Centre (JRC), EUROPEAN COMMISSION
16. Cairo University, EGYPT
17. Technische Universitat Darmstadt, Institute and Laboratory of Geotechnics, GERMANY
18. Department of Geology of National Environmental Agency of Georgia, GEORGIA
19. Universidad Politecnica de Ingenieria, UPI, HONDURAS
20. Instituto Hondureño de Ciencias de la Tierra, IHCIT /Universidad Nacional Autónoma de Honduras UNAH, HONDURAS
21. National Institute of Disaster Management, New Delhi, INDIA
22. Amrita Vishwa Vidyapeetham, Amrita University, Tamilnadu, INDIA
23. Gadjah Mada University, INDONESIA
24. Parahyangan Catholic University, INDONESIA
25. Research Center for Geotechnology-Indonesian Institute of Sciences, INDONESIA
26. Building & Housing Research Center, IRAN
27. Soil Conservation and Watershed Management Research Institute, IRAN
28. University of Firenze, Earth Sciences Department, ITALY
29. ISPRA-Italian Institute for Environmental Protection and Research, ITALY
30. University of Calabria, Laboratory of Environmental Cartography and Hydraulic and Geological Modeling, ITALY
31. Istituto di Ricerca per la Protezione Idrogeologica (IRPI), of the Italian National Research Council (CNR), ITALY
32. Kyoto University, Disaster Prevention Research Institute, JAPAN
33. University of Tokyo, Geotechnical Engineering Group, JAPAN
34. Niigata University, Research Institute for Natural Hazards and Disaster Recovery, JAPAN
35. Forestry and Forest Product Research Institute, JAPAN
36. Japan Landslide Society, JAPAN
37. Korea Institute of Geoscience and Mineral Resources (KIGAM), REPUBLIC OF KOREA
38. Korea Forest Research Institute, REPUBLIC OF KOREA
39. Korea Infrastructure Safety & Technology Corporation, REPUBLIC OF KOREA
40. Korea Institute of Construction Technology, REPUBLIC OF KOREA
41. Korean Society of Forest Engineering, REPUBLIC OF KOREA
42. Slope Engineering Branch, Public Works Department of Malaysia, MALAYSIA
43. Institute of Geography, UNAM, MEXICO
44. International Centre for Integrated Mountain Development (ICIMOD), NEPAL
45. Department of Geology, University of Nigeria, Nsukka, NIGERIA
46. Norwegian Geotechnical Institute (NGI), Oslo, NORWAY
47. Grudec Ayar, PERU
48. Department of Engineering and Ecological Geology, Moscow State University, RUSSIA
49. JSC "Hydropotect Institute", RUSSIA
50. University of Belgrade, Faculty of Mining and Geology, SERBIA
51. Comenius University, Faculty of Natural Sciences, Department of Engineering Geology, SLOVAKIA
52. University of Ljubljana, Faculty of Civil and Geodetic Engineering (ULFGG), SLOVENIA
53. Geological Survey of Slovenia, SLOVENIA
54. University of Ljubljana, Faculty of Natural Sciences and Engineering (UL NTF), SLOVENIA
55. Central Engineering Consultancy Bureau (CECB), SRI LANKA
56. National Building Research Organization, SRI LANKA
57. Landslide group in National Central University from Graduate Institute of Applied Geology, Department of Civil Engineering, Center for Environmental Studies, CHINESE TAIPEI
58. National Taiwan University, Department of Civil Engineering, CHINESE TAIPEI
59. Ministry of Agriculture and Cooperatives, Land Development Department, THAILAND
60. Asian Disaster Preparedness Center, THAILAND
61. Institute of Telecommunication and Global Information Space, UKRAINE
62. California State University, Fullerton, USA & Tribhuvan University, Institute of Engineering, Nepal, USA/NEPAL
63. Institute of Transport Science and Technology, Ministry of Transport, VIET NAM
64. Vietnam Institute of Geosciences and Mineral Resources, Ministry of Natural Resources and Environment, VIET NAM
地すべり災害リスクの理解と軽減を地球規模で推進するための
国際防災戦略(ISDR) – 国際斜面災害研究機構(ICL) 仙台パートナーシップ 2015 - 2025

ポスト 2015 年防災枠組みと持続可能な開発目標の実施と進行管理のためのツール

2005年1月18日～22日にかけて神戸市で開催された第2回国連防災世界会議において国際斜面災害研究機構（ICL）はセッションを共催し、「統合地球システムの危険度解析と持続可能な災害管理」の研究と学習への総括的アプローチを行うための地球規模のパートナーシップとプラットフォームを構築した。このパートナーシップは、国連教育科学文化機関（UNESCO）、国連国際防災戦略事務局（UN-ISDR）、世界気象機関（WMO）、国連食糧農業機関（FAO）、国連大学（UNU）、国際科学会議（ICSU）、世界工学団体連盟（WFEO）らと同意書を交換することにより成立した。これはさらに2006年に「東京行動計画」を採択し、実施することを通じて地すべりに関する地球規模のパートナーシップを構築することにつながった。これに伴い、ICLが現在実施している国際斜面災害研究計画（IPL）である。

国連が主催し日本政府がホストして2015年3月14日から18日まで仙台で開催された第3回国連防災世界会議において、ICLと、そのプログラムであるIPLは、ワーキングセッション「潜在的リスク要因」をユネスコ、国土交通省、および他の該当する機関と共催し、さらに国際防災戦略に貢献した。

このワーキングセッションにおいては、兵庫行動枠組み2005-2015に関連する成果についてレビューを行うとともに、災害リスクの原因とそこから派生する様々な影響について検討を行った。脆弱性と危険への露出をもたらす主な要因を概観し、災害を引き起こす自然現象とその危険度評価を推進するための道程を提案した。また、ここに参加した科学・学術機関、政府・非政府機関らが、「地すべり災害の理解と軽減を地球規模で推進するための国際防災戦略(ISDR) – 国際斜面災害研究機構(ICL) 仙台パートナーシップ 2015 - 2025」を提案した。これに伴う地球規模のプラットフォーム（仙台パートナーシップ）は、将来10年間にわたり、災害予防を追求し、地すべり防災のための実務的な解決策を提供するとともに、防災教育・情報提供・公共へのアウトリーチに活用されることとなる。このパートナーシップは、災害リスクの理解と軽減に関心を持つすべての関係者、すなわち、国際・各国・地方の政府機関及び非政府機関、各種プログラム・イニシアチブ、の参画を求めるものである。このパートナーシップは、ポスト2015年防災枠組みの目的と目標の実施に直接寄与するような確実かつ実務的な成果をもたらすことに焦点を当てる。

「地すべり災害リスクの理解と軽減を地球規模で推進するための仙台パートナーシップ 2015 - 2025」をここに設立する。このパートナーシップは、ポスト2015年防災枠組みと持続可能な開発目標の実施と進行管理のためのツールとならんとするものである。

パートナーシップに参加する各パートナーは以下の決議を採択する。
我々は下記の各項目を認識している：

- 地すべり災害は、山地、都市域、沿岸域、島嶼部に存在する脆弱な居住地が、土と水の危険な変動にさらされることにより引き起こされること。
- 気候変動は、地すべりが発生し得る地域において、豪雨の頻度あるいは規模の増大、発生場所、期間の変動によって、地すべりの危険性を増大させる。
- 山地と沿岸域における開発、それは道路や鉄道の建設によってもたらされるものであり、そして、人口移動に伴う都市域の拡大は、地すべりへの露出を増大させている。
- 頻繁ではないものの、大地震は危険な高速長距離運動地すべりや液状化を引き起こすことがある。地震が誘発する沿岸域や海面下の大規模地すべり、そして海底巨大地すべり（数百mから千mの深さの一つ）は巨大な津波を引き起こす可能性がある。このような危険な土塊や水塊の衝撃が、脆弱な人々を直撃した場合には、大変壊滅的な被害をもたらすかもしれない。
- 降雨、地震および火山噴火等の複数の誘因が同時に作用する場合には、ラハール（火山泥流）、土石流、落石、巨大地すべりなどの壊滅的な地すべりが発生し、より大規模な衝撃を与えかねない。
- 地すべり災害の理解のためには、複合災害の観点と社会的・制度的な脆弱性に注目することが必要である。地すべり災害の規模を事前にアセスし、効果的な対応策を立案するには、社会的・制度的そして物理的な脆弱性についての研究が必要となる。

我々は以下の社会的・財政的投資を伴う研究と能力開発に関する初期の協力分野について合意した。

- 地すべりに関して発災時期、発災場所の両面でより高い精度と信頼性を持った、人間を中心にした早期警報技術を、気候変動下にあることに特に留意しつつ開発すること。
- 複数種の災害の特定と災害対策の一環として、より高い精度と信頼性をもつ、危険な自然現象の及び発生範囲と脆弱性を示す地図の作成および脆弱性・危険度評価技術を開発すること。
- 災害対策の有効性は災害リスク（危険な自然現象あるいは出来事と社会的脆弱性）の理解のための科学技術開発、政治的な関与、そして市民の防災意識と知識に依存する。
- 災害リスクの理解と軽減、特に社会的・制度的脆弱性を軽減するためには、高いレベルの社会的投資、財政投資が不可欠であり、政策・計画・研究・能力開発、そして途上国、先進国の誰もが無料でかつ容易に利用することができる出版物とツールの作成を統合的に組み合わせて実施することが必要である。
国連防災世界会議（日本国仙台市開催）への自発的貢献

ること。

地すべり災害危険度の理解のために、たとえば気候変動が大規模地すべり・土石流に与える影響、特に途上国における早期警戒と避難を実現するための局地的豪雨に対する有効な予知の方法、津波を引き起こしたり巨大化させたりする地震時海底地すべりの発生機構と動力学、壊滅的災害を引き起こす巨大地すべりの予知と災害予測のための地盤工学的研究、といった先端的研究を推進するための新たなイニシアチブを開発すること。

我々はさらに、これらの活動を地域レベル、国家レベル、コミュニティレベルでバランス良く実施し、より多くの専門家、実務家、意思決定者者全員にとって有益な政策の決定、プログラムの創設を推進することを提唱することに合意した。

我々はさらに、2年毎にジュネーブで開催される防災グローバルプラットフォームにおいて、「地すべり災害の理解と軽減を地球規模で推進するための仙台パートナーシップ 2015-2025」によるポスト2015防災枠組みへの貢献の進捗状況が報告され、今後現れるであろう種々の課題が議論されることについて合意した。

本パートナーシップへの参加の呼びかけ

第3回WCDRRに参加し、ポスト2015防災枠組みの実施に寄与する地球規模、地域規模、国家、地方レベルの能力のある諸機関は、本パートナーシップに参加・署名し、本パートナーシップに明瞭に定義された課題と目的に関連したプロジェクトへ参加し、このイニシアチブを支持することに招待されている。潜在的パートナーは、本パートナーシップのホスト機関にコンタクトされたい。

ホスト機関と事務局

国際斜面災害研究機構（ICL）が、国連世界防災会議（仙台、日本）に対する自発的貢献である仙台パートナーシップ2015-2025のホスト機関である。日本の京都に置かれているICL事務局が仙台パートナーシップの事務局を務める。

署名:
佐々恭二
理事長
国際斜面災害研究機構
仙台パートナーシップ主催機関

日付: 16/03/15

Ms. Margareta Wahlström
国連事務総長特別代表（防災担当）
国連国際防災戦略事務局

日付: 16 Mars 2015 in Seoul
国連防災世界会議（日本国仙台市開催）への自発的貢献

Mr. Qunli Han
部長
生態学地球科学部
国連教育科学文化機関
16 March 2015

Mr. Dominique Burgeon
緊急・復興支援部長
国連食糧農業機関
16 March 2015

武内和彦
上級副学長
国際連合大学
16 March 2015

Mr. Petteri Taalas
事務局長
世界気象機関
16 March 2015

Mr. Gordon McBean
会長
国際科学会議
16/03/2015

小松利光
副会長
世界工学団体連盟
March 16, 2015

Mr. Roland Oberhänsli
会長
国際地質科学連合
16/03/2015

Mr. Alik Ismail-Zadeh
事務局長
国際測地学地球物理学連合
16 March 2015, SENDAI, JAPAN
国連防災世界会議（日本国仙台市開催）への自発的貢献

齊藤 馨
内閣府政策統括官（防災担当）付参事官
（普及啓発・連携担当）

16/03/2015

16.03.2015

丸山秀明
室長
防災科学技術推進室
文部科学省

大西 隆
会長
日本学術会議

March 16, 2015

稲葉カヨ
副学長
男女共同参画・国際・広報担当
京都大学

Mr. Prefetto Franco Gabrielli
イタリア国家市民保護局長

16.03.2015

Mr. Jadran Perinici
クロアチア国家保護救済局長

Mr. Walter Ammann
創設者
グローバル・リスク・フォーラム（GRF）ダボス
16 March 2015

ISDR-ICL 仙台パートナーシップ 2015-2025 アネックス

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国連防災世界会議（日本国仙台市開催）への自発的貢献

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国際連合防災世界会議（日本国仙台市開催）への自発的貢献

| 19 | ホンジュラス | ホンジュラス国立自治大学地球科学研究所  
Universidad Politécnica de Ingeniería, UPI |
| 20 | ホンジュラス | ホンジュラス国立自治大学地球科学研究所  
Instituto Hondureño de Ciencias de la Tierra, IHCIT /Universidad Nacional Autónoma de Honduras UNAH, HONDURAS |
| 21 | インド | インド国立災害管理研究所  
National Institute of Disaster Management, New Delhi |
| 22 | インド | アムリタ大学  
Amrita University, Tamilnadu |
| 23 | インドネシア | インドネシア国ガジャマダ大学  
Gadjah Mada University |
| 24 | インドネシア | インドネシア国バライハンガントリック大学  
Parahyangan Catholic University |
| 25 | インドネシア | インドネシア科学院地盤工学研究センター  
Research Center for Geotechnology-Indonesian Institute of Sciences |
| 26 | イラン | イラン建築住宅研究センター  
Building & Housing Research Center |
| 27 | イラン | イラン土壌保全・流域管理研究所  
Soil Conservation and Watershed Management Research Institute |
| 28 | イタリア | イタリア国フローレンス大学応用地質学科  
University of Firenze, Earth Sciences Department |
| 29 | イタリア | イタリア環境保護研究所  
ISPRA-Italian Institute for Environmental Protection and Research |
| 30 | イタリア | イタリア国カラブリア大学  
UNIVERSITY OF CALABRIA, DIMES (Dipartimento di Ingegneria Informatica, Modellistica, Elettronica e Sistemistica) , CAMILAB (Laboratory of Environmental Cartography and Hydraulic and Geological Modeling) |
| 31 | イタリア | イタリア科学院水文地質保全研究所  
Istituto di Ricerca per la Protezione Idrogeologica (IRPI),of the Italian National Research Council (CNR) |
| 32 | 日本 | 京都大学防災研究所  
Kyoto University, Disaster Prevention Research Institute |
| 33 | 日本 | 東京大学(生産技術研究所, 地盤工学研究グループ)  
University of Tokyo, Institute of Industrial Science and Geotechnical Research Group |
| 34 | 日本 | 新潟大学災害復興科学研究所  
Niigata University, Research Institute for Natural Hazards and Disaster Recovery |
<p>| 35 | 日本 | 森林総合研究所 |</p>
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Forestry and Forest Product Research Institute

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<td>National Taiwan University, Department of Civil Engineering</td>
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<td>Taiwan, China</td>
<td>Landslide group in National Central University from Graduate Institute of Applied Geology, Department of Civil Engineering, Center for Environmental Studies</td>
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<td>59</td>
<td>Thailand</td>
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<td>Asian Disaster Preparedness Center (ADPC)</td>
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<td>California State University, Fullerton, USA &amp; Tribhuvan University, Institute of Engineering</td>
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<td>Institute of Transport Science and Technology</td>
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<td>Vietnam Institute of Geosciences and Mineral Resources, Ministry of Natural Resources and Environment</td>
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ISDR-ICL SENDAI PARTNERSHIPS 2015-2025

for global promotion of understanding and reducing landslide disaster risk

12:00-13:30 on 16 March 2015, JUNSEN, Sendai, Japan

Front (left to right): Sorrenti Ambra (for Franco Gabrielli, Italian Civil Protection), Irasema Alcantara-Ayala (for Gordon Mcbean, ICSU), Srikantha Herath (for Kazuhiko Takeuchi, UNU), Roland Oberhansli (IUGS), Kaoru Saito (Cabinet Office, Japan), Giuseppe Arduino (for Qunli Han, UNESCO), Kyoji Sassa (ICL), Margareta Wahlström (UNISDR), Dominique Burgeon (FAO), Robert Mikac (for Croatia Civil Protection), Takashi Onishi (Science Council of Japan), Alik Ismail-Zedeh (IUGG), Kaoru Takara (for Kayo Inaba, Kyoto University).

Back (left to right): Hiroshi Fukuoka (ICL), Nicola Casagli (ICL), Yuki Matsuoka (UNISDR), Alexandros Makarigakis (UNESCO), Toshimitsu Komatsu (WFEO), Satoru Nishikawa (Water Agency, Japan), Badaoui Rouhban (IPL-ICL), Paolo Canuti (ICL), Yueping Yin (ICL), Matjaz Mikos (ICL)

Left Bottom: Qunli Han (UNESCO) and Franco Gabrielli (Italian Civil Protection)
Left-top: Speech by Ms Margareta Wahlström celebrating the launch of the ISDR-ICL Sendai Partnerships 2015-2025.

Right-top: Originally designed sake cup for the cerebration of the Sendai Partnerships. Sake cup is a Japanese sumac lacquerware. ICL logo and the edge are pure Gold. ICL logo was designed by K. Sassa at the ICL foundation. I: Cultural heritage/building at landslide risk, C: Advancing Consortium (C is inclined during motion), L: Retaining wall for landslide disaster risk reduction

Bottom: Thanks for all partners by Mr. Kyoji Sassa and Toast for the success of the the ISDR-ICL Sendai Partnerships 2015
International Forum
“Japanese contribution to Landslide Disaster Risk Reduction”
Sendai partnership 2015-2025 for global promotion of understanding and reducing landslide disaster risk
Science and Technology Research Partnership for Sustainable Development (SATREPS)
Organized by ICL and the Japan Landslide Society
Supported by the Japan Science and Technology Agency (JST) and UNESCO
Kyoji SASSA
Executive Director of ICL

Aim of the Conference
• The International Consortium on Landslides (ICL) proposed the “Sendai Partnerships 2015-2025 for global promotion of understanding and reducing landslide disaster risk” in contribution to the Third UN World Conference on Disaster Risk Reduction. The proposal goes into effect by the signature of ICL, Special Representative of Secretary General of the United Nations, UNESCO, other 17 organizations in Japan and overseas. This partnership was significantly gained from the implementation of JICA and JST Joint funded SATREPS projects.
• We will introduce the results of SATREPS project in Croatia (2009-2014) and in Vietnam (2011-2017), and other SATREPS and JICA projects in Malaysia, Butan and Honduras. Then, we will examine further Japan’s international contribution for the landslide disaster reduction as a part of Sendai Partnerships 2015-2025.
• ICL and UNESCO, UNISDR, and others will organize the Fifth World Landslide Forum (WLF5) in Niigata, Japan. This conference is the mid-term milestone of the Sendai Partnerships 2015-2025 and the first five year milestone of the Sendai Framework for Disaster Risk Reduction 2015-2030. Participants will examine road map of the Sendai partnerships 2015-2025 to WLF5 2020.
An international Consortium on Landslides (ICL) was established during the UNESCO-Kyoto University Joint Symposium in 2002. Participants are from UNESCO (ADG:AS-Nagy), UNISDR (Pedro Basabe), WMO (DSG:Michel Jarraud), MOFA & MEXT, KU(Kaoru Takara), Japan and others.

High-Level Panel Discussion: Initiative to create a safer geoenvironment toward WCDR2015 and forward

High-level panel was chaired by Hans van Ginkel (Former Rector of UNU), UNESCO (Director-General Irina Bokova), UNISDR, WMO, ICSU/IRD, China Geological Survey, ICL together from floor discussed. The 2014 Beijing Declaration “Landslide Risk Mitigation: Toward a Safer Geoenvironment” was adopted on 6 June 2014 following this panel discussion, which was the preparation for the ISDR ICL Sendai Partnerships 2015-2025 to be adopted in Sendai 2015. 531 people, 211 national and international organizations from 40 countries and 5 organizations of United Nations System participated WLF3.
ISDR-ICL Sendai Partnerships 2015-2025 for global promotion of understanding and reducing landslide disaster risk

The partnerships was proposed by ICL and adopted in a session of “Underlying risk factors” of 3rd WCDRR in AM on 16 March 2015. It was agreed and signed by leaders of 16 UN, International and national organizations in PM on 16 March 2015 in Sendai, Japan. Signatories are ICL Executive Director, Ms. Margareta Wahlström (SRSG), and leaders of UNESCO, FAO, UNU, ICSU, WFEO, IUGS, IUGG, KU, SCJ, GRF and Japanese (Cabinet office and MEXT), Italian and Croatian Governments.
A method to assess landslide motion for vulnerability and Exposure for landslide risks: LS-RAPID simulation (Sassa et al. 2014) based on the landslide dynamics parameters of soils taken from the site.

2014.8 Hiroshima Landslide Disaster

A method to assess landslide-tsunami motion for vulnerability and exposure for integrated landslide-tsunami risk: LS-Tsunami (Sassa et al. 2016)

The Unzen-Mayuyama landslide-tsunami disaster in Japan. 15,000 people were killed by the landslide and its landslide-induced tsunami around Ariake Sea in 1792.
Science and Technology Research Partnership for Sustainable Development (SATREPS)

Kaoru Takara
SATREPS Research Supervisor
Japan Science and Technology Agency
November 24, 2016

About SATREPS
Nowadays, joint research efforts with Japan in science and technology are gathering much attention among developing countries.

Research focuses on 'GLOBAL ISSUES' that cannot be resolved by a single country or region.

Science & Technology × Official Development Assistance (ODA)

- Science and Technology: Promoting science and technology, encouraging innovation
- Meeting Global Needs: Resolving global issues and contributing to the science and technology community
- Japan’s Capabilities: World-leading technology, proven research capacity, soft power

- International Cooperation: ODA, development assistance
- Meeting Local Needs: Capacity development to address issues emerging as local needs in developing countries
- Developing Countries’ Capabilities: Direct experience, knowledge, and data needed for research on global issues, potential to contribute to the global economy through new markets and industries
**Project Scheme**

- **Developing Country (Counterpart)**
  - Universities, Research Institutions, etc.
  - Principal Investigators & Researchers
  - Request for Collaboration
  - Application Accepted

- **Japan**
  - Universities, Research Institutions, etc.
  - Principal Investigators & Researchers
  - Dispatch of Experts (Researchers from Japan)
  - Funds for research expenses (in the recipient country)
  - Project management & Evaluation

- **Ministry of Foreign Affairs (MOFA)**
  - Jointly Approve Projects
  - Collaboration/Cooperation
  - Complementary Funding

- **JICA**
  - Project Accepted
  - Project Proposal
  - Project Accepted

- **Japan Science and Technology Agency (JST)**
- **Agency for Medical Research and Development (AMED)**

※ SATREPS projects in the field of ‘Infectious Diseases Control’ have been transferred to AMED (Japan Agency for Medical research and Development).

**Programme Aims**

1. **Enhancing Cooperation in Science & Technology**
   ~Building win-win relationships between Japan and developing countries~

2. **New Technology, New Knowledge, Innovations**
   ~Addressing global issues and advancing science~

3. **Capacity Development**
   ~Boosting self-reliant R&D capacity and sustainable research systems, training human resources and coordinating networking between researchers~

**Utilize Research Outcomes**

~Expecting outcomes to make a real contribution to society~
Point

Duration of Research 3 - 5 years (After provisional period*)

Project Budget

Approx. 1,000,000 USD*/year for one project

(*1USD=100JPY)

JST/AMED Approx. 360,000USD (36million yen)
JICA Approx. 600,000USD (60million yen)

* The provisional period is the period before the R/D and MOU are signed and the project officially starts.

Research Fields & Areas

- Environment and Energy
  - Global-scale Environmental Issues
  Climate change mitigation & adaptation, Safe water supply, Biodiversity conservation...
  - Low-carbon Society/energy
  Biomass energy, Energy efficiency, Renewable energy..

- Bioresource
  Breeding and cultivation technology, Bioresource management..

- Disaster Prevention and Mitigation
  Natural disaster mechanisms (Earthquakes, Volcanic...), Disaster mitigation..

- Infectious Diseases Control
  Diagnostic tool, Vaccines, Therapeutic products development
  (Avian influenza, HIV/AIDS, Dengue fever...)
  ※ 'Infectious Diseases Control' has been transferred to AMED.
  (AMED: Japan Agency for Medical research and Development)
Counterpart Research Countries

115 projects in 46 countries around the world
(since 2008)

<table>
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<tr>
<th>Area</th>
<th>Number of eligible countries</th>
<th>Number of projects</th>
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<tr>
<td>Africa</td>
<td>17 countries</td>
<td>30 projects</td>
</tr>
<tr>
<td>Latin America/Others</td>
<td>15 countries</td>
<td>25 projects</td>
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Projects funded by SATREPS in Disaster Prevention and Mitigation

11 on-going projects
- Vietnam (2011-) landslide
- Turkey (2012-) EQ and tsunami
- Bangladesh (2013-) flood, high tide
- Indonesia (2013-) volcano
- Myanmar (2014-) resilient system
- Colombia (2014-) EQ, tsunami, volcano
- Bangladesh (2015-) EQ, city planning
- Nepal (2015-) EQ
- Mexico (2015-) EQ, tsunami
- The Philippines (2016-) Extreme weather
- Bhutan (2016-) EQ, buildings

10 projects completed
- Indonesia (2008-2012) EQ, volcano
- Bhutan (2008-2013) GLOF
- Croatia (2008-2013) landslide
- The Philippines (2009-2014) EQ, volcano
- South Africa (2009-2014) EQ
- India (2009-2014) Extreme weather info.
- Peru (2009-2014) EQ, tsunami
- Cameroon (2010-2015) CO2 lakes
- Malaysia (2010-2015) landslide, flood
- Chile (2011-2016) EQ, tsunami

SATREPS For the Earth, For the Next Generation

JST Japan Science and Technology Agency
Disasters: Global overview

(Source: NatCatSERVICE, Munich Re 2016)

History of global DRR agenda

Courtesy of Badaoui Rouhban (2015)
## Top 10 Global risks for 2016

<table>
<thead>
<tr>
<th>In terms of Likelihood</th>
<th>In terms of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Large-scale involuntary migration</td>
<td>1. Failure of climate-change mitigation and adaptation</td>
</tr>
<tr>
<td>2. Extreme weather events</td>
<td>2. Weapons of mass destruction</td>
</tr>
<tr>
<td>mitigation and adaptation</td>
<td>4. Large scale involuntary migration</td>
</tr>
<tr>
<td>4. Interstate conflict</td>
<td>5. Severe energy price shock</td>
</tr>
<tr>
<td>5. Major Natural catastrophes</td>
<td>6. Biodiversity loss and ecosystem collapse</td>
</tr>
<tr>
<td>6. Failure of national governance</td>
<td>7. Fiscal crises</td>
</tr>
<tr>
<td>7. Unemployment or underemployment</td>
<td>8. Spread of infectious diseases</td>
</tr>
<tr>
<td>8. Data fraud or theft</td>
<td>9. Asset bubble</td>
</tr>
<tr>
<td>10. Illicit trade</td>
<td></td>
</tr>
</tbody>
</table>

(Source: World Economic Forum)

## Recent Agenda

- Education for Sustainable Development (ESD)
- SFDRR2015-2030
- Sustainable Development Goals (SDGs)
- Paris Agreement at COP21
Dear Prof. Kyoji Sassa, Executive Director of International Consortium on Landslides
Dear H.E. Mr. Dražen Hrastić, Ambassador of the Republic of Croatia

Distinguished Guests,

On behalf of the Vietnam Embassy in Japan, it is a great honor for me to participate in the International Forum on “Japanese contribution to Landslide Disaster Risk Reduction” organized by the International Consortium on Landslides (ICL) and the Japan Landslide Society (JLS), held in Tokyo for the first time.

I would like to take advantage of this great opportunity to extend my deep appreciation to the International Consortium on Landslides (ICL) for its excellent initiative on the Sendai Partnerships 2015–2025 for global promotion of understanding and reducing landslide disaster risk”.

I would like also to express my special thanks to the Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA) for supporting this activity under SATREPS projects.

At the conference today, the researchers from Japan, Vietnam and Croatia will review their results in the previous SATREPS and JICA Projects on landslide disaster reduction and discuss the possibilities for further collaborative research.

Vietnam, as many other countries, is facing up to the climate change and many natural disasters, including floods and landslides.

It is of my satisfaction to note that your research projects turned out to be very fruitful and productive. It is also pleased to see that the researchers of three countries today have a chance to discuss in details for new joint research projects, leading them to a new stage of further cooperation.

I would like to conglataulate all of you on the excellent results in the past and I do strongly believe in the continuity of your collaborative research and your contribution for the landslide disaster reduction in the future.

I wish the International Symposium on “Japanese contribution to Landslide Disaster Risk Reduction” a great success.

Thank you very much for your kind attention.

Mr. Bui Viet Khoi,
Counsellor, Head of Science and Technology Section
Embassy of the S.R. of Vietnam in Japan
JICA-JST Joint Project in Vietnam
Development of Landslide Risk Assessment Technology along Transport Arteries in Viet Nam

WG 1
Objectives and Achievements

Kyoji Sassa, Project Leader
Executive Director of ICL
Nguyen Xuan Khang, Project Director
Director of ITST

Geology and Rainfall in Vietnam
Objectives of SATREPS Joint research

- Mountainous areas of Greater Mekong Sub-region are subject to frequent slope disasters caused by a combination of weak ground, steep slopes, and tropical monsoon.
- Safety ensuring of transport arteries connecting north and south is the most important issue for national development in Vietnam.
- Establishment of an effective landslide risk assessment technology suitable for Vietnam is the key issue for disaster reduction.
- Technologies of landslide mapping, landslide risk identification, soil testing and computer simulation, landslide monitoring and early warning are jointly developed and transferred to Vietnam.
- An extensive human resources with an advanced landslide risk assessment technology are developed through capacity development in Vietnam and in Japan.
- Network for landslide risk reduction is established in Vietnam, Japan and other mountainous countries.
Development of Landslide Risk Assessment Technology along Transport Arteries in Viet Nam

**Overall Objective**
Social implementation of the developed landslide risk assessment technology and early warning system will contribute to the safety ensuring of transport arteries through urban and local communities in Viet Nam.

**Project Purpose**
Landslide risk assessment technology to reduce landslide disasters along main transport arteries areas is developed, and education and capacity development for the effective use of this technology is implemented in Viet Nam.

**Outputs**
1. Wide-area landslide mapping and identification of landslide risk area
2. Development of landslide risk assessment technology based on soil testing and computer simulation
3. Risk evaluation and development of early warning system based on landslide monitoring
4. Preparation of Integrated guidelines for the application of developed landslide risk assessment technology

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**PROJECT IMPLEMENTING STRUCTURE**

**Institute of Transport Science and Technology (ITST)**
- Project Director: Nguyen Xuan Khang (Director General)
- Project Manager: Dinh Van Tien (Director for planning)

**Project Cooperation Organization**
- Viet Nam Landslide Association for Transport (approved in 2014)
- Vietnam National University, Hanoi (establishment of joint research office with Kyoto University in 2010)

**Integrated Research “Development of Landslide Risk Assessment Technology” and Education (G1)**
- Leaders: Kyoji Sassa, Nguyen Xuan Khang, Dinh Van Tien, Toyohiko Miyagi, Hirotaka Ochiai
  - Planning and coordination of research, Implementation of integrated research, Capacity development
  - Organization of symposia, workshops, research meetings, publication and information dissemination

**Tohoku Gakuin Univ. (G2)**
- Leader: Toyohiko Miyagi
  - Wide-area landslide mapping & Landslide risk identification

**(NPO) ICL (G3)**
- Leader: Kyoji Sassa
  - Soil testing & Computer simulation of landslide initiation and motion

**FFPRI (G4)**
- Leader: Hirotaka Ochiai
  - Landslide monitoring & Development of early warning system
Application to Developing Countries (Case for Vietnam)

Haivan Station Landslide

Landslide Mapping

A dynamic loading undrained ring shear apparatus to measure landslide dynamics parameters

Application of Testing and Simulation to Haivan station landslide in Vietnam

The method to assess exposure to landslides and landslide-induced tsunamis is being applied to Vietnam and other areas through ICL-network (34 countries and 62 organizations). The technologies will be transferred through the planned ISDR-ICL Landslide interactive teaching tools and full color books published in the World Landslide Forum in 2017 (Ljubljana, Slovenia), 2020 (Niigata, Japan) and 2023 (USA under examination) during the Sendai Partnerships.

Testing of Haivan samples (Left-top), simulation by LS-RAPID (right) and LS-Tsunami (Left-bottom)
Review of Activities (WG3)

WG3 has successfully developed the world's first high-stress (up to 3 MPa) undrained dynamic-loading ring-shear apparatus (ICL-2) to simulate large-scale landslides (100-200 m in depth) using the budget provided by the Japan Science and Technology Agency (JST) which was reported in Landslides Vol.11, No.5.

- A practical version of ICL-2 has been developed to donate it to Vietnam together with technological transfer. The practical and sustainable version of ICL-2 used in Vietnam needs many of technological development, to change the loading system for easy handling, to change the rubber edge system to keep undrained condition for easy maintenance, and the many of safety systems to avoid damages of apparatus by mishandling.

- After ICL-2 donated version has been completed, it has been tested by Vietnamese long term and short term trainees for around two years. All trouble sources are solved, and all trainees had confident to use ICL-2. The trainees has developed video manuals in addition to the written manuals for teaching engineers who have not visited Japan. The video manual made by ITST is included in Landslide Dynamic:ISDR-ICL Landslide Interactive Teaching Tools.

- ICL2 was applied by Lam Huu Quang and other Vietnamese engineers to test the samples taken from drilling in the Hai Van Station and succeeded to test those samples. This is the world first successful application of the undrained dynamic-loading ring-shear apparatus to test samples taken from the potential sliding surface found from the drilled cores in the precursor stage of landslides.

- WG3 main objectives has been completed within the project period.

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Review of Activities (WG3)

WG3 has published or submitted five papers to Landslides (2015 Impact Factor is 3.049) as below.


Review of Activities (WG1-Guidelines)

Based on the technological transfer from Japan to Vietnam, Vietnamese researchers have made the guidelines in the following 5 parts – 33 guidelines (GL). The guidelines will be submitted to the Ministry of Trasport (MOT) to be approved as the guidelines of MOT.

**Part 1. Mapping and Site Prediction.**
This includes 8 GLs (No.1-No.8), covers on Landslide classification, Field Work for Landslide Engineers, Geotechnical, topo survey, inventory, occurred landslide risk evaluation Hazard, susceptibility mapping.

**Part 2. Material Tests**
This includes 8 GLS (No.9-No.16), covers the ring shear testing apparatus, 5 types of test, direct shear test and portable direct shear test.

**Part 3. Monitoring**
This includes 9 GLs (No.17-No.25) covers on parameters for Landslide Monitoring Systems for conventional landslide (slow and middle velocity) and high velocity landslide (Debris flow).

**Part 4. Landslide experiment**
This includes 5 GLs (No.26-No.30), covers on Introduction, relationship between Landslide Motion and Cumulative rainfall, Pore water Pressure Distribution, Volumetric Strain, Velocity

**Part 5. Software and simulation**
This includes 3 GLs (No.31-No.33) which support for landslide study and mapping

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Review of Activities (WG1-Teaching Tools)

The United Nations World Conference on Disaster Risk Reduction (WCDRR) was organized in Sendai, Japan from 14-18 March 2015. The Sendai Partnerships 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk was proposed by ICL and agreed and signed by 17 international and national organizations (UNISDR, UNESCO, WMO, FAO, UNU, ICSU, WFEO, Gov of Japan, Italy, Croatia et al.). One of the proposed activities in this partnerships is to develop an integrated teaching tools on landslides. Landslide Dynamics: ISDR-ICL Landslide Interactive Teaching Tools (LITT). It contains 102 text tools, 1,700 pages in two volumes. Within 102 tools, 18 tools come from this SATREPS projects in Vietnam and in Croatia. The video manual for the undrained dynamic-loading ring-shear apparatus (ICL-2) and its testing was produced by Lam Huu Quang et al., ITST.

LITT includes PPT tools for lesson and PDF tools of papers/reports and manuals as well as text tools. This LITT is always updated in WEB by the interactive response between users and authors. A new updated version will be periodically published. The publication of LITT aims to provide the successful and effective technologies and experiences from many countries to the world and to create the latest landslide risk reduction technologies for the UN sustainable development goals and the Sendai Framework for Disaster Risk Reduction 2015-2030.
# Review of Activities (WG1: Capacity Development)

<table>
<thead>
<tr>
<th>Name</th>
<th>ITST/VNU</th>
<th>University</th>
<th>Doctor/Mater</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khang Dang Quang</td>
<td>VNU</td>
<td>Kyoto Univ.</td>
<td>Doctor</td>
<td>10/1/2012-9/30/2015</td>
</tr>
<tr>
<td>Le Hong Luong</td>
<td>ITST</td>
<td>Tohoku G. U.</td>
<td>Doctor</td>
<td>4/1/2013-3/31/2016</td>
</tr>
<tr>
<td>Pham Van Tien</td>
<td>ITST</td>
<td>Kyoto Univ.</td>
<td>Master</td>
<td>4/1/2013-3/31/2015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kyoto Univ. (KU Scholarship)</td>
<td>Doctor</td>
<td>4/1/2015-3/31/2018</td>
</tr>
<tr>
<td>Doan Huy Loi</td>
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<td>Kyoto Univ.</td>
<td>Master</td>
<td>4/1/2013-3/31/2015</td>
</tr>
<tr>
<td>Do Ngoc Ha</td>
<td>ITST</td>
<td>Shimane Univ.</td>
<td>Master</td>
<td>10/1/2012-9/30/2014</td>
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<tr>
<td>Pham Thi Chien</td>
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<tr>
<td>Vu The Truong</td>
<td>ITST</td>
<td>Shizuoka Univ.</td>
<td>Master</td>
<td>10/1/2013-9/30/2015</td>
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</table>

# Review of Activities (WG1-Capacity Development in Japan-Continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>ITST/VNU</th>
<th>University</th>
<th>Doctor/Mater</th>
<th>Period</th>
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<tbody>
<tr>
<td><strong>Short term training engineers (studying for Ph.D)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dinh Van Tien</td>
<td>ITST</td>
<td>Tohoku G. U.</td>
<td>Thesis Doctor</td>
<td>2016.9.15</td>
</tr>
<tr>
<td>Lam Huu Quang</td>
<td>ITST</td>
<td>Kyoto Univ.</td>
<td>For Thesis Doctor</td>
<td>Expected to complete in 2017.</td>
</tr>
<tr>
<td>Do Ngoc Ha</td>
<td>ITST</td>
<td>Kyoto Univ.</td>
<td>For Thesis Doctor</td>
<td>Studying</td>
</tr>
<tr>
<td>Ngo Doan Dung</td>
<td>ITST</td>
<td>Tohoku G. U.</td>
<td>For Thesis Doctor</td>
<td>Studying</td>
</tr>
<tr>
<td>Doan Huy Loi</td>
<td>ITST</td>
<td>Kyoto Univ.</td>
<td>For Course/Thesis Doctor</td>
<td>Studying</td>
</tr>
</tbody>
</table>
PIV and DSM Analysis and Detection of Slope Movement in a Ha Long landslide area by UAV

UAV photo

PIV Analysis

Line of DSM Analysis

Moved block with trees

Slope movement by DSM Analysis

Making the gabion box in October

Movement in the topsoil (thickness: 30-40 cm)

Crack

PIV result
AB cross section

BC cross section
ABC cross section

JICA–JST Joint Project in Vietnam
Development of Landslide Risk Assessment Technology along Transport Arteries in Viet Nam

Impact of project to Vietnam Society and output of mapping group

Dinh Van Tien, Project Manager
WG2 Leader of ITST
Toyoiko Miyagi, WG2 Leader
Professor of Tohokugakuin University

Overview of Four components and achievements

**WG1** integrated research, education, development of human resources, announcement and information spread; (2)
1. Technical integrating guidelines
2. 3 Doctors, 5 Masters, 4 doctor candidates

**WG2** wide-area landslide mapping and identification of landslide risk area; (6)
3. LS distribution map of HCM road
4. LS risk assessment map of HCM road
5. LS susceptibility map of HCM road
6. Landslide identify by air photo, From airplane or UAV
7. Field investigation and the inspection sheet making
8. Recognition of pre landslide through analysis mode of DSM

**WG3** development of landslide risk assessment technology based on soil testing and computer simulation; (4) and
9. Develop researching and simulation technology
10. The developed ring shear apparatus

**WG4** Risk
11. Shifting mechanism at Hai Van
12. Adding the function simulating tsunami in based on landslide monitoring; (4)
13. Selection Hai Van and Three boreholes
14. An integration monitoring system, early warning
15. Installation of data transmission system and display system
16. Landslide chutes and recording systems

International Consortium on Landslides (ICL) and Institute of Transport Science and Technology (ITST) – MOT- Vietnam
**Short-term objectives.**

To develop the landslide risk assessment technology to reduce disasters caused by landslides on transport arteries throughout the joint research based on experimental technology from Japan and human resources development to effectively technology implementation in Vietnam.

<table>
<thead>
<tr>
<th>WG No</th>
<th>Project achievement</th>
<th>Plan</th>
<th>Short-term objectives.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WG1 1</td>
<td>Technical integrating guidelines</td>
<td>Developing</td>
<td>ITST standard</td>
</tr>
<tr>
<td></td>
<td>3 Doctors, 5 Masters, 4 doctor cedadates</td>
<td>fee for maintenance</td>
<td>Geo. and LS disaster prevention Div.</td>
</tr>
<tr>
<td>WG2 3</td>
<td>LS distribution map of HCM road</td>
<td>combination 3,4,5, Expansion</td>
<td>LS mitigation Map for main roads</td>
</tr>
<tr>
<td></td>
<td>LS risk ascertainment map of HCM road</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>LS susceptibility map of HCM road</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Landslide Identify by air photo, From airplane or UAV</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Field investigation and the inspection sheet making</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Recognition of pre landslide through analysis mode of DSM</td>
<td>as above</td>
<td>new standard for LS recognition</td>
</tr>
<tr>
<td>WG3 9</td>
<td>Develop research and simulation technology</td>
<td>maintenance for further study</td>
<td>new standard for LS testing</td>
</tr>
<tr>
<td></td>
<td>The developed ring shear apparatus</td>
<td>application for other LSs</td>
<td>Testing and shearing service</td>
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<tr>
<td></td>
<td>Shifting mechanism at Ha Van</td>
<td>LS hazard map</td>
<td>Application other after HaVan</td>
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<tr>
<td></td>
<td>Adding the function simulating tsunami</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td>WG4 14</td>
<td>Selection Ha Van and Three boreholes</td>
<td>Propose new active Landslides</td>
<td>Application study case</td>
</tr>
<tr>
<td></td>
<td>An integration monitoring system , early warning</td>
<td>maintenance for further study</td>
<td>Monitoring study site</td>
</tr>
<tr>
<td></td>
<td>Installation of data transmission system and display system</td>
<td>maintenance for further study</td>
<td>Application monitoring Veiw</td>
</tr>
<tr>
<td></td>
<td>Landslide chutes and recording systems</td>
<td>continue study by MOT</td>
<td>Experiment for early warning</td>
</tr>
</tbody>
</table>

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**Long-term objectives.**

To socialize developed landslide risk assessment technology and early warning system to not only ensures transport arteries operation but also mountainous resident areas in Vietnam.

<table>
<thead>
<tr>
<th>WG No</th>
<th>Project achievement</th>
<th>Plan</th>
<th>Long-term objectives.</th>
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</thead>
<tbody>
<tr>
<td>WG1 1</td>
<td>Technical integrating guidelines</td>
<td>Developing</td>
<td>National Standard</td>
</tr>
<tr>
<td></td>
<td>3 Doctors, 5 Masters, 4 doctor cedadates</td>
<td>New Standards for countermeasure</td>
<td>MOT LS countermeasure</td>
</tr>
<tr>
<td>WG2 3</td>
<td>LS distribution map of HCM road</td>
<td>expansion for other areas</td>
<td>national LS mitigation map, dissemination</td>
</tr>
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<td>LS risk ascertainment map of HCM road</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>LS susceptibility map of HCM road</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Landslide Identify by air photo, From airplane or UAV</td>
<td>upgrading</td>
<td>National Standard</td>
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<td></td>
<td>Field investigation and the inspection sheet making</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Recognition of pre landslide through analysis mode of DSM</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td>WG3 9</td>
<td>Develop research and simulation technology</td>
<td>up grade standard</td>
<td>Important LS case for mitigation</td>
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<td>The developed ring shear apparatus</td>
<td>application for other LSs</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Shifting mechanism at Ha Van</td>
<td>expansion for other LSs</td>
<td>LS Hazard map</td>
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<tr>
<td></td>
<td>Adding the function simulating tsunami</td>
<td>expansion for other LSs</td>
<td>as above</td>
</tr>
<tr>
<td>WG4 14</td>
<td>Selection Ha Van and Three boreholes</td>
<td>expansion for other LSs</td>
<td>selection of high-value targets</td>
</tr>
<tr>
<td></td>
<td>An integration monitoring system , early warning</td>
<td>as above</td>
<td>as above</td>
</tr>
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<td></td>
<td>Installation of data transmission system and display system</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td></td>
<td>Landslide chutes and recording systems</td>
<td>developing</td>
<td>National Standard for LS early warning</td>
</tr>
</tbody>
</table>
Discussions on the Flow chart Research - The 4th volume of World Landslide Forum 3 (WLF3) - 2-6 June 2014, Beijing:

Tohoku Gakum University

Landslide classification in consideration of fuzzy nature

Tohoku Gakum University
Impact of project to Vietnam Society and Output of mapping group

Landslide geology Mechanism
LS and Geology Zone ABC and LS moving type and geologies

- Rotational and translational sallow debris – common Paleozoic Sedimentary
- Guily and Flow – 40% schist
- Rock fall – 60% Hornfels

Tohoku University

Vietnam - Japan SATREPS Project "Development of Landslide Risk Assessment Technologies along Transport Arteries in Vietnam"

LS distribution map
6 map of HCM route
01 Hai Van area map

Hai Van Pass
Ho Chie Minh Route NR NO.2
6 Landslide Risk assessment map using AHP evaluation

Typical landslide Risk assessment map along HCM road

Landslide micro features (morphology) and geology is considered using AHP for Risk assessment map

LS susceptibility Map
- slope angle, land use, rock type, total annual average precipitation, fault density, and distance to the road, AHP

LS susceptibility Map
**Application sensing data for Landslide Identify and the wider area mapping using **Usual aerial photographs / ALOS W3D data**

**Aerial photo interpretation**

- Normal slope
- Main scarp
- Landslide body
- Slip surface

Use the ALOS W3D data and UAV / SM. The skills all sorts of bird's eye view will available with low cost and easily.

Landslide Identify map of National No7

**Field investigation and the inspection sheet making using Aerial photo taken by UAV at each landslide area for identify the outline**
Recognition of pre-landslide by DSM comparing

Landslide on national highway No7, Vietnam

Result compare 2 DSMs by PIV

Book1 includes 8 guidelines is under development., 10 papers were published
THANKS FOR YOUR ATTENTION!
Monitoring system in Hai Van and landslide flume construction in ITST, Vietnam

Hirotaka Ochiai, Shiho Asano (Forestry and Forest Products Research Institute),
Huynh Dang Vinh, Do Ngoc Ha (Institute of Transport Science and Technology)

Purpose of Landslide monitoring and flume test

- When landslide prone slopes are estimated by the mapping or actual slope deformation, we need to consider about risk level of collapse.
- Specific landslide risk level and estimation of collapse time for the early warning from disaster is able to be considered based on the actual landslide phenomenon. Landslide monitoring is very important for the risk level estimation.
- Web based the landslide monitoring system is developed and installed on the landslide prone slopes.
- This system is consisted by many sensors that utilized various kind of technology and presented the real time monitoring data on web. It could be useful for clarification of landslide mechanism for the early warning. It will be the prototype model of landslide monitoring in Vietnam in a future.
- Relationship between landslide displacement and initiation is different on each landslide is necessary for forecasting and early warning. The landslide flume equipment by rainfall simulator is installed in ITST and landslide examination is started for early warning.
Final slope failure prediction in real landslide based on the displacement

Deformation of landslide mass increase rapidly just before final slope failure (Fig. 2). Failure timing prediction can be conducted using inversion velocity of deformation (Fig. 3). Prediction accuracy increases near failure time (Fig. 4).

Study area (Hai van st. landslide)
Hirotaka Ochiai, Shiho Asano – Monitoring system in Hai Van and landslide flume construction in ITST, Vietnam

**Boring and geological survey**

Boundary of Low-High density (-12m)

- Silty clay
- Loose sand

To pay attention on the installation work for safety, preliminary observation of rain and displacement was conducted.

**Slope displacement by extensometer**

(Short-span and Long-span)

- Short-span extensometer
  - Lower position start to move since late rainy season
  - Sensitive measurement

- Long-span extensometer
  - Different timing

Location of Long-span extensometer
Surface displacement observation (Moving targets monitoring by Total station and GNSS)

3D displacement observation by robotic total station monitoring

Total station observation: Active area is found

3D displacement observation by GNSS

Groundwater table measurement (Groundwater pressure gauge)

Rainfall gauge

Groundwater table

GL-30m

GL-51m

30m (0-30m screened)

Weathereed granite

51m (60m hole) (47.4-51.4m screened)

Granite rock
Underground displacement
(Borehole inclinometer and Vertical extensometer)

From periodical to continuous monitoring of inclinometer

Data transferring system

56
Web observation

- All data can be seen and downloaded on the web-site.
- The web site needs to be accessed by the parties concerned of Hai van landslide monitoring.
- Access level (ex. High or low) of web site will be set in order to use effectively.

Web-based landslides analysis software for Vietnam

"Map"
In 2013, landslide experimental facility was designed and the building was made. In 2014, the data logging system and sensors are donated. The landslide flume was designed based on the soil properties of the weathered granite of Hai Van area. In 2015, the landslide flume with rainfall simulator was constructed and first landslide experiment in Vietnam was conducted in ITST in November 2015. Vietnamese researchers participate in developing these facilities, are encouraged for human resources development. They are expected to be key persons after the project finished.
Landslide flume

Crane system

Spraying system

Image monitoring system

Landslide experiment started in ITST from November 2015.

Result of landslide experiment

Rainfall intensity: 50mm/h

Porewater pressure

Material: Weatherd Granite sand

Displacement

Date: June 21, 2016
Landslide occurrence on the flume

Before

After

Results of inverse velocity from the displacement of the 4th experiment in Jul. 21, 2016
Trial test of forecasting with observed data in Hai van

Example of forecasting of final slope failure by Flume test

Final slope failure can be estimated by "Inversion velocity of slope displacement"

Landslide prediction by Hai van observation

displacement

Inversion velocity

Conclusion

Landslide monitoring system was developed and installed in Hai van slopes.

It provides the newest information of landslide activity and risks for early warning.

Landslide flume experiment was started. It provides the important information about the relationship between landslide activity and landslide risks based on the landslide mechanism.

These system will contribute to reduce the large-scale landslide disaster triggered by heavy rain.

This system is specialized for the specific landslide. When the landslide risk estimation for the wide transportation system would be needed, another type of the warning system should be consider (ex. rainfall and soil water forecasting).
Thank you very much!
November 24, 2016  TKP/Tokyo
International Forum
“JAPANESE CONTRIBUTION TO LANDSLIDE DISASTER RISK REDUCTION”
Organized by ICL, Japan Landslide Society

“INSTRUCTION AND ESSENTIAL OUTPUTS OF THE CROATIAN-JAPANESE RESEARCH PROJECT ON LANDSLIDES”

Hideaki MARUI, Niigata University

Contents of the presentation:

1) Overview composition of the joint research project
2) Comprehensive monitoring system
3) Landslide dynamics
4) Hazard Zonation and land-use guideline
5) Lumped mass system model with damper
6) Concluding remarks
Implementation Institutions of Croatian Side

CROATIA

University of Zagreb
University of Rijeka
University of Split
Croatian Water Geological Survey

(40 researchers were included.)

Implementation Institutions of Japanese Side

Niigata University
ICL
Kyoto University

(15 researchers were included.)

Application in other areas in Croatia and/or in neighboring countries is envisaged

Project Purpose
Development of the methods of formulating land-use guidelines for mitigation of landslide-flood disasters

Dissemination of research results
Prepare manuals of the methods
Capacity Development

Component a
Formulation of integrated landslide-flood hazard maps for the target areas

Component b
Development of landslide risk assessment methods, and landslide early warning system

Component c
Development of flash flood/debris flow simulation models and early warning system

Conceptual Diagram of the Project
Comprehensive monitoring system (Grohovo landslide)

- Installation of monitoring system in the Grohovo landslide area
- Development of the early warning system
- Collection of basic data to clarify the mechanism of the landslide

○ Comprehensive monitoring system with combination of extensometers, GPS, total station
○ Automated real time monitoring using Wi-Fi communication system
Results of monitoring by extensometers at Grohovo landslide

1. Left up figure shows accumulation value of movements. Point (P11) is treated as a stable point. Compression is indicated by (+), extension by (-).
2. Lower convex shapes shows Block 1 and 2. Distance from basement line shows amount of movement.
3. Left down figure shows the estimated two landslide blocks on the target slope.
4. Upper Block is colored by red. Middle Block is colored by green.
5. It is necessary to check the margin of the upper Block.
   - Margin can be at Point P0 at the top of the slope.
   - Margin can be over the ridge.
6. Two additional extensometers will be installed to check the location of the margin.
Comprehensive Monitoring system (Kostanjek landslide)

- Installation of monitoring system and arrangement of early warning system in the large scale landslide behind Zagreb city area

Achievement Quotient

Installation of monitoring system ongoing

O Combination with extensometers, GPS, accelerometers

Displacement measured in the tunnel in Kostanjek landslide area using extensometer

Installation of extensometers in Kostanjek landslide area (Zagreb)
With dense collaboration with the Office of Emergency Management (OEM) of Zagreb City

Early Warning System

Necessity of Emergency Operation

Length: 1.3km
Width: 1.0km
Depth: 90m

Overview of Kostanjek Landslide in Zagreb City
Why the current state of the Kostanjek landslide is so dangerous?

Because: This type of landslide can suddenly change the behavior and the sliding velocity by normal rainfall events.
4 days after the velocity reached 1mm per day, the landslide slipped down.

Case analysis on Oikubo Landslide occurred on 15th July, 2007 in Japan

Case analysis on Kostanjek Landslide in Croatia after November 2012

Is the current situation of the Kostanjek landslide so critical?

SAITO and UEZAWA method for time prediction of slipping down of landslide.

\[ \log t_f = \text{const} - \log \varepsilon \]

The time to collapse by SAIITO and UEZAWA method

The time to the collapse time of setting the Length of an extensometer to Tenm

<table>
<thead>
<tr>
<th>Steady strain Velocity</th>
<th>The inside of time : 1 day</th>
<th>The inside of time : 1 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1mm/day</td>
<td>2.766</td>
<td>116.1</td>
</tr>
<tr>
<td></td>
<td>(7.1×10^-8)</td>
<td>(20.9×451.5)</td>
</tr>
<tr>
<td>2mm/day</td>
<td>1.476</td>
<td>61.5</td>
</tr>
<tr>
<td></td>
<td>(380×5.743)</td>
<td>(15.8×239.3)</td>
</tr>
<tr>
<td>5mm/day</td>
<td>638</td>
<td>26.8</td>
</tr>
<tr>
<td></td>
<td>(16.4×2.481)</td>
<td>(6.8×103.5)</td>
</tr>
<tr>
<td>10mm/day</td>
<td>598</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>(8.7×1.316)</td>
<td>(3.6×54.8)</td>
</tr>
<tr>
<td>20mm/day</td>
<td>179</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>(4.6×697)</td>
<td>(1.0×29.0)</td>
</tr>
<tr>
<td>1mm/hour</td>
<td>151.5</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>(3.9×589.7)</td>
<td>(1.0×24.6)</td>
</tr>
<tr>
<td>2mm/hour</td>
<td>80.3</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>(20.6×321.5)</td>
<td>(0.9×13.0)</td>
</tr>
<tr>
<td>4mm/hour</td>
<td>42.6</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>(10.9×166.6)</td>
<td>(0.5×6.9)</td>
</tr>
<tr>
<td>10mm/hour</td>
<td>18.4</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>(4.7×71.6)</td>
<td>(0.2×3.0)</td>
</tr>
</tbody>
</table>

Quotation: The Public Works Research Institute, the Ministry of Construction, a landslide observe standard investigation report, No.3184, 1993

Steady strain rate of 2mm/day → the landslide will slip down approximately in two months.

Prediction of a collapse time is possible independent from clay types.
### Example of evacuation criteria

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CAUTION</th>
<th>WARNING</th>
<th>EVACUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOUNT OF MOVEMENT (CRITERIA)</td>
<td>&gt;1mm/day</td>
<td>&gt;10mm/day</td>
<td>&gt;2mm/hour (2 hours continuous) &gt;4mm/hour</td>
</tr>
<tr>
<td>BASIC RESPONSE POLICY</td>
<td>begin providing information</td>
<td>enhance monitoring</td>
<td>begin evacuation</td>
</tr>
<tr>
<td></td>
<td>begin operating continuous monitoring system</td>
<td>prepare for evacuation</td>
<td></td>
</tr>
<tr>
<td>PRINCIPAL MATTERS TO BE UNDERTAKEN</td>
<td>provision of information to relevant organization(s) site patrol</td>
<td>continuous monitoring system (24 hours)</td>
<td>continuous monitoring</td>
</tr>
<tr>
<td></td>
<td>check of monitoring equipment</td>
<td>confirmation of moving block(s)</td>
<td>establishment of disaster control headquarters</td>
</tr>
<tr>
<td></td>
<td>re-installation and additional installation of monitoring equipment</td>
<td>and re-examination of the possibility of moving block(s) expanding and</td>
<td>decision and recommendation of evacuation</td>
</tr>
<tr>
<td></td>
<td>investigation into information transmission methods</td>
<td>the dangerous areas of the landslide</td>
<td>assignment of evacuation instructor</td>
</tr>
<tr>
<td></td>
<td>provision of information to residents and implementing bodies/ies related to roads, railways, etc.</td>
<td>preparation for evacuation and confirmation of evacuation routes</td>
<td>establishment of evacuation site</td>
</tr>
<tr>
<td></td>
<td>confirmation of evacuation warning system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Citation: Prevention measures for secondary disasters - For use in advisor system, National Association of Disaster Prevention, 1994)

Examples of places to which the evacuation criteria applied in districts applicable to the advisor system
- Amount of Movement: >2mm/hour:

Notes
As the behavior of landslides changes as mass movement progresses, movement characteristics unique to the area the landslide is generated are exhibited. Therefore, it is risky to generalize all landslides in the same way, and as a general principle they should be considered on a case by case basis.

### Development of dynamic-loading ring shear apparatus

- Clarification of landslide mechanism
- Estimation of velocity and travel distance of sliding mass

**Achievement Quotient**

- 2009 (FS) 2010 (Design) 2011 (Completion) 2012 (Purchase) 2013 (Testing)

- Measurement of shear strength of soil and pore water pressure
- Volume of soil specimen ca. 300 cm³ (ID= 100 mm, OD= 140 mm)
- Loading corresponding to seismic wave form

Test results using soil sample from Kostanjek landslide area

70
Tests for earthquake-induced landslides

Using soil samples from model sites

(Left up) Test results using soil sample (Marl) from Kostanjek landslide under undrained condition. (Right up) Test results using soil sample (Flysh) from Grohovo landslide under undrained condition. Soil sample of Kostanjek landslide shows lower friction angle of 13.8 degree. Soil sample of Grohovo landslide shows higher friction angle of 20.4 degree. (Left bottom) Structure of the ring shear apparatus

Evaluation of danger degree by landslide dynamics

Estimation of travel distance of sliding soil mass

Numerical simulation on travel distance of sliding soil mass was carried out concerning Grohovo landslide using an Integrated Landslide Simulation Model (LS-RAPID). A vertical imaginary column is considered within a landslide mass. The model calculates the discharge and the height of soil mass by assuming that the balance of all forces acting to the column (Self-weight, Seismic forces, Lateral pressure, Shear resistance including the effect of pore water pressure) will accelerate the soil mass. Shear strength parameters of weathered flysch material is already tested.
Numerical simulation of travel distance of sliding soil mass of Grohovo landslide (caused by increase of pore water pressure)

Occurrence of landslide at the top of slope

Overburden pressure to the upper block
Lower block is forced to reach to the opposite slope
Sliding soil mass blocks the river channel

Evaluation of endangered areas using “Analytical Hierarchy Process (AHP)”

The AHP is a structured technique for organizing and analyzing complex decisions based on mathematics.

- Modification of AHP-Method appropriate to the natural conditions of Croatia

Achievement Quotient

- Interpretation of landslide topography
- Evaluation of danger degree of individual slopes using modified criteria

Modified criteria for AHP-Method in consideration of the geomorphological and geological conditions
Evaluation of danger degree using AHP-Method (Grohovo)
Contents of manual for Hazard Mapping and Land-use guideline:

*Definition and terminology.
*Description of the types and levels of landslide zoning.
*Definition of levels of mapping and suggested scales.
*Guidance on formation process of hazard map and risk map.

A Certain Modifications should be necessary.
Development of new model to explain landslide movement

Lumped mass system model with damper

Damper \( (k = A \cdot Cd) \)

Landslide mass

\[ F : \text{Downward force} \quad [ F = D - R \quad \text{if} \quad F > 0 ] \]

\[ D : \text{Driving force} \quad [ = mg \sin \theta ] \]

\[ R : \text{Resistant force} \quad [ = (mg \cos \theta - u) \tan \phi' + c'A] \]

Fs: Safety factor, Fs=R/D. If Fs>1 then R>D (Stable), F=0 (F can not be negative)
If Fs<1 then R<D (Unstable), F>0

Kinematic diagram of landslide mass

Equation of motion:

\[ ma = F - kv \quad [1] \]

Where,
\[ m : \text{Mass of the landslide body} \]
\[ a : \text{Moving acceleration of the landslide} \]
\[ F : \text{Downward force} \quad [ F = D - R \quad \text{if} \quad F > 0 ] \]
\[ k : \text{Coefficient of dashpot} \quad [ k = ACd ] \]
\[ Cd : \text{Coefficient of damper} \]
\[ v : \text{Moving velocity of the landslide} \]
\[ D : \text{Driving force} \quad [ = mg \sin \theta ] \]
\[ R : \text{Resistant force} \quad [ = (mg \cos \theta - u) \tan \phi' + c'A] \]
\[ g : \text{Gravitational acceleration} \]
\[ \theta : \text{Gradient of the slope} \]
\[ u : \text{pore water pressure} \]
\[ c' : \text{Cohesion of the slip surface} \]
\[ \phi' : \text{Internal friction angle of the slip surface} \]
\[ A : \text{Area of the slip surface} \]

In case of a cross section, 'A' means the length of the slip surface
Dividing equation [1] by m, leads to the following formula:

\[ \frac{dv}{dt} = \frac{F}{m} - \left( \frac{k}{m} \right) \cdot v \]  \[2\]

Where,

- \( t \): Time
- \( \frac{dv}{dt} \): Moving acceleration of the landslide \( (=a) \)

Using the method of separation of valuables in Equation [2], and integrating both sides of the equation with respect to time, the landslide velocity is indicated by the following equation:

\[ v = \left( \frac{F}{k} \right) \left( 1 - e^{-\left( \frac{k}{m} \right) t} \right) \]  \[3\]

Where, \( k = A \cdot Cd \). Therefore Equation [3] is as follows:

\[ v = \left( \frac{F}{A \cdot Cd} \right) \left( 1 - e^{-\left( \frac{A \cdot Cd}{m} \right) t} \right) \]  \[4\]

Moreover, in a very short time \( (t < 10^{-5} \text{ second}) \), the term \( e^{-\left( \frac{A \cdot Cd}{m} \right) t} \) will converge to ‘zero’.

Hence, the velocity of landslide is given approximately as follows:

\[ v = \frac{F}{A \cdot Cd} \]  \[5\]

Equation [5] means that when \( A \cdot Cd \) is constant, the velocity of landslide increases or decreases directly in proportion to the downward force.
Application of damper model for the Ksotanjek landslide

Ksotanjek landslide is a large scale, deep-seated landslide.

Maximum length: 1,300 m  
Average length: 1,100 m  
Depth: 70 – 90 m  
Inclination of slip surface: 5°

On the landslide and in its surrounding areas there are many factories and houses.

Extensometer (EX-09) is installed in the Tunnel to the slip boundary portion.

Location map of monitoring equipment in the Ksotanjek landslide area

Tensile displacements of the extensometers were seen.

Displacement velocity of extensometer Ex-09 varies in proportion to the groundwater fluctuations recorded in GWL-2.

Relation among monitoring data at Ksotanjek landslide
Model simulation of the Kostanjek landslide:

Based on the formula $v = F/A \cdot C_d$, the velocity ($v$) and displacement ($x$) of the landslide were calculated using observed daily level variations in GWL-2.

Groundwater level in borehole 2: “WL=2.37m” for “$F_s=1.0$”

Schematic diagram of simplified landslide mass

Comparing the simulation values with the observed values of extensometer Ex-09 shows a slight difference, however the overall trend is almost the same.

Fs is reduced by the drawdown of GWL-2.
Concluding remarks:

# The most important initial stage is fundamental study to grasp actual behavior of landslide, to know characteristics of landslide and to clarify mechanism of landslide.
# Only based on such fundamental study results, planning and design of effective and useful mitigation measure can be feasible.
# On the basis of such idea, comprehensive monitoring systems were installed in two representative target landslide areas.
# Abundant interesting and important data on characteristics and mechanism of landslides have been provided by such monitoring system.
# It enables to develop some new model to explain landslide movement in relation with triggering factors.
# In the final stage, practical method of hazard zonation and further land-use guidelines were formulated and also early warning system were arranged in the target areas for mitigation of landslides disasters.
# Additional follow up researches and analyses are on going based on the instruction and outputs of the joint research project.

Thank you for your attention!
Hvala na pažnji!

Large scale landslide on the opposite slope of Grohovo landslide
What is the mechanism of the latest rapid movement after slow movement of the range of about 5m in 50 years?

Moriwaki (2001) showed the “Relationship between critical surface displacement, critical strain and length of the landslide (source area). The amount of critical strain for slipping down to landslide length should be 0.6% to 2%.

For the case of the Kostanjeck landslide:
Length : about 1300m
Critical surface displacement: 
\[0.6 \sim 2\% \times 1300m = 7.8 \sim 26m\]

The previous total displacement of 5m is close to the lower limit of the critical surface displacement of 7.8m for slipping-down.

For this reason, it is estimated that current moving velocity is high.
OUTLINE:

- Introduction
- Monitoring System at the Grohovo Landslide
- Monitoring System at the Kostanjek Landslide
- Soil Testing and Landslide Simulation
- Conclusions
INTRODUCTION

- The Japanese – Croatian Bilateral Project *Risk Identification and Land-Use Planning for Disaster Mitigation of Landslides and Floods in Croatia* started in 2009, selected for the Science and Technology Research Partnership for Sustainable Development program (SATREP) under the auspices of the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA).
- The Project activities were conducted through 3 working groups (WG):  
  - Working group on landslides (WG1)  
  - Working group on floods (WG2)  
  - Working group on hazard maps and land-use guidelines (WG3)  
- The Project was completed in March 2014.
The Project activities of Working Group on Landslides (WG1)
- Activities: comprehensive real time monitoring of landslides, laboratory soil testing, numerical modeling of static and dynamic landslide behavior, early warning system
- Study areas: the Grohovo Landslide in Primorsko-Goranska County and the Kostanjek Landslide in the City of Zagreb.
The Grohovo Landslide was last time reactivated in December 1996, after long time dormant period and about $1.0 \times 10^6$ m$^3$ were moved down the slope and buried the Rječina riverbed forming a landslide dam.

The Grohovo Landslide is the part of the old dormant landslide activated in 1893 of about 6.5 Mm$^3$. There are signs of many old landslides in this part of the Rječina River Valley.
In 1894 the Rječina River Recovery Project has been designed by the Ministry of Agriculture of the Hungarian Kingdom, and restoration began in 1889. The designer, civil engineer Bela Pech, mapped all the landslides on the 1894 topographic map.

- The monitoring system was designed to consist of geodetic and geotechnical monitoring.
- Geodetic monitoring includes geodetic surveys with a robotic total station (25 prisms) and displacement measurements of 9 GPS rovers.
- Equipment for the geotechnical monitoring includes vertical inclinometers (2) in combination with vertical wire extensometers (4), long and short-span extensometers (13+3), pore pressure gauges (4), pluviometer and weather station.
- Pore pressure gauges, inclinometers and vertical extensometers are installed at two locations inside the central part of the landslide body.
- Extensometers are installed from Rječina riverbed to the limestone mega-blocks at the top of the slope.
The robotic station measures 25 benchmarks (prisms) every 30 minutes.

- GPS postprocessing:
  - 1 hour
  - 12 hours

- Data transfer:
  - Wi-fi from GPS to PC Unit
  - UMTS from PC Unit to the University

The screen of the analyses software System Anywhere
COMMENT OF THE MONITORING RESULTS

- After installation in September 2011, the geodetic monitoring and data collection were started.
- Collected data are liable to numerous influences such as daily, monthly and yearly temperature and humidity variation and local disturbing effects.
- For appropriate reduction of weather condition influences, it is necessary to have two years data collection and analysis.
The weakest link in the Grohovo landslide monitoring system is power supply: solar panels and windmill cannot produce enough electric energy to ensure system running during winter season (November to early March).

Establishment of an early warning system and defining of alarm thresholds is based on existing cognition of the Grohovo landslide behavior so as from collected consequent comprehensive monitoring data.
The Kostanjek landslide is the largest landslide in the Republic of Croatia, located in the western residential area of the City of Zagreb.

- Landslide was activated in 1963 and main cause of sliding was excavation of marl at the foot of slope.
- Area of landslide is 1.2 km² and estimated sliding mass of $32 \times 10^6$ m³.
The monitoring system was designed to consist of geodetic and geotechnical monitoring.

Geodetic monitoring includes geodetic surveys of displacement measurements using 15 GNSS rovers.

Equipment for the geotechnical monitoring includes vertical inclinometer (1) in combination with vertical wire extensometers (4), long and short-span extensometers (9), pore pressure gauges (3), 5 water level gauges, 2 mini divers and pluviometer.

Pore pressure gauges, inclinometers and vertical extensometers are installed at a location inside the central part of the landslide body.

Seismic activity (geophysical monitoring) of the landslide is measured with 7 accelerometers.

GNSS units

15 double frequency Trimble NetR9 TI-2 GNSS rovers with Zephyr Geodetic 2 GNSS antenna
Trimble NetR9 TI-2 GNSS rover
Zephyr Geodetic 2 GNSS antenna

TRIMBLE 4D software
Pore pressure gauges (3), water level gauges (5), mini divers (2) and pluviometer

Three-components MEMS accelerometers (7 pcs)
- Geophysical monitoring is an important part of comprehensive landslide monitoring to better understanding of landslide behavior in earthquake conditions.
- Establishment of an early warning system and defining of alarm thresholds is based on existing cognition of the Kostanjek landslide behavior so as from collected consequent comprehensive monitoring data.

4 SOIL TESTING LANDSLIDE SIMULATION
SOIL TESTING

LANDSLIDE SIMULATION

- The LS-Rapid software is the landslide simulation model developed by Professor Sassa possible to integrate the whole process of stable state, failure, post-failure strength reduction, motion and deposit of sliding mass.
LANDSLIDE SIMULATION

- The topography of the Rječina River Valley was determined using original DEM data. The limestone rock mass is situated at the top of the slopes, while the siliciclastic rocks and flysch are situated on the lower slopes and the bottom of the valley. Depth of the sliding mass varies from 3 to 10 m over the flysch bedrock and from 0.0 to 0.5 m over the limestone rock mass.

- In the simulation, the friction angle and cohesion are reduced from their peak values to the normal motion time values within the source area in the determined distribution of the unstable mass.

- The strength reduction started in the moment when the travel length became equal to shear displacement at the start of strength reduction (DL, mm).

The ground water level rising in the model was expressed by excess of the pore pressure ratio until the value of \( r_p = 0.60 \), which is correspondent to the ground water level equal to terrain surface.

- The time period of ground water level rising in the model was set up as 60 seconds and one second in the model was correspondent to one day real time period.

- The most important simulation parameters are the steady state shear resistance \( (\tau_{ss}) \), the lateral pressure ratio \( (k) \) and the critical shear displacements (DL, DU).

<table>
<thead>
<tr>
<th>Surface resistance</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total unit weight of the mass ((\gamma))</td>
<td>20 kN/m³</td>
<td>Benac et al., 2005</td>
</tr>
<tr>
<td>Steady state shear resistance at the source area ((\tau_{ss}))</td>
<td>60 kPa</td>
<td>Test data, Obiric et al., 2012</td>
</tr>
<tr>
<td>Lateral pressure ratio ((e_{pa} / e_0))</td>
<td>0.7</td>
<td>Estimation from the test data</td>
</tr>
<tr>
<td>Friction angle inside landslide mass ((\phi))</td>
<td>30°</td>
<td>Benac et al., 2005</td>
</tr>
<tr>
<td>Friction angle during motion ((\phi_d))</td>
<td>26</td>
<td>Test data, Obiric et al., 2012</td>
</tr>
<tr>
<td>Peak friction angle at sliding surface ((\phi_{pa}))</td>
<td>34°</td>
<td>Benac et al., 2005</td>
</tr>
<tr>
<td>Peak cohesion at slip surface ((c_{pa}))</td>
<td>7.5 kPa</td>
<td>Benac et al., 2005</td>
</tr>
<tr>
<td>Shear displacement at the start of strength reduction (DL)</td>
<td>30 mm</td>
<td>Test data, Obiric et al., 2012</td>
</tr>
<tr>
<td>Shear displacement at the end of strength reduction (DU)</td>
<td>3000 mm</td>
<td>Test data, Obiric et al., 2012</td>
</tr>
<tr>
<td>Pore pressure generation rate ((e_{pa}))</td>
<td>0.7</td>
<td>Estimation</td>
</tr>
<tr>
<td>Cohesion inside mass ((c))</td>
<td>0.0 kPa</td>
<td>Benac et al., 2005</td>
</tr>
<tr>
<td>Cohesion at sliding surface during motion ((c_{pa}))</td>
<td>0.0 kPa</td>
<td>Benac et al., 2005</td>
</tr>
<tr>
<td>Excess pore pressure ((e_{pa}))</td>
<td>0.0 – 0.5</td>
<td>Assumption</td>
</tr>
</tbody>
</table>
5 CONCLUSIONS

THE MAIN RESULTS ACHIVED OF THE WG ON LANDSLIDES

- Establishment of the Grohovo Landslide Monitoring system as base for the Early Warning System
- Establishment of the Kostanjek Landslide Monitoring system as base for the Early Warning System
- Soil testing using new developed portable ring shear apparatus (ICL-1) with possibilities to simulate the formation of a landslide shear surface and the following post-failure motion in static and dynamic circumstances
- Landslide motion simulation using LS-Rapid software that enables identification of circumstances for landslide initiation and post-failure landslide run-off
International Forum

Thank you for your attention!
JAPANESE - CROATIAN SATREPS FY2008 PROJECT 2009-2014

‘HAZARD MAPS AND LAND-USE GUIDELINES’ (WORKING GROUP 3)

SNJEŽANA MIHALIĆ ARBANAS
UNIVERSITY OF ZAGREB, FACULTY OF MINING, GEOLGY AND
PETROLEUM ENGINEERING (UNIZG-RGNF)
CROATIAN LEADER OF WORKING GROUP 3

ŽEĻJKO ARBANAS
UNIVERSITY OF RIJEKA, FACULTY OF CIVIL ENGINEERING (UNIRI-GF)

THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT:
GENERAL INFORMATION

PROJECT TITLE:
Risk Identification and Land Use Planning for Disaster Mitigation of Landslides and Floods in Croatia

SPECIFIC OBJECTIVES:
2009-2014

PILOT AREAS:
The City of Zagreb
Primorsko-Goranska County
Splitsko-Dalmatinska County
THE JAPANESE-CROATIAN SATUREPS FY2008 PROJECT:
WORKING GROUP 3

WG3 TITLE:
Hazard maps and land-use guidelines

SPECIFIC OBJECTIVES:
• Identification and mapping of landslides
• Landslide susceptibility and hazard zonation
THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT: WORKING GROUP 3

WG3 TITLE:
Hazard maps and land-use guidelines

SPECIFIC OBJECTIVES:
- Identification and mapping of landslides
- Landslide susceptibility and hazard zonation

Risk mapping, assessment and planning
APPLICATION OF INNOVATIVE TECHNOLOGIES (2009-2014):
CITY OF ZAGREB

IDENTIFICATION AND MAPPING OF LANDSLIDES

CITY OF ZAGREB:
PILOT AREA AND APPLIED INNOVATIVE TECHNOLOGY

Airborne Laser Scanning (ASL)
CITY OF ZAGREB:
PILOT AREA AND APPLIED
INNOVATIVE TECHNOLOGY

DTM derived from ASL data

Landslides in the City of Zagreb activated in 2013 and 2014
CITY OF ZAGREB:
PILOT AREA AND LANDSLIDE EVENTS IN 2013 AND 2014

Orthophoto map 1:5,000
(City of Zagreb)
CITY OF ZAGREB: LANDSLIDE MAP

- average landslide density of approx. 37 landslides/km²
CITY OF ZAGREB:
LANDSLIDE MONITORING AND HAZARD MAPPING

CITY OF ZAGREB:
LANDSLIDE MONITORING AND HAZARD MAPPING
DISSEMINATION AND VISIBILITY OF PROJECT RESULTS / SUSTAINIBILITY

- INTERNATIONAL CONFERENCES
- INTERNATIONAL ORGANIZATIONS
- CROATIAN LANDSLIDE PORTAL (WWW.KLIZISTA-HR.COM)

THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT:
DISSEMINATION AND VISIBILITY OF PROJECT RESULTS / SUSTAINIBILITY

International Consortium on Landslides

THIS IS TO CERTIFY THAT
CROATIAN LANDSLIDE GROUP FROM FACULTY OF CIVIL ENGINEERING,
UNIVERSITY OF RIJEKA AND FACULTY OF MINING, GEOLOGY
CROATIAN LANDSLIDE GROUP
Landslide, Science, Society

• Croatian landslide scientists become member of the International Consortium on Landslides
THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT: DISSEMINATION AND VISIBILITY OF PROJECT RESULTS / SUSTAINABILITY

ORGANIZATION OF INTERNATIONAL CONFERENCES ON LANDSLIDES:
- 1st Regional Symposium on Landslides in Adriatic-Balkan Region, Zagreb, 2013
- 2nd Regional Symposium on Landslides in Adriatic-Balkan, Belgrade, 2015
- 4th World Landslide Forum, Ljubljana, 2017
- 3rd Regional Symposium on Landslides in Adriatic-Balkan, Ljubljana, 2015

CROATIAN LANDSLIDE PORTAL
WWW.KLIZISTA-HR.COM
COOPERATION WITH LOCAL/REGIONAL AND NATIONAL AUTHORITIES
NATIONAL, COUNTY, CITY AND MUNICIPAL LEVEL

THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT:
COOPERATION WITH LOCAL/REGIONAL AND NATIONAL AUTHORITIES

- City of Zagreb (County)
  - OEM - City Office of Emergency Management
  - City Office for The Strategic Planning and Development Of The City
  - City Office for Physical Planning, Construction of the City, Utility Services and Transport

- Primorsko-Goranska County
- City of Rijeka
- Municipality of Čavle, Primorsko-Goranska County
- DUZS (National Protection and Rescue Directorate)
THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT:
COOPERATION WITH LOCAL/REGIONAL AND NATIONAL AUTHORITIES


- National Protection and Rescue Directorate (DUSZ) signed ISDR-ICL Sendai Partnership 2015-2025

THE JAPANESE-CROATIAN SATREPS FY2008 PROJECT:
WORKING GROUP 3

WG3 TITLE:
Hazard maps and land-use guidelines

SPECIFIC OBJECTIVES:
- Identification and mapping of landslides
- Landslide susceptibility and hazard zonation

Voluntary commitment to the World Conference on Disaster Risk Reduction
Sendai, Japan, 2015
ISDR-JC. SENDAI PARTNERSHIPS 2015-2025
FOR GLOBAL PROMOTION OF UNDERSTANDING AND REDUCING LANDSLIDE DISASTER RISK
Tools for Implementing and Monitoring the Post-2015 Framework for Disaster Risk Reduction and the Sustainable Development Goals

At the 2nd United Nations World Conference on Disaster Reduction, which was held in Kobe, Japan, on 19-22 January 2005, the International Conference on Landslides (ICL) organized a session which resulted in a global partnership and initiatives taking a holistic approach to research and learning on 'Integrated Earth System risk analysis and sustainable disaster management'. This partnership was forged through a "Letter of Intent", that was signed by UNESCO, UNISDR, WHOH, FAO, UNEP, ICCL, and IGPE. It further led to the adoption and implementation of the 2008 Tokyo Action Plan, thus creating a global partnership on Landslides, i.e., the current International Programme on Landslides (IP-ICL).

At the 3rd Conference on Disaster Risk Reduction (ICDRR), which was convened by the United Nations and hosted by Japan in Sendai from 14 to 18 March 2011, the ICL, and its IPL, contributed further to the 2013 International Strategy for Disaster Reduction (ISDR) and co-organized the Working Session "Reducing Risk Factors" together with UNISDR, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and other pertinent organizations.

At the Working Session, the causes that make-risk and their cumulative effects, as well as the relevant achievements of the Hyogo Framework for Action 2005-2015, were reviewed. Maps to address the principal sources of vulnerability and exposure and to enable a quick identification of critical areas for intervention were created. These maps, created by several scientific and academic institutions and governments and non-governmental organizations, proposed that the Sendai Partnership 2015-2025 for Global Promotion of Understanding and Reducing Landslide Disaster Risk be established. This second global
Thank you very much for your attention!
SATREPS Project for
“Research and Development for Reducing Geo-Hazard Damage in Malaysia Caused by Landslide and Flood”
2011 – 2016 (5 years)

Background

• Concern for economical damage by landslide and flood in accordance with the climate change as well as recent population increase and urbanization
<Project Purpose>
Proposal of a trial disaster risk management system with an integrated data system landslide and flood

- Construction of the system for reducing geo-hazard
- Human resources development with sufficient skills and experiences
- Establishment of cooperation framework centering governmental agencies

Implementation Framework

Group 1: Remote sensing / geographical information system
- Collection of the natural/social environmental data
- Feasibility studies on CP/SAR boarded on UAV
- Estimation of hazardous area using spatial information

Group 2: Flood risk assessment
- Wide-range simulation
- High-resolution model in selected area
- Propose of hazard map

Group 3: Landslide risk assessment
- Statistical analysis in wide area
- Numerical analysis in selected area
- Propose of hazard map

Group 4: Disaster information database (data acquisition/integration)
- Construction of GIS database
- Integration of flood/landslide data
- Cooperation with GRAMS

Group 5: Early warning system/dissemination
- Planning of early warning system of flood/landslide
- Providing risk communication tools
- Cooperation with GRAMS

Collaborations

H. Fukuoka – SATREPS Project for “Research and Development for Reducing Geo-Hazard Damage in Malaysia Caused by Landslide and Flood”
Organizations concerned

### Research team in Malaysia
- Universiti Sains Malaysia (USM)
- Multimedia University (MMU)
- Universiti Tenaga Nasional (UNITEN)

### Research team in Japan
- The University of Tokyo (UT)
- Center for Environmental Remote Sensing, Chiba University (CEReS)
- National Institute of Earth Science and Disaster Prevention (NIED)
- International Centre for Water Hazard and Risk Management (ICHIARM)
- Experts from Vision Tech Inc.(VTI), Kyoto University (Niigata University), Ibaraki University, and Kyushu University

### Ministries concerned in Malaysia
- Economic Planning Unit (EPU)
- Ministry of Higher Education (MOHE)
- Ministry of Science, Technology and Innovation (MOSTI)
- National Security Council (NSC)
- Public Work Department (PWD)
- Department of Irrigation and Drainage (DID)
- Malaysia Remote Sensing Agency (MRSA)
- Malaysia Meteorological Department (MMD)

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Study of Landslide Disaster Prevention System in Malaysia as a Disaster Mitigation Prototype for South East Asia Countries

Swee Peng KOAY *, Hirosi FUKUOKA, Lea Tian TAY, Satoshi MURAKAMI, Tomofumi KOYAMA, Huah Yong CHAN, Naoki SAKAI, Hemanta HAZARIKA, Suhaimi JAMALUDIN, Habibah LATEH
East-West Highway Cut Off after Landslides Occurred at 23rd December, 2014 night.

Landslides Happened on 23rd Dec., 2014 along East-West Highway, Malaysia

Monitoring Sites and Landslides Occurred Sites

Monitoring Sites

Casualty

- > 100 casualties
- 11 - 100 casualties
- 1 - 10 casualties
- 0 casualty
Real Time Slope Monitoring Site (70.52KM East-West Highway)

Monitoring Site in N05°, 36.042’, E101°, 35.546’
Cross section of Monitoring Site (geological situation)

Concept of the Groundwater Well

[Concept]
The bedrock surface is covered by highly weathered with 1 to 2 m thickness. The highly weathered zone is an impermeable layer.
In case that target of the groundwater monitoring is the displaced mass layer, it is better to make the strainer section from 1 m above the bedrock surface to avoid penetrating the strainer into the impermeable layer (highly weathered zone).

[Installation]
GW Well-1: Strainer section=0.5 to 1.0 m, Water level sensor=0.5 to 1.5 m
GW Well-2: Strainer section=0.5 to 1.0 m, Water level sensor=0.5 to 1.5 m

Concept of the Inclinometer Deployment

[Concept]
- 1st depth: 1 m above the bottom of surface layer (colluvium)
- 2nd depth: 1 m below the bottom of surface layer (colluvium)
- 3rd depth: 1 m above the surface of bedrock

[Installation]
Inclinometer-1: 1st depth=1.8 m, 2nd depth=3.8 m, 3rd depth=6.8 m
Inclinometer-2: 1st depth=1.8 m, 2nd depth=3.8 m, 3rd depth=6.8 m

Joint studies on landslide mechanism
Real-scale landslide flume test at NIED
(National Institute for Earth Science and Disaster Resilience)
Exercise to conduct constant-volume direct shear test in the campus

Cross section of Monitoring Site
(Arrangement of instruments)
Photos from The Site

Photo taken on 24/11/2015

Photo taken on 27/06/2016

Rainfall (890mm in 9 days) and Slope Movement Data (Y-Direction)

Moreover, in May 2016

The devices in the monitoring site showed the movement of the slope after heavy and continuous rainfall as below:

![Graph showing rainfall and slope movement](image)

**Movement of the Surface of the Slope detected by Extensometer**

![Graph showing extensometer readings](image)

The displacement reading is 1549.35mm at 20:45 on 18/05/2016.

The displacement reading is 188.86mm at 12:45 on 18/05/2016.
Early Warning System

By
1 collecting the real time monitoring data from the sites
2 analyzing the rainfall intensity data

we establish the real time slope failure prediction system for the monitoring sites as next slide
Real Time Landslide Prediction and Early Warning System

Real Time Landslide Prediction on Monitoring Sites

Enlarge Interface refer to Next Slide

Enlarge Interface refer to Slide after Next
Real Time Landslide Prediction

Reference: Landslide Prediction Using Numerical Analysis

Early Warning Information Dissemination

Short Mail(Mobile Phone) Received from Alert System
Alert message (Email) sent by slope monitoring server after rainfall data exceeding threshold level

http://e-participatory.cs.usm.my/LandslideInputVersionCA/
Collected Rainfall Intensity Data in Km 18 of Jalan Tebedu, Sarawak
(Landslides Occurred at 9:23a.m., 27th Feb, 2016)

<table>
<thead>
<tr>
<th>Time</th>
<th>Rainfall Intensity [mm/h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>26/02/2016</td>
<td>0</td>
</tr>
<tr>
<td>27/02/2016</td>
<td>2</td>
</tr>
<tr>
<td>28/02/2016</td>
<td>4</td>
</tr>
<tr>
<td>29/02/2016</td>
<td>0</td>
</tr>
<tr>
<td>30/02/2016</td>
<td>0</td>
</tr>
<tr>
<td>01/03/2016</td>
<td>0.5</td>
</tr>
<tr>
<td>02/03/2016</td>
<td>0.2</td>
</tr>
<tr>
<td>03/03/2016</td>
<td>0.3</td>
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<tr>
<td>04/03/2016</td>
<td>0.1</td>
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<tr>
<td>05/03/2016</td>
<td>0.05</td>
</tr>
<tr>
<td>06/03/2016</td>
<td>0.02</td>
</tr>
</tbody>
</table>

INPUT FILE Format

Information Dissemination by IT Technology

Early warning system is NOT enough for lessen casualty. Public awareness(preparedness) on natural hazard is very important for disaster prevention. So, the below information should be disseminated:

a) Hazard map
b) Information on landslides historical occurrence venue
c) Evacuation map for preparedness escaping to shelter if the slope failure occurs
H. Fukuoka – SATREPS Project for “Research and Development for Reducing Geo-Hazard Damage in Malaysia Caused by Landslide and Flood”

Hazard Map

http://e-participatory.cs.usm.my/historicalmap/MemberPages/historical.aspx

Landslides Historical Data

The details (photo) of landslides occurrence will be shown

Hazard Map Management System


Information on Evacuation Center

http://jmgeo.hazard.cs.usm.my/map/map/eMapEmbed.jsp?cid=1&gid=0&mid=26
Real Time Monitoring and Information Dissemination System
(as our study)

Site 1 Data logger for sending data from the devices to server(i-Sensor) in USM

Internet Send data every 5 minutes

i-Sensor Server
(USM)

Site 2 Data logger for sending data from the devices to server(i-Sensor) in USM

Early Warning System and Data Dissemination System

Control and Command Center

i-Sensor Server
(USM)

copy data

Website
(Public user)

Intranet

Prediction Workstation (USM)

Warning Light + Buzzer

Website
(Public user)

Website
(Public user)

Website
(Public user)

Website
(Public user)

Send Message:
Email & SMS

e-participatory Server (USM)

Website
(Public user)

Website
(Public user)

Website
(Public user)

Website
(Public user)
3. Public Awareness Education

The smart public will not be panic to confront the natural hazard with well preparedness.

In Malaysia, one of the developing countries, as there are only a few community center facilities, it is hard to organize public disaster awareness talk to public (adults).

The education attainment rate for adults who are 25 years and above is not high (year 2009), in Malaysia and other South East Asia countries, except Singapore.

(* Source: ASEAN State of Education Report 2013)
Education attainment of the population aged 25 years and above (%) in South East Asia Countries (ASEAN)

<table>
<thead>
<tr>
<th>Country Name</th>
<th>Primary</th>
<th>Lower Secondary</th>
<th>Upper Secondary</th>
<th>Tertiary Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunei</td>
<td>98</td>
<td>75 (secondary)</td>
<td>75 (secondary)</td>
<td>11</td>
</tr>
<tr>
<td>Cambodia</td>
<td>20.1</td>
<td>9.2</td>
<td>4.2</td>
<td>-</td>
</tr>
<tr>
<td>Indonesia</td>
<td>36.58</td>
<td>14.45</td>
<td>29.34</td>
<td>7.5</td>
</tr>
<tr>
<td>Laos</td>
<td>68.4</td>
<td>75</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Malaysia</td>
<td>23.7</td>
<td>17.5</td>
<td>31.2</td>
<td>18.8</td>
</tr>
<tr>
<td>Myanmar</td>
<td>83.54</td>
<td>39.57 (secondary)</td>
<td>39.57 (secondary)</td>
<td>-</td>
</tr>
<tr>
<td>Philippines</td>
<td>89.4</td>
<td>59.9 (secondary)</td>
<td>59.9 (secondary)</td>
<td>28.1</td>
</tr>
<tr>
<td>Singapore</td>
<td>96.8</td>
<td>93.2</td>
<td>74.6</td>
<td>63.6</td>
</tr>
<tr>
<td>Thailand</td>
<td>89.7</td>
<td>72.7 (secondary)</td>
<td>72.7 (secondary)</td>
<td>45.8</td>
</tr>
<tr>
<td>Vietnam</td>
<td>98.5</td>
<td>84.96 (secondary)</td>
<td>84.96 (secondary)</td>
<td>51.7</td>
</tr>
</tbody>
</table>

* Source: ASEAN State of Education Report 2013
* means not available
**secondary means the survey does not separate lower or upper secondary

Public Awareness Education in Schools

Moreover, most of the adults are busy in their works daily.

These are the reasons why we choose to educate school students, in schools, to bring public awareness to family by bottom-up, information dissemination among family members.
Natural Hazard Education

Conducted natural hazard education in primary schools

1) 7th. April, 2015 in Sekolah Kebangsaan RPS Banun, Address: 48km, East-west Highway from Gerik.
Most of the students are aborigines Jahai, Negrito tribe (rural area).

2) 12th. October, 2015 in Sekolah Jenis Kebangsaan Perempuan China,
Address: 2-D, Jalan Gottlieb, Penang
Most of the students are Malaysian Chinese (urban area).

3) 2nd. November, 2015 in Sekolah Kebangsaan Minden Height
Address: Minden Heights, 11700 Gelugor, Pulau Pinang
Most of the students are Malay (urban area)
In Public Awareness Education

1. Conducting questionnaire (before and after education) to understand how details the students know about landslides

2. Educating School Children and indirectly to the Community (adults) by showing video and explaining the mechanism of slope failure

3. Providing Hazard Map Information

Hands-on education on weather station

Hands-on education will give students better picture on the weather, and attract their attention on natural hazard
4. Conclusion

1) IT Technology plays very important roles in
   a) Analyzing slope condition and prediction the slope failure
   b) Information dissemination (such as slope condition, hazard map, evacuation map and landslides historical map) to the public

2) Public Awareness:
   a) Natural hazard education should be conducted in schools, especially in the areas near to lakeside, riverside and hilly area
   b) In developing countries, educating school children can bring public awareness to family while doing communication among family members
THANK YOU for Your Attention
JST/JICA SATREPS Study on Glacial Lake Outburst Floods in the Bhutan Himalayas

ブータンヒマラヤにおける氷河湖決壊洪水に関する研究

2009～2011
Leader: K. Nishimura (Nagoya University)
(C/P in Bhutan: Department of Geology and Mines Royal Gov. of Bhutan)
Presenter: D. Higaki (Hirosaki University)

Background

- Glacial lake outburst floods (GLOFs) as natural hazards in the Himalayan countries

Photos courtesy of Dr. Yamada & WECS, Nepal
The Dīg Tsho GLOF in 1985 triggered by the fall of ice mass (photo by Umemura, J. in 2003)

Landslides triggered by the stream erosion of GLOF in 1985 (Khumbu, Nepal, WECS, 1987)
Erosion and sedimentation are the GLOF associated hazards.
Short term problems

- GLOF
- Erosion/sedimentation
- Landslide
- Natural dam
- Outburst flood
- Devastation along the river

Long term problems
- Recurrence of landslides
- Heavy sediment load to downstream

"watershed-based landslide and sediment management"

Outline of Project

- Re-evaluation of Himalayan glacial lakes
- Evaluation of the past GLOF experienced lakes
- Glacial lake inventory using high-res. ALOS data
- Expansion mechanisms of Himalayan glacial lakes
- Detailed analysis on potentially dangerous glacial lakes
- In-situ surveys in the Mangde-Chhu river basin
- Breach and flood simulations
- Hazard mapping
- Social surveys
- Proposal for early warning system
Structure of Project

- **Process Group**
  - Expansion mechanisms and *in-situ* surveys
  - Nagoya University and 7 institutions

- **Satellite Group**
  - Glacial lake inventory
  - JAXA and 4 institutions

- **Assessment Group**
  - Flood simulations and hazard mapping
  - Earth System Science Co Ltd and 5 institutions

- **Counterparts in Bhutan**
  - 9 researchers from Department of Geology and Mines
New Inventory

- Based on ALOS mosaic images with high-res digital terrain model

Expansion History

- Wider regions around the Bhutan Himalaya
- Climatic analysis is possible
D. Higaki – Study on Glacial Lake Outburst Floods in the Bhutan Himalayas

Formation Conditions

- Himalayan glacier with glacial lake has
  - gentle slope termini
  - large lowering since the LIA
- Prioritization
  - Which ones we have to keep watch?

Breach Simulation

- Moraine property based on *in-situ* samples
- Also important is angle of damming moraine
  - More gentle moraine, more robust against inflow
  - Consistent with re-evaluation criteria
**Flood Simulation**
- GLOF vs. cyclone floods
- Flood discharge
- Peak propagation

**Hazard Mapping**
- Detailed 3D simulation around targets requiring protection
- Also important are social surveys
Gentle slopes with houses and paddy fields (Kungarapten, Bhutan)
Deep-seated landslides may occur due to stream erosion by GLOF

Landslide Inventory

- Potential hazards induced by GLOFs or floods

Higaki & Sato (2012GER)

Legend:
1: Rock creep
2: Landslide
3: Scarp
4: Terrace

Aug 2009  Mar 2011

Primary School
Bjizam Bridge
Mangde-chhu
Early Warning System

- Rapid increase of water level as a GLOF feature
- Compared with a cyclone flood
- Proposed EWS by Department of Energy

Related Products

- Changes in glaciers
  - First volumetric survey in Bhutan
- Interactions between glacier and glacial lake

Tshering et al. (in prep)
Tsubuki et al. (in prep)
D. Higaki – Study on Glacial Lake Outburst Floods in the Bhutan Himalayas
5. Research on Landslide Hazard Map in Honduras

Report on Hazard Map Training

Contents

1. Introduction

2. Previous studies of JICA* project

3. Landslide Hazard Mapping
   – under Capacity Development

*: Japan International Cooperation Agency
1. Introduction

This presentation shows a part of the JICA project “Assistance for Strengthening and Capacity Building of professional Techniques for the Control and Mitigation of Landslides in the Tegucigalpa Metropolitan Area” with continuous projects.

Under this project, I (we) show how to make the hazard map with counterparts in two areas El Edén and Nueva Santa Rosa of Tegucigalpa.

2. Previous studies of JICA project

2000-2002: The study on flood control and landslide prevention in Tegucigalpa metropolitan area of the republic of Honduras (JICA).

2011-2013: Project on landslide prevention in Tegucigalpa metropolitan area (ODA)

2011-2013: Hazard geology focusing on the landslides in Tegucigalpa (JICA-JSPS)

2011-2013: Technical support for landslide studies at Honduran universities (JICA-SV)
17 Landslides caused by Hurricane Mitch in Tegucigalpa


(The Google Earth image is used as the base map)
Countermeasures against Landslides

- Drainage with gabions
- Embankment

- Drainage well

Berrinche

- Reparto

Berrinche

Rio Choluteca
3. Landslide Hazard Mapping

2015-2016: Assistance for Strengthening and Capacity Building of Professional Techniques for the Control and Mitigation of Landslide in Tegucigalpa Metropolitan Area (JICA).

**Stuffs**
- JICA Experts: Drs. H. Yamagishi, H. Yagi, G. Sato, and K. Hirota
- Companies: Kokusai Kogyou Co., Ltd., OYO International Corporation

**Counterparts**
- Alcaldia Municipal del Distrito Central (Municipal Office of the Central District)
- Universidad Nacional Autónoma de Honduras (National Autonomous University of Honduras)
3.1 Educational program

*Educational three activities as followings;*

1. The **lecture** to learn geology and geomorphology.
2. The **practice** to read aerial photography and map.
3. **Fieldwork** to confirm landslides after practice.

---

**Educational process of the project seminar (JICA)**

**One set**

1. **lecture**
2. **practice**
3. **field**

---

Repeated
3.2 Sites Selection for activity

Two examples of landslide distribution map

Flow diagram indicates the educational process to make the hazard map.
To make landslide Inventory

Currently, this structure has been changed.

To evaluate each landslide block

Example: number 2 landslide block
Analytic Hierarchy Process: AHP

Lately, we do the inventory of the landslide with the system to have criterion weight. 

<table>
<thead>
<tr>
<th>Level II</th>
<th>Level III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharp &amp; clearness of microtopography</td>
<td></td>
</tr>
<tr>
<td>Fragmentation of primary block into sub-blocks</td>
<td></td>
</tr>
<tr>
<td>Topographic feature of landslide mass or toe part profile</td>
<td></td>
</tr>
<tr>
<td>Geological &amp; geomorphological setting</td>
<td></td>
</tr>
<tr>
<td>Water collectability from upper slope of landslide crown</td>
<td></td>
</tr>
<tr>
<td>Land cover, artificial change and habitation on landslide mass</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Categoría</th>
<th>Elemento</th>
<th>número de deslizamiento de tierra</th>
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<tbody>
<tr>
<td>Microtopografía</td>
<td>Inclinación</td>
<td>20</td>
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<tr>
<td></td>
<td>Gradas de fragmentación</td>
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<td>Pendiente convexa</td>
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<td>Pendiente concava</td>
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<td></td>
<td>Filtración de agua en la parte del pie</td>
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<td>Escorrentías de invierno</td>
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<td>Condición del Terreno</td>
<td>Urbanización densa</td>
<td>20</td>
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<tr>
<td></td>
<td>Vegetación de bosque</td>
<td></td>
</tr>
</tbody>
</table>

Puntaje Total

Numerals is a weight for each criteria.

Schematic Illustration of weighting system for landslides locating on hilly slope

For Dr. Yagi

Twenty points for each Category at most, even if the total score number of the elements passes more than twenty.
And a hundred points totally at most.

Geologic map of two sites in the project
Discussion and putting together our thoughts with GIS after field investigation for landslide
3.3 results

**biggining**

Susceptibility map

**fulfillment**

Hazard map

El Edén

Nueva Santa Rosa

Hazard maps (el Edén y Nueva Santa Rosa)

Land movement

- active
- latent
- no active

*By tow examples of UNAH and AMDC*

3.4 conclusion

1. Results of the previous project for landslide education are sustained, because it has been concentrated to work at the same time during 2011 to 2013.

2. There were several people in the counterparts who use GIS skillfully.

3. Educational methods that circulate lectures, exercises and fieldworks are basic, but it was possible to go to the site finely in a short time, and to be able to discuss with the result of investigation worked well.
CEPEIGE (ECUADOR) E-LEARNING PROGRAM (LANDSLIDE COURSE; MODULE IV) (GIS USING LANDSLIDE MAPPING PROGRAM) IN 2014
H. Yamagishi, R.M. Lopez – Landslide Mapping Education Programs in Latin America-CEPEIGE (ECUADOR) and UNESCO ENHANS PROJECT(PERU)

E-learning of Geographical Institute of Ecuador (CEPEIGE)


Simultaneous discussion with tutor and applicants using Hangouts

Topics of Module IV: Landslide Mapping and GIS
• Definition, types and causes of Landslide
• Inventory and mapping of Landslide using topographic maps, airphotographs and satellite images
• How to deal with landslides using GIS
• How to make Landslide hazard maps using GIS

CEPEIGE opened the international landslide training course by e-learning. In this Module IV (landslide mapping and GIS) a total of 18 applicants from Ecuador, Columbia, Chile, Argentina and Mexico participated, most of them are professionals from institutes and universities. A total of 14 applicants passed the first stage. And then 2 applicants developed the second stage as final research report.

Contents of the second session of Module IV (first stage)
Definition of landslide, types and basic knowledge for inventory
Contents of the third session of Module IV (first stage)
Landslide Inventory using airphotographs and satellite images

Identificación de Deslizamientos en Tegucigalpa

Fotografías aéreas digitales a color desarrolladas por JICA para Tegucigalpa en el año 2013 (usadas por el Grupo de Mapeo de Deslizamientos de Tegucigalpa)

Escarpes, estanques y escombros

Deslizamientos profundos vistos en Google Earth (Tegucigalpa)

Contents of the fifth session of Module IV (first stage)
GIS training and data acquisition/management

Seleccione el Area y Descargue los datos

Importe el DEM de 30m de Ecuador a QG-GIS

Crear las Curvas de Nivel

Mapa de Inventario de Deslizamientos sobre Mapa de Relieve

Como se relacionan los deslizamientos del mapa de inventario (polígonos) con los ríos (polilíneas) por medio de selección espacial

Los análisis de SIG determinaron los deslizamientos peligrosos
**Discussion using Facebook**

![Image of Facebook discussion]

**Direct Discussion with students**

*By Skype (participants are mostly Professors and geologists in institutes)*

**Tutor:** Rigoberto Moncada Lopez

![Image of Skype discussion]

**Contents of the fourth session of Module IV (first stage)**

*Video conference*
Second stage (Research Reports)

1. Topics: landslide mapping and GIS
2. Initially 4 people applied, but only two people completed the report
3. One was an engineering geologist from Colombia and the other was a geographer from Argentina.

- Landslide Inventory using topographic maps and satellite images.
• Use of aerial photographs for inventory near Bogotá, Colombia.

• Landslide analysis using satellite images from Google Earth and DEM.
UNESCO ENHANS PROJECT WORKSHOP

- ENHANS “Extreme Natural Hazards and Societal Implications” of the UNESCO. An intensive training program includes volcanic hazard, seismic hazard, flooding hazard and landslide hazard training:
- We are responsible to landslide hazard training program. Our first workshop was executed on November of 2015, in Lima, Peru.

The objective of this landslide and related disaster project is to train key representatives and technicians who should then replicate landslide mapping and hazard assessment methodologies in their respective countries (Chile, Ecuador and Peru). This project is on-going: next year we are doing in Ecuador and Chile, as well as Peru.

Preparation Events for ENHANS Project in Chile, Ecuador and Peru

- Quito Meeting, 2015, April
- Santiago Meeting, 2015, April
- Lima Meeting, 2015, September
Opening Ceremony and Training Activities for the workshop in Lima, Peru, 2015, Sep. (Opening ceremony, training of stereoscopy and GIS applications)

Training Process in Lima Peru

1. Preparations: Information Compilation and Explanation of Landslide Principles
2. Landslide Inventory at desk using all available information
3. Field Visit and Report
4. Modification of Inventory with Field Data
5. Import of Inventory to GIS
6. Elaboration of Individual Landslide Inventory Map
7. Elaboration of Final Group Landslide Inventory Map
8. Final Map and Report Submission
Landslide inventory map of Chosica with aerial photographs (1961-1962) (also developed by participants)
H. Yamagishi, R. M. Lopez – Landslide Mapping Education Programs in Latin America-CEPEIGE (ECUADOR) and UNESCO ENHANS PROJECT (PERU)

- Landslide inventory map of site in Huancavelica using DEM analysis (also developed by participants).

- Use of DEM and topographic maps for landslide identification in Huancavelica (also developed by participants).
Map of Field Visit Debris flows in Chosica (east of Lima)

- Field visit Activities in Chosica
Conclusions

- Training activities in the methodology were able to successfully teach participants how to use available information for the development of landslide inventory maps both in a virtual (Ecuador-CEPEIGE) or classroom (Peru-ENHANS/UNESCO) environment.
- Participant profile is essential for effectiveness of training. Higher comprehension of GIS, landslide and geology topics are greatly recommended.
- An essential component of this methodology is field visit also, to confirm in situ the existence of landslides.
- This methodology is practical and low-cost for different scales, both for regional and local landslide mapping.
- However, how these educations are carried out smoothly, depends on how many data are available, such as air photos and digital data such as DEM etc. There are very few data in Latin American countries excepting for 30m DEM from JAXA(Alos3 etc) free in charge.
国際斜面災害研究機構（ICL）

ICLの活動、地すべり国際ジャーナルとフルカラーリーの本発行は、下記の賛助機関に支援していただいている。
（株）マルイ（大阪）、和山ボーリング（株）（横手）、（有）太田ジュオリーシー（西宮）、坂田電機（株）（東京）、国土防災技術（株）（東京）、（財）砕石地すべり技術センター（東京）、松本開発（株）（金沢）、応用地質（株）（東京）、国際航業（株）（東京）、（株）オサシテクノス（高知）

We keep clean nature for the future

Stress / Speed Dual Control
Ring Shear Apparatus

Marui & Co., Ltd.

GEOENGINEERING CONSULTANTS
OKUYAMA BORING CO., LTD.
Company Profiles

We support your technique by Testing Machines.

Environment, Concrete Ground & Disaster Prevention

Established: 1971
Capital: ¥43,200,000
Head office & Factories: Daito City, Osaka
Branch offices: Tokyo, Nagoya, Fukuoka
Certification

1) JCSS 0128 (Conforming ISO17025)  
< Force-proving Instruments & Uniaxial Testing machines >

2) ISO9001:2008  
(Factory & Branches)

Company motto

「運・根・鈍」
UN KON DON

「Luck, Perseverance and Simple honesty」
Ring shear Apparatus for Geotechnical engineering & Disaster prevention

ICL-Type1

ICL-Type2 (High-stress dynamic-loading undrained)

New type ICL-type1

Old type

Point
- Compact
- No loading flame
- Single central axis
- Only one load cell
- Undrained dynamic-loading
Point

- Motion of megaslide
- No loading flame
- Gap control system
- Only one load cell
- Undrained dynamic-loading

Outline of the mechanical structure

Shear box and the close-up view of the undrained gap
Testing machine for Geotechnical Engineering

Quality first  
Time Saving!

“HI-MULTI”  
Automatic Quadruplex Triaxial compression testing machine

Testing machine for Geotechnical Engineering

Quality first  
Time Saving!

Cyclic Direct Shear Apparatus  
Direct Shear Apparatus of the Japanese Geotechnical Society type
Our company’s World wide trading

"The best companies don’t create customers. They create fans."

Peter F. Drucker
Key Word (4C)

- Curiosity : Interest! Why!
- Challenge : Quick decision!
- Collaboration: Win-Win
- Coaching : Support and cooperation by universities and research institutes

<Our company is “Small head but great wit”!>

Thank you for your attention!

Let’s collaborate and develop new technology together
Osaka prefecture will run for the host city of *the World Exposition 2025*! 

Welcome to OSAKA!
• 1990~ Nepal, Indonesia
  (Technical cooperation project ; JICA )
• 2011  Malawi
  (Groundwater Development project )
• 2012  Vietnam
  (Study on slope stabilization method project)
3D Coupling Numerical Simulation of Landslide and Surge

Time 0.0sec
Time 17.5sec
Time 10.0sec
Time 47.5sec

Seismic slope stability analysis
Susceptibility mapping for earthquake-induced landslides

Elasto-viscoplastic analysis for landslide deformation
New simple drilling system for water drainage boring
How about JCE

Information of JCE

PROFILE

Name: Japan Conservation Engineers & Co., Ltd.
President: YANAI Katsuaki
Headquarters: 3-18-5 Toranomon, Minato-ku, Tokyo 105-0001, JAPAN
[Technical Department]
11-12-2 Kitaurawa, Urawa-ku, Saitama 330-0074, JAPAN

Homepage: http://www.jce.co.jp/
Tel./Fax Numbers: +81 3 3436 3673 / +81 3 3432 3707
[Technical Department]
+81 48 833 0422 / +81 48 833 0424

Capital: 342 million Yen
Net Sales: 8,339 million (fiscal year ended September 30, 2011)
Employees: 361 (as of April 1, 2012)
Established: May, 1966
Management system: ISO 9001:2008 (Quality management standard)
Consulting
Afforestation/Forest Road/
Forest Management
Rural Development
Steep slope - Resilience
Retirement
Maintenance and control
River works/Erosion control
Seepage prevention/Anchor
Forest for damage forest
prevention

AFFORESTATION/FOREST ROAD/FOREST MANAGEMENT/
RURAL DEVELOPMENT/STEEP SLOPE • AVALANCHE/
ENVIRONMENT

Carry out the land conservation effectively through the natural hazard risk areas survey using GE and consulting forest
conservation plan based on characteristic forest and basin.

Survey and Design for afforestation
Forest road restoration

Living environmental preservation forest
Construction works for forest road restoration

Construction Works
- Landslide prevention construction
- Anchor works/Crib works
- Filling works/Drainage well work
- Tunnel works
- Slope protection works
- Crib works/Pulling rock preventive structures
- Reinforced soil works
- Grouting works

Safety First
and best security

LANDSLIDE PREVENTION CONSTRUCTION
Conduct to the quality and safety controls with reliable techniques.

Anchor Works/Crib Works

Observation box
Observation wire
Index wire
Anchor wire
Anchor displacement gap
Introduction of GODAI

Godai Development Corporation

Profile of Godai Development Corporation

- **Head Office**: 1-35, Kuroda, Konanawacho City, Ishikawa 921-0001 JAPAN
- **Shizuoka Office**: 56 Yanagishiri, Makogawa City, Shizuoka 420-0052 JAPAN
- **Sendai Office**: 1F 512, Aoba Heights Bldg 211, Senbyakun-machi, Wakabayashi-ku, Sendai City, Miyagi 980-0057 JAPAN

<table>
<thead>
<tr>
<th>CEO</th>
<th>Tohru Ishikawa, Kaneo Oda</th>
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<tbody>
<tr>
<td>Establishment</td>
<td>8 March, 1985</td>
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<tr>
<td>Capital stock</td>
<td>35 million Yen</td>
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<td>Number of employees</td>
<td>63</td>
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**Business Line**

**Civil Engineering Consulting**
- Survey: ground, aviation, rivers, lakes, coasts, etc, registers
- Research and Analysis: landslides, geological research, soil research, EIA, environmental impact assessment, FGD, etc.
- Civil Design: roads, bridges, tunnels, urban planning, tap water and sewage, airports, ports, development, construction management, parks, railways
- Planning and management of Natural disaster: slope disaster (landslides, steep slopes), rivers and erosion control
- IT Consulting: software development and selling, contract-based software development, network building, database building including Geographic Information System, "MASEU NET"

198
Software Package (Automatic Calculation Technology)

2D Slope Stability Analysis

This software can analyze slope stability of landslides and slope failures in two dimensions. Considering civil engineering users' workflow, its automatic calculation of high-frequency procedures is characteristic for them.

Software Package (3D Expression Technology)

3D Slope Stability Analysis

This software can analyze slope stability of landslides and slope failures in two dimensions. It can create three dimensional data automatically from cross section using spline surface.
Software Package (Structure Calculation Technology)

Design Calculation System for Landslides and Slope Failure Measures

Design Calculation System of Anchor Works, Piles, Reinforcing Steel Bar, etc.

It enables users to make structure calculation and construction estimation at the same time. Users can decide the most suitable and most efficient method at one trial procedure.

Software Package (Simulation Technology)

Design Calculation System for Rock-fall Protection

Design Calculation System for Rock-fall Protection

All planning works such as rock-fall simulation, structure calculation, construction estimation, comparison of construction method, are possible in one software.
Software Package (3D Geological Expression Technology)

3D Ground Modeling System

This software can be used to express and utilize the geological information in 3D. It can create three dimensional ground models automatically from cross section using spline surface.

Entrusted development of software

Arrangement of Reinforcements, Ground Anchorage Design Calculation Report
### System Technology (Database System for Government Office)

<table>
<thead>
<tr>
<th>System Name</th>
<th>Outline</th>
<th>Foundation Act</th>
<th>Customer</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Data Management System of Water Quality and Quantity</td>
<td>management of periodic hydrological data</td>
<td>Tatsumi Dam Construction Office</td>
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<tr>
<td>Telemeasuring Facilities Control System</td>
<td>management of telemeasuring facilities register</td>
<td>Kanazawa-city, River Dept.</td>
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<td>River Control Information System</td>
<td>database of river status research</td>
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<td>Rainwater Drainage Management System</td>
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<td>GIS</td>
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<td>Disaster Assessment System</td>
<td>management of disaster assessment sheets</td>
<td>Act on National Treasury's Expenditure for Project to Recover Public Civil Engineering Works Damaged by Disaster</td>
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<td>Kitakawa, City, Construction Office</td>
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<tr>
<td>Document Management System</td>
<td>management of report information</td>
<td>Rekis, Transit, Railway Office, Kometu Station</td>
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<tr>
<td>Drawing Management System</td>
<td>management of construction drawings</td>
<td>Kanazawa, Ports and Harbor Bureau</td>
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<td>Construction Records Management System</td>
<td>management of construction records</td>
<td>Rekis, Transit, Railway Office, Kometu Station</td>
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<td>management of periodic shoreline data</td>
<td>Ishikawa, City, Civil Engineering Office</td>
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</table>

### System Technology (GIS System for Government Office)

- **“Sabour-I” (Sediment Disaster Alert Information System in Ishikawa)**
- **“Tatsumi Dam” Environmental GIS System**

- Construction Register Management System
- Public Facilities Register Management System
Internet business ("ISABOU NET")

We are administering the civil engineering information portal site "ISABOU NET" which has over 24,000 members.

Advertising Revenue 30,000,000 Yen
Total User Charge 7,000,000 Yen

GODAI’s Sales Network

Software Users • • • 3,000 companies
ISABOU NET Members • • • 28,000 persons
Our Business
Our company is a maker of measurement instruments for natural disaster prevention.

Vision
“We contribute to the Safety of Society with Reliable Information.”

Natural Disaster
- Landslide
- Debris Flow
- Slope Failure
- Natural Dam

Exploration
- Landslide
- Hydrologic studies
- Survey of water quality
- Weather observation

Maintenance
- Slope Monitoring
- Flood Disaster
- River water level observation
- Agricultural water management
Company Information

OSASI TECHNO INC.

- Established in 10 Jun 1972
- Head office & Factory: Kochi prefecture, Japan
- Tokyo Head office, 1 Branch office: Fukuoka prefecture
- Number of staff: 64

Head office in Kochi prefecture, JAPAN

Monitoring System

Water Level, Inclination, Rainfall, Strain, Alarm, Site Network, Cellular Device, Internet, Data Logger, Sensor, Administrator & Community, Computer, Smartphone, Tablet.
Products lineup

- Observation instruments
  - Extensometer
  - Rain Gauge
  - Strain Gauge
  - Water Level

- Cloud service
  - Remote sensing system

- Communication instruments
  - Cellular device
  - Radio transceivers

- Alarm equipment for Local alarm system
  - Alarm unit

- Hybrid type
  - Multi-point inclinometer

Landslide Remote Monitoring System (LRMS)

Application Example

Cloud Service

Data Sharing with Relatives

Management office

Data Check

Alarm Mail

Field Personnel

Evacuation Order to Residents

Selective connection WIRE or RADIO

Radio Transceiver

Extensometer

Rainfall Gauge

Cellular Device

Alarm Unit

Landslide Area

Monitoring Display

Internet

OSASI

OSASI TECHNOS INC.
Use Example in JAPAN

- **Location**
  Shizuoka Prefecture / tea plantation

- **Client**
  Ministry of Land, Infrastructure, Transport and Tourism IN JAPAN
Contact us

OYO Corporation
Instruments & Solutions Division

Address: 43 Miyukigaoka, Tsukuba, Ibaraki 305-0841, Japan
TEL: +81-2985-15078
FAX: +81-2985-17290
e-mail: seihin@oyo.jp
Website: www.oyo.co.jp/english/products

CONTENTS

1. Monitoring Method Transition
2. Remote Monitoring System
3. Cloud Service
4. Expanded Feature
1. Monitoring Method Transition

- Manual monitoring
  - Analog data logging
    - Digital data logging
      - Telemeter transmission
      - Wireless transmission
        - Internet
          - Cloud

2. Remote Monitoring System

FIELD

- Monitoring Data
  - i-SENSOR Rain
  - i-SENSOR Logger M4
  - i-SENSOR Tilt

REMOTE AREA

- Data Center / Office
- Relay Station
- Administrator / Stakeholder
3. Cloud Service

(1) Data Browsing

Hourly-rain

24h-rain

(2) Application

Snake Curve: slope stability analysis using rainfall data
4. Expanded Feature

Disaster Risk Management System
Combine the “REMOTE MONITORING” with GIS

Contact us

OYO Corporation
Instruments & Solutions Division

Address: 43 Miyukigaoka,
Tsukuba, Ibaraki
305-0841, Japan

TEL: +81-2985-15078
FAX: +81-2985-17290
e-mail: seihin@oyo.jp
Website: www.oyo.co.jp/english/products
Company's Business contents

- We have been developing effective and economical countermeasures for Rock-fall, Slope failure and Avalanche.
- Lately we started to deal in countermeasure for small size Debris flow.
- We develop, design, produce and install facilities by ourselves consistently.
Overseas Activity

We have an office at Seoul Korea.
Installing Rock-fall barriers and Debris flow barriers.

Debris flow barrier installed in Seoul city
**Overseas Activity**

We carried out JICA’s project 2013～Sep.2016 in Turkey.

Pilot survey for disseminating small and medium enterprises technologies for countermeasure against avalanche hazards.

Avalanche Prevention fence installed in Bolu Turkey
Activity of JICA’s project in Turkey
We trained Turkey local constructor and carried out installation of avalanche prevention fence. Also we carried out a training program in Japan and workshops(3 times) in Turkey concerning countermeasure for avalanche for Turkey government people.

Products for Slope failure and Debris flow
**SLOPE GUARD FENCE**

Fence for Slope Failure using Lotus Root Steel Tube

Pillar of the fence is made of newly developed lightweight Lotus Root Steel Tube, so pillar is relatively light but bending strength is very high. This fence is planar structure, so it can be installed in a narrow construction area mainly on the narrow road side and at the back of local houses.

---

**Performance verification actual scale test**

When we develop products, we confirm the performance by actual tests and analysis by computer simulation.

Energy can be absorbed in harmony with collapse of the entire steel pipe. 
→Pillar doesn’t break as strain doesn’t concentrate on the outer steel pipe.

Load test for Sediment soil pressure  Load test for Impact force
U-GUARD
Structure for small size debris flow using Lotus Root Steel Tube

This is a newly developed debris flow barrier using Lotus Root Steel Tube. It is installed at the end of valley to protect roads and houses. Since it is a planar structure with piles structure, installation area is smaller than the general concrete dam, and it is possible to reduce the construction period and cost.

Design Condition

(1) Design load
  • Impact force of debris flow + Sediment soil pressure

(2) Consider following factors to design the facility
  • Peak flow amount of debris flow m3/s
  • Unit volume weight of debris flow KN/ m3
  • Water depth of debris flow m
  • Flow speed of debris flow m/s
  • Fluid force of debris flow KN/ m2
  • Maximum gravel diameter m
  • Density of the gravel t/m3
Thank you for your attention!

We will contribute to Reduce the damage of Slope disaster of the world.

Junichiro Aizawa
PROTEC ENGINEERING, INC.
Phone :+81-25-278-1551
E-mail: aizawa@proteng.co.jp
Website: http://www.proteng.co.jp/en/
Evaluation of the landslide stability at the time of earthquake using numerical analysis

**INPUT**

- Seismic data
  - seismic motion data base containing generating landslide
  - evaluation of active fault and subduction-zone earthquake
- Geo-data
  - geological distribution
  - bedrock and soil strength
  - dynamic deformation characteristic
  - strain softening characteristics of sliding surface

**Output**

- Numerical analysis model construction
  - model for evaluating of the landslide stability: FEM containing sliding surface element
  - sliding surface element importable such soil characteristics information as strain softening
OUTPUT

before earthquake
after earthquake

horizontal displacement (m)

Ground surface
Center of gravity
Sliding surface

(see)
Construction of a geological information management system

CIM (Construction Information Modeling)

HAZAMA ANDO Corporation
SHINJI UTSUKI

3D landslide figure using CIM method

CIM is automatically figured from a few borehole informations.

Plane figure with two tunnels.

3D figure at excavated slope with landslide

Automatically figured sectional figures at any point
3D-ICT slope measurement system

- Automatically figured any measurement results at CIM in real time.
- Check this CIM by pc at the headquarter office using ICT system.

Slope measurement system with UAV

3D photo model – initial photo model = Z displacement

MV5R処理によって得られる複数時期の点群(DEM)を用いて、複数時期間に発生した地すべりや土砂移動の三次元的変動を捉え、地形の面積変化や移動方向の解析などもできます。
結論および今後の展開
現場のニーズに即した技術開発と施工現場適用
・CIM・ICT・AI技術を活用した情報化施工実施
・現場の「見える化」＋「見守り」管理
↓
・現場で安価かつ容易に利活用実現
今後の展開
新技術を活用した地質評価の高度化、見せる化
・調査・設計段階 地質に関わる課題摘出
・施工段階 地質状況確認、最適な設計変更
・維持管理段階 経時変化確認、最適な対策
↓
地質状況に応じた最適な建設事業の実現

トンネルCIM 開発の経緯～現場適用～今後の展開
CIM活用の利点
岩判定立会い
吹付部＝切羽手前の地質状況を3次元的に俯瞰
掘削の進捗に伴う地質状況の変化を「見える化」
↓
地質状況に応じた最適な支保設定に寄与

弱風化部が
広がっていく状況を
3次元に表現
吹付部の地質状況を
3次元的に俯瞰
岩判定時切羽
トンネルCIM 開発の経緯～現場適用～今後の展開

CIM活用の利点
竣工検査対応
トンネル全線にわたる地質状況を俯瞰
設計変更箇所の地質状況を「見える化」

竣工検査対応の高度化実現
CIM上に切羽写真を3次元配置するとともに施工情報を紐付
設計変更箇所の地質状況を3次元的に俯瞰

ダム堤体材料原石採取における賦存量CIM管理システムの構築

調査・段階設計 必要骨材量算定、原石山設計
施工段階 原石採取、骨材供給、賦存量管理

・CIMを活用した情報化施工
3次元地質図による詳細検討
賦存量算出などの省力化、高精度化
Red Relief Image Map
New Visualization Method

Providing solution using geospatial technology
Airborne LiDAR (Light Detection and Ranging)

**Profile**

- Surface under the tree can be acquired

**Data**

- Point cloud
  - Original
  - Ground

- Grid data
  - DSM
  - DEM

**Visualization**

- Red Relief Image map
- Contour map
- Orthophoto
Problem on expressing detailed topography

Contour map of Bear Earth DEM too complicate for lava field at Mt. FUJI

Photogrammetry Airborne LiDAR

Conventional method – Shaded Relief

features are depending on light direction
Red Relief Image Map (RRIM)

Slope angle
More red with steep slope

Factor of valley and ridge
More brighter on mountain top

Overlapped Image

Patents have been registered in Japan, China, Taiwan and USA


Red Relief Image Map from 1m DEM

Crater line

Fuji Sabo Office, "Fujiasami" No.38

General contour map

Image from digital camera
Real surface features can be expressed
Application

① Kilauea-iki crater, Hawaii
② St. Helens, WA
③ Topo-bathy mapping using RRIM
④ 3D Model using photographs taken by UAV etc.

Kilauea-iki crater, Hawaii
3D Model using photographs taken by UAV

3D Point Cloud

RRIM from 5cmDSM
3Dモデリングサービス

特徴① プラットフォームを選ばない！
航空機・手持ちカメラ、DMM、オプティカルカメラ
無人航空機・各種カメラ
特徴② リアル3D！
オーバーハングも表現可能
特徴③ 高度化を実現
災害時に滅多発生。24時間に機動の写真で実際モデルを作成した例

リアル3D
建物表現可能

データ集約
穴埋め、間引き、平滑化等
データ活用
3Dモデル
DSM、オルソ

写真画像
外部構定要素
カメラライターレーション

3Dモデルデータ作成
空中三角測量、モデリング
テクスチャ貼付

新手法【マルチビューステレオ方式】
航空カメラ
持ち上/持ち下カメラ

Asia Air Survey Co., Ltd.
International Forum
“Japanese contribution to Landslide Disaster Risk Reduction”
Sendai partnership 2015-2025 for global promotion of understanding and reducing landslide disaster risk
Science and Technology Research Partnership for Sustainable Development (SATREPS)
Organized by ICL and the Japan Landslide Society
Supported by the Japan Science and Technology Agency (JST) and UNESCO
Kyoji SASSA
Executive Director of ICL

Sendai Partnerships 2015-2025 Road Map to 2020

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国際地すべりジャーナル（Landslides）の発展計画 From bimonthly to monthly journal

- 200 pages x 6 times/year
- 300 pages x 6 times/year
- 170 pages x 12 times/year

地すべり教材の作成（Landslide Interactive Teaching Tools, テキスト、PPT, PDF）

- 1700 pages (97 tools)
- 2200 pages (130 tools)

世界地すべりレポート（ICL World Report on Landslides）

- Model establishment and 30 reports
- 300 reports and data sharing within reporters

One Field Summer School/year
One field summer school+ Summer school/year
Kyoji SASSA - Activities of ICL for implementation of Sendai partnership

斜面防災世界フォーラム (World Landslide Forum)

WLF1 2008, Tokyo, Full color Book1(Springe)+Mono-color book 2
WLF2, 2011, Rome, Full color Book 7(Springer)
WLF3, 2014, Beijing, Full color Book 3 (Springer)+Mono-color book 1
WLF4, 2017, Ljubljana, Full color Book 5 (Springer)

Vol.1 Sendai Partnerships is Open access book.

WLF5, 2-6 Nov. 2020, Kyoto, Japan (300 from Japan, 300 from abroad)
Full color Book 5 (Springer) + Free Access thematic issue of Landslides +
CD proceeding (open access in IPL web)

1. Full color books (Vol.1-Vol.5) published by Springer-Nature Full color
   Paper submission is by end of 2019. Published by WLF5 in September
2. Free access Thematic issue “Sendai Partnerships 2015-2025” of Landslides will be published in October 2020 (free access from 10 October to 10 November 2020)
3. Open access proceedings by IPL Global Promotion Committee in IPL WEB
   Paper submission is by the end of April 2020

Please join the organizing committee and propose the session which are suitable for you (in Japan, China, Korea, private companies and policy makers etc)
Please access to ICL World Reports on Landslides in IPL WEB <http://iplhq.org/ls-world-report-on-landslide/>

An Example of Report
(1792 Unzen Mayuyama Landslide)
Unzen 3D Simulation Video (LS-RAPID)

3D Simulation video (LS-Tsunami)
Aim of the Conference

- The International Consortium on Landslides (ICL) proposed the “Sendai Partnerships 2015–2025 for global promotion of understanding and reducing landslide disaster risk” in contribution to the Third UN World Conference on Disaster Risk Reduction. The proposal goes into effect by the signature of ICL, Special Representative of Secretary General of the United Nations, UNESCO, other 17 organizations in Japan and overseas. This partnership was significantly gained from the implementation of JICA and JST Joint funded SATREPS projects.

- We will introduce the results of SATREPS project in Croatia (2009-2014) and in Vietnam (2011-2017), and other SATREPS and JICA projects in Malaysia, Butan and Honduras. Then, we will examine further Japan’s international contribution for the landslide disaster reduction as a part of Sendai Partnerships 2015-2025.

- ICL and UNESCO, UNISDR, and others will organize the Fifth World Landslide Forum (WLF5) in Niigata, Japan. This conference is the mid-term milestone of the Sendai Partnerships 2015-2025 and the first five year milestone of the Sendai Framework for Disaster Risk Reduction 2015-2030. Participants will examine road map of the Sendai partnerships 2015-2025 to WLF5 2020.
An international Consortium on Landslides (ICL) was established during the UNESCO-Kyoto University Joint Symposium in 2002. Participants are from UNESCO (ADG:AS-Nagy), UNISDR (Pedro Basabe), WMO (DSG:Michel Jarraud), MOFA & MEXT, KU(Kaoru Takara), Japan and others.

High-Level Panel Discussion:

Initiative to create a safer geoenvironment toward WCDR2015 and forward

High-level panel was chaired by Hans van Ginkel (Former Rector of UNU). UNESCO (Director-General Irina Bokova), UNISDR, WMO, ICSU/IRDR, China Geological Survey, ICL together from floor discussed. The 2014 Beijing Declaration “Landslide Risk Mitigation: Toward a Safer Geoenvironment” was adopted on 6 June 2014 following this panel discussion, which was the preparation for the ISDR-ICL Sendai Partnerships 2015-2025 to be adopted in Sendai 2015. 531 people, 211 national and international organizations from 40 countries and 5 organizations of United Nations System participated WLF3.
ISDR-ICL Sendai Partnerships 2015-2025 for global promotion of understanding and reducing landslide disaster risk

The partnerships was proposed by ICL and adopted in a session of “Underlying risk factors” of 3rd WCDRR in AM on 16 March 2015. It was agreed and signed by leaders of 16 UN, International and national organizations in PM on 16 March 2015 in Sendai, Japan. Signatories are ICL Executive Director, Ms. Margareta Wahlström (SRSG), and leaders of UNESCO, FAO, UNU, ICSU, WFEO, IUGS, IUUG, KU, SCJ, GRF and Japanese (Cabinet office and MEXT), Italian and Croatian Governments.

A method to assess landslide motion for vulnerability and Exposure for landslide risks: LS-RAPID simulation (Sassa et al. 2014) based on the landslide dynamics parameters of soils taken from the site

2014.8 Hiroshima Landslide Disaster
A method to assess landslide-tsunami motion for vulnerability and exposure for integrated landslide-tsunami risk: LS-Tsunami (Sassa et al 2016)

The Unzen-Mayuyama landslide-tsunami disaster in Japan. 15,000 people were killed by the landslide and its landslide-induced tsunami around Ariake Sea in 1792
Landslides in Vietnam and
the needs to develop the landslide risk
assessment technology

Dr. Eng. Le Quoc Hung

INTERNATIONAL FORUM
Japan’s Contribution to Landslide Disaster Risk Reduction
ISDR-ICL Sendai Partnerships 2015-2025 and SATREPS programme
Tokyo, 23-24 November 2016

CONTENTS

1. Landslides in Vietnam

2. State-Funded Landslide Project (SFLP)

3. Needs of contribution from Japan
1. Landslide in Vietnam: Prone areas

Landslide susceptibility map in Vietnam - 1:1,000,000 scale
(Nguyen Trong yen et al., 2006)

1. Landslide in Vietnam: Causes

- Vietnam = one of the countries affected by global climate change
  - Abnormal weather events ➔ extreme rainfall
- Mountainous regions in Vietnam:
  - Prone to geo-hazards
  - Potential of mineral resources, hydroelectricity, tourism etc.
  - Play an important roles in national socio-economic
  - Attract human resources

- Rapid development and urbanization in mountains
  - Human activities ➔ negative impacts (deforestation, mining, slope-cuts for construction, etc.).
    ➔ significantly promoting geohazard process
      ➔ triggering landslides in residential areas, road corridors, hydroelectricity’s reservoir, mining areas...
      ➔ increasing loss of lives and damages to people, infrastructure and environment.
1. Landslide in Vietnam: Consequences

Landslides in Lao Cai province
1. Landslide in Vietnam: Consequences

Landslides in Dien Bien province

2. SFLP: State-funded Landslide Project in Vietnam

Full title:
Investigation, assessment and warning zonation for landslides in the mountainous regions of Vietnam

- Timed:
  - Phase I: 2012-2016
  - Phase II: 2017-2020

- Carried out by:
  - 15 research institutions and all administrative divisions under MONRE
  - Leading agency: Vietnam Institute of Geosciences and Mineral Resources (VIGMR)
  - Principal manager: Dr. Le Quoc Hung

- Implemented in mountainous areas
  - 75% area of the country mainland
  - 37/63 provinces
2. SFLP: Goals

- Establishment of a standard national database on landslides and generation of landslide hazard maps at 1:50,000 for 37 mountainous provinces of Vietnam, and at 1:10,000 for hot-spot areas;
- Design of an Early Warning System for landslides, and implementing that in a number of test areas.

2. SFLP: Workflow


250
2. SFLP: Deliverables

1. A national database and WebGIS on landslides and related factors;
2. Landslide warning zonation maps at 1:50,000 scales for 37 mountainous provinces, and at 1:10,000 scales for hotspot areas:
   - Landslide inventory maps
   - Landslide susceptibility maps
   - Landslide hazard maps
   - Landslide risk maps
3. A pilot network of landslide monitoring stations
4. Reports and guidelines to end-users for:
   - Using the result maps, WebGIS and database
   - Recommendation of landslide mitigation measures;
   - Dissemination and communication of landslide preparedness, prevention and mitigation;
   - Landslide monitoring and early warning for very high landslide hazard areas.

2. SFLP: Results so far (10/2012-11/2016)
Landslide inventory maps at 1:50,000 scales for 15 provinces
2. SFLP: Results so far (10/2012-11/2016)

Landslide inventory maps at 1:50,000 scales for 15 provinces

Landslide susceptibility maps at 1:50,000 scales for 4 provinces
2. SFLP: Results so far (10/2012-11/2016)

Transfers of result maps to local authorities and involved organizations

a WebGIS on landslides in Vietnam

3. Need of contribution from Japan: for the next tasks of SFLP

➢ Rainfall & landslide correlations
  ➢ Establishment of rainfall thresholds for different areas
  ➢ Use of rainfall thresholds for
    ➢ Temporal probability assessment
    ➢ Development of an early warning system

➢ Landslide hazard assessment
➢ Landslide vulnerability and risk assessment
➢ Community-based landslide risk management
3. Need of contribution from Japan:
for the current problems of landslides

- Very pressing needs to develop:
  - Landslide risk assessment technology on swarm-landslides triggered by extreme rainfall events
  - Landslide risk reduction in the progress of climate change, urban development
  - Integrated technology of early warning and landuse change based on the reliable landslide hazard assessment

3. Need of contribution from Japan:
for SATREPS projects

- Past SATREPS project by ICL-ITST (2011-2016)
  - Assessed large-scale landslides along the transport arteries
  - Highly evaluated in Vietnam
  - Terminated on 6 November 2016
3. Need of contribution from Japan: for SATREPS projects

➢ Planned SATREPS project by ICL-VIGMR (2017-2022)
➢ Asked Japan to support
   ➢ Research and implementation of combined early warning and landuse change in vulnerable human settlements exposed to hazardous motion of debris

3. Need of contribution from Japan: for SATREPS projects

➢ Planned SATREPS project by ICL-VIGMR (2017-2022)
➢ Proposal submitted to the Embassy in October 2016
3. Need of contribution from Japan: for SATREPS projects

➤ Planned SATREPS project by ICL-VIGMR (2017-2022)

➤ Overall goals:
➤ Application of the developed combined technologies of early warning-evacuation
➤ Landuse change to reduce landslide disaster risk is realized to contribute to the safety ensuring of vulnerable human settlements

➤ Purposes:
➤ Collaborative research based on the world most-advanced landslide risk assessment technology
➤ Development of combined guidelines of early warning and landuse change to reduce landslide disaster risk in vulnerable human settlements

3. Need of contribution from Japan: for SATREPS projects

➤ Planned SATREPS project by ICL-VIGMR (2017-2022)

➤ Outputs:
➤ A new technology of localized hillslope heavy-rain forecasting is developed
➤ The initiation mechanism of swarm-landslides in Vietnam is elucidated; and the hazard assessment technology of fluidized swarm-landslides in Vietnam is established
➤ Guidelines of early-warning and land-use change are established and applied to the selected pilot site: Ha Long City
I wish all of participants to support our application of this planned project

PROJECT PROPOSAL FOR JAPAN’S TECHNICAL COOPERATION

RESEARCH AND IMPLEMENTATION OF COMBINED EARLY WARNING AND LANDUSE CHANGE IN VULNERABLE HUMAN SETTLEMENTS EXPOSED TO HAZARDOUS MOTION OF DEBRIS

Looking forwards to collaborating with you in the coming time!

Thanks for your attention!
Concept

The forum is a venue to spin knowledge from disasters and weave wisdom of disaster risk reduction into society

The forum would

1) Promote the implementation of the Sendai Framework for Disaster Risk Reduction
2) Explore Japanese experiences on disaster risk reduction and observe recovery process of the Tohoku Region
3) Welcome participants from disaster risk reduction experts as well as non-experts
Concept

4) Explore and develop business opportunities in disaster risk reduction
5) Focus on solution-oriented discussion on disaster risk reduction with concrete examples provided by multi-stakeholders
6) Thank assistance to Tohoku from all over the world after the 11 March 2011 East Japan Earthquake and Tsunami Disaster

Concept

BOSAI

is a traditional Japanese term, indication a holistic approach to reduce human and economic losses from disasters which represents activities in all disaster phase, including prevention, recovery, response and mitigation
Date. November 25sat -27mon, 2017

Venue. Sendai International Center (Sendai, Japan)
Organizer:
Organizing Committee for the World Bosai Forum / IDRC 2017 in Sendai

Member of the committee (tbc.)

Tohoku University
International Research Institute of Disaster Science
Global Risk Forum GRF Davos
City of Sendai
Miyagi Prefecture
Kohoku Shimpo Publishing Co
Sendai Chamber of Commerce and Industry
Tohoku Economic Federation

Supporters (tbc.)
- Cabinet Office
- Ministry of Foreign Affairs
- Ministry of Land Infrastructure and Transportation and Tourism,
- Japan International Cooperation Agency JICA,
- Science Council of Japan
- Japan Bosai Platform
- World Bank
- UNDP
- National Research Institute for Earth Science and Disaster Resilience
- Miyagi Prefecture
- Tohoku Economic Federation
- Sendai Chamber of Commerce and Industry
Participants.
- UN and other agencies
- Private Sector
- Governments
- Civil Society
- Academia
- Media

How to attend

**Register Online (December/January)**

Participation fee: 300 USD / person
Program.

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Program. Draft Idea of Session themes

- Solution-oriented discussion to facilitate implementation of Sendai Framework for Disaster Risk Reduction
- Sharing interactive Ideas and innovative and cutting-edge technologies
- Insight-building cross-cutting discussion across various sectors and scientific disciplines.
Program. Draft Idea of Sessions themes

- Role of local government / Good practices from Sendai city
- Role of media in DRR / Link between academia and media
- Outreach to the public / Events related to the World Tsunami Awareness day
- Success stories from the experience of mitigation, response, recovery and reconstruction from disaster
Program. Draft Idea of the Business exhibition

◆ Attractive exhibition of innovative and cutting-edge technologies by leading companies for disaster risk reduction and a resilient society

from Japan Bosai Platform HP

from Fujitsu Journal

https://www.kurumaerabi.com/car_news/info/106869/

http://www.lets.co.jp/?author=3


From Pacific Consultants
Program. Draft Idea of the Panel exhibition

◆ Panel presented by multi-stakeholder

Program. Related events
• Excursion to affected areas
• Cultural Event

and more...
Schedule.
2016
Aug. Launch of the event
Dec. Establishment of the organizing committee
Homepage open
Apr. First Announcement
Confirm main speakers
Registration open
2017
Jul. Final announcement
Final call for speakers
Oct. Registration closed

2016 Aug. Launch of the event in Davos
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<td>Kaoru Takara</td>
<td>寶馨</td>
<td>JST</td>
<td>Japan Science and Technology Agency, Kyoto University, DPRL</td>
<td>科学技術振興機構 防灾領域研究主幹、京都大学防災研究所</td>
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268
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