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日伊土砂災害防止技術会議報告書

危機管理技術研究センター 砂防研究室

Report on Japan-Italy Conference on Sediment Disaster Prevention Technology

Erosion and Sediment Control Division
Research Center for Disaster Management

国土交通省 国土技術政策総合研究所

National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure, Transport and Tourism, Japan

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概　要

本報告は、平成 24 年 11 月 28 日から 30 日にかけて日本で開催された「第 8 回日伊土砂災害防止技術会議」について、その議事内容、両国における研究成果等の発表内容、ならびに今後の共同研究の方向性について両国が合意した事項について概要を報告するものである。

キーワード：大規模土砂災害、ソフト対策、国際協力

Synopsis

“The 8th Japan-Italy Conference on Sediment Disaster Prevention Technology” was held from November 28th to 30th, 2012. This Technical note reports the outline of the proceedings, the contents of the research presentations, and the agreements on future collaboration of both countries in the conference.

Keywords: Large-scale sediment-related disaster, Non-structural measure, International collaboration

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１．会議の概要

1.　会議の概要

1.1 はじめに

平成 24 年 11 月 28 日から 30 日にかけて「第 8 回日伊土砂災害防止技術会議」が東京を中心に開催された。本会議は、平成 10 年 5 月にイタリア・サルノ市周辺で多数発生した泥流による土砂災害に対する日本とイタリアの共同調査を契機として、平成 10 年 11 月に開催された第 6 回日伊科学技術協力合同委員会において設置することが合意されたものである。第 1 回会議は平成 11 年 11 月に東京および鹿児島において開催された。その後、日本・イタリア両国において交互に開催されてきており、8 回目である今回は日本における開催となった。

1.2 日程および参加者

1.2.1 日程

11 月 30 日の東京における会議に先立ち、28 日には浅間山の火山砂防事業の視察、29 日には東日本大震災被災地の視察が行われた。日程を表-1 に示す。

表-1　日程

11月27日	国土交通省技監、砂防部長表敬訪問
28日	浅間山直轄火山砂防事業視察 （群馬県嬬恋村、長野県軽井沢町他）
29日	東日本大震災被災地視察 （宮城県石巻市、女川町他）
30日	会議（東京）

1.2.2 参加者

本会議の参加者は表-2 の通りである。

表-2　参加者

イタリア　ヴェネト州	
マウリツィオ・コンテ	環境大臣
アンドレア・バッシ	運輸都市建設委員会委員長
ニコラ・イニャツィオ・フィンコ	環境委員会委員長
ゲリー・ボラット	環境委員会事務局長
マリアーノ・カッラーロ	環境部長
イタリア国立研究評議会　水文地質防災研究所	
アレッサンドロ・パスート	パドヴァ支部研究所長
ジャンルーカ・マルカート	パドヴァ支部所員
シルヴィア・ペルカッチ	ペルージャ支部所員
国土交通省　水管理・国土保全局　砂防部	
南　哲行	砂防部長
大野　宏之	砂防計画課長
渡　正昭	保全課長
山口　真司	砂防計画課地震火山砂防室長
国土技術政策総合研究所　危機管理技術研究センター	
後藤　宏二	危機管理技術研究センター長
岡本　敦	砂防研究室長
水野　正樹	砂防研究室主任研究官
内田　太郎	砂防研究室主任研究官
独立行政法人土木研究所　土砂管理研究グループ	
小山内　信智	グループ長
石塚　忠範	火山・土石流チーム上席研究員
武士　俊也	地すべりチーム上席研究員
千田　容嗣	地すべりチーム総括主任研究員
野呂　智之	雪崩・地すべり研究センター所長
砂防関係機関	
大井　英臣	（一社）国際砂防協会会長
近藤　浩一	（一財）砂防・地すべり技術センター理事長
在日イタリア大使館	
アルベルト・メンゴーニ	科学技術部科学技術担当参事官
石山　誠一郎	科学技術部科学技術担当参事官補佐

1.3 現地視察

1.3.1 浅間山直轄火山砂防事業視察

11 月 28 日、イタリア側参加者は浅間火山博物館や現地を視察し、関東地方整備局利根川水系砂防事務所より過去の噴火における被害や浅間山直轄火山砂防事業の概要等について説明を受け、両国共通の課題である火山噴火に起因する土砂災害について意見交換を行った（写真-1）。

写真-1　浅間山現地視察

1.3.2 東日本大震災被災地視察

翌日は宮城県石巻市や女川町を視察し、宮城県および東北地方整備局北上川下流河川事務所より被災の状況や復興への取り組みなどについて説明を受けた（写真-2）。イタリア側からは津波被害の状況や復興対策等について活発な質問が出され、震災に対する関心の高さがうかがえた。

写真-2　女川町における現地視察

1.4 会議

1.4.1 議事次第

会議は 11 月 30 日、東京都港区の三田共用会議所において開催された。議事次第は表-3 の通りである。

表-3　議事次第

10:00	**開会挨拶**
	・南砂防部長 ・コンテ　ヴェネト州環境大臣 ・イタリア大使館メンゴーニ参事官
10:15	**基調講演**
	・日本の砂防事業について 南砂防部長 ・ヴェネト州の水害リスク管理 コンテ大臣
12:00	**昼食・休憩**
13:30	**セッション1：大規模土砂災害について**
	・Webを活用した深層崩壊自動モニタリング マルカート水文地質防災研究所パドヴァ支部研究員 ・日本における最近の大規模土砂災害 小山内土木研究所土砂管理研究グループ長
14:40	**セッション2：土砂災害へのソフト対策について**
	・降雨による崩壊予測・警戒システム ペルカッチ水文地質防災研究所ペルージャ支部研究員 ・日本における豪雨に起因する土砂災害 岡本国総研危機管理技術研究センター砂防研究室長
15:50	**日伊砂防技術協力15年間の振り返りと、今後の協力の方向性について**
	・土砂災害に関する日伊科学技術協力の15年間 パスート水文地質防災研究所パドヴァ支部研究所長 ・近年の日伊土砂災害技術協力 後藤国総研危機管理技術研究センター長
16:30	**議論・意見交換**
17:00	**閉会挨拶**
	・大野砂防計画課長

1.4.2 基調講演

会議の前半では、国土交通省水管理・国土保全局の南砂防部長およびイタリア・ヴェネト州のコンテ環境大臣より、両国における最近の土砂災害、洪水被害および対策事業について基調講演が行われた。

南砂防部長からは日本における昨今の砂防事業の概要が、コンテ大臣からはヴェネト州における最近の洪水被害や、都市域における貯水池、緑地帯等の整備を通じた排水機能の強化に向けた施策が紹介された。あわせて、カッラーロ環境部長よりヴェネト州で発生した大規模崩壊に対する対策工事や、土砂災害発生時の行動マニュアルを住民へ配布する取り組みについて説明があった。

1.4.3 セッション１：大規模土砂災害について

午後からは大きく 2 つのテーマについて両国より話題提供が行われた。1 つめは大規模土砂災害に関する話題で、イタリアの水文地質防災研究所パドヴァ支部のマルカート氏からは、東部イタリアアルプスで発生した深層崩壊に対するWEBベースの遠隔モニタリングシステムの運用や、ハザードマップ作成に向けた土砂移動現象の再現計算について発表があった。

また小山内土木研究所土砂管理研究グループ長からは日本において最近発生した大規模土砂災害に関する報告があった。

1.4.4 セッション２：土砂災害へのソフト対策について

2 つめのテーマは土砂災害に対するソフト対策で、水文地質防災研究所ペルージャ支部のペルカッチ氏からは、過去の災害事例より、降雨継続時間と積算雨量の関係から土砂災害発生時期を予測するシステムを構築し運用中であること、今後土砂災害危険箇所情報と組み合わせることにより精度の向上に取り組むことなどが紹介された。

また国土技術政策総合研究所危機管理技術研究センター砂防研究室の岡本室長からは、日本における豪雨起因の土砂災害の発生状況、ならびに土砂災害警戒情報の運用状況等についての発表があった。

1.4.5 日伊砂防技術協力 15 年間の振り返りと、今後の協力の方向性について

会議の総括として、国総研の後藤危機管理技術研究センター長および水文地質防災研究所パドヴァ支部のパスート研究所長より、日伊両国間での約 15 年間におよぶ技術協力の振り返りと、今後の共同研究の方向性についての提案が行われた。

1.4.6 議論・意見交換

最後に会議全体を通しての討議が行われ、イタリア側からは日本の土砂災害警戒情報の運用実績や深層崩壊の定義等について質問が出された。また、そのような両国で共通の研究テーマについてワーキンググループを設置するなど共同研究を継続し、その成果を行政にも反映していくことが望ましいとの認識で一致した。また本会議についても継続的に開催していくことが確認され、次回の会議を平成 26 年にイタリアで開催することで合意した。

以上の合意事項について、大野砂防計画課長とパストート所長による議事録への署名が行われ、閉会となった。

写真-3　会議の様子

写真-4　テクニカルセッション

写真-5　議事録署名

写真-6　会議参加者

1.5 おわりに

近年多発する土砂災害、特に大規模土砂災害や、それらに対するソフト面での対策については両国が直面する共通の行政課題となっており、今回の会議では、両国におけるこれらの課題への先進的な取り組みについて情報交換をすることができました。このような技術交流を行うことは、日本・イタリア両国のみならず世界で発生する土砂災害に対応するための技術力向上の面で非常に有意義なことです。今後も本会議を継続的に開催し、両国の情報共有・共同研究を通じて砂防技術の発展が進むことが望まれます。

最後になりましたが、本会議および現地視察の実施にあたっては、宮城県土木部、群馬県嬬恋村、東北地方整備局、関東地方整備局ならびに砂防関係法人の皆様をはじめ多くの方々にお力添えをいただきました。この場を借りて御礼申し上げます。

２．議事録

2. 議事録

2.1 挨拶

① コンテ環境大臣

・豪雨による水害・土砂災害は日伊両国の共通の重要な課題。

・日伊土砂災害防止技術会議は重要な会議。これまで 8 回の会議を通じて両国のきずなを深めることができた。

・浅間山、宮城県の津波被災現場の調査や関係者との協議を通じて、ヴェネト州の防災対策に活かしたい。その際は CNR（国立研究評議会）の引き続きの協力を求めたい。

・ヴェネト州では、豪雨災害による経済ロスも大きい。気象災害への安全保障を進めたい。

② メンゴーニ参事官

・大使館として、1998 年からの砂防分野の日伊協力を見守ってきた。

・国土交通省と CNR の熱心な活動とそこで積み上げられてきた多くの成果を理解している。

・土砂災害は両国にとって重要なテーマ。

・今後も大使館として日伊会議を支援したい。CNR のパスート氏と緊密に連絡をとっている。

2.2 コンテ氏

・ ヴェネト州では、2010 年 11 月豪雨で洪水被害が発生。

・ パドバ市周辺で洪水被害があった。堤防のメンテナンス不足により侵食・決壊が発生。今後、河川事業を強化したい。

・ ヴェネト州では集中豪雨の頻度が増大している。1970 年以降は平野部でも豪雨が増加している。48 時間で 600mm の降雨。

・ 都市地域の拡大による雨水浸透が妨げられたことが最大の要因。

・ 堤防強化や都市排水施設の整備を進めている。

・ 大河川流域では、貯水容量 100～400 万 m^3 の調整池の整備を進めている。

・ 対策工事には時間がかかるので、避難体制の整備などリスク管理が必要。水路管理組合、市民保護局との連携が重要。

・ （ここからカッラーロ氏説明）ヴェネト州は 29%が山地で 15%が丘陵地となっており、総人口の 20%がこれら地域に居住している。これら地域は美しい観光資源である一方、土砂災害の危険がある。

・ ヴェネト州では約 1 万箇所の土砂災害危険箇所が確認されている。市町村や地方政府が砂防ダム斜面対策工等の設置を行っている。

・ ひとたび土砂災害が発生すると広範囲にわたり影響が出る。

・ ベルーノ地方のテッシーナ地すべりでは 1,000 万 m^3 もの泥流が発生した。ここでは延長 1,300m の排水トンネルを整備し対策にあたっている。また、土砂災害発生時の行動マニュアルについても作成し関係機関、住民に配布している。

- 市街地では、家庭用雨水貯水槽や下水道、公園等を活用し都市排水整備を行っている。またその一環で緑地帯を整備し中心地へ雨水が流れ込みにくい状態としている。
- 流域モデルにより降雨流出量を計算し洪水予測も実施している。

2.3 マルカート氏

- ヴェネト州のドロミテ山群（東部イタリアアルプス）のロトロン渓谷（流域面積 5km²）における深層崩壊のモニタリングを実施。標高は 590m～1,950m に位置し、平均傾斜は 55%（約 29 度）。
- 幅 600m の深層崩壊に起因する土石流で下流の集落が被災するおそれ。
- 雨量計、監視カメラ、伸縮計（崩壊地頭部）、トータルステーションによる自動監視（42 点）、渓流における振り子式センサー（渓床に設置）、砂防堰堤水通しのワイヤーセンサー、集落におけるサイレンなどから構成される。
- 各種センサーの情報を一元的に見ることができる Web ベースのプラットフォームを立ち上げた。避難勧告を出す市町村、様々な専門家がアクセスできる。ちょうど昨日も現地で降雨があり Web 上で我々が確認しテレビ会議で今後の対応を現地に指示することが出来た。
- ヴェネト州の協力を得て 2010 年 11 月豪雨の前後の DEM（2m メッシュ）を作成し、地形変化、土砂移動量を把握。これをもとに災害の再現計算を実施。結果をハザードマップの作成に活用する予定。
- 日本の専門家も Web サイトを見て助言やコメントを伝えてほしい。

2.4 ペルカッチ氏

- イタリアでは 843 年～2012 年までの間に土砂災害で 17,610 名が被害を受けた。2011 年は 36 名で 2012 年は 17 名となっている。
- 降雨による土砂災害の発生条件を解明し災害発生予測システムを構築する必要がある。
- イタリアでは降雨継続時間と積算雨量によって経験的な CL（土砂災害警戒基準雨量線）を設定している。これは国際学会誌でも多く発表し取り上げられているところ。
- 本 CL 決定に際して、全国で土砂災害を発生させた 2,300 以上の降雨イベントについて整理した。
- 全国 1,950 箇所の雨量計で 6 時間おきに観測値をシステムに取り込んでいる。また、12 時間ごとに 72 時間先の降雨予測を行っている。
- 以上で整理したデータをもとに CL を引き、それと平行なラインを引くことで、災害発生確率を 0.005%以下、0.005%～0.5%、0.5%～1.5%、1.5%～5%、5%以上の領域に区分した。
- 本予測システムと土砂災害危険箇所データを組み合わせてより詳しい予測を行っている。
- 今後はさらに予測頻度を上げていくこと、地域別の予測システムを作ること、危険箇所とのより良い組み合わせ方などの課題に取り組んでいきたい。

2.5 質疑応答

- パスート氏：深層崩壊の監視、二次災害防止は世界的に注目されている。20 年前にイタリアでもワーキンググループ（WG）をつくって研究したが、いつのまにか解散した。日伊で WG をつくって共同研究してもよいテーマ。深層崩壊の定義は何か。
- 小山内グループ長：深層崩壊の定義が砂防学会で提案された。大きな土砂移動現象のうち、狭義の地すべりは比較的緩勾配で緩慢に移動するものでハード対策も出来る。しかし深層崩壊は急勾配での突発的な現象で土砂量も概ね 10 万 m^3 以上となりソフト対策がメインとなる。岩盤崩落はイタリアで多くの知見があると思う。深層崩壊について日伊共同で研究したい。
- 山口室長：火山、地震、豪雨による土砂災害は日伊共通の課題。15 年来続いてきた日伊の協力・交流の成果をさらに発展させるため、共通のテーマをつくるべき。研究だけでなく行政にも反映したい。
- パスート氏：共同研究のテーマをつくることは賛成。あまり多すぎないことが必要で２～３程度に集中するべきではないか。関心のある研究者で WG を設置したい。今回の会議にヴェネト州が参加したが、ヴェネト州と CNR は既に研究成果を行政に反映する連携を進めている。このような活動を通じてベストプラクティスを示すことにより、研究成果の実際の社会への反映ができる。
- カラーロ氏：研究だけでなく行政に反映するような協力に賛成する。降雨による土砂災害警戒基準雨量の研究だけでなく、警報システムについて協力したい。日本の土砂災害警戒情報の運用実績は精度が良いように感じた。もう少し詳しく知りたい。
- 岡本室長：災害捕捉率は比較的良いが空振り率も高い。年平均 1,000 回発表しているが、実際に土砂災害が発生したのは 40 回程度である。発表頻度が高いと危機感を持ちづらく課題だ。今後は降雨だけでなく、災害発生情報やセンサーによる監視と組み合わせることを検討している。
- コンテ氏：日本の協力に深く感謝。研究・行政の両面で重要な会議。国土保全の成果を２国間だけでなく、世界に広げるべき。２年後の会議をヴェネト州で開催したい。
- 大野課長：今回の議論を通じてイタリア、ヴェネト州を身近に感じた。深層崩壊や警戒避難等の両国共通の課題が多くあることが良く分かった。さらに友情を深めるとともに協力関係を続けていきたい。

３．発表資料

3.1 基調講演

「日本の砂防事業について」

砂防部長

南　哲行

SABO Administration in JAPAN

November 30 , 2012

Dr. Noriyuki MINAMI

Director-General, Sabo Department,

Ministry of Land, Infrastructure, Transport and Tourism, JAPAN

Ministry of Land, Infrastructure, Transport and Tourism

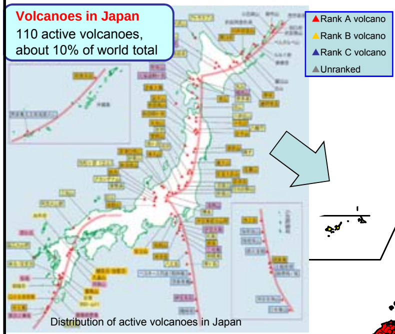
1. Recent Sediment-Related Disasters

Multiple Causes of Sediment Related Disasters in Japan

MLIT

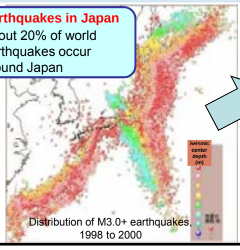
Most advanced countries in Europe have stable geology and no volcanoes or earthquakes. Therefore, sediment related disasters after heavy rain are rare. But Japan suffers from all of these adverse conditions. Sediment related disasters countermeasures are essential to saving lives and a vital prerequisite for infrastructure.

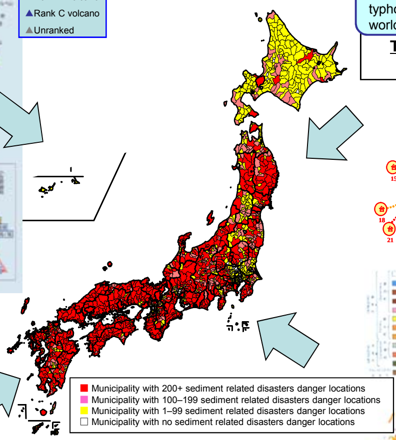
Volcanoes in Japan
110 active volcanoes, about 10% of world total



Distribution of active volcanoes in Japan

Earthquakes in Japan
About 20% of world earthquakes occur around Japan

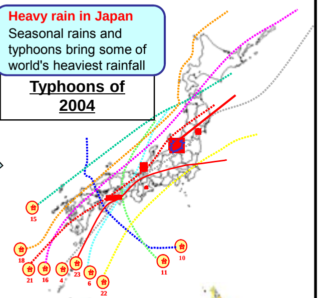

Distribution of M3.0+ earthquakes, 1998 to 2000

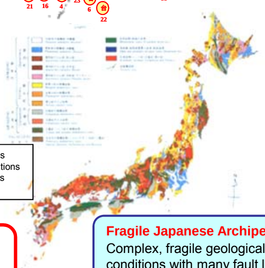


As of November 30, 2011

Due to harsh natural conditions, about 90% of Japan's cities/town/villages are near danger of sediment related disasters

Heavy rain in Japan
Seasonal rains and typhoons bring some of world's heaviest rainfall


Typhoons of 2004



Fragile Japanese Archipelago
Complex, fragile geological conditions with many fault lines

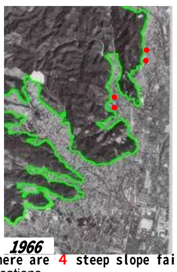
Geological distribution in Japan

Expanding Urbanization and Sediment Related Disasters

MLIT

○ Random sprawling of urbanized areas is rapidly increasing the risk of sediment rerated disasters.

Present situation of residential development (example of Saeki-ku, Hiroshima city)


1966
There are 4 steep slope failure locations.


1974
hazard


1986


1999
The number of steep slope failure hazard locations increased to 24.

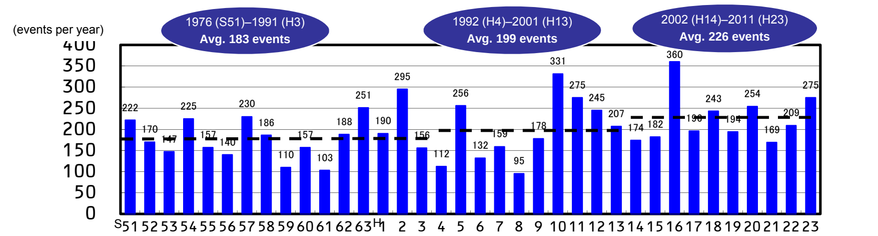


Debris flow and Slope failure disasters that destroyed the residential area that extended to the mountain foot because of residential development
(Disasters in Hiroshima city by the torrential rain at the end of June 1999).

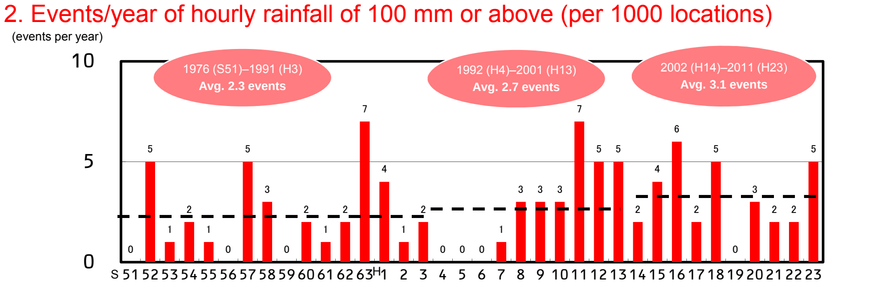
Number of Incidents per Year of Hourly Rainfall (1976–2011)

1. Events/year of hourly rainfall of 50 mm or above (per 1000 locations)

- Events/year of hourly rainfall
- 1300 AMeDAS observation stations nationwide



2. Events/year of hourly rainfall of 100 mm or above (per 1000 locations)



Source: Japan Meteorological Agency data

Triggers of Sediment-related disasters

① Torrential rain by typhoons, etc.

- Slope failure
- Debris flow (including drift wood disasters)
- Landslide

② Volcanic activities

- Lava flow
- Pyroclastic flow
- Volcanic debris flow
- Collapse of volcanic edifice

③ Earthquake

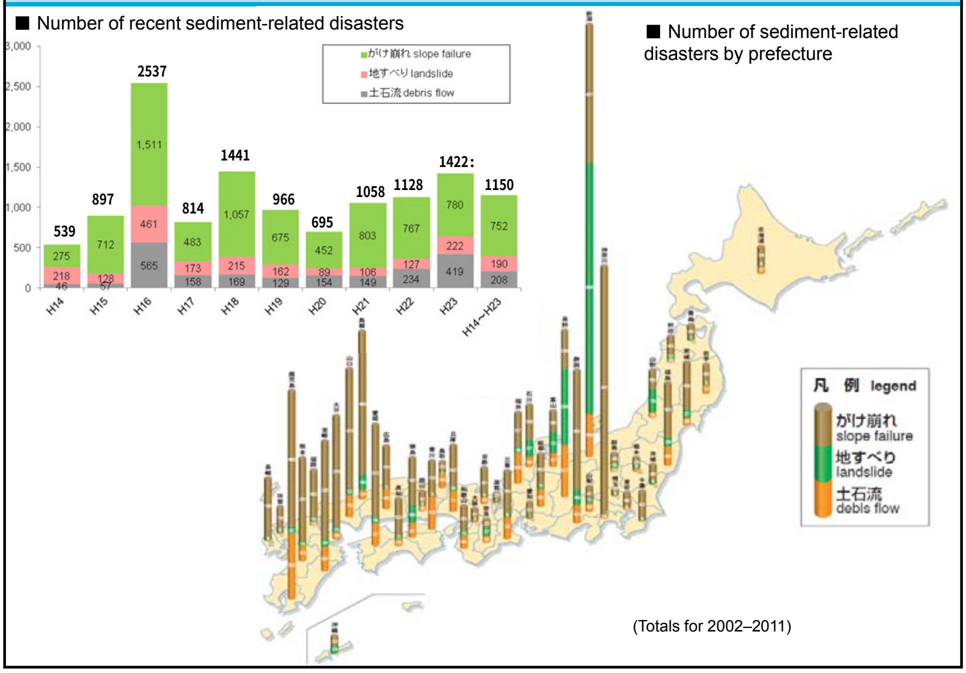
- Collapse of volcanic edifice
- Collapse of natural dam
- Torrential rain disaster
- Collapse of volcanic edifice

Debris flow caused by the rainy frontal torrential rain (Yamaguchi pref. July (2009)

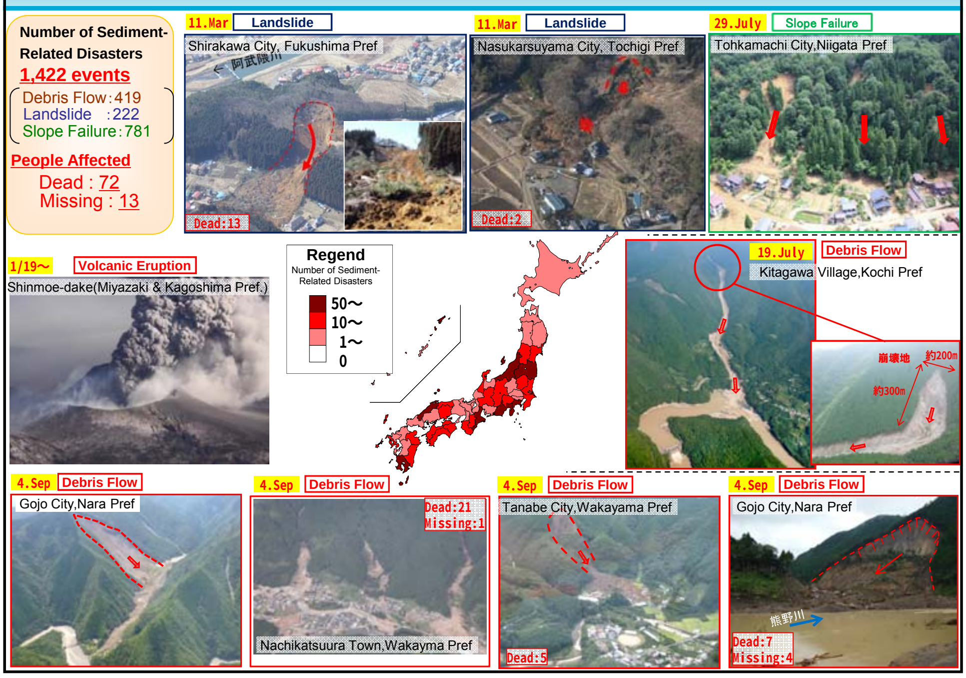
Mt. Kirishima (Shinmoedake) eruption January 2011

Landslide induced by Great East Japan Earthquake (Shirakawa City, Fukushima Pref.: March 2011)

Over Past 10 Years, Sediment-Related Disasters Have Occurred in Every Prefecture

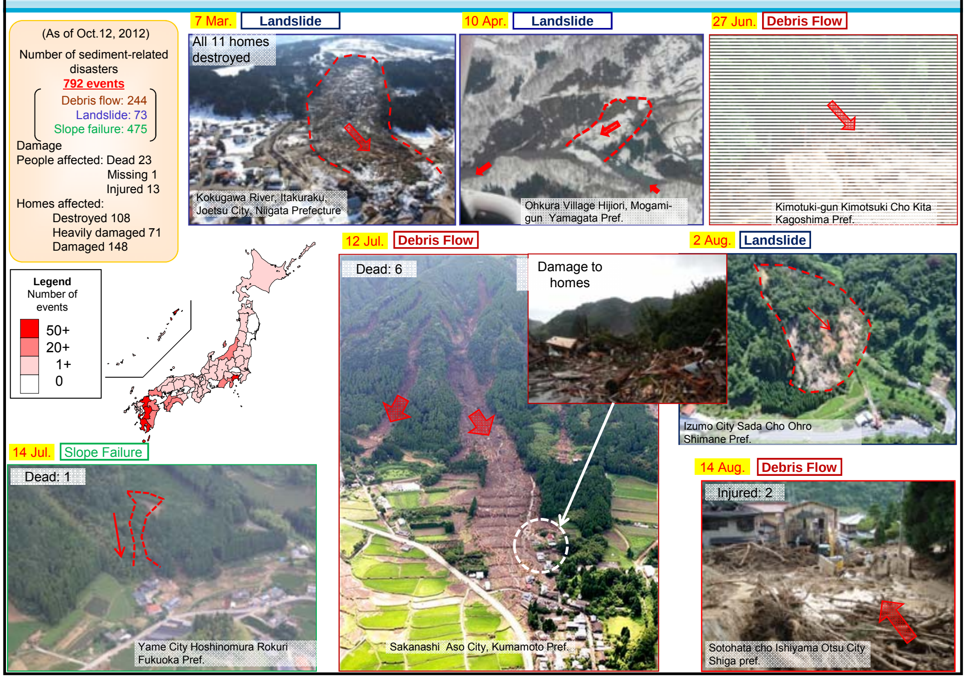


Major Sediment-Related Disasters in 2011



1) Sediment-Related Disasters induced by Torrential Rain

Major Sediment-Related Disasters in 2012



Disasters at Facilities for Persons Requiring Assistance During Disasters

Hofu City, Yamaguchi Pref. (July 21, 2009)

Special nursing home Life Care Takasago
Date of disaster: July 21, 2009
Damage: 7 dead

2) Sediment-Related Disasters induced by Earthquakes

Sediment-Related Disasters in 2011 Great East Japan Earthquake

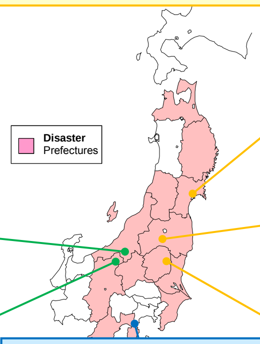
MLIT

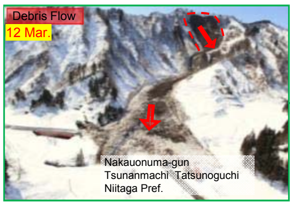
Number of sediment-related disasters
141 events

Debris flow: 13 events
Landslide: 29 events
Slope failure: 97 events
Snow avalanche: 2 events

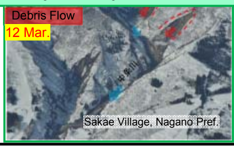
• Earthquake Off the Pacific Coast of Tohoku 114 events
Dead: 19
• North Nagano Pref. Earthquake 24 events
East Shizuoka Pref. Earthquake 3 events

[2011 Earthquake Off the Pacific Coast of Tohoku]
• Date and time: March 11, 2011 14:46
• Location and depth: Off Sanriku region, 24 km
• Locations where seismic intensity 6 lower recorded Miyagi, Fukushima, Ibaraki, Tochigi, Iwate, Gunma, Saitama, Chiba Prefectures





[North Nagano Prefecture Earthquake]
• Date and time: March 12, 2011 03:59
• Location and depth: North Nagano Pref., 8 km
• Locations where seismic intensity 6 lower recorded: North Nagano Pref., Niigata Pref. Chuetsu



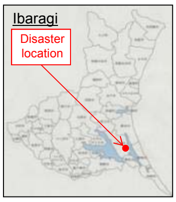
[East Shizuoka Prefecture Earthquake]
• Date and time: March 15, 2011 22:31
• Location and depth: East Shizuoka Pref., 14 km
• Locations where seismic intensity 6 lower recorded: East Shizuoka Pref.

Sediment-Related Disasters by Rainfall After 2011 Great East Japan Earthquake

MLIT

In municipalities where severe tremors were observed during the Great East Japan Earthquake, even modest amounts of rainfall led to sediment-related disasters.
These events after the 2011 earthquake took place at locations categorized as Type B (*2) in the emergency inspections (*1) carried out by municipalities.

(*1) In municipalities where seismic intensity of 5 upper or greater was observed, emergency inspections were carried out to prevent or meliorate sediment-related disasters during the snow melt and rainy seasons.
(*2) Type A: Locations where deformation is large, and construction work is needed urgently
Type B: Locations where deformation is slight and construction work is to be carried out as required after detailed surveys
Type C: Locations without deformation where construction work is not needed



[Cliff collapse]
Date: June 13, 2011
Disaster location: Namegata City Ibaragi Pref. (inside debris flow special precaution zone)
Rainfall: Total rainfall 41 mm (daily rainfall 41 mm, max. hourly rainfall 12 mm)
Seismic intensity: Main shock (6 -), aftershocks (5 + (1 event), 5 - (1 event))
Damage: Homes damaged

Damage

Sediment-related disasters occur even when rainfall is not very strong! !

3) Sediment-Related Disasters after Volcanic Eruptions

Countermeasures To Volcanic Eruptions

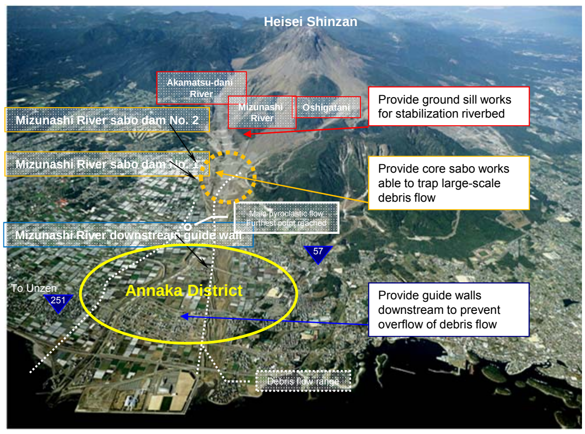
MLIT

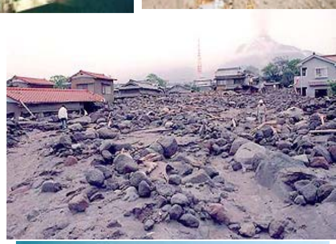
Mount Unzen, Fugen-dake

➢ Began volcanic activity in 1990, after a pause of 198 years. Pyroclastic flow claimed 54 victims and the region was devastated by repeated debris flows.

Provision of Sabo Works

➢ Sabo restoration work project were carried out by Central Goverment project beginning 1993 to protect downstream homes etc. from debris flows.





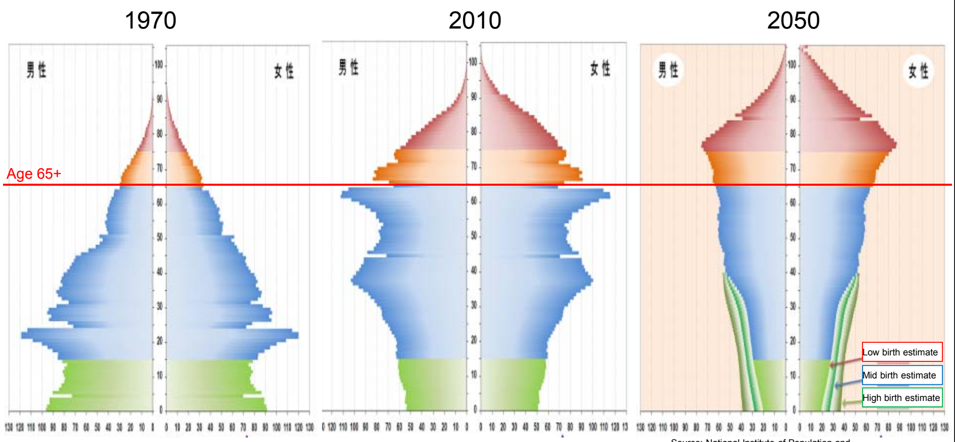
2. Problems

Aging Society

In today's rapidly aging society, the elderly have become vulnerable to disasters, for example requiring more time to evacuate. Warning, evacuation and mutual assistance systems to respond to the aging of society are needed.

40 years ago Population aged 65+ 7%	←	Today Population aged 65+ 23%	→	40 years from now Population aged 65+ 42%*

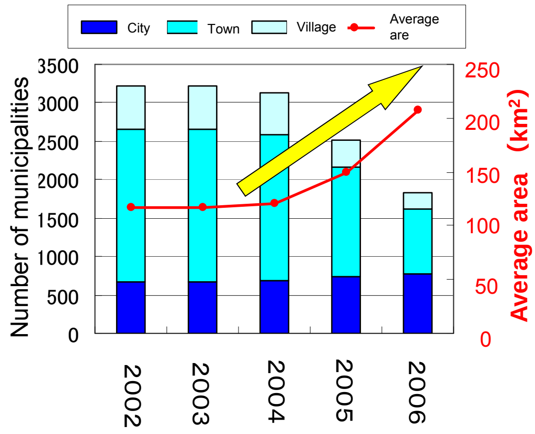
* Case of low birth/death rates

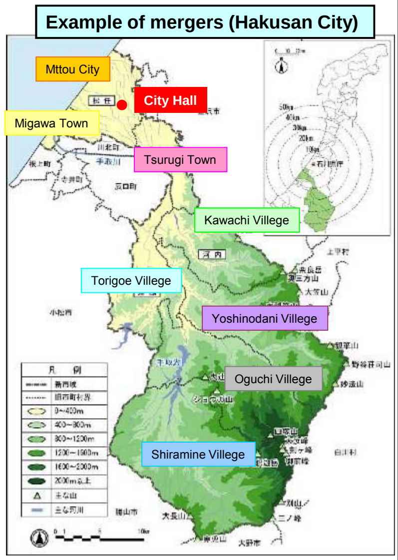


Source: National Institute of Population and Social Security Research data

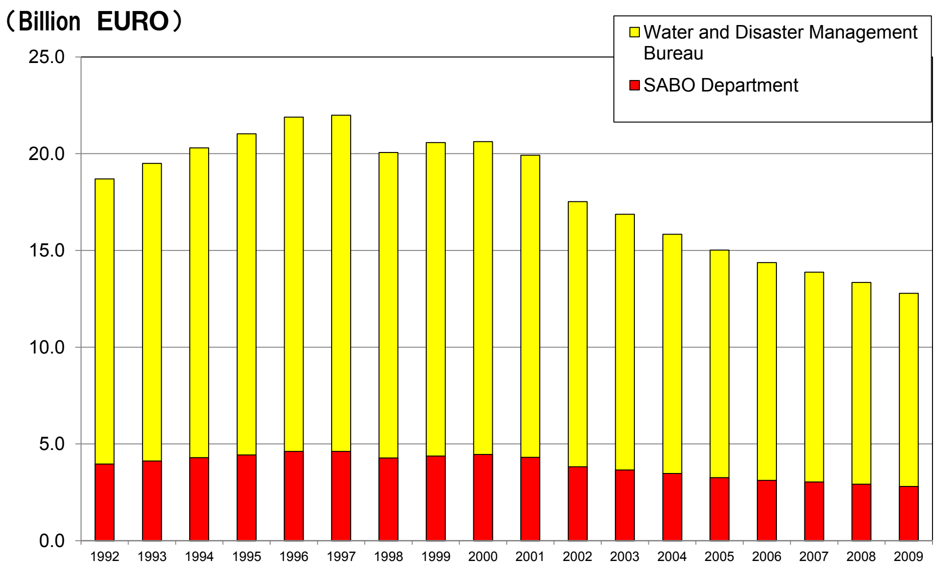
Municipal Mergers

• The area that must be covered by 1 municipality has increased as municipalities have merged.
• From the end of 2002 to the end of 2006, the area of the average municipality increased by 77%.





Budget for Disaster Management



1EURO＝ 105.75JPY(28.Nov.2012)

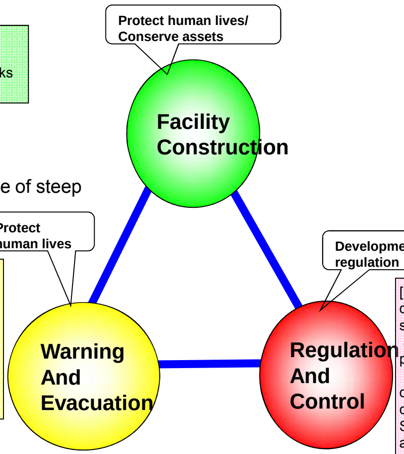
3. Countermeasures against Sediment-Related Disasters

Three main actions of countermeasures against Sediment Related disasters

1. **"Facility construction"** Structural measures to protect human lives and to conserve assets
2. **"Warning and Evacuation"** Non-structural measures to protect human lives through evacuation
3. **"Regulation and Control"** Non-structural measures to regulate new residential area development at sediment disaster danger spot

Sabo works,
Landslide prevention works
Slope failure prevention works
Land conservation

[Based on]
Erosion Control Act
Landslide Prevention Act
Act for prevention due to collapse of steep slopes



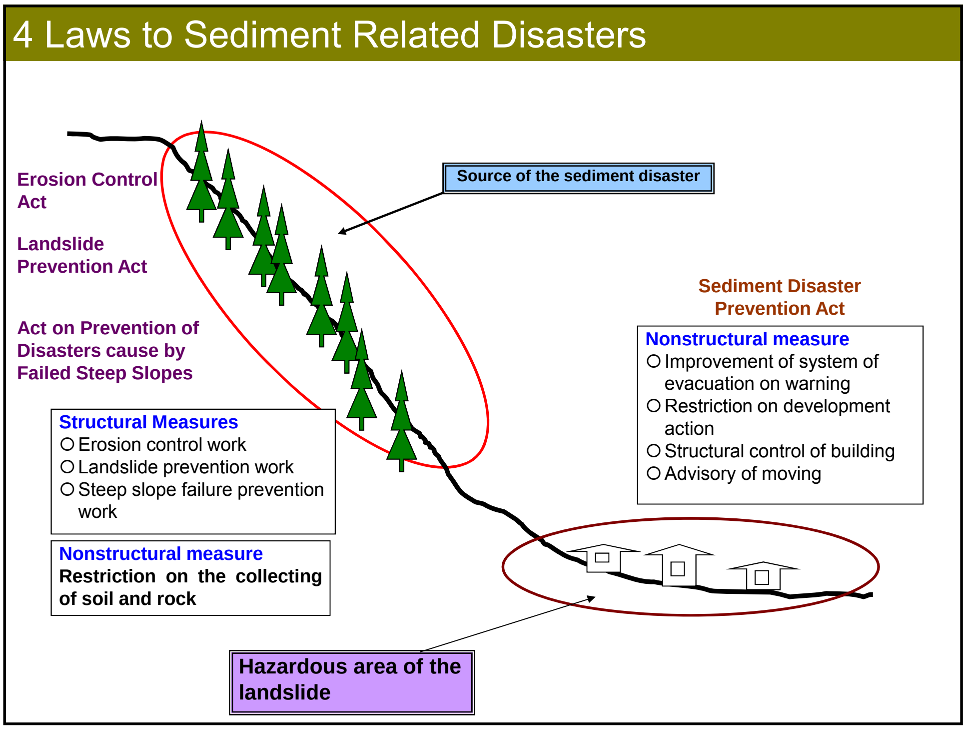
In areas designated as "sediment-related hazard areas"
・Preparation of hazard maps for sediment-related disasters
・Strengthening of warning and evacuation system through preparation of sediment-related disaster information and their dissemination, improvement of information system etc.

[Based on]
Sediment-related disaster prevention act

Non structural measures

[Restriction on acts, Restriction on land development, Restriction on building structure]
Sabo designated area and Landslide prevention area
・Restriction on cutting, mounding and other acts deemed harmful for the conservation of land
Special sediment-related disaster hazard area
・Restriction on building structures
・Restriction on specific development works

Responding to Sediment Related Disasters by Facility Construction
About 1,000 sediment-related disasters occur every year, causing tremendous damage.
Countermeasures are vital to protect human lives and property.
Debris flow
Debris flow at Aso City, Kumamoto Pref.
(July 2012: 1 death, 10 homes destroyed)
[Countermeasure]
<Build sabo dam to trap debris flow>
Debris trapped after July 2012 torrential rain (Oita Pref.)
Sabo dam
<Build debris flow accumulation work>
Sept. 2012: Trapped debris flow by heavy rain (Mie Pref.)
Debris flow
Debris flow accumulation work
Trapping inside accumulation work
Landslide
Landslide at Joetsu City, Niigata Pref.
(March 2012: 11 homes destroyed)
[Countermeasure]
<Remove landslide-causing groundwater>
Collecting well
Inside collecting well
<Build facilities to stop landslide>
Anchor work
Pile work
Slope failure
Slope failure at Minamiaso, Kumamoto Pref.
(July 2012: Damage prevented by facility)
[Countermeasure]
<Build retaining walls to trap landslide>
June 2012: Trapped slope failure by heavy rain (Oita Pref.)
Slope failure
Retaining wall
<Build slope frame work to stop slope failure>
23



4 Laws to Sediment Related Disasters
Erosion Control Act
Landslide Prevention Act
Act on Prevention of Disasters cause by Failed Steep Slopes
Source of the sediment disaster
Sediment Disaster Prevention Act
Nonstructural measure
○ Improvement of system of evacuation on warning
○ Restriction on development action
○ Structural control of building
○ Advisory of moving
Structural Measures
○ Erosion control work
○ Landslide prevention work
○ Steep slope failure prevention work
Nonstructural measure
Restriction on the collecting of soil and rock
Hazardous area of the landslide

Overview of Sediment Disaster Prevention Act

Sediment Disaster Prevention Act (2000)

For areas at risk of disaster, publicize the risk, organize a warning and evacuation system, discourage new home building, encourage relocation of existing homes.

[Specification of Precaution Areas Under Sediment Disaster Prevention Act]

Sediment disaster precaution area

These are areas where residents are at risk of death or injury in the event of a steep slope collapse or other disaster. Publicize the risk and organize warning and evacuation systems.

Sediment disaster special precaution area

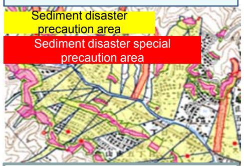
In areas where steep slope collapse has occurred, and where buildings have been damaged and there is serious danger of death or injury to residents, regulations are established for certain kinds of development and structural regulations are established for buildings.

Debris flow

Collapse of steep slopes

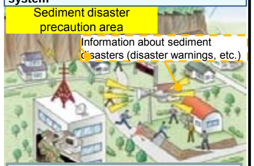
Landslide

Notify residents of disaster risk areas



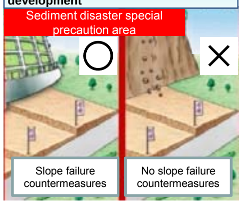
Display locations at risk of disaster in sediment disaster precaution areas

Organize warning and evacuation system



Specify information transmission system and important points for evacuation in disaster plans for municipalities

Restrictions on certain kinds of development



Structural regulations for buildings

3. Countermeasures against Large-Scale Sediment-Related Disasters

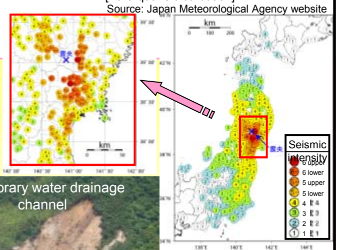
Unzen Fugendake (1991)

Pyroclastic flow caused 43 deaths on June 3, 1991

Response to Sediment-Related Disasters of 2008 Earthquakes in Iwate and Miyagi Prefectures

There were 15 river blockages (natural dam) in Iwate and Miyagi Prefectures.
In 9 of these central government sediment-related emergency projects were carried out

[Earthquake distribution]
Source: Japan Meteorological Agency website



- Earthquake date and time: June 14, 2008 08:43 (M7.2)

1. Earthquake scale
Max. seismic intensity 6 upper
(Oshu City, Iwate Pref.; Kurihara City, Miyagi Pref.) [M7.2]

2. Damage
By debris flows
Deaths and missing: 18

3. Sediment disaster events
Sediment disaster events: 48
River blockage (natural dam) locations: 15

Emergency response to river blockage (natural dam)
Azabu area (Kurihawa City Miyagi Pref.)

Response

[On day of disaster]
- Helicopter survey by advance party
→ Confirm natural dam

- Urgent inspections
→ Conduct about 2,800 inspections and report results to Iwate and Miyagi Prefectures

[3 days after earthquake]
- Start emergency countermeasures
(central government sediment-related emergency projects)

- Perform 24-hour construction work

[7 days after earthquake]
- Temporary water drainage channel

Act to partially amend the Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas (established on November 17, 2010)

Enforced since May 1, 2011

Background

① Many landslide dams (or the damming of rivers) were formed by the Iwate-Miyagi Nairiku Earthquake (2008) and the Mid Niigata Prefecture Earthquake (2004).
② In case of imminent large-scale sediment disasters associated with landslides, landslide dams and debris flows accompanying volcanic eruptions:
- **They may cause a good deal of damage over a wide area once they occur,**
- **Because of the continuously changing circumstances, technical skills are required to understand the risks**

Landslide dam formed by the Iwate-Miyagi Nairiku Earthquake

Area designated for evacuation at first in the lower basin of the Iwaigawa River (roughly 20 km from the landslide dam (or the damming of the river))

Issues

With regard to imminent large-scale sediment disasters:
① It is within the authority of municipalities to issue evacuation instructions to local residents. However, they lack necessary technical skills. As a consequence, they may have difficulty acquiring information, on which they can base their judgments about evacuation instructions, on their own. Thus, they need technical assistance from the central or prefectural government.
② The roles and involvement of the central and prefectural governments are not clearly defined.

Purpose of the amendment

① The central or prefectural governments need to provide information about the probable areas and time period of damage, so that municipal governments can make proper judgments about the issuance of evacuation instructions to local residents when facing imminent large-scale sediment disasters.
② It is necessary to legally specify the roles and involvement of the central government in the case of sediment disasters requiring high technical skills, and those of prefectural governments in the case of other sediment disasters.

Summary

Imminent large-scale sediment disasters〔landslides, landslide dams and debris flows accompanying volcanic eruptions〕

Additional items

The carrying out of emergency investigations by the central government in the case of landslide dams, debris flows accompanying volcanic eruptions and the flooding of landslide dams (i.e., sediment disasters requiring high technical skills) and by prefectural governments in the case of landslides

Notification of information about the probable areas and periods of damage (i.e., emergency information about sediment disasters) drawn from the findings of the emergency investigations to municipal governments and its dissemination to the public

Issuance of evacuation orders for residents by municipalities (pursuant to Article 60 of the Basic Act on Disaster Control Measures), etc.

Protection of the lives and health of the citizens from sediment disasters

Emergency surveys

MLIT

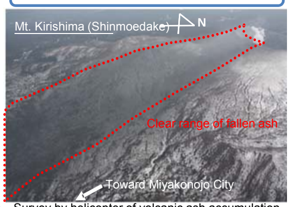
- On January 27, 2011, Mt. Kirishima (Shinmoedake) began intensified volcanic activity. The activity continued, leading to volcanic ash accumulation in the surrounding areas.
- To survey the volcanic ash accumulation, surveys were carried out from a helicopter and the ground.
- The ash distribution and ash thickness were determined, and debris flow simulations were carried out for streams at risk of debris flows.

Volcanic eruption

January 2011 eruption of Mt. Kirishima (Shinmoedake)

Volcanic ash accumulated across a wide area in the mountains, creating the risk of debris flows from accumulated ash.

Survey of volcanic ash accumulation



Survey by helicopter of volcanic ash accumulation in streams at risk of debris flow

Ground survey of volcanic ash accumulation

Preparation of emergency debris flow disaster information by data analysis

• Actions for preparation of emergency debris flow disaster information

Helicopter survey of fallen ash (27 Jan. 2011)

Helicopter survey of fallen ash (28–29 Jan. 2011)

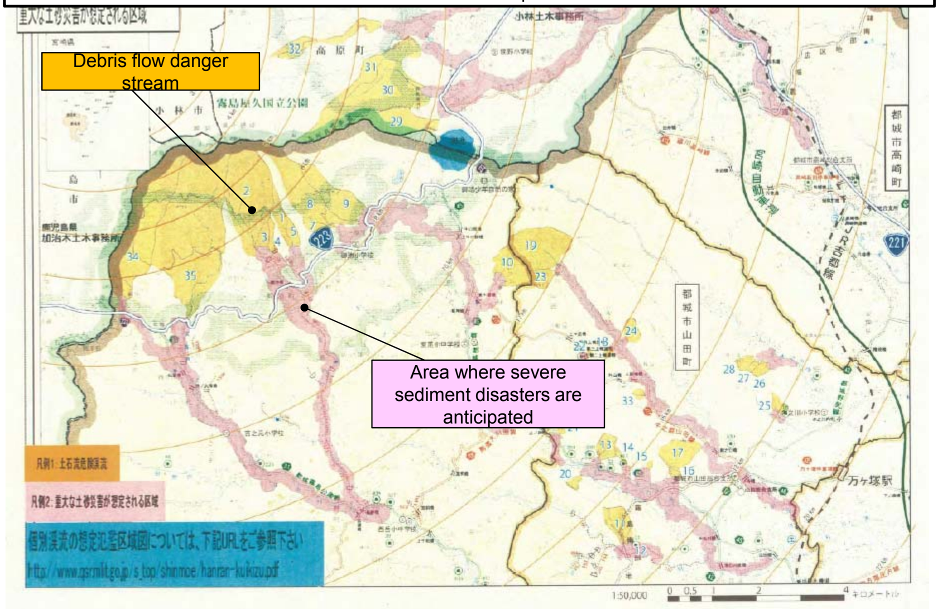
Check of streams at risk of debris flows from accumulated ash (30 Jan. 2011)

Analysis by simulation (31 Jan.–3 Feb. 2011)

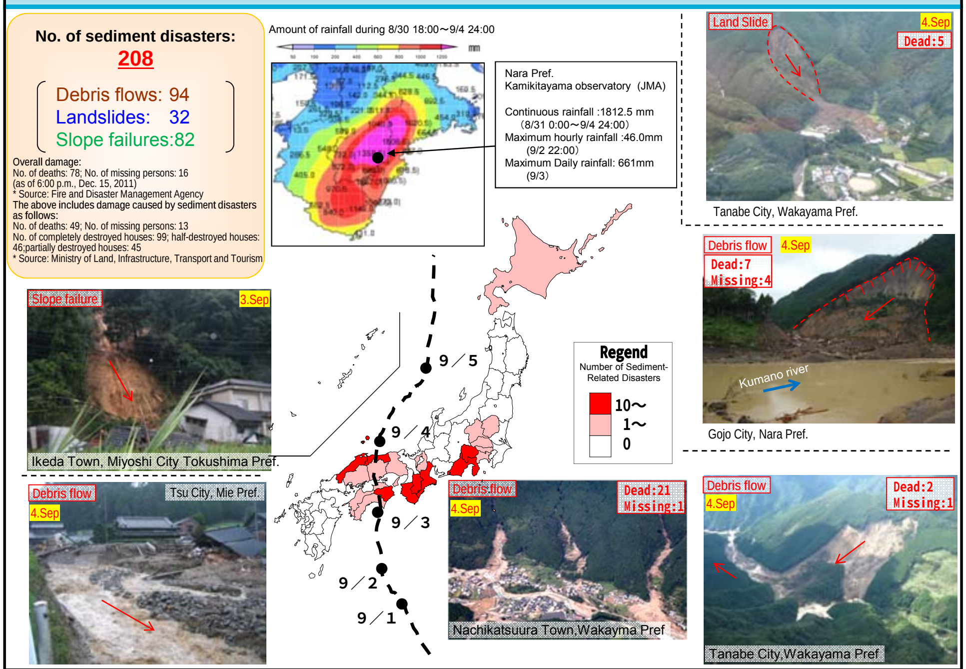
Provision of information to local governments (4 Feb. 2011)
Provision of information updated by rainfall standards (1 Mar. 2011)

Sediment Disaster Emergency Information (Areas Where Severe Sediment Related Disasters Are Anticipated)

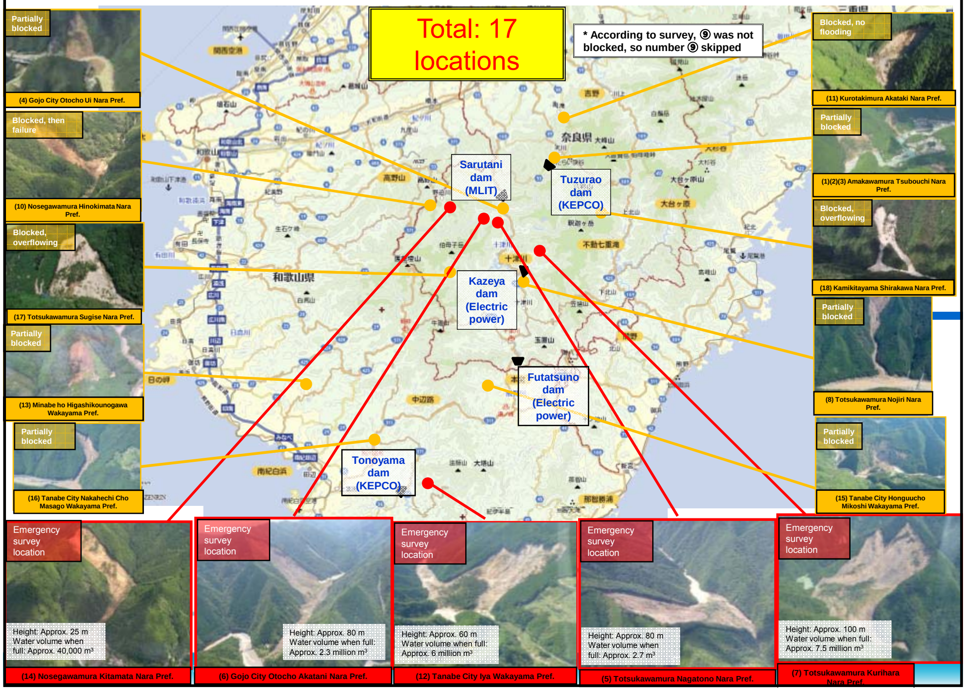
Display debris flow risk streams around Mt. Kirishima (Shinmoedake) and areas where severe sediment disasters are anticipated.



Number of sediment disaster caused by Typhoon Talas



Landslide dams caused by Typhoon Talas (Mie, Nara, Wakayama Prefectures)



Conducting an emergency survey on river blockage caused by Typhoon Talas, and taking other related action

MLIT

Sep. 6, 2011: An emergency survey was conducted in the three drainage areas of the Kumano River (Totsu River), and one drainage area of the Hiki River in Wakayama Prefecture.

Sep. 8, 2011: Emergency information on sediment disaster, such as (1) debris-flow-prone areas, and (2) when to expect serious sediment disaster for evacuation purposes, was sent to relevant prefectural governments, and municipalities, and support was provided for precautious evacuation.

Sep. 12, 2011: In the four areas where an emergency survey was conducted on September 6, 2011, information on surveying was updated, and emergency information on sediment disaster was provided again. (Measured with a laser device from an helicopter. → Aerial photos were taken. [by the Geospatial Information Authority of Japan])

Sep. 13, 2011: Because it was confirmed that another drainage area of the Kumano River (Totsu River) in Nara Prefecture requires an emergency survey, an additional emergency survey was conducted.

Sep. 15, 2011: Issuance of emergency information on sediment disaster, and a newly discovered area of the river blockage in the drainage area of the Kumano River (Totsu River) in Nara Prefecture.

Implementation of emergency survey, etc.

Occurrence of river blockage

Akadani, Ooto-cho, Gojo City, Nara Prefecture

Continuous observation of the flood height of the river blocked

Dropping a buoy for measuring the water level

Measuring the height of the river blocked, etc.

Measurement with the use of a laser device from above the river

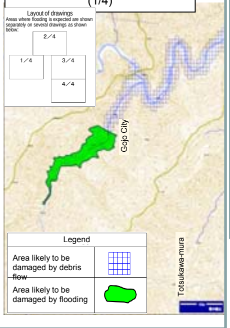
Monitoring the downstream area of the river blocked

Observation via a monitoring camera above the satellite communications vehicle

Issuance of emergency information on sediment disaster

Debris-flow-prone areas

Akadani, Ooto-cho, Gojo City (1/4)



When to expect serious sediment disaster

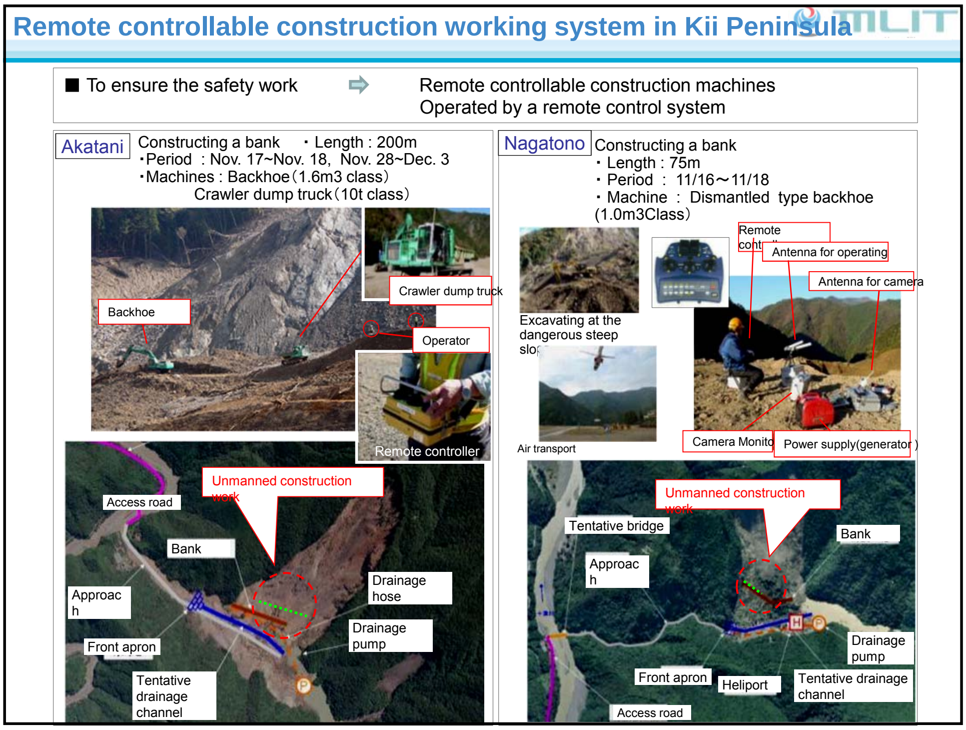
Akadani, Ooto-cho, Gojo City

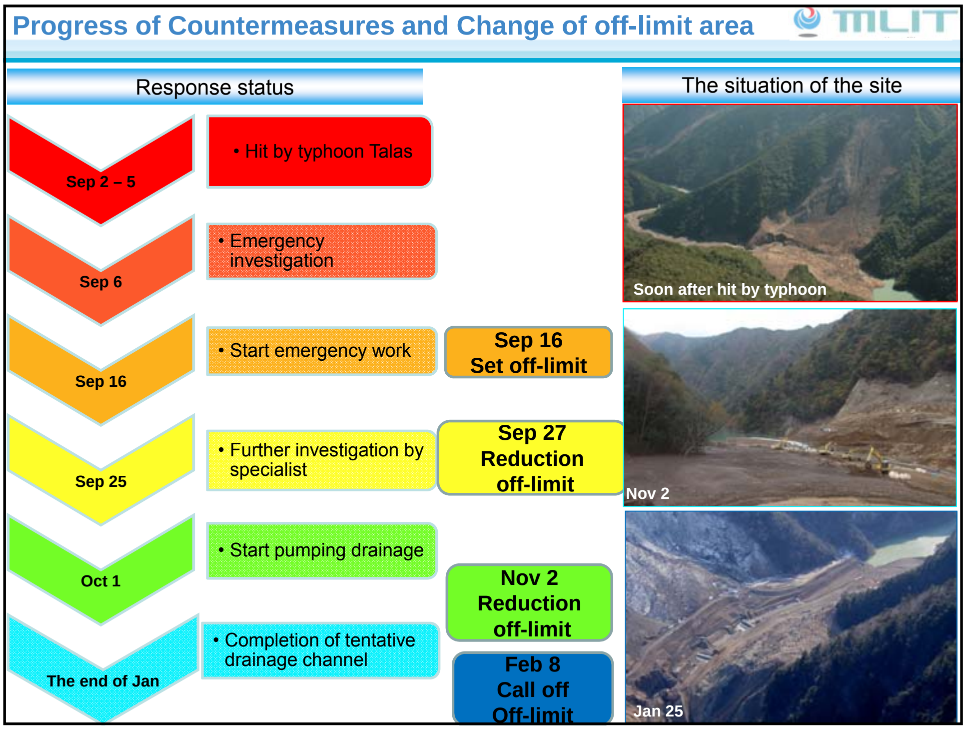
Area where river blockage was confirmed	When to expect serious sediment disaster
Akadani, Ooto-cho, Gojo City, Nara Prefecture	When a sudden shower occurs

(Reference)

Evacuation	Estimated accumulated rainfall to the highest possible water level of river before causing river blockage
Evacuation will be necessary.	Approximately 30 mm

As of Sep. 12, 2011

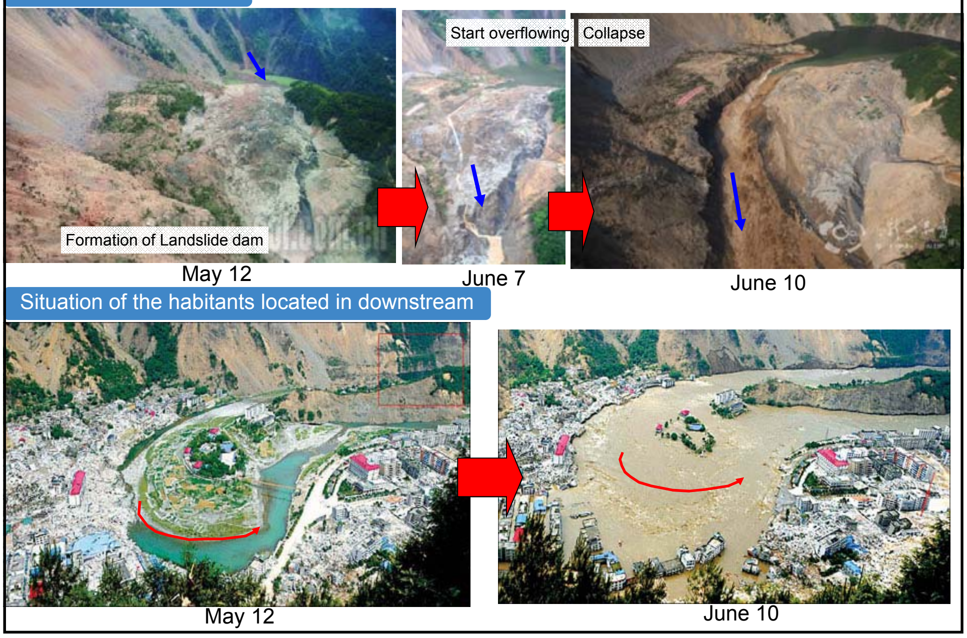

Remote controllable construction working system in Kii Peninsula
To ensure the safety work
Remote controllable construction machines
Operated by a remote control system
Akatani
Constructing a bank ・Length : 200m
・Period : Nov. 17~Nov. 18, Nov. 28~Dec. 3
・Machines : Backhoe（1.6m3 class）
Crawler dump truck（10t class）
Backhoe
Crawler dump truck
Operator
Remote controller
Access road
Unmanned construction work
Bank
Approach
Drainage hose
Drainage pump
Front apron
Tentative drainage channel
Nagatono
Constructing a bank
・Length : 75m
・Period : 11/16～11/18
・Machine : Dismantled type backhoe (1.0m3Class)
Remote control
Antenna for operating
Antenna for camera
Excavating at the dangerous steep slope
Air transport
Camera Monitor
Power supply(generator)
Unmanned construction work
Tentative bridge
Approach
Bank
Drainage pump
Front apron
Heliport
Tentative drainage channel
Access road


Progress of Countermeasures and Change of off-limit area
Response status
The situation of the site
Sep 2 – 5
• Hit by typhoon Talas
Soon after hit by typhoon
Sep 6
• Emergency investigation
Sep 16
• Start emergency work
Sep 16 Set off-limit
Sep 25
• Further investigation by specialist
Sep 27 Reduction off-limit
Nov 2
Oct 1
• Start pumping drainage
Nov 2 Reduction off-limit
The end of Jan
• Completion of tentative drainage channel
Feb 8 Call off Off-limit
Jan 25

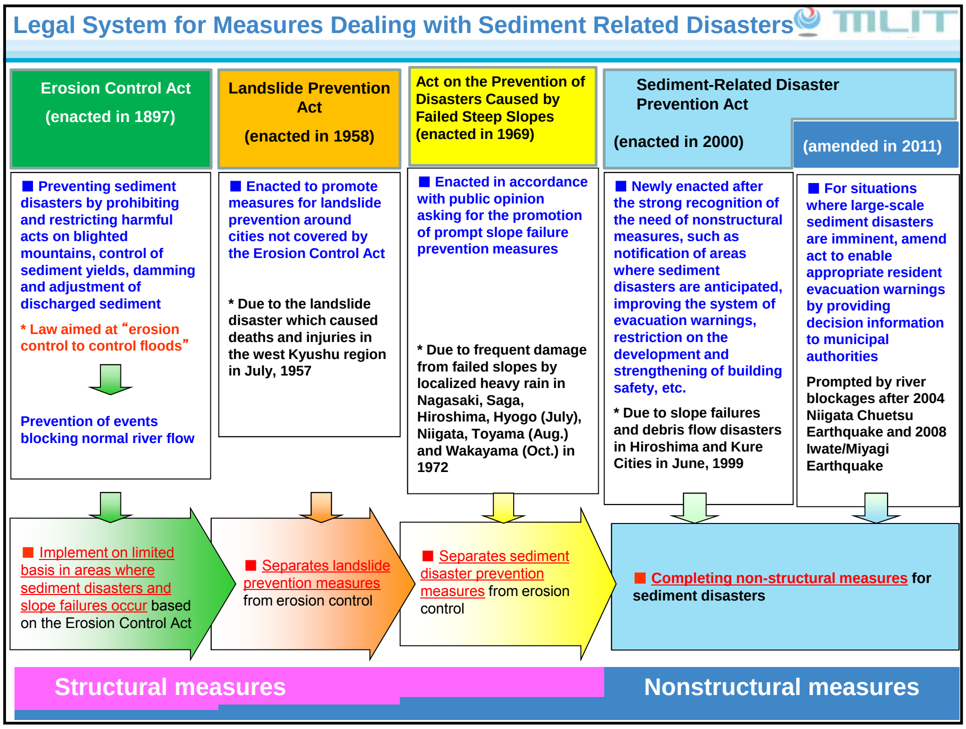
Catastrophic damage caused by collapse of landslide dam (2008 Sichuan earthquake)

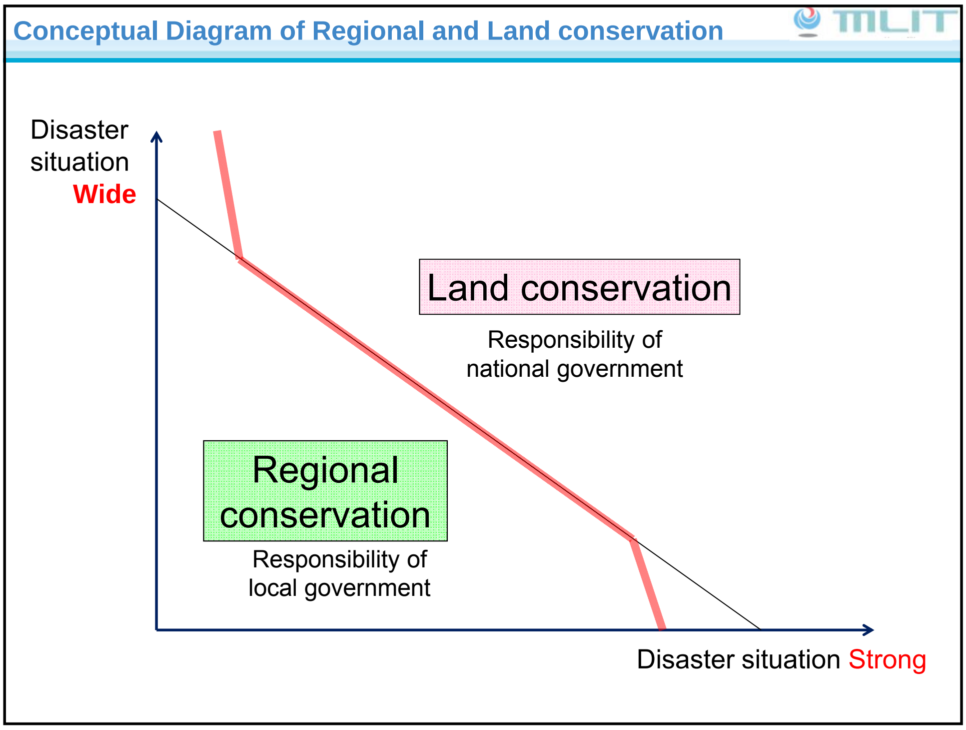
Situation of landslide dam

2008 China



4. Sabo Administration in the Future

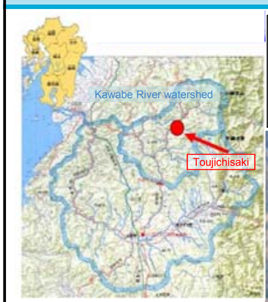

Legal System for Measures Dealing with Sediment Related Disasters
MLIT
Erosion Control Act
(enacted in 1897)
Landslide Prevention Act
(enacted in 1958)
Act on the Prevention of Disasters Caused by Failed Steep Slopes
(enacted in 1969)
Sediment-Related Disaster Prevention Act
(enacted in 2000)
(amended in 2011)
■ Preventing sediment disasters by prohibiting and restricting harmful acts on blighted mountains, control of sediment yields, damming and adjustment of discharged sediment
* Law aimed at "erosion control to control floods"
Prevention of events blocking normal river flow
■ Enacted to promote measures for landslide prevention around cities not covered by the Erosion Control Act
* Due to the landslide disaster which caused deaths and injuries in the west Kyushu region in July, 1957
■ Enacted in accordance with public opinion asking for the promotion of prompt slope failure prevention measures
* Due to frequent damage from failed slopes by localized heavy rain in Nagasaki, Saga, Hiroshima, Hyogo (July), Niigata, Toyama (Aug.) and Wakayama (Oct.) in 1972
■ Newly enacted after the strong recognition of the need of nonstructural measures, such as notification of areas where sediment disasters are anticipated, improving the system of evacuation warnings, restriction on the development and strengthening of building safety, etc.
* Due to slope failures and debris flow disasters in Hiroshima and Kure Cities in June, 1999
■ For situations where large-scale sediment disasters are imminent, amend act to enable appropriate resident evacuation warnings by providing decision information to municipal authorities
Prompted by river blockages after 2004 Niigata Chuetsu Earthquake and 2008 Iwate/Miyagi Earthquake
■ Implement on limited basis in areas where sediment disasters and slope failures occur based on the Erosion Control Act
■ Separates landslide prevention measures from erosion control
■ Separates sediment disaster prevention measures from erosion control
■ Completing non-structural measures for sediment disasters
Structural measures
Nonstructural measures


Conceptual Diagram of Regional and Land conservation
MLIT
Disaster situation Wide
Land conservation
Responsibility of national government
Regional conservation
Responsibility of local government
Disaster situation Strong

(1) Regional Conservation

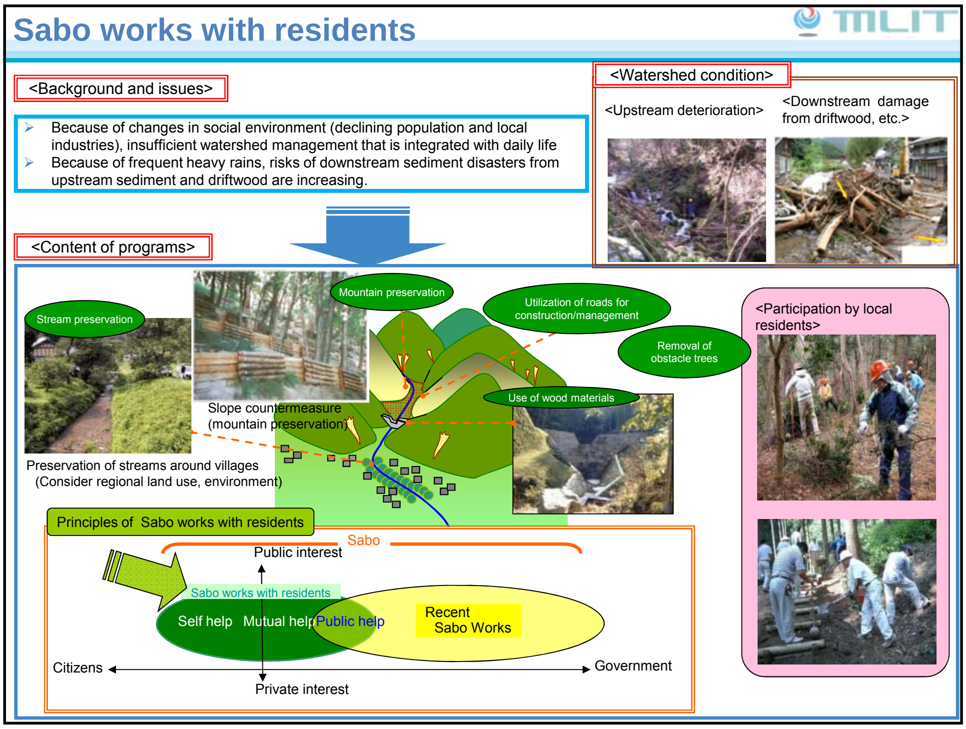
Example of effective facility: Kuma River , Kawabe River Water System (Taguchi No. 2 Sabo Dam, Taguchi Sabo Dam)

Dates of disasters: July 12, 2012 [max. hourly rainfall 68 mm (12.July, 11:00), continuous rainfall 322 mm (12.July, 01:00–13.July, 14:00)]
June 24, 2012 [max. hourly rainfall 31 mm (24.June, 09:00), continuous rainfall 274 mm (23.June, 08:00–24.June, 21:00)]
Disaster location:Itsuki Villege, Kumamoto Pref.
Damage: Debris flow occurred because of a rain season rain front, but sabo dams had been provided and trapped the debris (approx. 7,600 m3).
Damage to the area downstream was prevented.



Approx. 7,100 m3 trapped after rains of July 12 (Photo July 13, 2012)

2 dams trapped debris and prevented debris flow disaster


Sabo works with residents
MLIT
<Background and issues>
Because of changes in social environment (declining population and local industries), insufficient watershed management that is integrated with daily life
Because of frequent heavy rains, risks of downstream sediment disasters from upstream sediment and driftwood are increasing.
<Watershed condition>
<Upstream deterioration>
<Downstream damage from driftwood, etc.>
<Content of programs>
Stream preservation
Mountain preservation
Utilization of roads for construction/management
Removal of obstacle trees
Use of wood materials
Slope countermeasure (mountain preservation)
Preservation of streams around villages (Consider regional land use, environment)
<Participation by local residents>
Principles of Sabo works with residents
Sabo
Public interest
Sabo works with residents
Self help
Mutual help
Public help
Recent Sabo Works
Citizens
Government
Private interest


Protect yourself !! Evacuation trainings
国土交通省
Evacuation training with physically challenged person
Rescue training using a helicopter
Hazard Map making by residents themselves
Studying for disaster prevention at a refuge

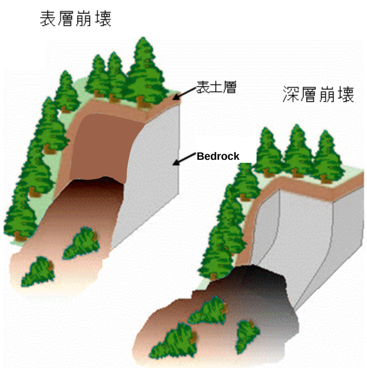
(2) Land Conservation

What is Deep-Seated Collapse?

➢ Deep-seated refers to collapse not only of the surface in mountain and hill slopes (weathered layer) but collapse that reaches down to the bedrock.

➢ It occurs after torrential rain, earthquakes, snowmelt, etc.

Characteristics of deep-seated collapse
- The motion of soil and rock blocks is sudden and temporary
- The speed of soil and rock block motion is high
- Soil and rock blocks are deformed and do not retain their original shapes
- The amount of debris is greater than in surface collapses, and reaches farther distances




(Former) Mimikawa Saigo Villege, Miyazaki Pref. (2005)

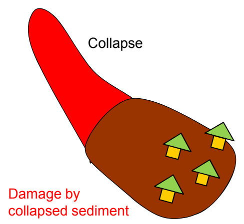

(Former) Tanocho Mt. Wanizukayama, Miyazaki Pref. (2005)


Gojo City Akatani, Nara Pref. (2011)

Sediment Related Disasters by Deep-Seated Collapse

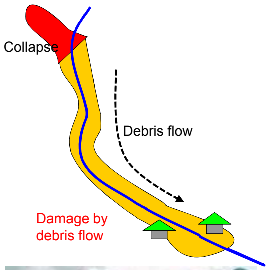
- Compared to sediment disasters, which occur about 1,000 times per year, deep-seated collapses occurred only 31 times in the decade between 2001 and 2010.
- Because the amount of moving debris is large compared to surface collapses, severe damage can result if a deep-seated collapse occurs.
- The following types of damage are caused by deep-seated collapses.

① Falling of collapsed debris



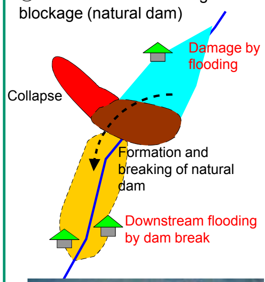
Gojo City Otocho Ui Shimizu, Nara Pref. (2011)

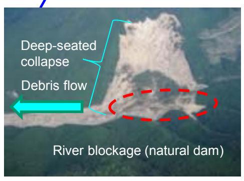
② Downstream debris flow



(Former) Tanocho Mt. Wanizukayama, Miyazaki Pref. (2005)

③ Formation and breaking of river blockage (natural dam)



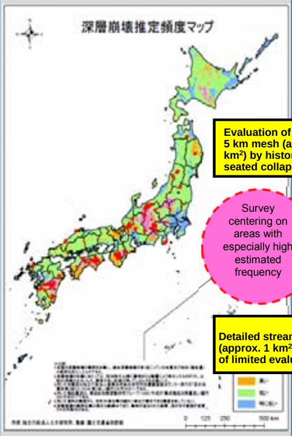


Tanabe city Iya, Wakayama Pref. (2011)

Survey Results on Deep-Seated Collapses (published September 10, 2012)

- "**Deep-seated collapse estimated density map**" showing nationwide deep-seated collapse trends
- Create and publish a "**Deep-seated collapse stream level evaluation map**".

Deep-seated collapse estimated frequency map (published August 2010)



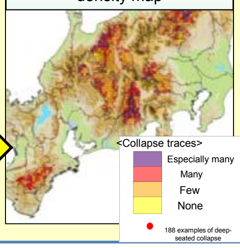
From about 120 examples of deep-seated collapse events since the Meiji period (1868–1912), frequency was estimated on basis of relation with Quaternary uplift and geological conditions.

Evaluation of wide-area 5 km mesh (approx. 30 km²) by historical deep-seated collapse events

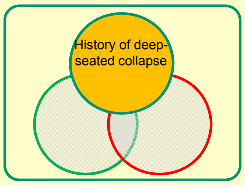
Survey centering on areas with especially high estimated frequency

Detailed stream-level (approx. 1 km² evaluation of limited evaluation area

Deep-seated collapse traces density map

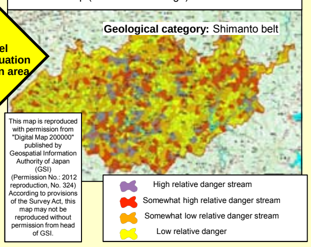


Divide the entire country into a 5 km mesh (about 30 km2). For areas where the anticipated frequency of deep-seated collapse is "especially many", evaluate in 4 stages by using index 1 of deep-seated collapse traces among the 3 indices of the stream-level survey.



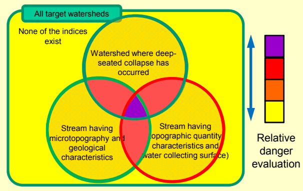
Enables grasp of nationwide historical deep-seated collapse trends

Example of a deep-seated collapse stream level evaluation map (Kii Mountain Range)



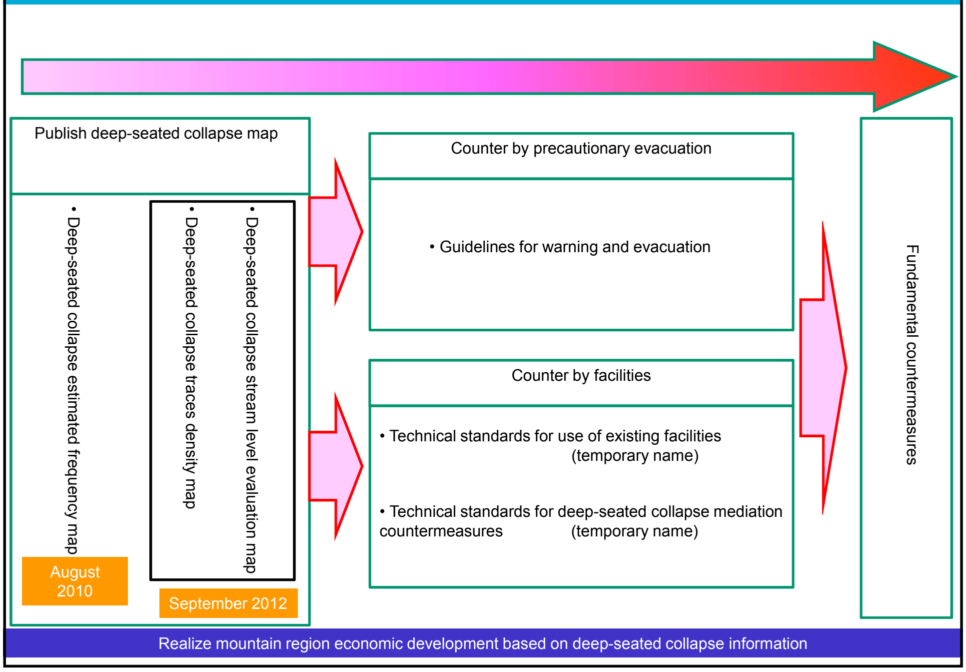
This map is reproduced with permission from "Digital Map 200000" published by Geospatial Information Authority of Japan (GSI) (Permission No.: 2012 reproduction, No. 324) According to provisions of the Survey Act, this map may not be reproduced without permission from head of GSI.

For areas where ground and weather conditions are thought to be roughly equal, in units of 1 km², evaluate using 3 indices of past deep-seated collapse incidents, geological structure and microtopography, and topographic quantity

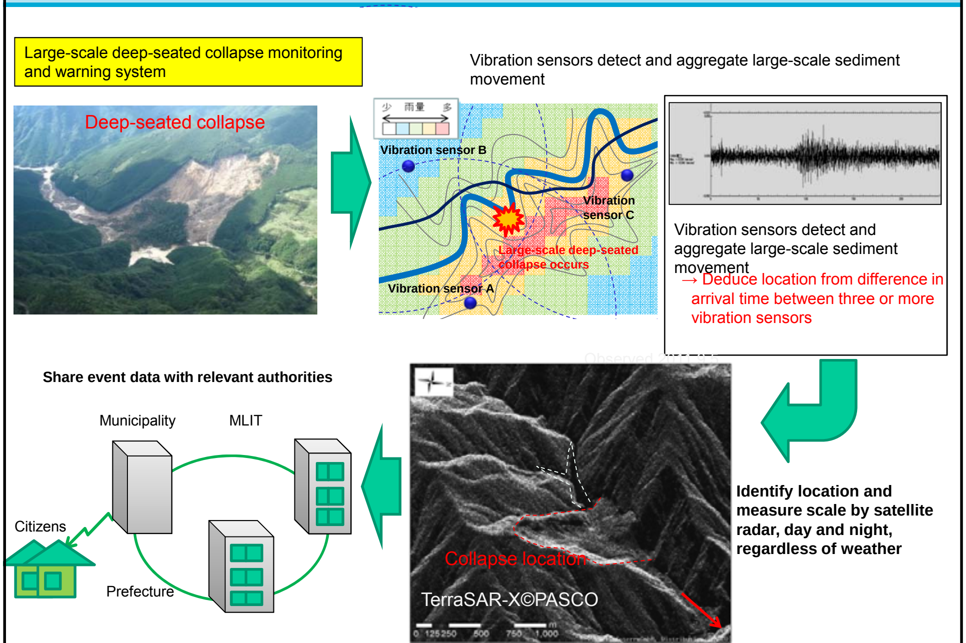


Allows relative danger to be grasped within an area in stream units

Countermeasures to Deep-seated collapse (draft)



Monitoring system to Deep-Seated Collapse



River blockage at Gojo City Akatani Nara Pref. discovered from satellite images

Training with prefectures and municipalities against Large-Scale Sediment Disaster

Date and time: October 3 , 2012 13:00–17:00
Location: Katashinamura Office, Gunma Pref.
Participating organizations: Kanto Regional Development Bureau. Tone River System Sabo Work Office, Gunma Prefecture, Numata City, Katashinamura
Participants: 107 (breakdown: 51 training participants, 36 observers, 2 media, 18 office staff)

<Purpose of event>

Recently, numerous records for heavy and torrential rainfall have been broken, and numerous sediment disasters are occurring all over Japan. More than ever before, national and local governments need to cooperate to respond swiftly and precisely

To enable this, training that envisaged a large-scale sediment disaster was carried out to check the roles of the various relevant organizations and verify the transmission of information, with the aim of enhancing swift and smooth disaster response capabilities.

- Postulated disaster: River blockage (natural dam) caused by large-scale collapse, and multiple simultaneous sediment disasters
- Purpose of training: Swift provision of information to relevant authorities; execution of surveys according to Sediment Disaster Prevention Act; assessment of prospective damage from natural dam and emergency recovery measures; other
- Training method: Learning type training

Overview of Technical Emergency Control Force (TEC-FORCE)

Background to establishment of TEC-FORCE

- Support by Regional Development Bureaus and other offices to public service organizations during large-scale natural disasters has contributed to early recovery from many disasters, including the Maruyamagawa River dike break after Typhoon No. 23 in 2004 and the Niigata Chuetsu Earthquake in 2007.
→ However, on those occasions, the support system was organized each time after the disaster occurred.
- To prepare for large-scale natural disasters, and enable even speedier support to local public service organizations, TEC-FORCE was established in April 2008.
→ By designating employees as TEC-FORCE members in advance, everyday training and material preparation became possible.

Activity

On instructions from the Minister (director of the disaster countermeasure department), carry out the following activities.

- Disaster situation surveys
- Emergency response to disasters
- Support for local government disaster relief
- Prevention of secondary disasters

Preparation

- By designating employees as TEC-FORCE members, establish system in advance for dispatch and reception of personnel and materials, for rapid response
- Enhance capabilities through periodic training and drills
- Strengthen by preparing action plans and operating bases

Total number of TEC-FORCE members

Total of 3,575 members drawn from MLIT organizations
(As of August 1, 2012)

Deployment of disaster countermeasure equipment

- Deploy disaster countermeasure equipment (helicopters, pump trucks, lighting trucks, satellite communication vehicles, fast assembly bridges, etc.) to regional development bureaus and offices.

Technical Assistance by Experts for Sediment Related Disasters

For sediment disasters nationwide, respond to requests from regional development bureaus and prefectural governments by dispatching experts to offer technical assistance and support for disaster countermeasures.

[Content of technical assistance]

- Conduct local survey
- Offer assistance and advice on emergency countermeasures and recovery
- Offer guidance and advice about warning and evacuation

[Flow of dispatch of sediment disaster experts]

Regional development bureau/ Prefecture government → (1) Dispatch request → Sabo Department Land Conservation Division → (2) Select personnel → National Institute for Land and Infrastructure Management

National Institute for Land and Infrastructure Management → (3) Report results → Sabo Department Land Conservation Division → (4) Dispatch decision → Regional development bureau/ Prefecture government

In response to the debris flow disaster of June 27–28 at Kimotsukicho Kimotsuki-gun, Kagoshima Prefecture, organize warning and evacuation and provide assistance for future countermeasures.

Dispatch date: June 30 (Monday), 2012

Local survey by specialists

Technical assistance at Kagoshima

Press conference after survey

Conference with Kagoshima Prefecture

In response to the upstream debris flow disaster of July 3 at the Takemoto River in Yufuincho, Yufu City, Oita Prefecture, organize warning and evacuation and provide assistance for future countermeasures.

Dispatch date: July 5 (Thursday) to July 6 (Friday), 2012

Local survey by specialists

Technical assistance for Oita Prefecture

Local media interview

Conference at Yufu city, Oita Prefecture

3.2 基調講演

「ヴェネト州の水害リスク管理」

ヴェネト州環境大臣

マウリツィオ・コンテ

REGIONE DEL VENETO

Delegazione Italiana
TOKYO 2012

LA GESTIONE DEL RISCHIO IDRAULICO DEL TERRITORIO DELLA REGIONE VENETO

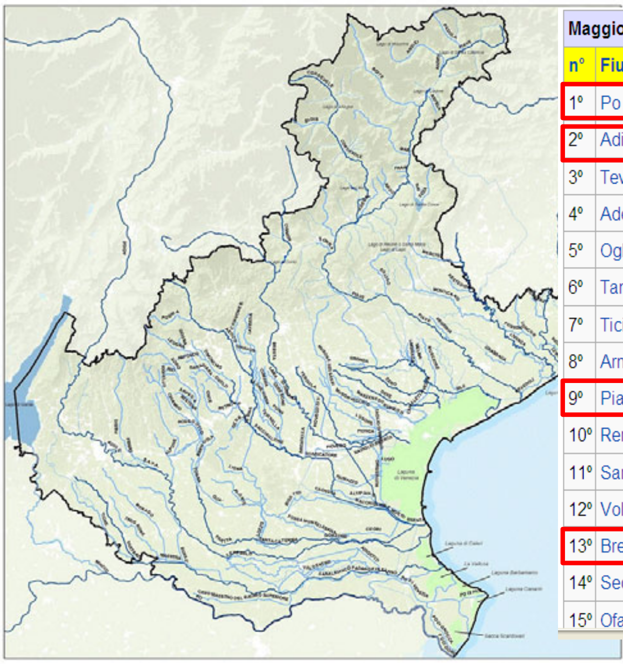
FLOOD RISK MANAGEMENT OF VENETO REGION AREA

Maurizio Conte
Assessore all'ambiente della Regione Veneto
ing. Mariano Carraro
Segretario regionale per l'ambiente – Regione Veneto

REGIONE VENETO

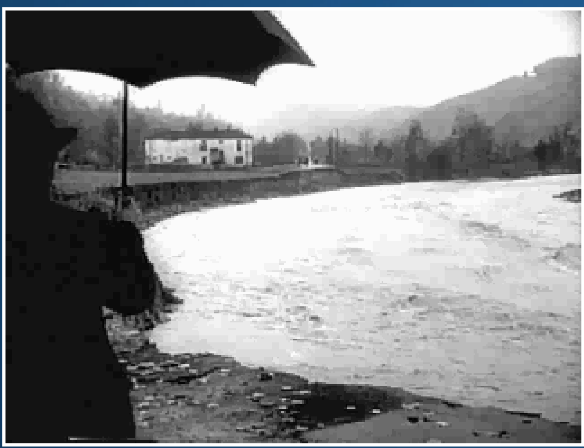
Superficie / Area	18.390 km^2
Abitanti / People	5.000.000

VENETO: TERRA DI FIUMI LAND OF RIVERS



Maggiori fiumi italiani			
n°	Fiume	km	Regioni attraversate
1°	Po	652	Piemonte, Lombardia, Emilia-Romagna, Veneto
2°	Adige	410	Trentino-Alto Adige, Veneto
3°	Tevere	405	Emilia-Romagna, Toscana, Umbria, Lazio
4°	Adda	313	Lombardia
5°	Oglio	280	Lombardia
6°	Tanaro	276	Piemonte, Liguria
7°	Ticino	248*	Svizzera, Piemonte, Lombardia
8°	Arno	241	Toscana
9°	Piave	220	Veneto
10°	Reno	211	Toscana, Emilia-Romagna
11°	Sarca-Mincio	194	Trentino-Alto Adige, Veneto, Lombardia
12°	Volturno	175	Molise, Campania
13°	Brenta	174	Trentino-Alto Adige, Veneto
14°	Secchia	172	Emilia-Romagna, Lombardia
15°	Ofanto	170	Campania, Basilicata, Puglia

ALLUVIONE DEL 2010
FLOOD OF 2010



ALLUVIONE DEL POLESINE 1951
FLOOD OF 1951


2 NOVEMBRE 2010
CALDOGNO (VI)


2 NOVEMBRE 2010
PONTE SAN NICOLO' (PD)

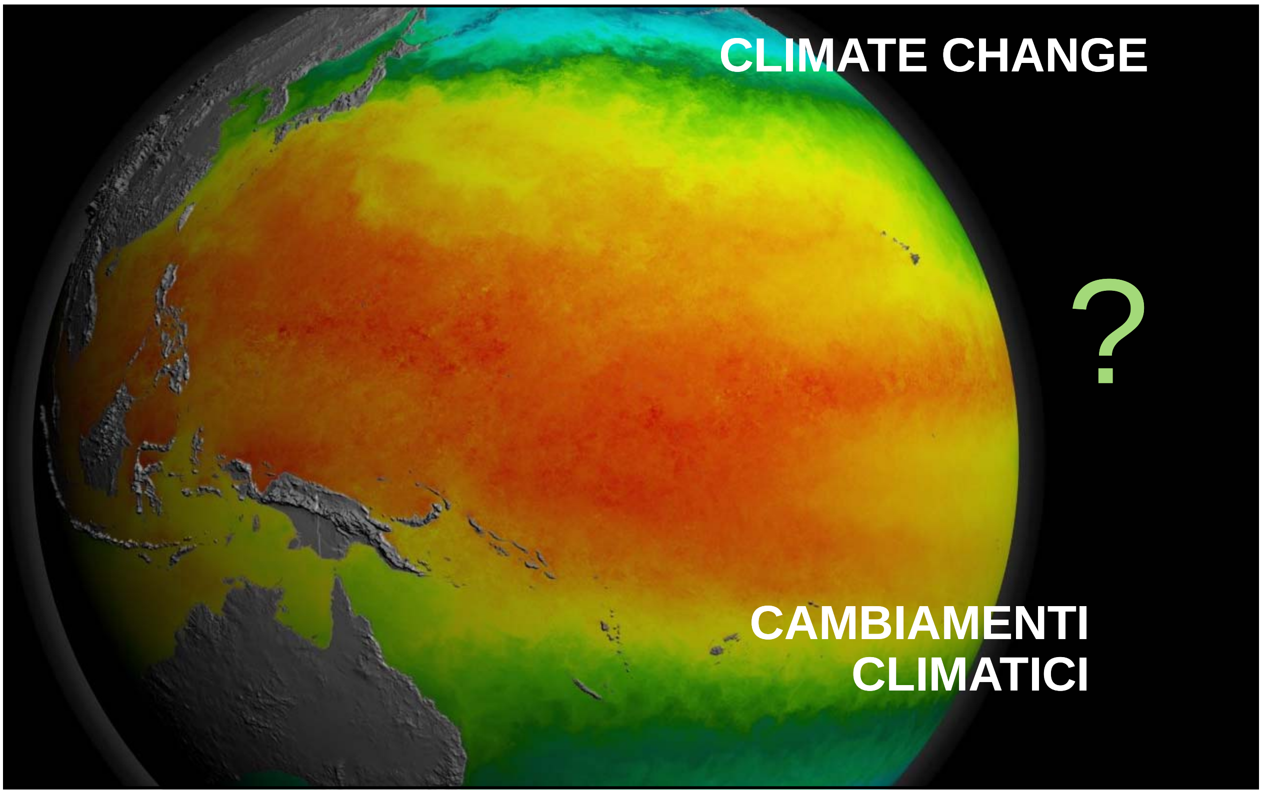

2 NOVEMBRE 2010
CASALSERUGO (PD)

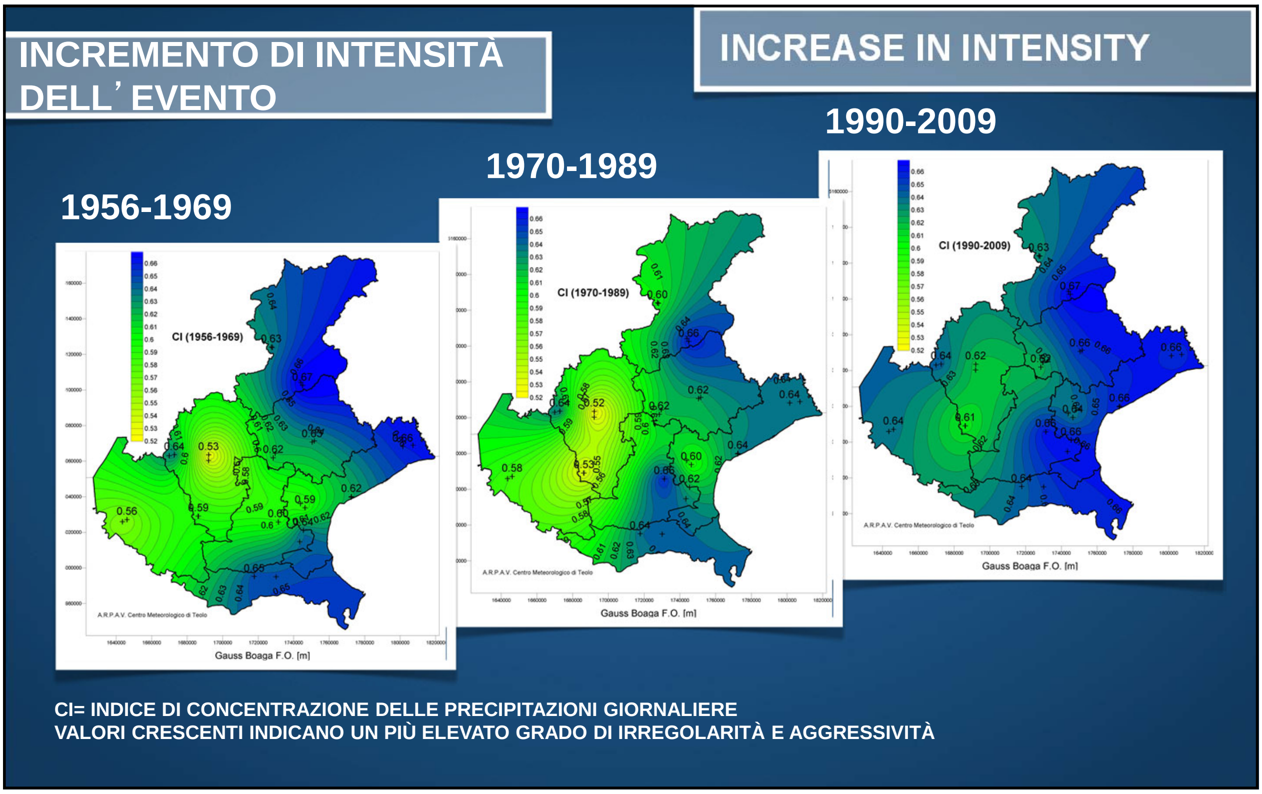

2 NOVEMBRE 2010
SALETTO (PD)


2 NOVEMBRE 2010
MONTEFORTE D'ALPONE (PD)


WHEN WILL IT HAPPEN AGAIN?
QUANDO
SUCCEDERÀ ANCORA?


TERRITORY IS
VULNERABLE
IL TERRITORIO È
VULNERABILE


CLIMATE CHANGE
?
CAMBIAMENTI
CLIMATICI


INCREMENTO DI INTENSITÀ DELL'EVENTO
INCREASE IN INTENSITY
1956-1969
1970-1989
1990-2009
CI (1956-1969)
CI (1970-1989)
CI (1990-2009)
A.R.P.A.V. Centro Meteorologico di Teolo
Gauss Boaga F.O. [m]
CI= INDICE DI CONCENTRAZIONE DELLE PRECIPITAZIONI GIORNALIERE
VALORI CRESCENTI INDICANO UN PIÙ ELEVATO GRADO DI IRREGOLARITÀ E AGGRESSIVITÀ


HUMAN ACTIVITIES
ATTIVITÀ ANTROPICHE


TREVISO 1954
TREVISO 2012
INCREMENTO DELLE SUPERIFICI IMPERMEABILI
INCREASE IN URBANIZATION


MINOR SENSIBILITA' E ATTENZIONE AL TEMA DELLA SICUREZZA IDRAULICA
LESS ATTENTION TO HYDRAULIC RISK


NO "MAGIC" SOLUTIONS


OCCORRONO NUOVE STRATEGIE
WE NEED NEW STRATEGIES


RICALIBRATURA DELLE RETI IDROGRAFICHE
WATERCOURSES RESHAPING


RICALIBRATURA DELLE RETI IDROGRAFICHE
WATERCOURSES RESHAPING

RICALIBRATURA DELLE RETI IDROGRAFICHE
WATERCOURSES RESHAPING

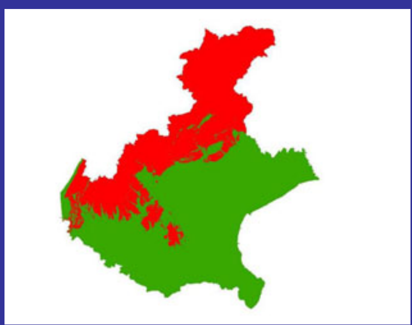
ADEGUAMENTO DEI SISTEMI FOGNARI
ADJUSTMENT OF SEWER SYSTEM


REALIZZAZIONE DI BACINI DI LAMINAZIONE
FLOOD RITENTION BASIN BUILDING

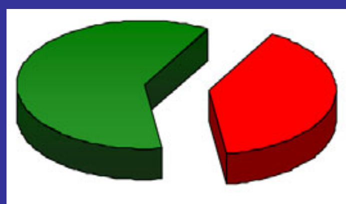

REALIZZAZIONE DI BACINI DI LAMINAZIONE
FLOOD RITENTION BASIN BUILDING


LIVING WITH FLOOD RISK
CONVIVENZA CON IL
RISCHIO IDRAULICO


LIVING WITH FLOOD RISK
CONVIVENZA CON IL
RISCHIO IDRAULICO



PLAIN

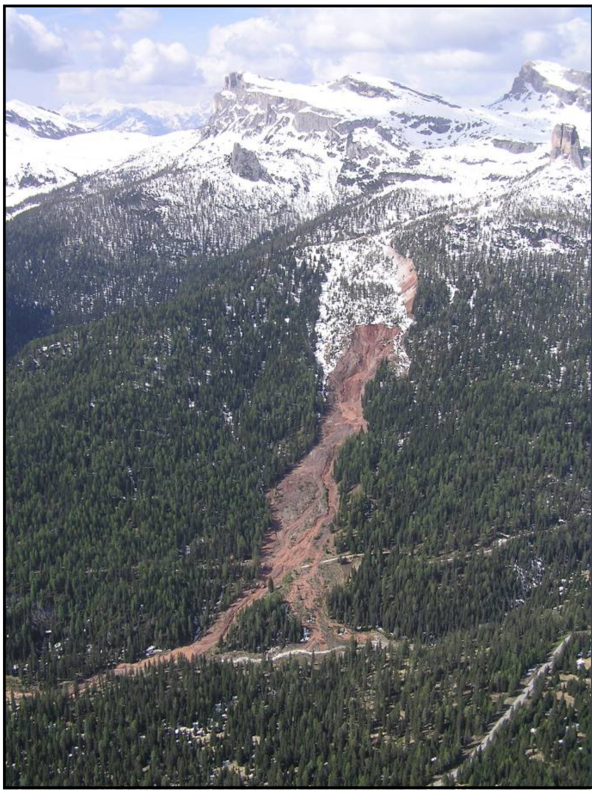


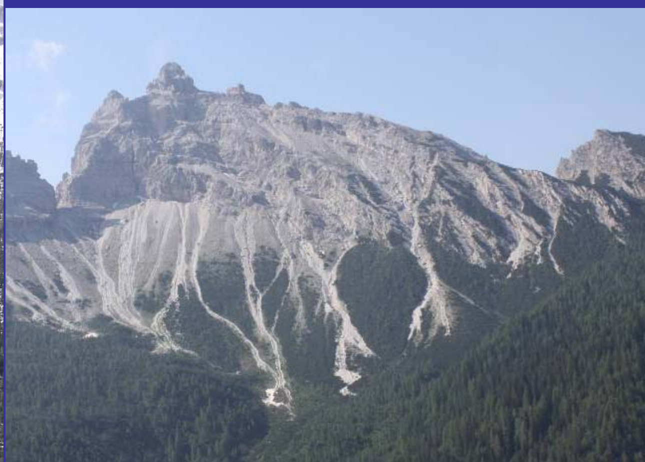
MOUNTAIN AND HILL

(2010)	surface (Kmq)	municipalities	population
MOUNTAIN	5.359,10	117	350.593
HILL	2.663,90	120	812.297
PLAIN	10.375,90	344	3.749.548
TOTAL	18.398,90	581	4.912.438

The Veneto Region is formed by about twenty-nine per cent of mountain surface and about fourteen percent by hilly areas. More than a fifth of the population lives in those area

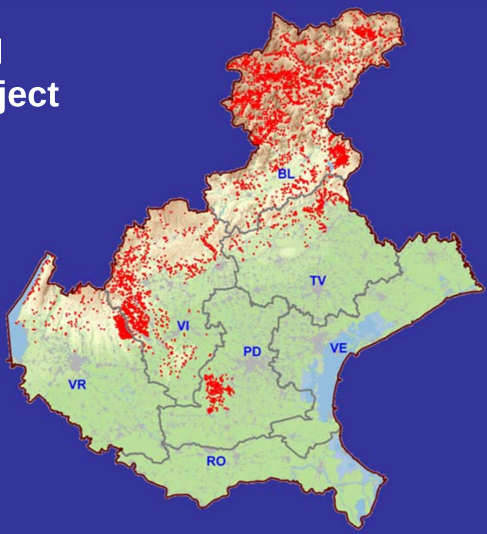
The mountainous and hilly areas of the Veneto Region are characterized by important natural beauties that have favored a great development of tourism both in summer and winter



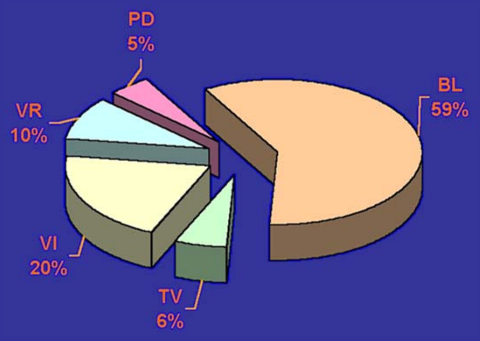


Landslides are one of the most dangerous natural hazards

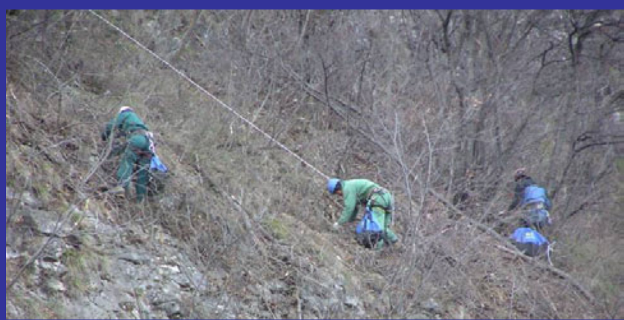
IFFI project



distribution of landslides in the Veneto Region

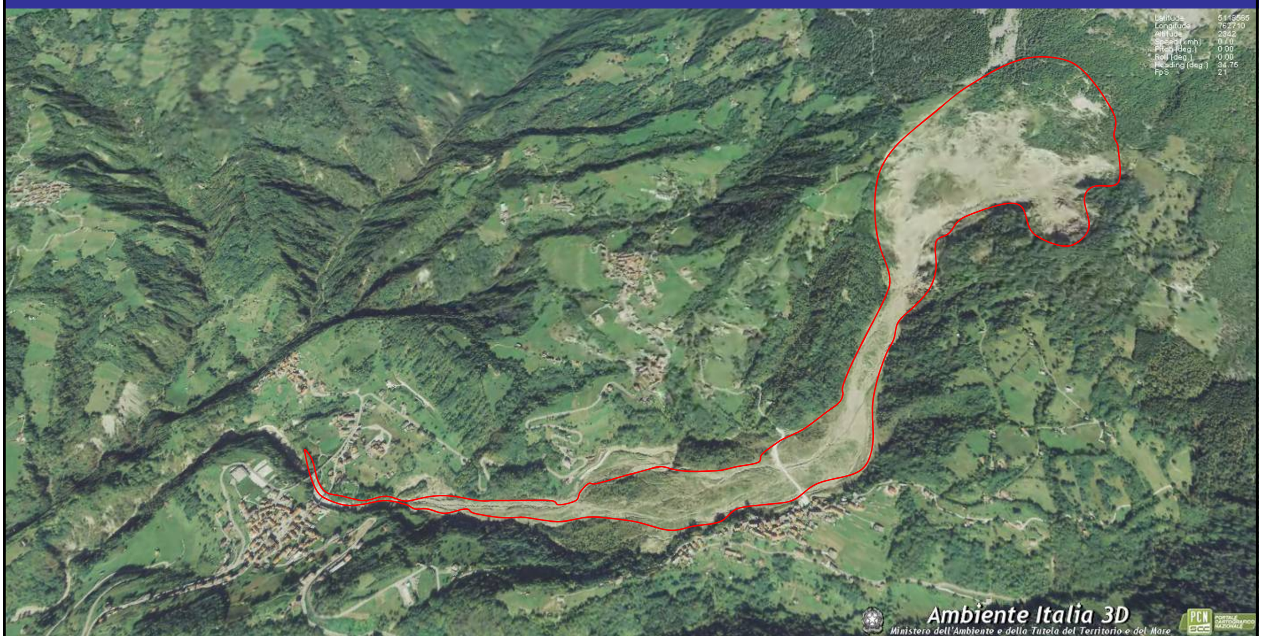


About ten thousand landslides have been classified in the Veneto region, but there are surely much more.



Municipalities and provincial authorities are responsible for the mitigation of landslides risk.

The Veneto Region intervenes when landslides affect rivers, forests, protected areas and in general where the events are very large.



The Tessina landslide located in the valley of Alpago in the province of Belluno is an example of a very large event.

Il collasso di rocce argillose ha originato la colata di fango.

Il volume totale è stimato in circa 10 milioni di metri cubi

The collapse of argillaceous rock originated the mud flow. The sliding rock turned to mud. The total volume is estimated at about ten million cubic meters.

The most important intervention was the excavation of a one thousand and three hundred meters long drainage tunnel.


AZIONI NON STRUTTURALI
PREVENZIONE E GESTIONE DELL'EMERGENZA
PROTEZIONE CIVILE COMUNE DI PADOVA
PROTEZIONE CIVILE COMUNE DI PADOVA
NON STRUCTURAL MEASURES
PREVENTION AND EMERGENCY MANAGMENT


VALUTAZIONE DI COMPATIBILITÀ IDRAULICA
INVARIANCE OF HYDRAULIC CONDITIONS
GUIDELINES
LINEE GUIDA CON CONTENUTI TECNICO SCIENTIFICI, È RIVOLTO AI TECNICI DELLE AMMINISTRAZIONI PUBBLICHE, AI PROFESSIONISTI E AGLI ADDETTI AI LAVORI PER FORNIRE UN QUADRO PROGETTUALE E NORMATIVO DI RIFERIMENTO COMUNE E CONDIVISO, AL FINE DI ACCELERARE LE PROCEDURE DI APPROVAZIONE DEGLI INTERVENTI MANTENENDO UN ADEGUATO STANDARD PROGETTUALE DELLE SOLUZIONI PROPOSTE.
VALUTAZIONE DI COMPATIBILITÀ IDRAULICA
LINEE GUIDA
Le LINEE GUIDA possono essere visionate e scaricate dal sito internet www.commissarioallagamenti.veneto.it

PREVENZIONE DAGLI ALLAGAMENTI E MITIGAZIONE DEGLI EFFETTI

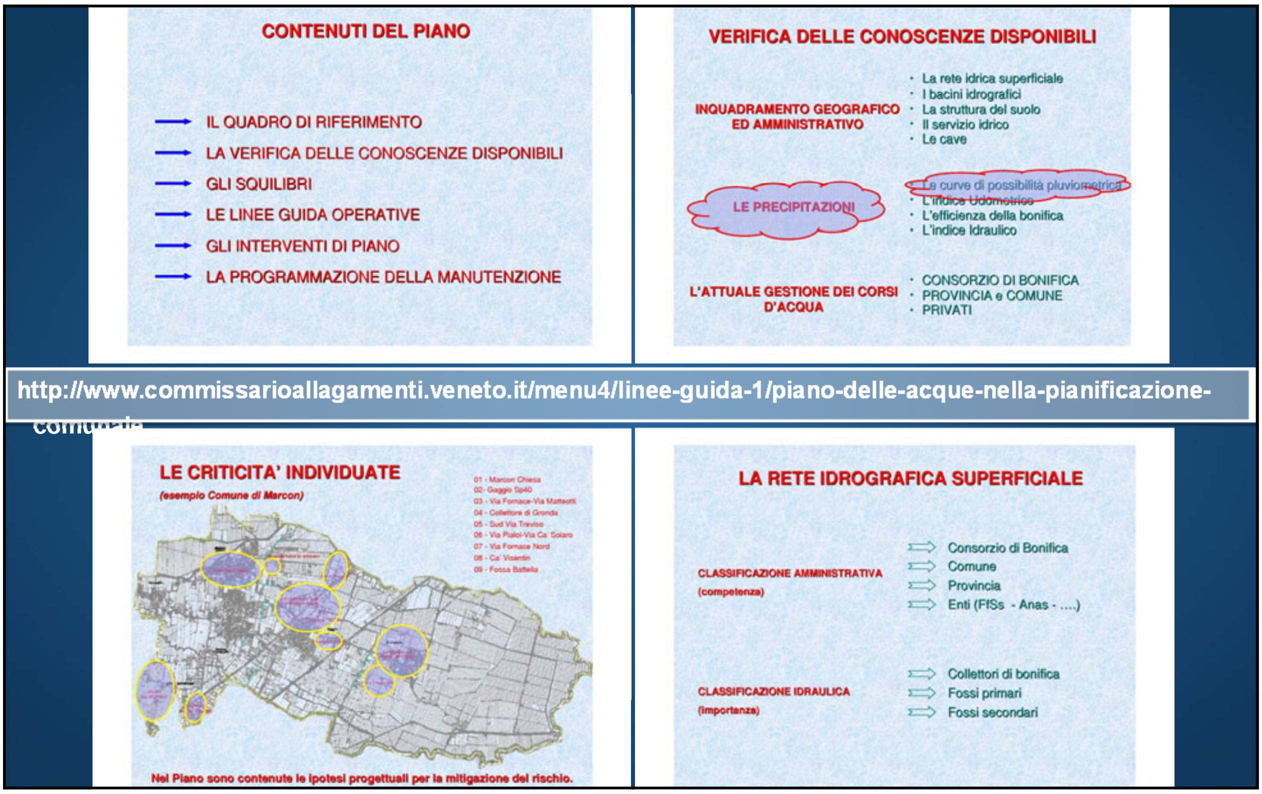
GUIDELINES TO PREVENT FLOODS

LINEE GUIDA CON **CONTENUTI DIVULGATIVI E INFORMATIVI**, È RIVOLTO AI CITTADINI CON LO SCOPO DI PRESENTARE GLI **ACCORGIMENTI DA ADOTTARE**, SIA PER PREVENIRE I FENOMENI DI ALLAGAMENTO DELLE AREE URBANE CONSEGUENTI AGLI EVENTI METEORICI, SIA PER MITIGARE GLI EFFETTI E I DANNI CONSEGUENTI ALLE INSUFFICIENZE DELLE RETI DI DRENAGGIO, IN PARTICOLARE CANALI DI BONIFICA E FOGNATURE.

Le LINEE GUIDA possono essere visionate e scaricate dal sito internet www.commissarioallagamenti.veneto.it

PIANIFICAZIONE COMUNALE: PIANO DELLE ACQUE

TOWN WATERCOURSES PLAN

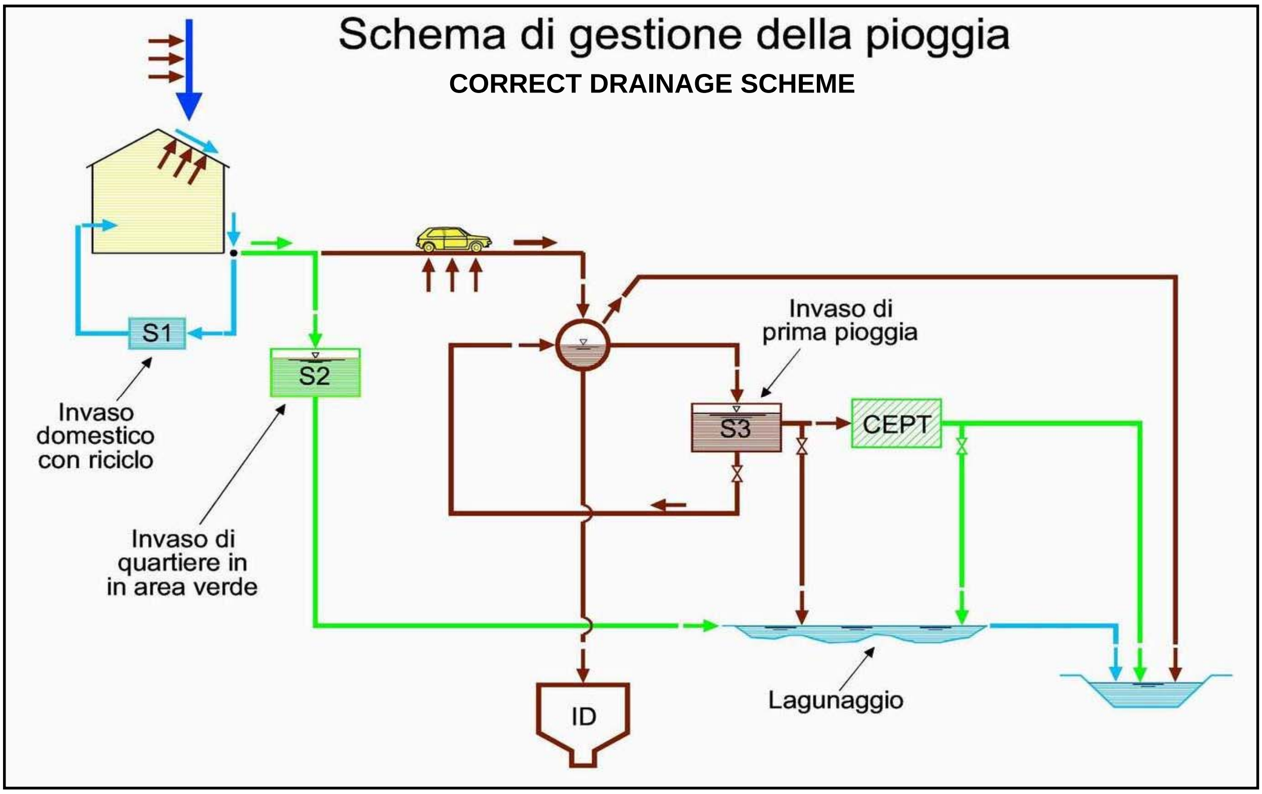


PIANIFICAZIONE E PROGETTAZIONE
PLANNING E DESIGN

DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI

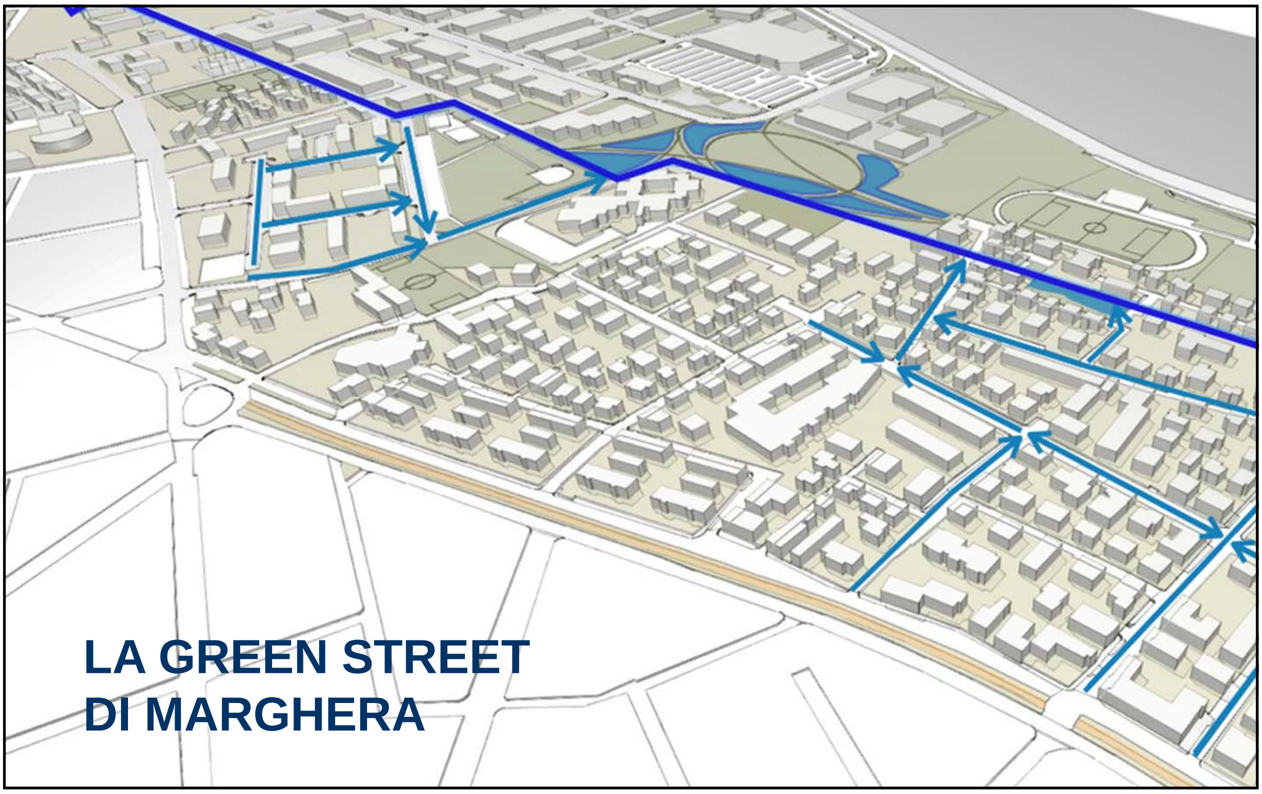
FLOOD RISK REDUCTION SYSTEMS


PIANIFICAZIONE E PROGETTAZIONE
DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
SISTEMI DI DRENAGGIO URBANO SOSTENIBILE
SUSTAINABLE URBAN DRAINAGE SYSTEMS
RIQUALIFICAZIONE URBANA
PARCHI URBANI ATTREZZATI
MODERAZIONE VELOCITA' TRAFFICO AUMENTO SICUREZZA
RISOLUZIONE RISCHIO IDRAULICO AUMENTO VALORI ESTETICI ECOLOGICI
BACINI DI RITENZIONE
riqualificazione ambientale paesaggistica con funzionalità idraulica di emergenza
CORRIDOI VERDI ALL'INTERNO DELLA CITTA
GREEN STREETS
sistemi drenanti sostenibili ad alto valore estetico

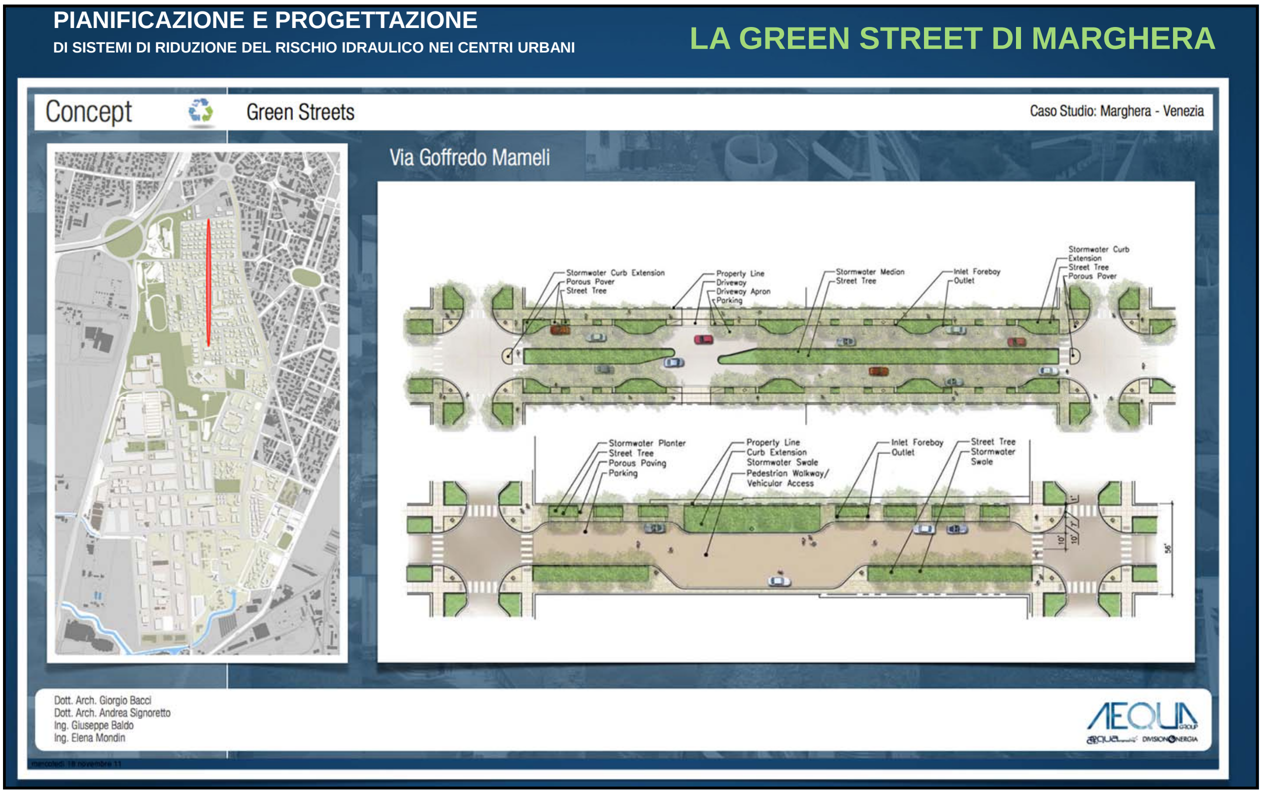

Schema di gestione della pioggia
CORRECT DRAINAGE SCHEME
S1
Invaso domestico con riciclo
S2
Invaso di quartiere in in area verde
Invaso di prima pioggia
S3
CEPT
ID
Lagunaggio


OPERE DI COMPENSAZIONE
DEI NUOVI INSEDIAMENTI
COUNTERVAILING MEASURES
IN NEW SETTLMENTS


OPERE DI COMPENSAZIONE
DEI NUOVI INSEDIAMENTI
COUNTERVAILING MEASURES
IN NEW SETTLMENTS


LA GREEN STREET
DI MARGHERA


PIANIFICAZIONE E PROGETTAZIONE
DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
LA GREEN STREET DI MARGHERA
Concept
Green Streets
Caso Studio: Marghera - Venezia
Via Goffredo Mameli
Dott. Arch. Giorgio Bacci
Dott. Arch. Andrea Signoretto
Ing. Giuseppe Baldo
Ing. Elena Mondin
AEQUA


PIANIFICAZIONE E PROGETTAZIONE
DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
LA GREEN STREET DI MARGHERA
Concept
Green Streets
Caso Studio: Marghera - Venezia
Via Goffredo Mameli
Stormwater Curb Extension
Porous Paver
Street Tree
Property Line
Driveway
Driveway Apron
Parking
Stormwater Median
Street Tree
Inlet Forebay
Outlet
Stormwater Curb Extension
Street Tree
Porous Paver
Stormwater Planter
Street Tree
Porous Paving
Parking
Property Line
Curb Extension
Stormwater Swale
Pedestrian Walkway/
Vehicular Access
Inlet Forebay
Outlet
Street Tree
Stormwater Swale
Dott. Arch. Giorgio Bacci
Dott. Arch. Andrea Signoretto
Ing. Giuseppe Baldo
Ing. Elena Mondin


PIANIFICAZIONE E PROGETTAZIONE
DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
LA GREEN STREET DI MARGHERA
Concept
Green Streets
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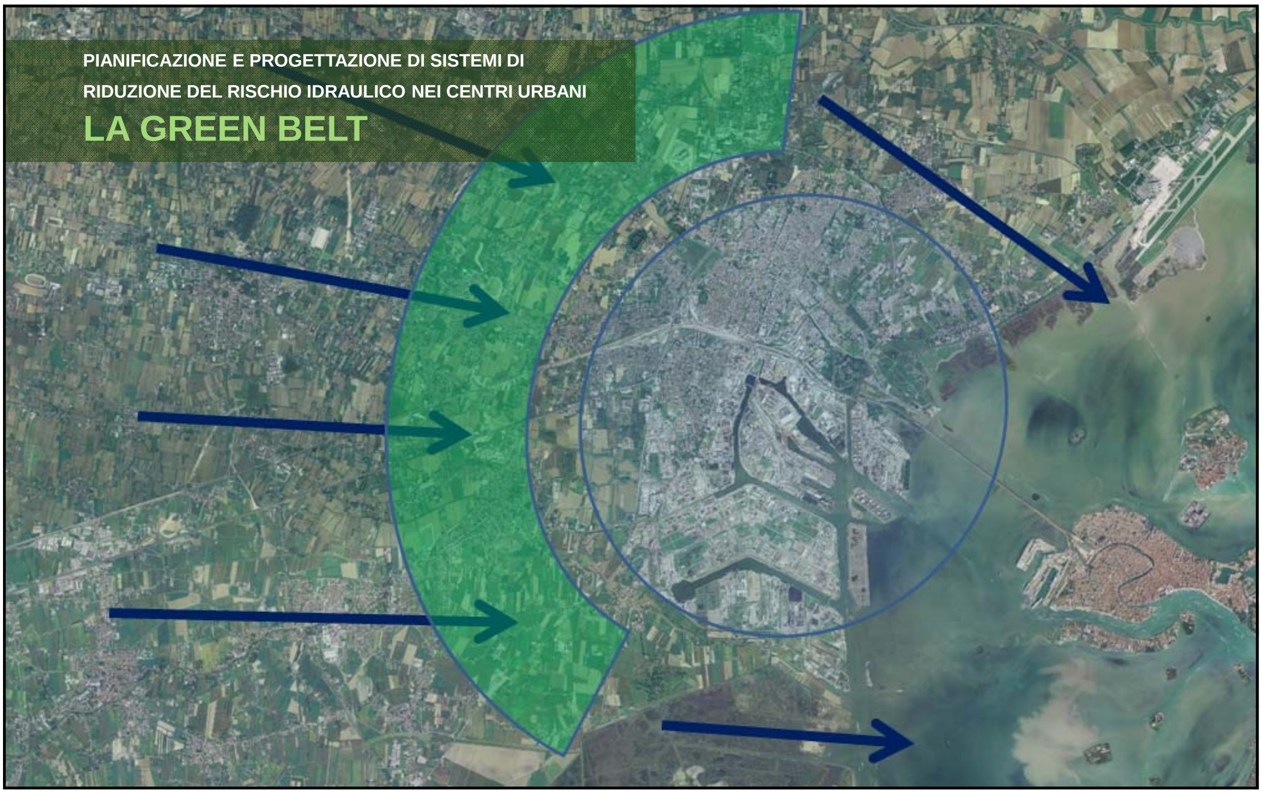
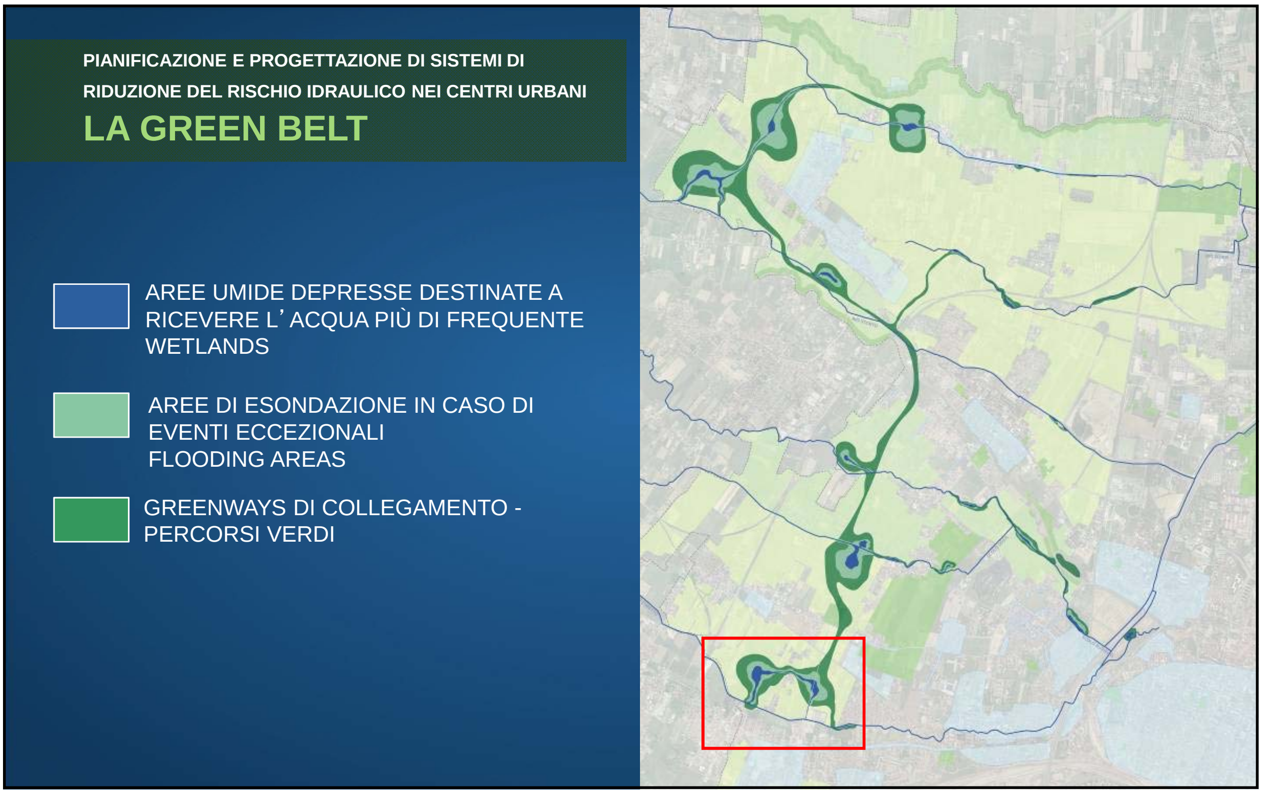
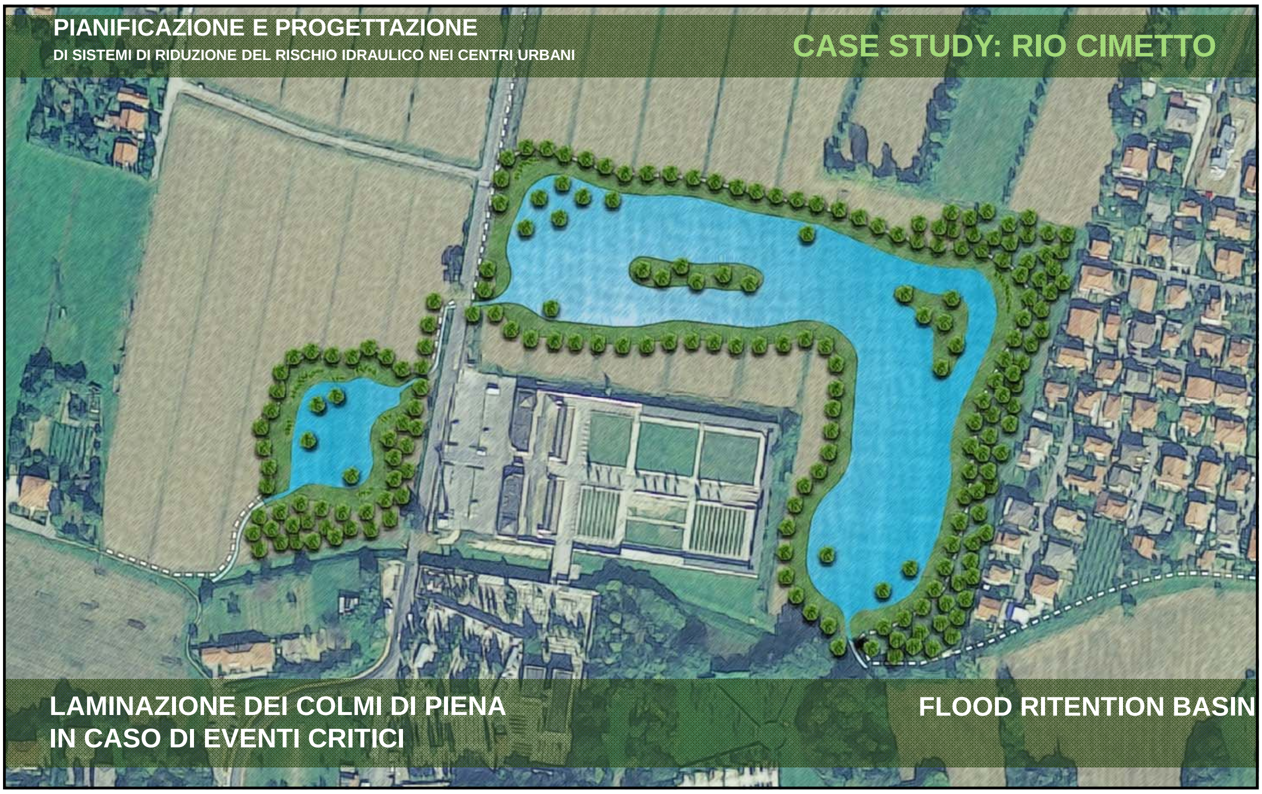
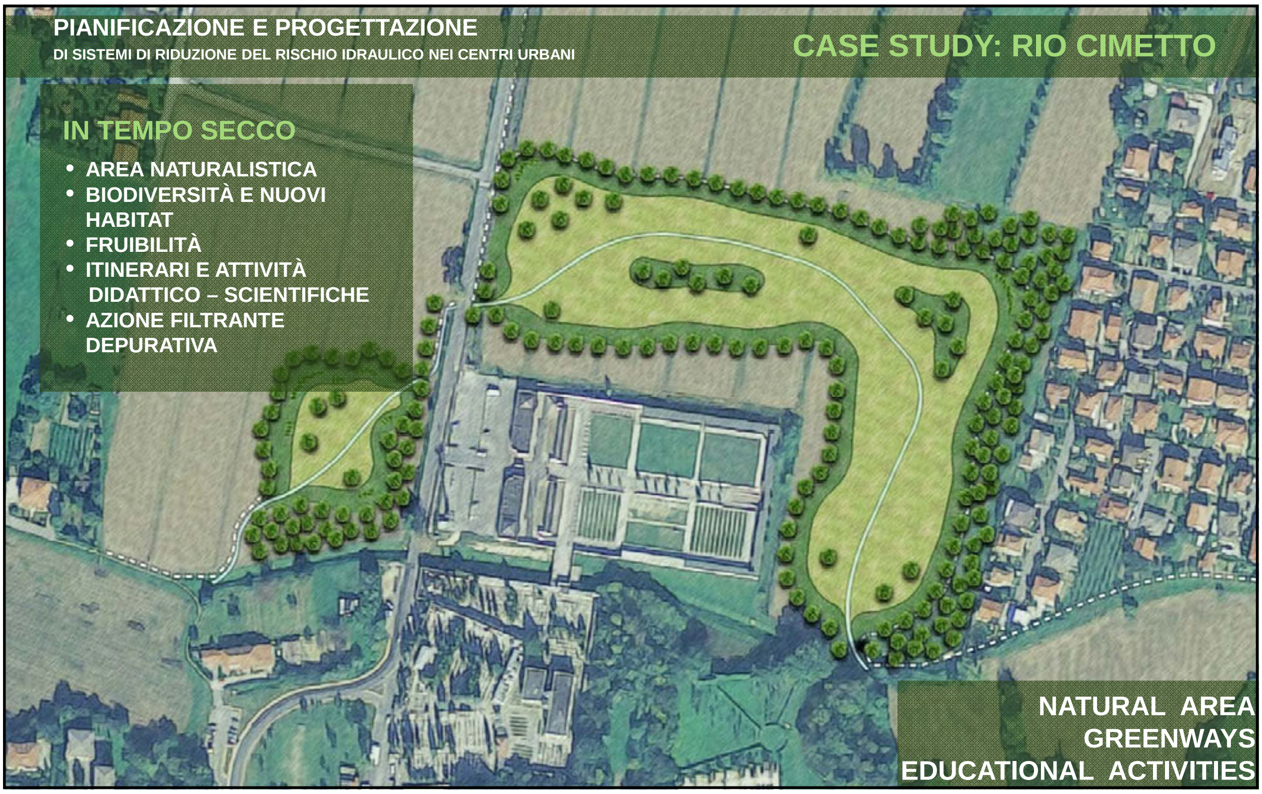

PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI
RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
LA GREEN BELT


PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI
RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
LA GREEN BELT
AREE UMIDE DEPRESSE DESTINATE A RICEVERE L' ACQUA PIÙ DI FREQUENTE WETLANDS
AREE DI ESONDAZIONE IN CASO DI EVENTI ECCEZIONALI FLOODING AREAS
GREENWAYS DI COLLEGAMENTO - PERCORSI VERDI


PIANIFICAZIONE E PROGETTAZIONE
DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
CASE STUDY: RIO CIMETTO
LAMINAZIONE DEI COLMI DI PIENA
IN CASO DI EVENTI CRITICI
FLOOD RITENTION BASIN


PIANIFICAZIONE E PROGETTAZIONE
DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
CASE STUDY: RIO CIMETTO
IN TEMPO SECCO
• AREA NATURALISTICA
• BIODIVERSITÀ E NUOVI HABITAT
• FRUIBILITÀ
• ITINERARI E ATTIVITÀ DIDATTICO – SCIENTIFICHE
• AZIONE FILTRANTE DEPURATIVA
NATURAL AREA
GREENWAYS
EDUCATIONAL ACTIVITIES

PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI
RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI

PARCO FLUVIALE DEL MARZENEGO
MARZENEGO RIVER PARK

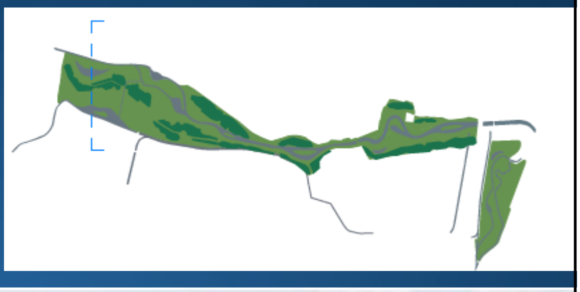
AREE FLUVIALI/ RIVER AREAS

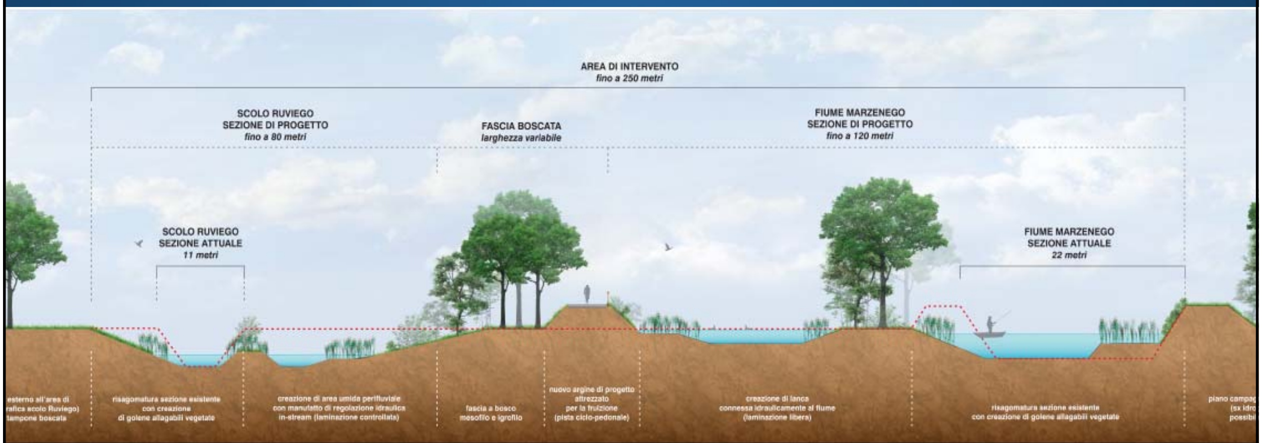
AREE GOLENALI VEGETATE /FLOODPLAINS

AREE A BOSCO / WOODS

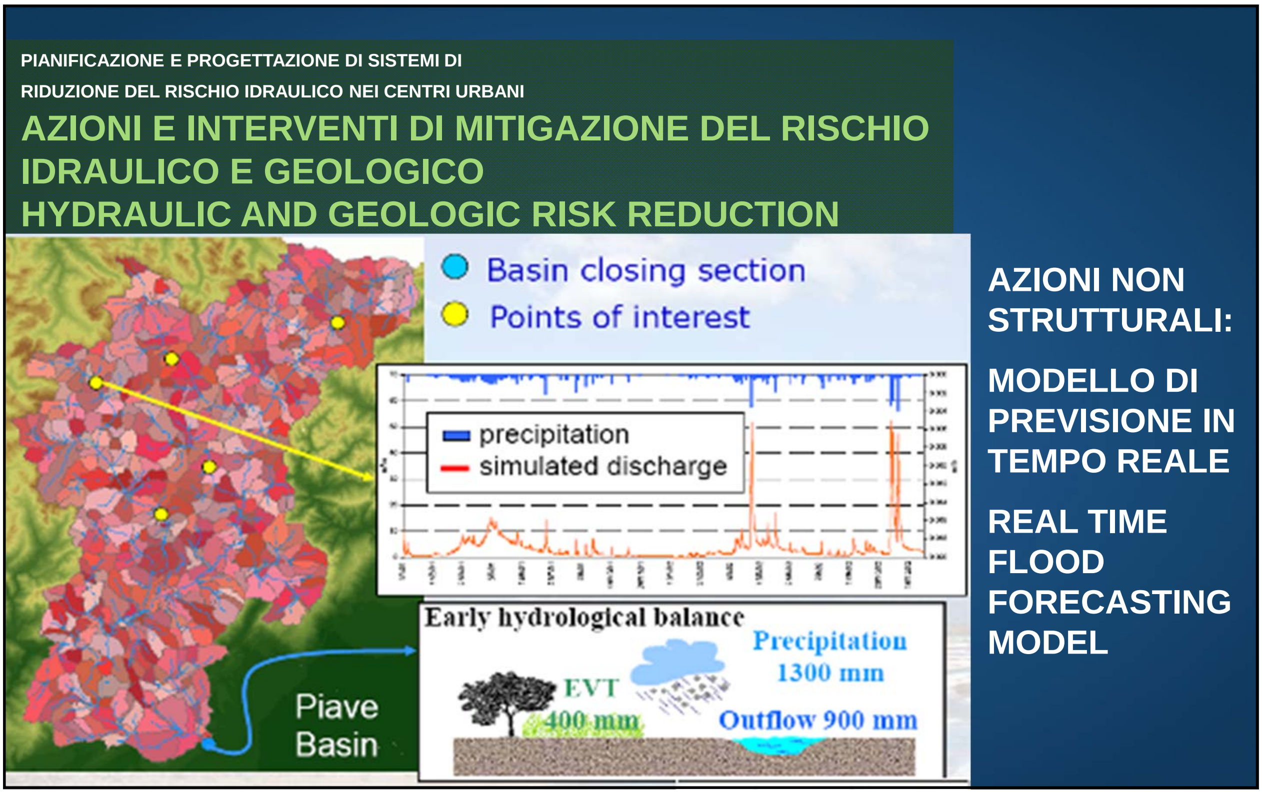
PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI
RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI

PARCO FLUVIALE DEL MARZENEGO
MARZENEGO RIVER PARK



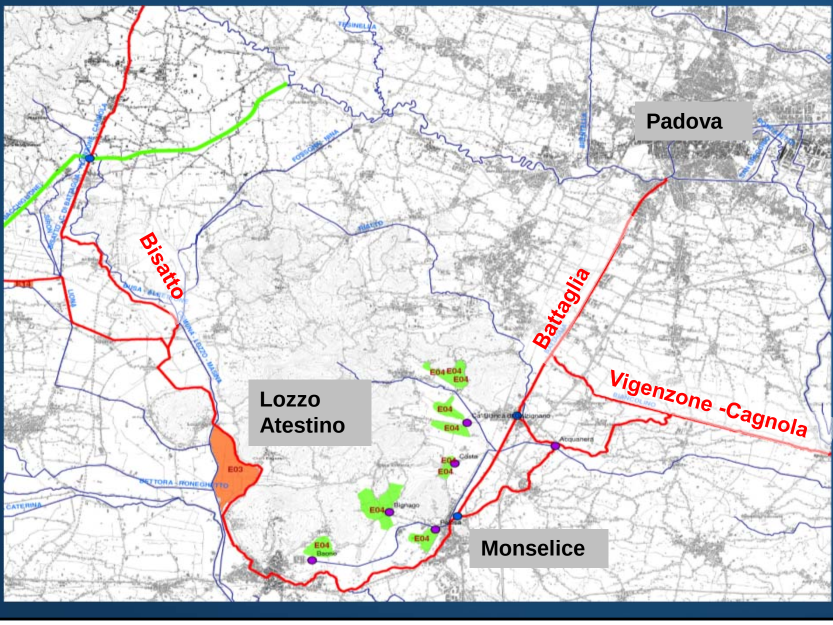



PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI
RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
AZIONI E INTERVENTI DI MITIGAZIONE DEL RISCHIO IDRAULICO E GEOLOGICO
HYDRAULIC AND GEOLOGIC RISK REDUCTION PLAN
OPERE STRUTTURALI: BACINI DI LAMINAZIONE
FLOOD RITENTION BASIN


PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI
RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI
AZIONI E INTERVENTI DI MITIGAZIONE DEL RISCHIO IDRAULICO E GEOLOGICO
HYDRAULIC AND GEOLOGIC RISK REDUCTION
Basin closing section
Points of interest
precipitation
simulated discharge
Early hydrological balance
EVT
400 mm
Precipitation
1300 mm
Outflow 900 mm
Piave Basin
AZIONI NON STRUTTURALI:
MODELLO DI PREVISIONE IN TEMPO REALE
REAL TIME FLOOD FORECASTING MODEL

PIANIFICAZIONE E PROGETTAZIONE DI SISTEMI DI RIDUZIONE DEL RISCHIO IDRAULICO NEI CENTRI URBANI

PIANO DI MITIGAZIONE DEL RISCHIO
FLOOD RISK REDUCTION PLAN



SISTEMA COMPLESSO: azioni strutturali, non strutturali comportamentali e gestionali

- **Aree allagate per fermo impianti/STOP OF PUMPING**
- **Aree di invaso/FLOOD RITENTION BASIN**
- **Idrovore / pumps**
- **Sostegni/hydraulic structures**

Per alleggerimento della rete principale

Gestione supportata da sistema previsionale di allertamento

Commissario Delegato per l'emergenza concernente gli eccezionali eventi metereologici del 26 settembre 2007 che hanno del territorio della Regione Veneto

THANKS FOR YOUR ATTENTION

Maurizio Conte **ing. Mariano Carraro**

www.regione.veneto.it www.commissarioallagamenti.veneto.it

3.3「Web を活用した地すべり
自動モニタリングシステム」

水文地質防災研究所パドヴァ支部研究員

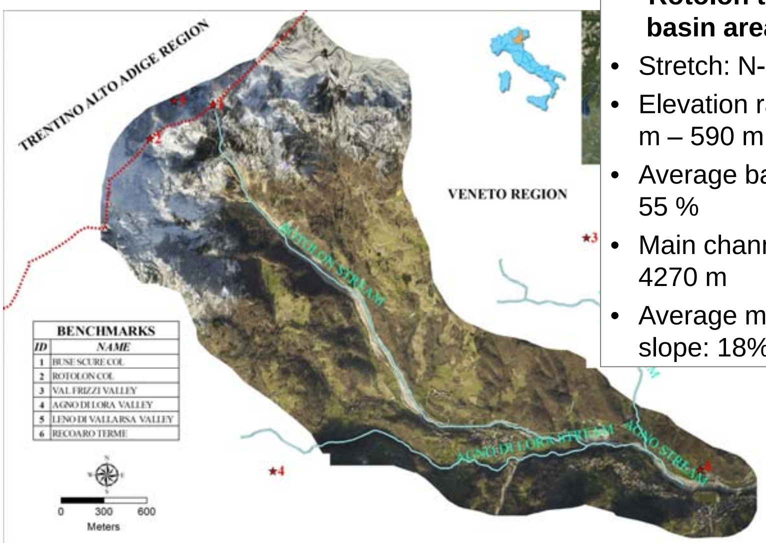
ジャンルーカ・マルカート

National Research Council of Italy

irpi Istituto di Ricerca per la Protezione Idrogeologica

A Web-based platform for automatic and continuous landslide monitoring: the Rotolon case study

Rotolon Web-based platform

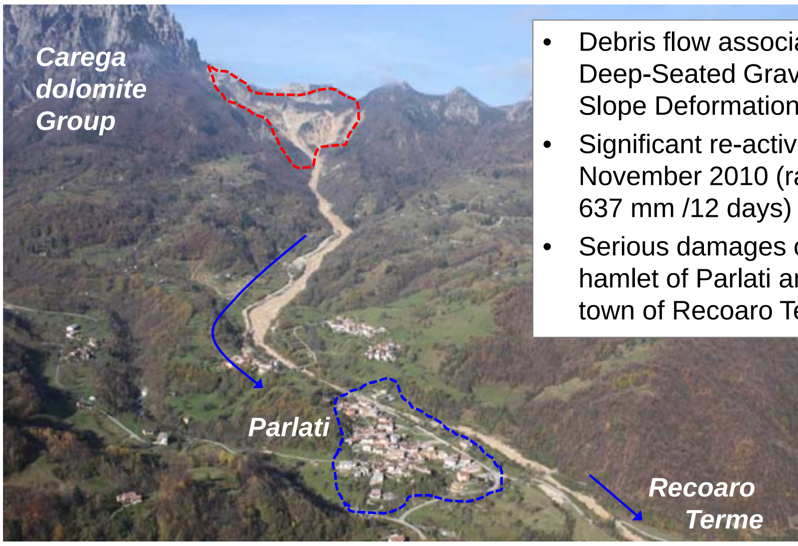


Rotolon torrent basin area (5 km²)

- Stretch: N-NW to S-SE
- Elevation range: 1950 m – 590 m
- Average basin slope: 55 %
- Main channel length: 4270 m
- Average main channel slope: 18%

Rotolon Web-based platform

Col Rotolon - Recoaro Terme, Vicenza (Eastern Italian Alps)



- Debris flow associated to a Deep-Seated Gravitational Slope Deformation
- Significant re-activation on November 2010 (rainfall of 637 mm /12 days)
- Serious damages on the hamlet of Parlati and the town of Recoaro Terme

A Web-based platform for automatic and continuous landslide monitoring 3

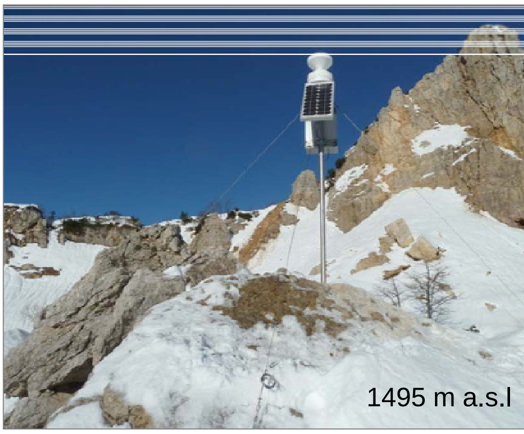
Rotolon Web-based platform

Col Rotolon - Recoaro Terme, Vicenza (Eastern Italian Alps)

A Web-based platform for automatic and continuous landslide monitoring 4

Rotolon Web-based platform

Monitoring System and implementation of an EWS



- **2 rain gauges**
- 1 video camera
- 6 wire extensometers
- Automated Total Station (ATS) with 42 benchmarks
- 3 pendulum section
- 1 trip wire
- Sirens system and thresholds
- Master Station
- Modem ADSL and WiFi
- Radio link

A Web-based platform for automatic and continuous landslide monitoring 5

Rotolon Web-based platform

Monitoring System and implementation of an EWS

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A Web-based platform for automatic and continuous landslide monitoring 6

Rotolon Web-based platform

Monitoring System and implementation of an EWS

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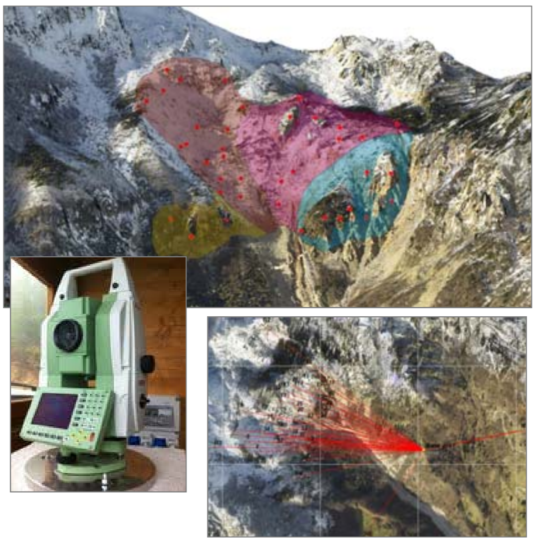
A Web-based platform for automatic and continuous landslide monitoring 7

Rotolon Web-based platform

Monitoring System and implementation of an EWS



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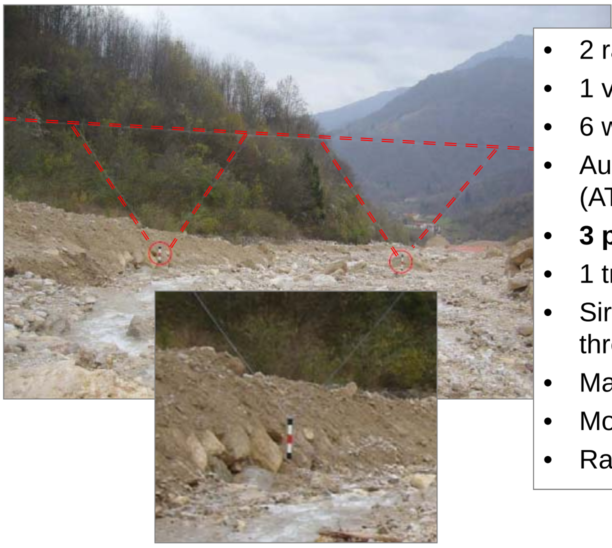
A Web-based platform for automatic and continuous landslide monitoring 8

Rotolon Web-based platform

Monitoring System and implementation of an EWS



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A Web-based platform for automatic and continuous landslide monitoring 9

Rotolon Web-based platform

Monitoring System and implementation of an EWS

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A Web-based platform for automatic and continuous landslide monitoring 10

Rotolon Web-based platform

Monitoring System and implementation of an EWS

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A Web-based platform for automatic and continuous landslide monitoring 11

Rotolon Web-based platform

Monitoring System and implementation of an EWS

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- 3 pendulum section
- 1 trip wire
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- **Master Station**
- Modem ADSL and WiFi
- Radio link

A Web-based platform for automatic and continuous landslide monitoring 12

Rotolon Web-based platform

Why a Web-based platform for disaster management?

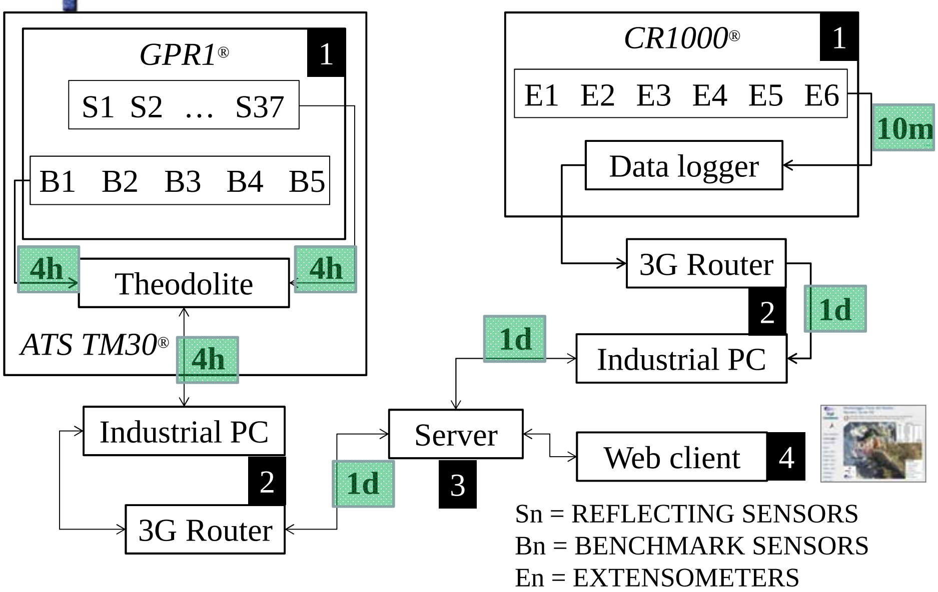
- Collecting data, connecting users and sharing information
- Reduce cost of maintenance and simplify the monitoring network
- Aggregate all monitoring system measures on a common DBMS
- Provide a cost-benefit solution for stakeholders actions

Features and rules of a Web-based platform:

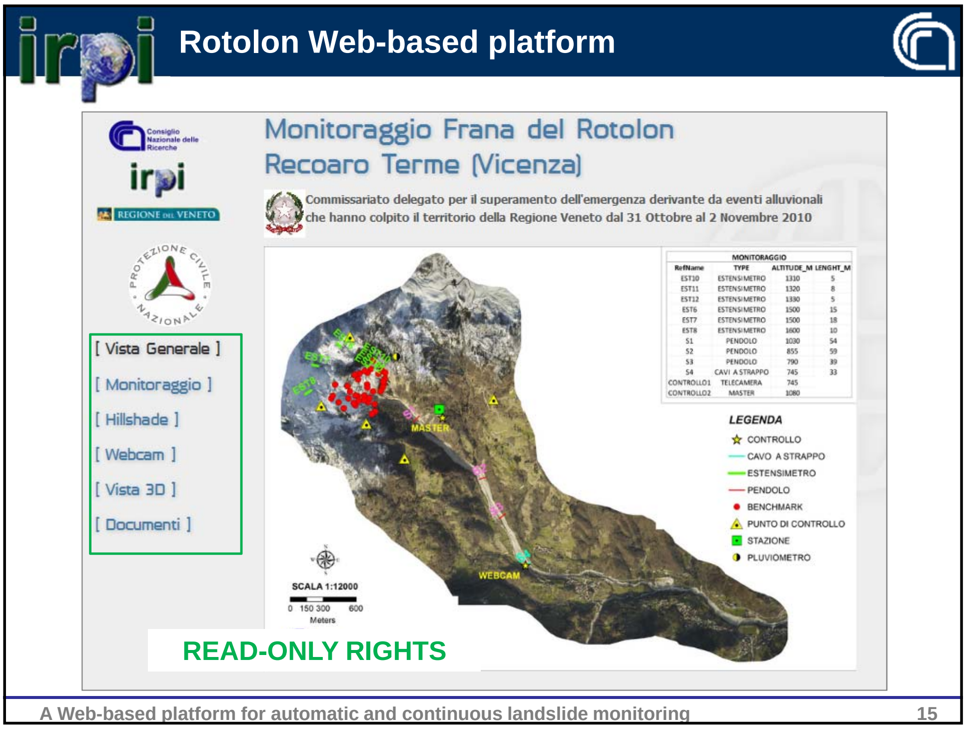
- Multi-user access and maintenance (admin rights)
- End-user support on prevention and decision-making (read-only rights)
- Common platform for a user-friendly interface (report and graphic layout)
- Integration and time-based synchronization of all measurements
- Near-real time and easy-to-use facility
- Automatic communication (Skype, email, SMS) by threshold criteria
- Apple SDK integration
- Remote user-interface for technical maintenance

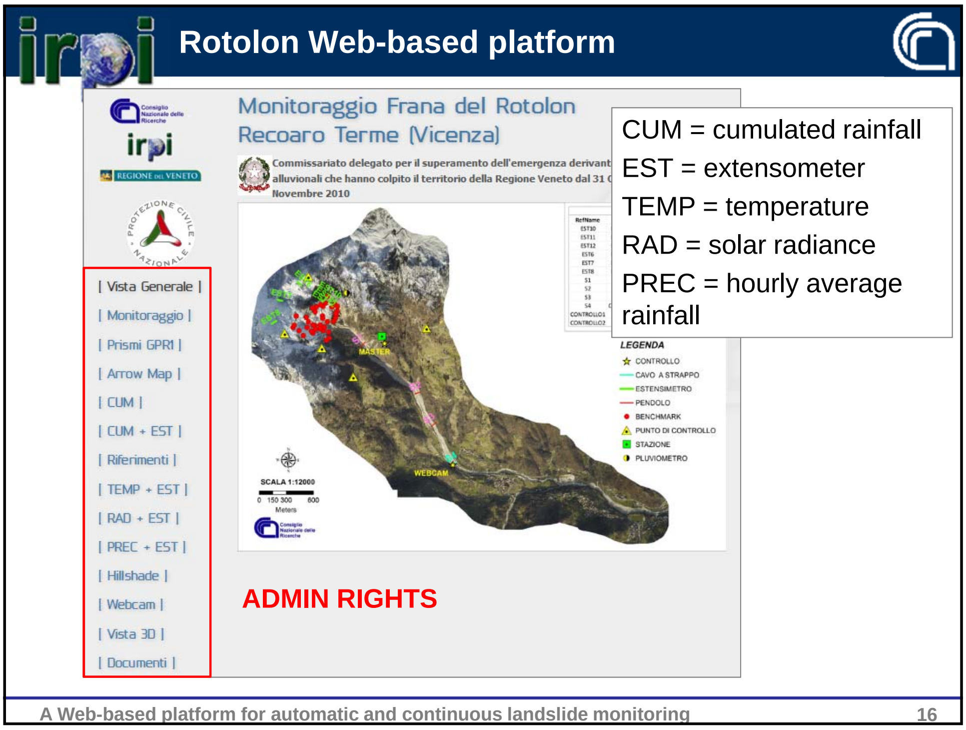
A Web-based platform for automatic and continuous landslide monitoring 13

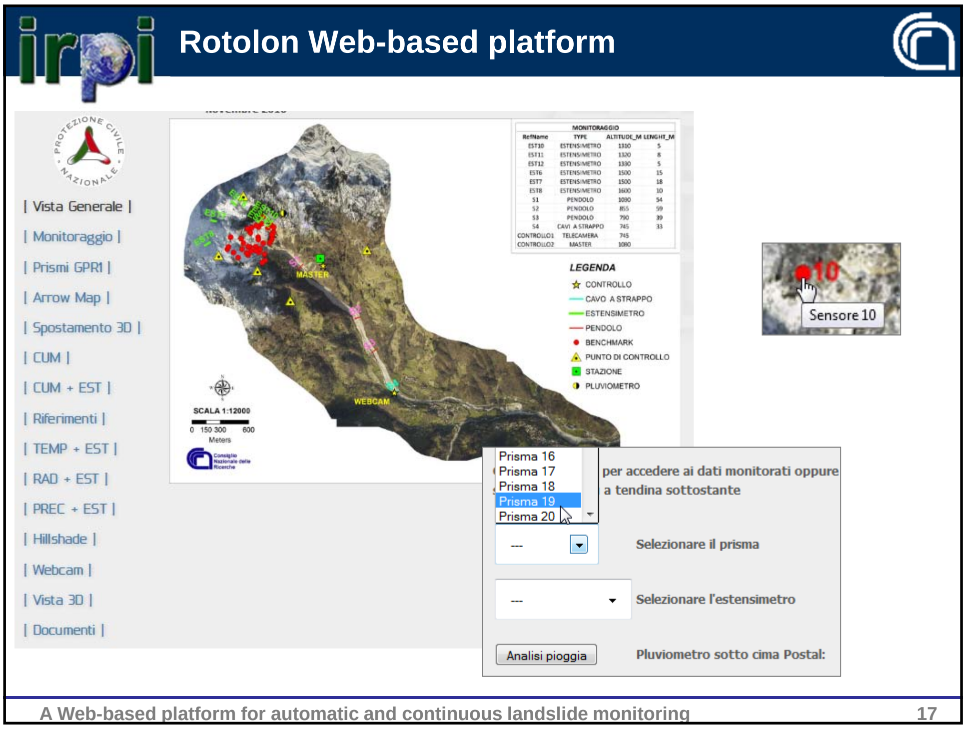
Rotolon Web-based platform

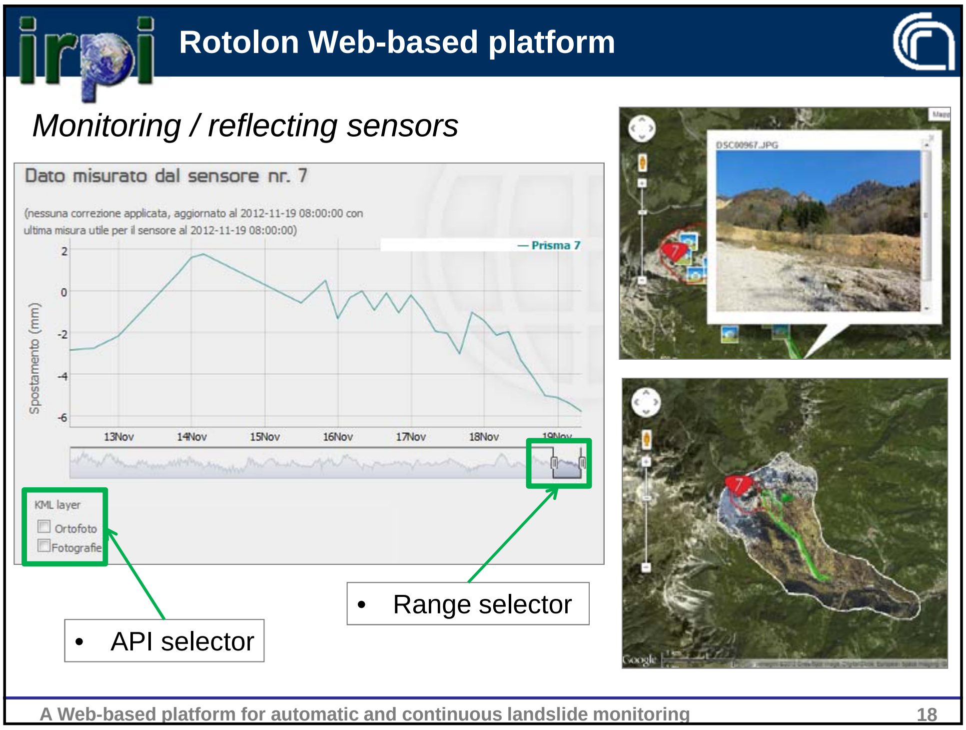


A Web-based platform for automatic and continuous landslide monitoring 14


Rotolon Web-based platform
Monitoraggio Frana del Rotolon
Recoaro Terme (Vicenza)
Commissariato delegato per il superamento dell'emergenza derivante da eventi alluvionali che hanno colpito il territorio della Regione Veneto dal 31 Ottobre al 2 Novembre 2010
[Vista Generale]
[Monitoraggio]
[Hillshade]
[Webcam]
[Vista 3D]
[Documenti]
LEGENDA
CONTROLLO
CAVO A STRAPPO
ESTENSIMETRO
PENDOLO
BENCHMARK
PUNTO DI CONTROLLO
STAZIONE
PLUVIOMETRO
MASTER
WEBCAM
SCALA 1:12000
READ-ONLY RIGHTS
A Web-based platform for automatic and continuous landslide monitoring
15


Rotolon Web-based platform
Monitoraggio Frana del Rotolon
Recoaro Terme (Vicenza)
CUM = cumulated rainfall
EST = extensometer
TEMP = temperature
RAD = solar radiance
PREC = hourly average rainfall
| Vista Generale |
| Monitoraggio |
| Prismi GPRI |
| Arrow Map |
| CUM |
| CUM + EST |
| Riferimenti |
| TEMP + EST |
| RAD + EST |
| PREC + EST |
| Hillshade |
| Webcam |
| Vista 3D |
| Documenti |
ADMIN RIGHTS
A Web-based platform for automatic and continuous landslide monitoring
16


Rotolon Web-based platform
| Vista Generale |
| Monitoraggio |
| Prismi GPR1 |
| Arrow Map |
| Spostamento 3D |
| CUM |
| CUM + EST |
| Riferimenti |
| TEMP + EST |
| RAD + EST |
| PREC + EST |
| Hillshade |
| Webcam |
| Vista 3D |
| Documenti |
MASTER
WEBCAM
SCALA 1:12000
LEGENDA
CONTROLLO
CAVO A STRAPPO
ESTENSIMETRO
PENDOLO
BENCHMARK
PUNTO DI CONTROLLO
STAZIONE
PLUVIOMETRO
Sensore 10
Prisma 16
Prisma 17
Prisma 18
Prisma 19
Prisma 20
per accedere ai dati monitorati oppure a tendina sottostante
Selezionare il prisma
Selezionare l'estensimetro
Analisi pioggia
Pluviometro sotto cima Postal:
A Web-based platform for automatic and continuous landslide monitoring
17


Rotolon Web-based platform
Monitoring / reflecting sensors
Dato misurato dal sensore nr. 7
(nessuna correzione applicata, aggiornato al 2012-11-19 08:00:00 con ultima misura utile per il sensore al 2012-11-19 08:00:00)
Prisma 7
Spostamento (mm)
13Nov
14Nov
15Nov
16Nov
17Nov
18Nov
19Nov
KML layer
Ortofoto
Fotografie
DSC00967.JPG
Range selector
API selector
A Web-based platform for automatic and continuous landslide monitoring
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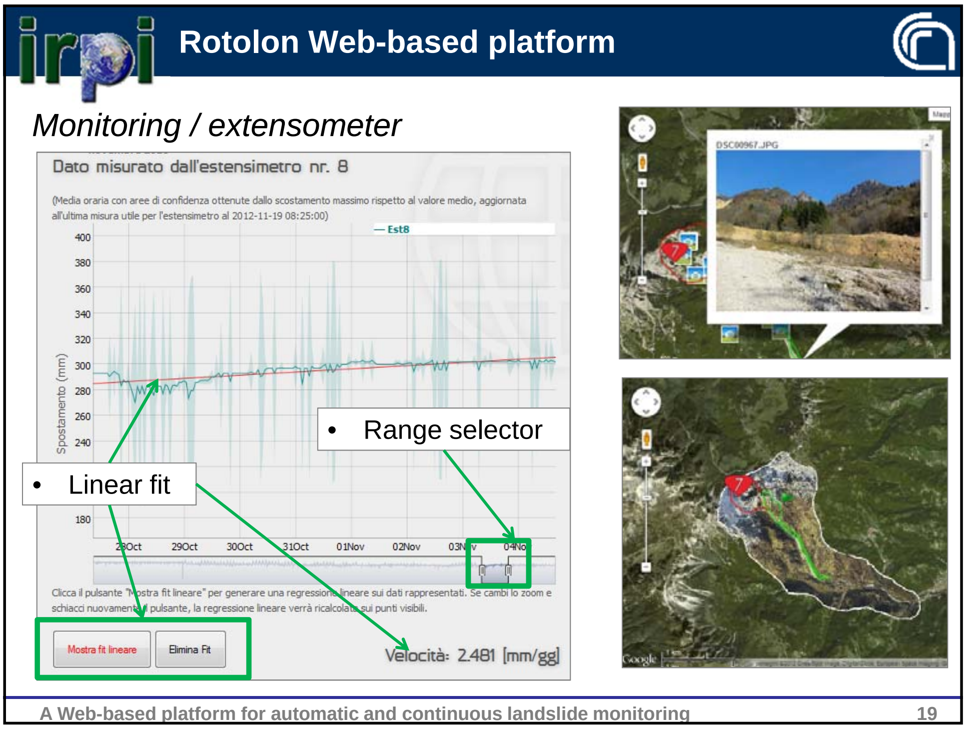
Rotolon Web-based platform
Monitoring / extensometer
Dato misurato dall'estensimetro nr. 8
(Media oraria con aree di confidenza ottenute dallo scostamento massimo rispetto al valore medio, aggiornata all'ultima misura utile per l'estensimetro al 2012-11-19 08:25:00)
Est8
Spostamento (mm)
28Oct 29Oct 30Oct 31Oct 01Nov 02Nov 03Nov 04Nov
Range selector
Linear fit
Clicca il pulsante "Mostra fit lineare" per generare una regressione lineare sui dati rappresentati. Se cambi lo zoom e schiacci nuovamente il pulsante, la regressione lineare verrà ricalcolata sui punti visibili.
Mostra fit lineare
Elimina Fit
Velocità: 2.481 [mm/gg]
A Web-based platform for automatic and continuous landslide monitoring
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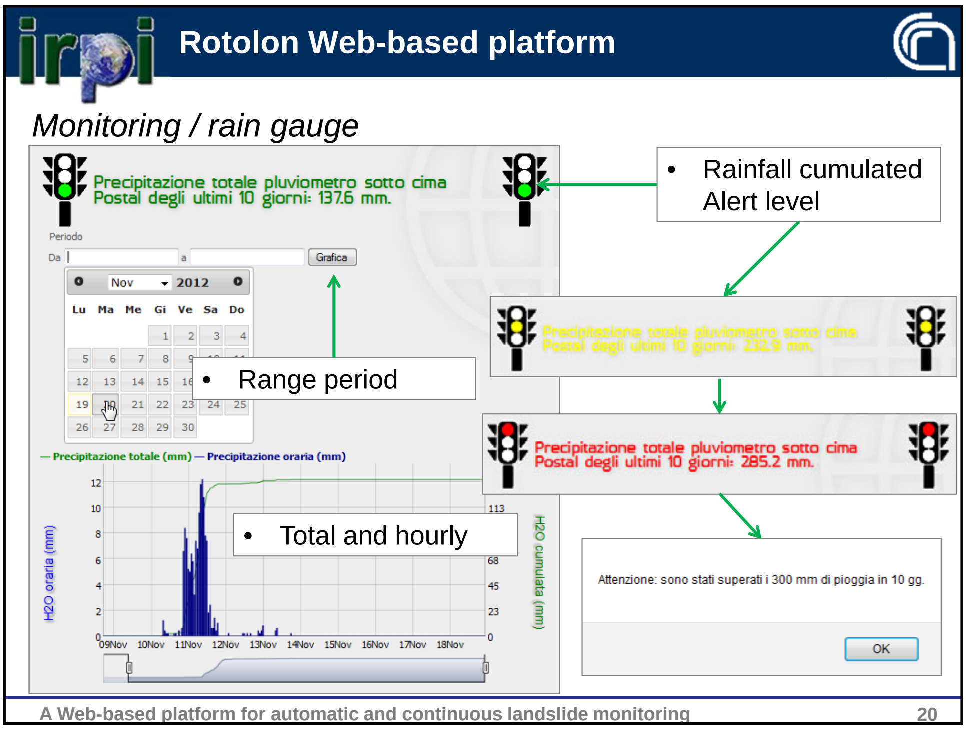
Rotolon Web-based platform
Monitoring / rain gauge
Precipitazione totale pluviometro sotto cima Postal degli ultimi 10 giorni: 137.6 mm.
Periodo
Da
a
Grafica
Nov 2012
Lu Ma Me Gi Ve Sa Do
Rainfall cumulated
Alert level
Range period
Precipitazione totale pluviometro sotto cima Postal degli ultimi 10 giorni: 232.9 mm.
Precipitazione totale pluviometro sotto cima Postal degli ultimi 10 giorni: 285.2 mm.
Precipitazione totale (mm) — Precipitazione oraria (mm)
H2O oraria (mm)
H2O cumulata (mm)
Total and hourly
09Nov 10Nov 11Nov 12Nov 13Nov 14Nov 15Nov 16Nov 17Nov 18Nov
Attenzione: sono stati superati i 300 mm di pioggia in 10 gg.
OK
A Web-based platform for automatic and continuous landslide monitoring
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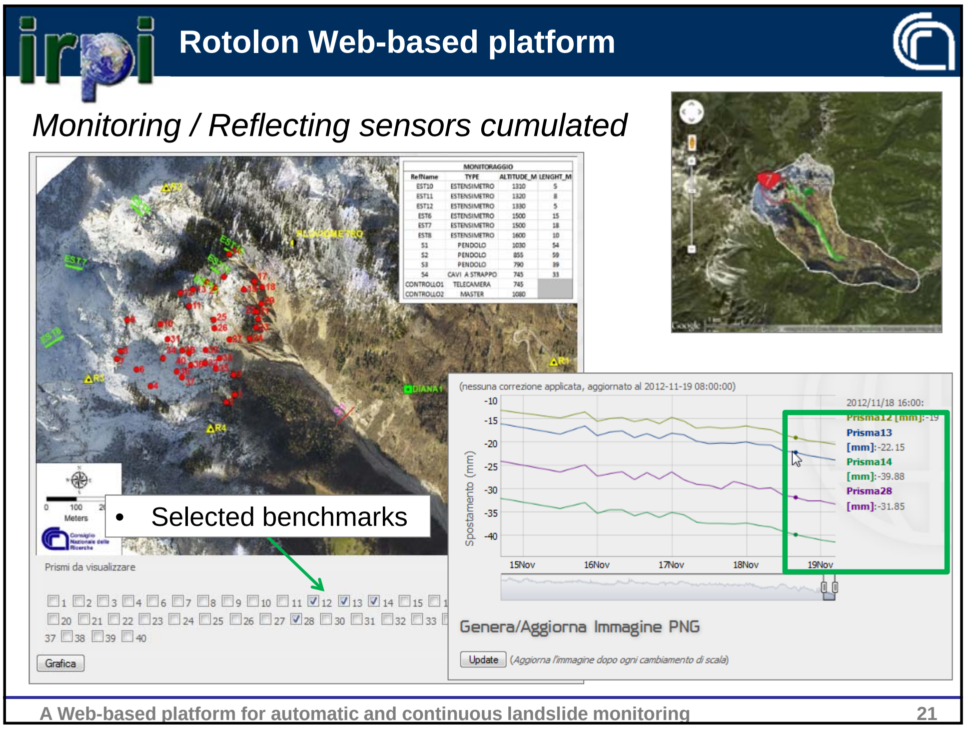
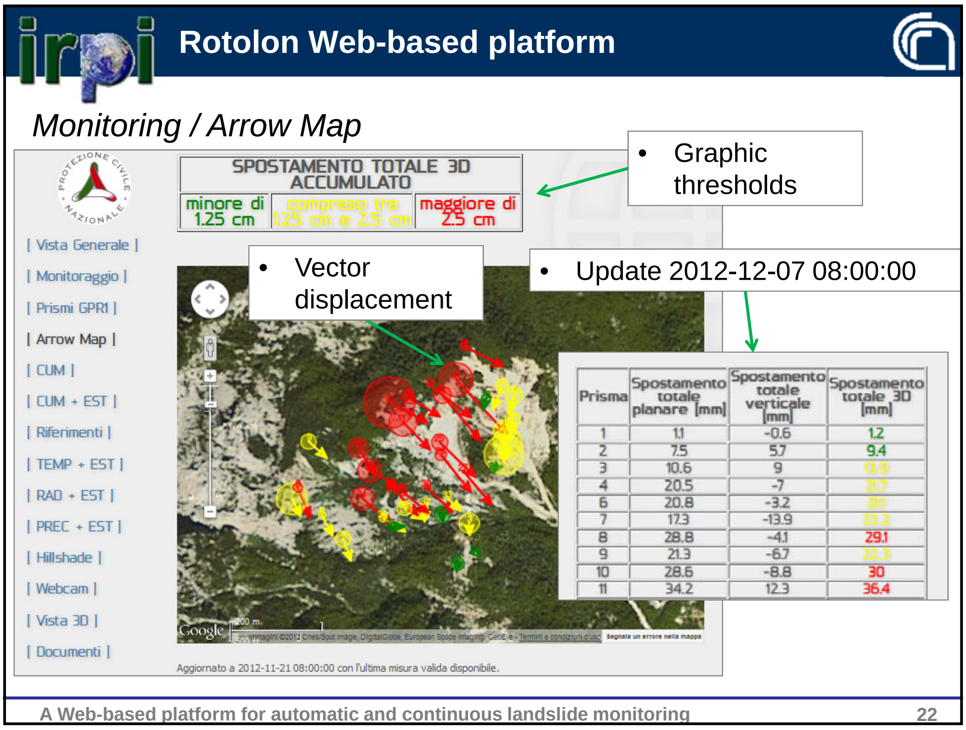


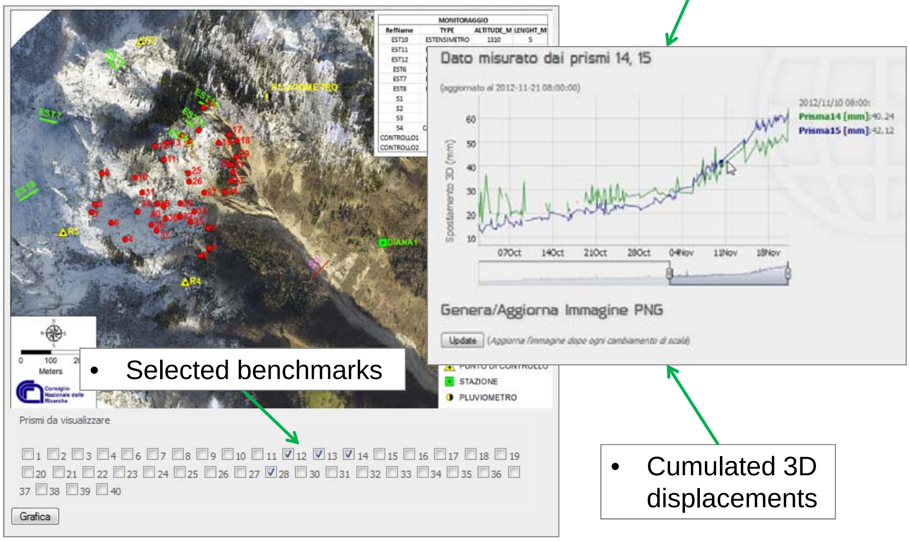


Prisma	Spostamento totale planare [mm]	Spostamento totale verticale [mm]	Spostamento totale 3D [mm]
1	1.1	-0.6	1.2
2	7.5	5.7	9.4
3	10.6	9	13.9
4	20.5	-7	21.7
6	20.8	-3.2	21.1
7	17.3	-13.9	22.2
8	28.8	-4.1	29.1
9	21.3	-6.7	22.3
10	28.6	-8.8	30
11	34.2	12.3	36.4

Rotolon Web-based platform

Monitoring / 3D displacement

- Update 2012-12-07 08:00:00



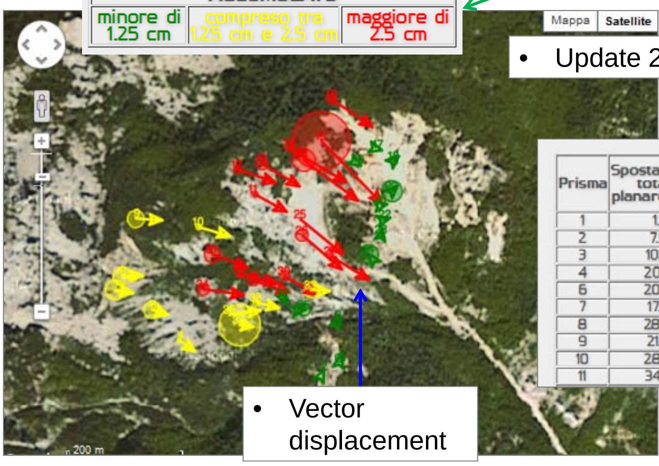
- Selected benchmarks
- Cumulated 3D displacements

Rotolon Web-based platform

Monitoring / Arrow Map

SPOSTAMENTO TOTALE 3D ACCUMULATO		
minore di 1.25 cm	compreso tra 1.25 cm e 2.5 cm	maggiore di 2.5 cm

- Graphic thresholds
- Update 2012-12-07 08:00:00

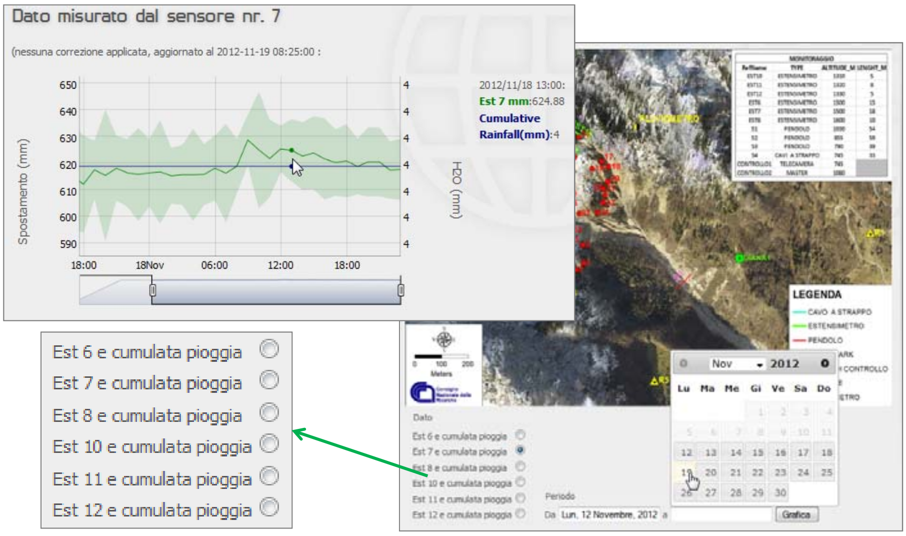


Prisma	Spostamento totale planare [mm]	Spostamento totale verticale [mm]	Spostamento totale 3D [mm]
1	1.1	-0.6	1.2
2	7.5	5.7	9.4
3	10.6	9	13.9
4	20.5	-7	21.7
6	20.8	-3.2	21.1
7	17.3	-13.9	22.2
8	28.8	-4.1	29.1
9	21.3	-6.7	22.3
10	28.6	-8.8	30
11	34.2	12.3	36.4

- Vector displacement

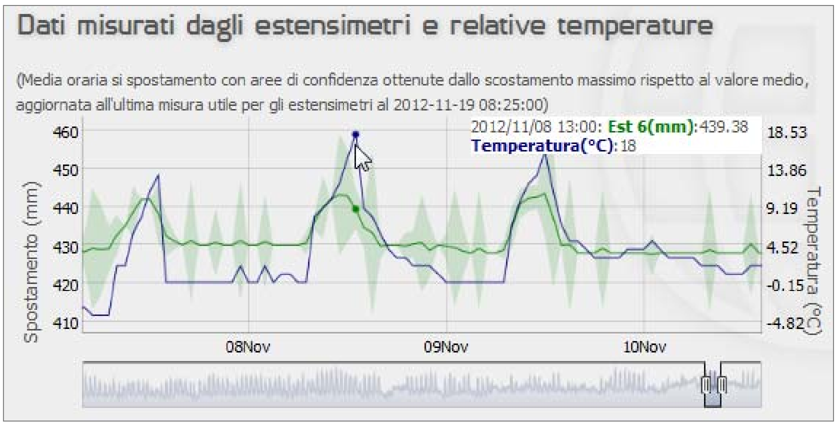
Rotolon Web-based platform

Monitoring / Cumulated rainfall + extensometers



Rotolon Web-based platform

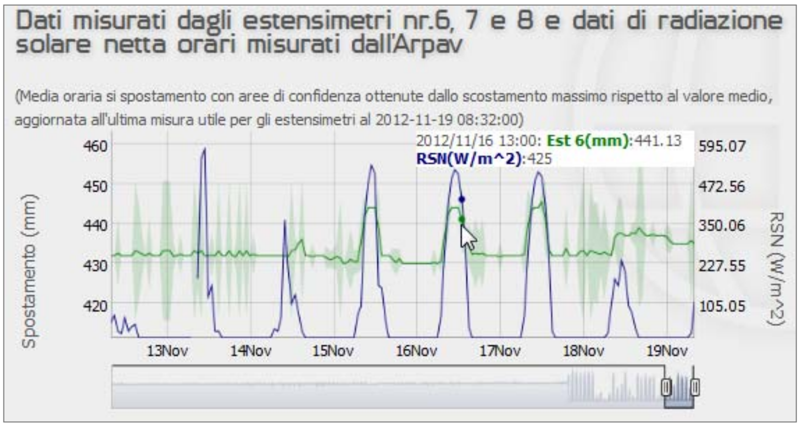
Monitoring / Temperature + Extensometers



- Applied for all extensometers

Rotolon Web-based platform

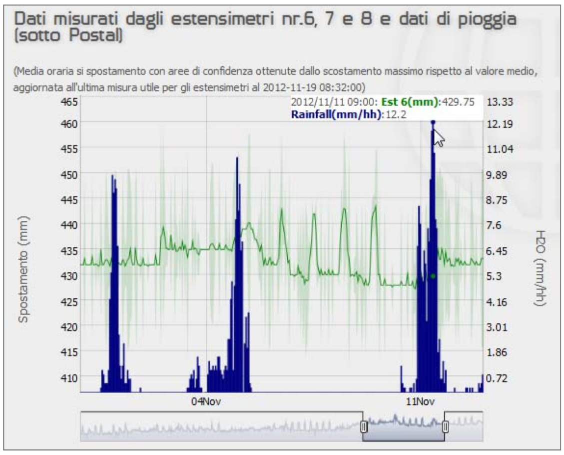
Monitoring / Radiance + Extensometers



- Applied for extensometers 6-7-8

Rotolon Web-based platform

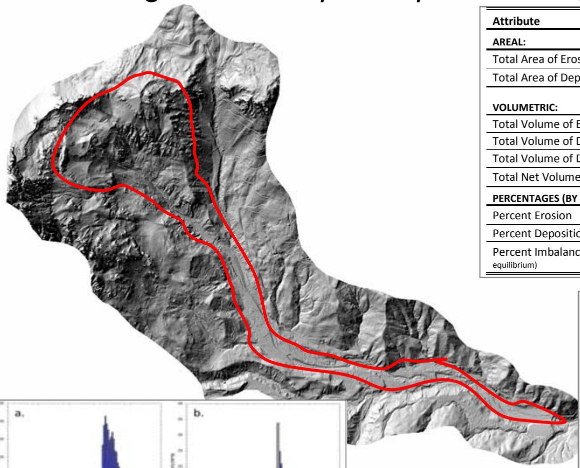
Monitoring / Rainfall + Extensometers



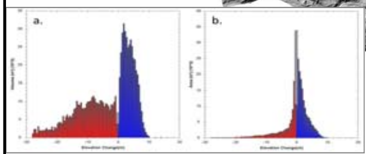
- Applied for extensometers 6-7-8

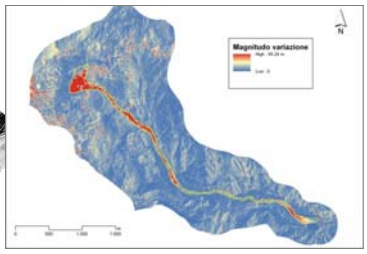
Rotolon Web-based platform

Monitoring / DTM 2m pre- & post-event (Oct 2010 – Nov 2010)



Attribute	Raw	Thresholded DoD Estimate:			
AREAL:					
Total Area of Erosion (m²)	114,900	91,732			
Total Area of Deposition (m²)	180,276	156,656			
VOLUMETRIC:				± Error Volume	% Error
Total Volume of Erosion (m³)	404,048	400,890	±	25,946	6%
Total Volume of Deposition (m³)	387,705	384,551	±	44,309	12%
Total Volume of Difference (m³)	791,752	785,441	±	70,255	9%
Total Net Volume Difference (m³)	-16,343	**-16,339**	**±**	**51,347**	314%
PERCENTAGES (BY VOLUME)					
Percent Erosion	51%	51%			
Percent Deposition	49%	49%			
Percent Imbalance (departure from equilibrium)	-1%	-1%			





Rotolon Web-based platform

Monitoring / Webcam

Consiglio Nazionale delle Ricerche

irpi

REGIONE DEL VENETO

PROTEZIONE CIVILE NAZIONALE

Monitoraggio Frana del Rotolon Recoaro Terme (VI)

Commissariato delegato per il superamento dell'emergenza derivante da eventi alluvionali che hanno colpito il territorio della Regione Veneto dal 31 Ottobre al 2 Novembre 2010

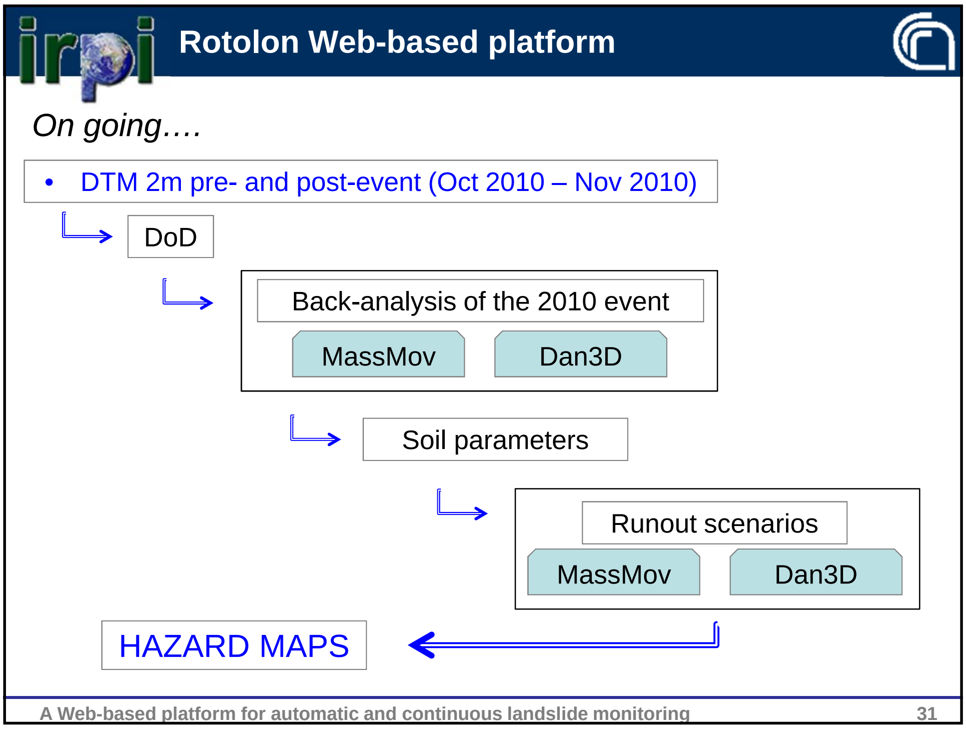
[Vista Generale]

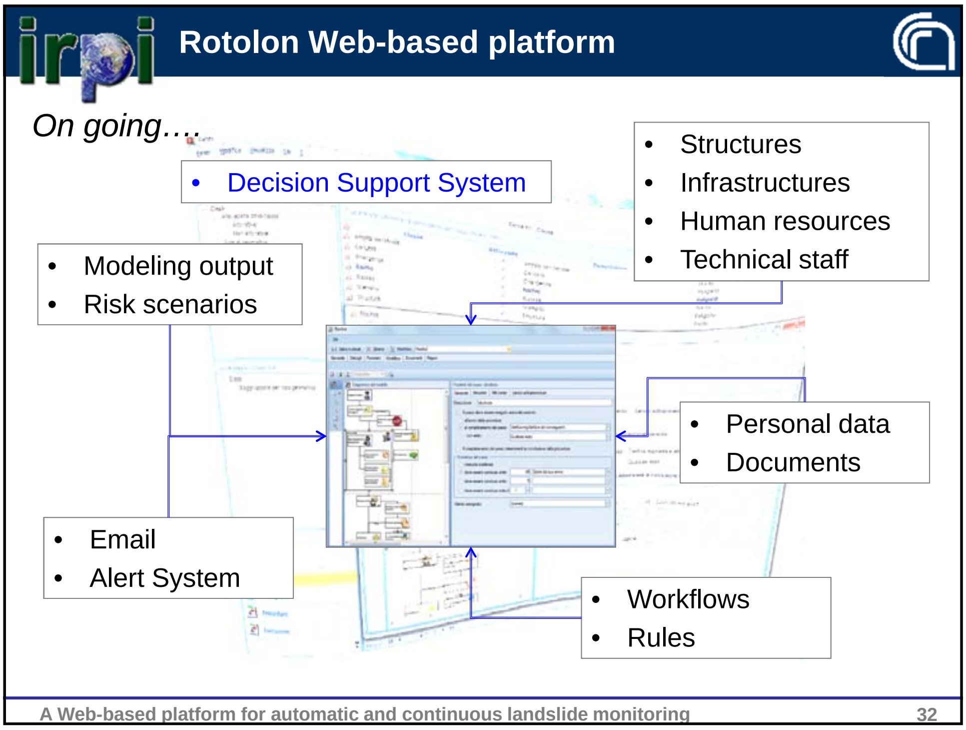
[Monitoraggio]

[Prismi GPR1]

[CUM]

[CUM + EST]


Rotolon Web-based platform
On going….
• DTM 2m pre- and post-event (Oct 2010 – Nov 2010)
DoD
Back-analysis of the 2010 event
MassMov
Dan3D
Soil parameters
Runout scenarios
MassMov
Dan3D
HAZARD MAPS
A Web-based platform for automatic and continuous landslide monitoring
31


Rotolon Web-based platform
On going….
• Decision Support System
• Structures
• Infrastructures
• Human resources
• Technical staff
• Modeling output
• Risk scenarios
• Personal data
• Documents
• Email
• Alert System
• Workflows
• Rules
A Web-based platform for automatic and continuous landslide monitoring
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3.4「日本における最近の大規模土砂災害」

（独）土木研究所

土砂管理研究グループ長

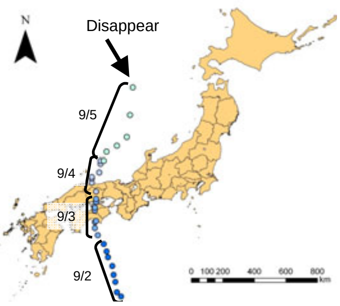
小山内　信智

Recent large-scale sediment-related disasters in Japan

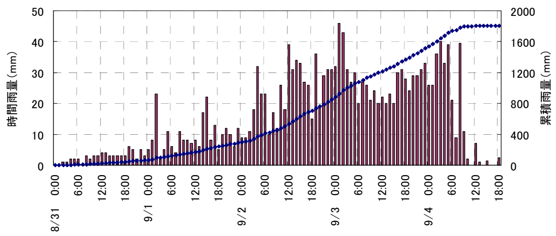
2012. Nov. 6

Public Works Research Institute
Nobutomo OSANAI

Rainfall by Typhoon No.12



Route of the typhoon No. 12's center at every three hours



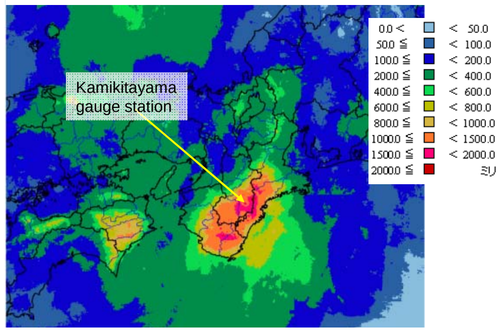
Rainfall data（Kamikitayama）

＜Typhoon No.12＞

As the typhoon moved slowly, it rained for a long period of time.

Kinki region, which was the right side of the typhoon route, was hit by record torrential rainfall .

The total rainfall at Kamikitayama rain gauge station exceeded 1800mm(which corresponds to 2/3 of annual average rainfall）



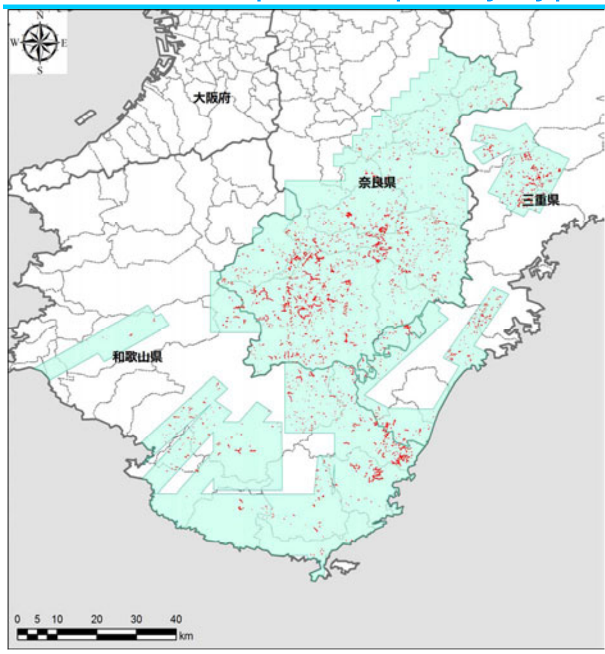
Total rainfall distribution estimated by analyzation

（Japan meteorological Agency(JMA) HP）


赤谷
清水（宇井）
流下方向


長殿発電所の被災
長殿発電所
流下方向

Collapsed slopes by Typhoon No.12



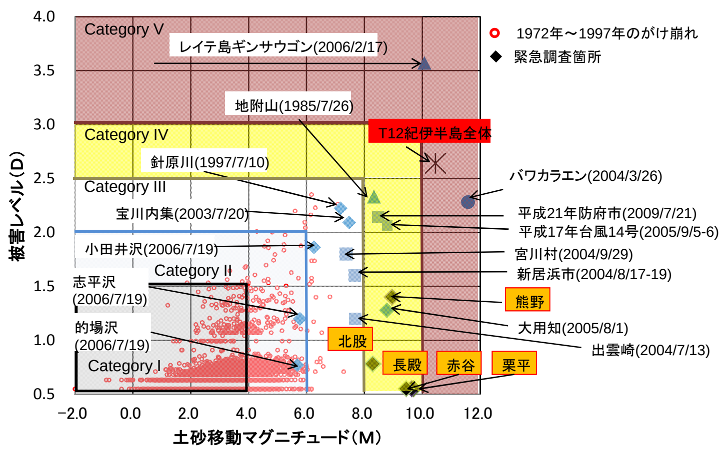
Collapse in the 3 prefecture

Number（N）	3,077
Area（A）	App. 10 millionm^2
Sediment volume（V）（Emergent survey）	App. 100 million m^3 (3,5million m^3)
Arial Photo Area（A_T）	App. 4800 million m^2
Collapse Ration（$A/A_T \times 100$）	App. 0.2%

Sediment Volume (Emergency Survey)

Nagatono	6.8 millionm^3
Kuridaira	13.9 milionm^3
Kitamata	1.2 millionm^3
Akadani	9 million m^3
Iya	4.1 million m^3
total	35 million m^3

5



土砂災害規模カテゴリー

X軸； $M=\log_{10}(V \times H)$

M:土砂移動マグニチュード、V:移動土塊の量(m^3)、H:土塊の移動比高差(m)

Y軸； $D=0.69 \times \log_{10}(x_1)+0.16 \times \log_{10}(x_2+x_3+x_4/3)+1.07$

D:被害レベル、x_1:死者・行方不明者数、x_2:負傷者数、x_3:全壊戸数、x_4:半壊・一部損壊戸数

（上記( )内が0の場合、x_1=0.3、$x_2+x_3+x_4/3$=0.1を代入する。被害が無い場合にはD=0.55となる。）

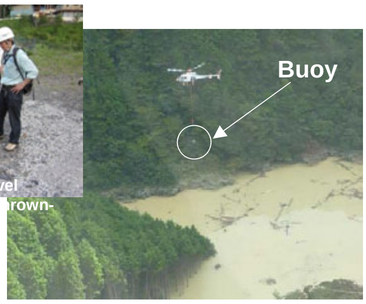
Natural dam countermeasure（Emergency survey）～water level observation～

Installing PWRI thrown-typed water level observation buoy/Watching water level

・Water level observation buoy (thrown-type) developed jointly by PWRI and a commercial company was operated immediately after the emergence of natural dam for emergency watching.

・It was developed so that it can watch the water level of natural dam in the place where there is no electric power or communication facility around, like mountainous area, and people cannot enter easily.

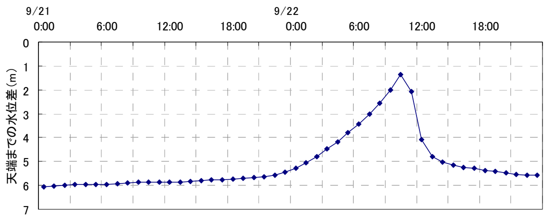
・Currently, they are under operation in the four natural dam sites. The observation data is provided in the Kinki Regional Development Bureau HP by real-time.



Throwing PWRI water level observation buoy

Ratio of delayed mails received within 5min. and maximum delay in minutes recorded in 4 natural dams from Sept. 16th to 22nd, 2011

	Sky view factor	Ratio of delayed mails received within 5 min.	Maximum delay in minutes
Akadani	63%	88%	26
Nagatono	64%	87%	27
Kuridaira	71%	95%	15
Iya	67%	96%	13

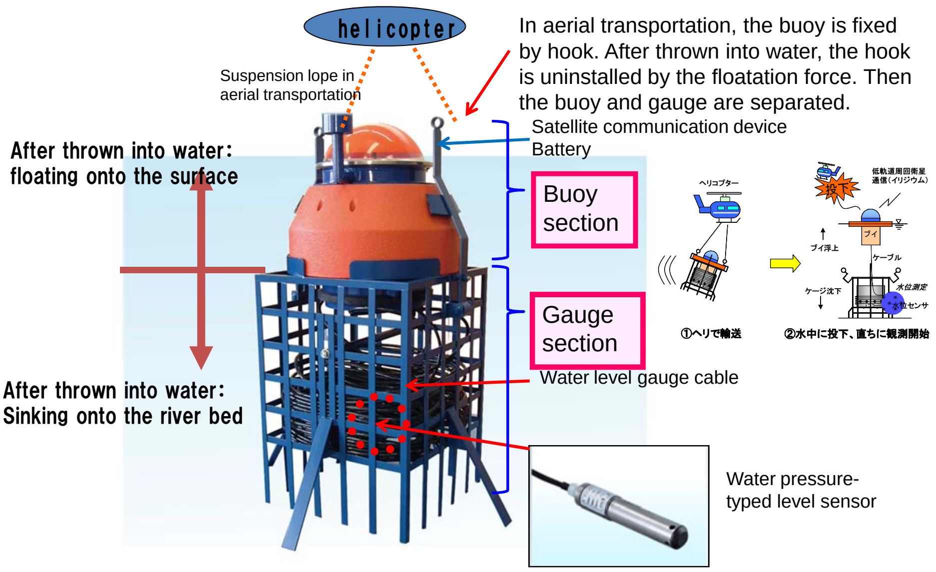


Water level observation result of natural dam（Akadani）

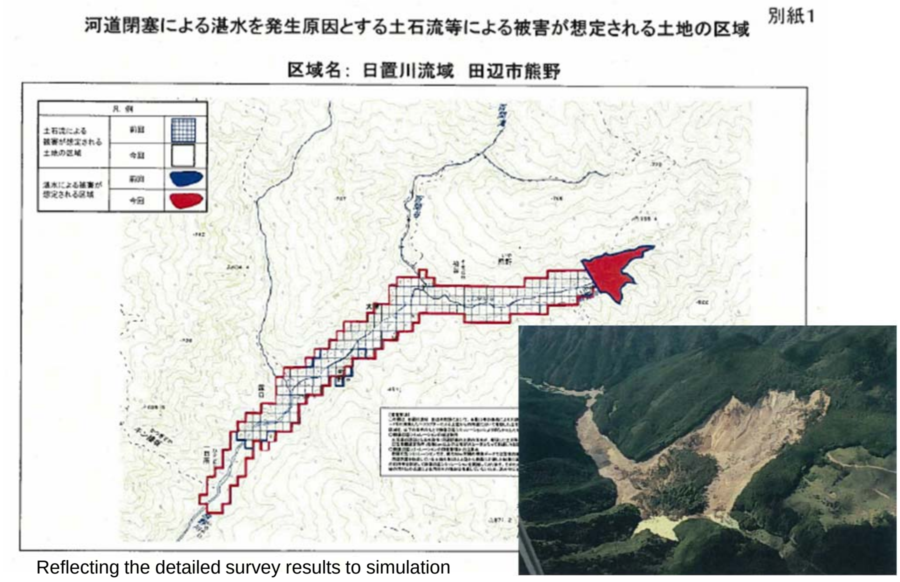
Natural dam countermeasure（emergency survey）～water level observation～

PWRI thrown-typed water level observation buoy

In aerial transportation, the buoy is fixed by hook. After thrown into water, the hook is uninstalled by the floatation force. Then the buoy and gauge are separated.



Natural dam countermeasure（emergency survey）～result～



Reflecting the detailed survey results to simulation

＜1st emergency survey＞　measuring promptly the shape of the natural dam by laser distance gauge

＜2nd emergency survey＞　Analyzing the detailed shape of natural dam by using aerial photos etc.

出水期に向け更なる安全度の向上を図る

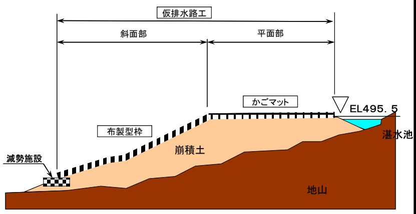
国土交通省

長殿地区

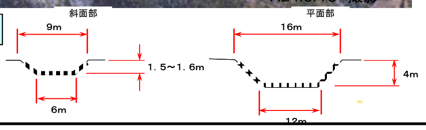
○長殿地区では、河道閉塞箇所で越流が起きると、堆積土砂の侵食が進み、土石流発生の危険性が高まります。
そこで、出水期に向け更なる安全度の向上を図るため、流水を安全に流すための仮排水路を平成24年度出水期までに完成させる予定です。

全景写真

縦断図



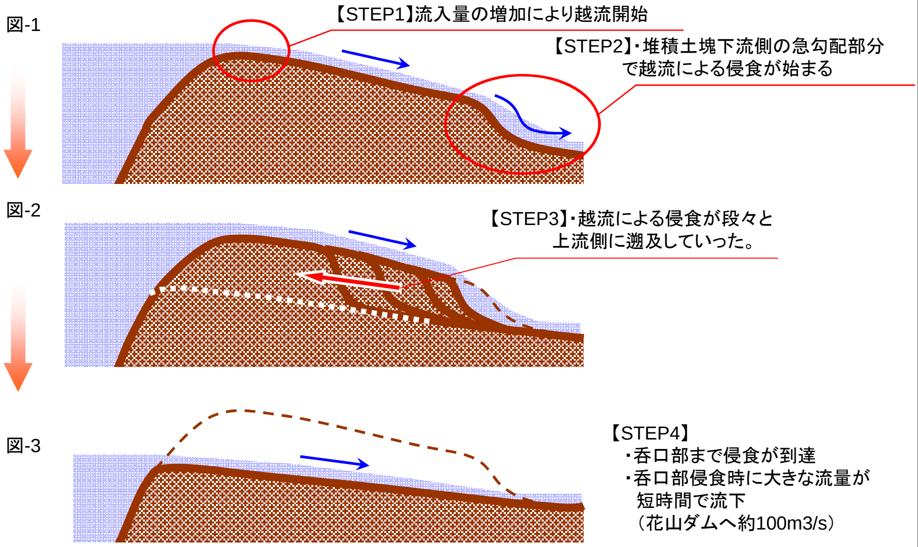
横断図



仮排水路工布製型枠施工予定箇所

侵食現象のメカニズム

根拠：現況を見ていた方へのヒアリングと変化状況を撮影した写真
及び現地調査等から次のように現象を整理できる



深層崩壊危険地域に関する調査（H22.8推定頻度マップ公表）

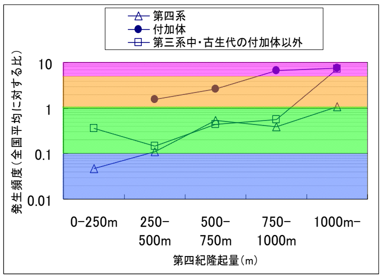
- 明治期以降の深層崩壊事例を約120事例収集。
- 事例から、第四紀**隆起量**と**地質**との関係を整理分析、統一的な指標で深層崩壊の危険性を検討し「深層崩壊推定頻度マップ」を作成し、公表（H22.8月）。

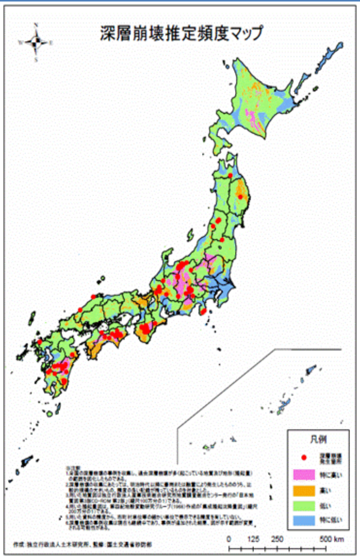
深層崩壊の発生事例の分析

- ●第四紀隆起量が大きいほど崩壊密度は大きい
- ●第四系の地域では、それ以外の地域に比べて崩壊密度が小さい
- ●付加体※では、付加体以外に比べて大きい

※プレートの沈み込みに伴い、陸側のプレートに付加された海底堆積物等からなる地質体

第四紀隆起量、地質と深層崩壊発生密度の関係



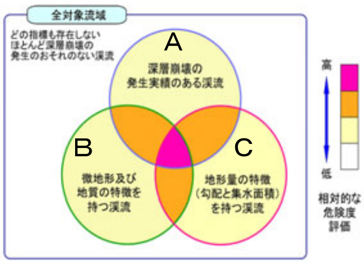


深層崩壊の発生に関連する評価指標の適用性検証

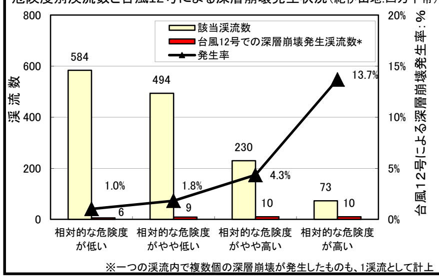
3つの要素を評価軸に「深層崩壊渓流レベル評価」を実施

<u>A発生実績</u>　<u>B地質構造及び微地形</u>　<u>C地形量</u>

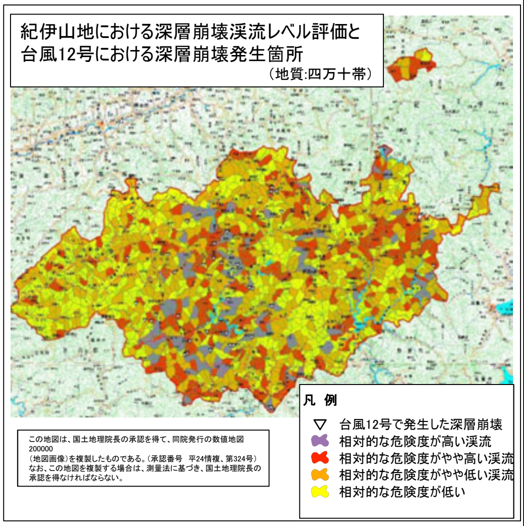
※②、③は、評価区域毎に深層崩壊跡地と関連性が高い微地形の種類、または地形量を選択

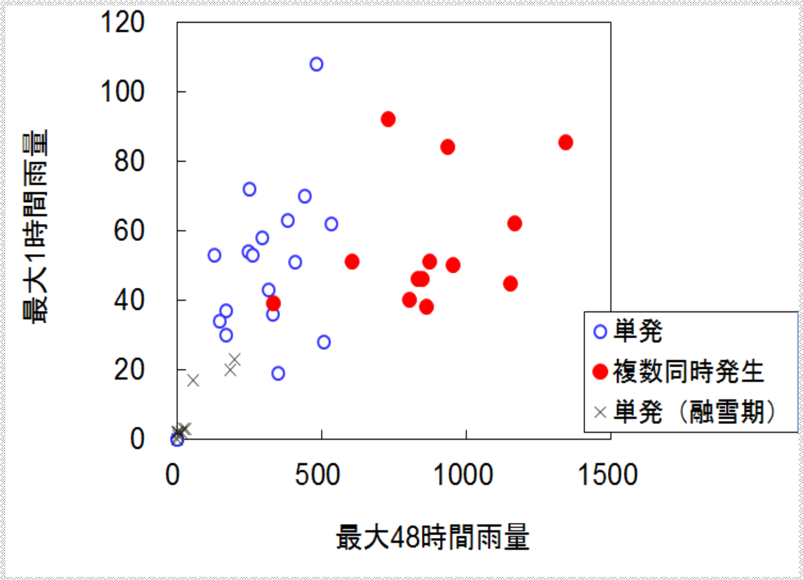


危険度別渓流数と台風12号による深層崩壊発生状況（紀伊山地:四万十帯）

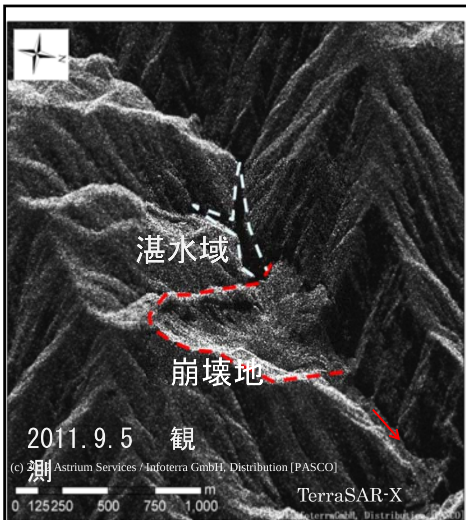


※一つの渓流内で複数個の深層崩壊が発生したものも、1渓流として計上





深層崩壊発生雨量



衛星SAR画像で発見された
2011年台風12号による
奈良県五條市赤谷の河道閉塞

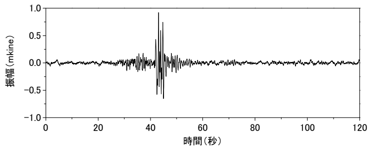
河道閉塞発見のためのチェックリスト

確認範囲	チェック項目	判断基準	評価
河道	湛水域	・湛水域がシャドウとして確認されるか ・上下流の澪筋幅と比べ不自然な幅となっているか ・ダム・取水堰等の人工構造物による湛水では無いか	
周辺地形	斜面勾配	・湛水域近傍に斜面は存在するか ・周辺斜面は発生する程度の急勾配斜面か　等	
崩壊地	滑落崖	・湛水域周辺に滑落崖が確認できるか ・滑落崖周辺に段差によるシャドウ・レイオーバーは確認できるか ・滑落崖の形状は斜面方向に対し円弧状となっているか　等	
	崩壊地内	・滑落崖の下に崩壊形状は確認されるか ・崩壊形状は斜面方向と整合しているか　等	
	崩積土砂（河道閉塞部）	・崩壊地内から下部にかけて崩積土は確認できるか ・崩積土の形状は舌状になっているか ・崩積土の到達範囲は地形形状と整合しているか ・河道閉塞部は谷を埋積する形状となっているか ・河道閉塞部の上流に湛水域は形成されているか ・崩積土上に倒木等の形状は確認されるか　等	
	崩壊規模	・河道閉塞が発生する程度の崩壊規模か	
	画像の肌理	・崩壊地内・崩積土等の表面は周辺林地と比べ平滑になっているか ・周辺斜面にみられる強度パターンと違うパターンとなっているか　等	
相対的位置関係	上下関係等	・滑落崖・崩積土・湛水域等の位置関係に不自然さはないか ・崩積土の到達範囲は地形と整合しているか　等	
	周辺地物	・周辺の道路網に分断はないか ・建物が埋積されているような状況は確認されるか	
総合評価			

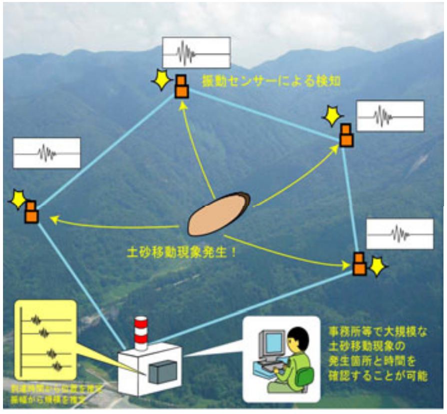
大規模土砂移動検知システム

概要

大規模な土砂移動現象が発する地盤振動は遠方まで伝播するため、高感度な振動計で地盤振動を観測することが可能



2005/9/6宮崎県西郷村で発生した大規模土砂移動と地盤振動観測データ（（独）防災科学技術研究所（Hi-net）の諸塚観測所）

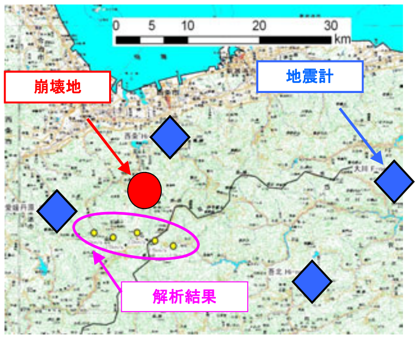


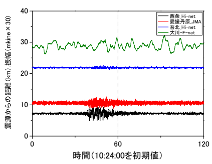
地震計ネットワークを用いて、大規模土砂移動現象の振動を観測し、震源特定解析によって、土砂移動現象の発生箇所と時間を予測するシステム
→大規模な土砂移動現象を広域に監視できる

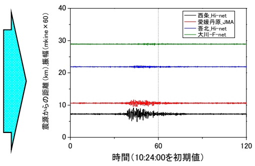
大規模土砂移動検知システム

既往事例

2012年9月4日愛媛県西条市東之川で発生した崩壊

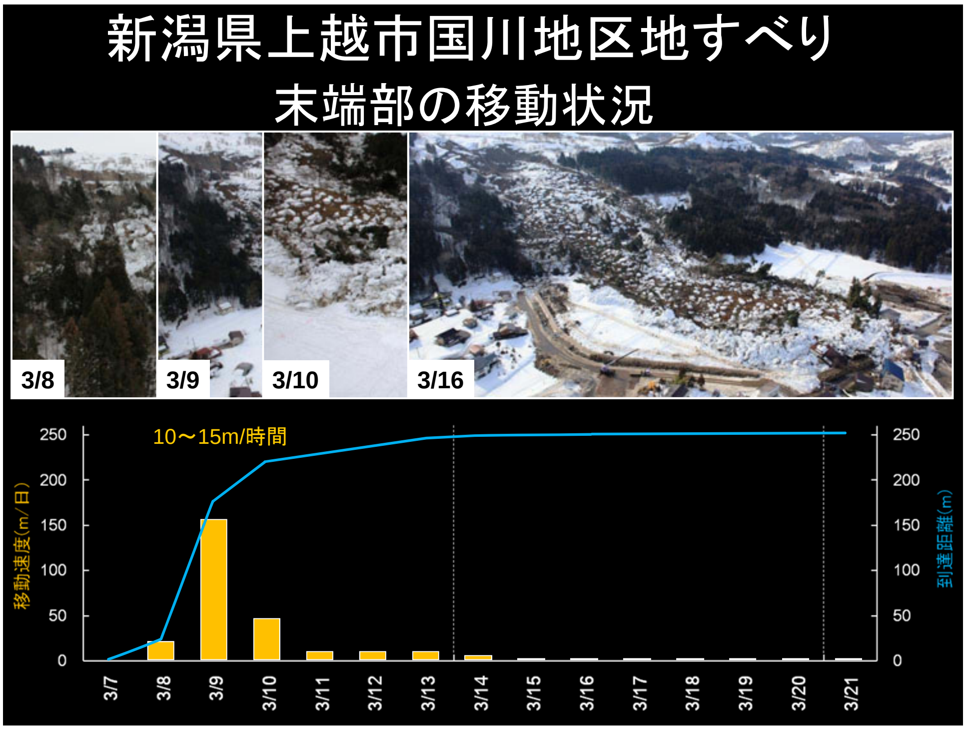




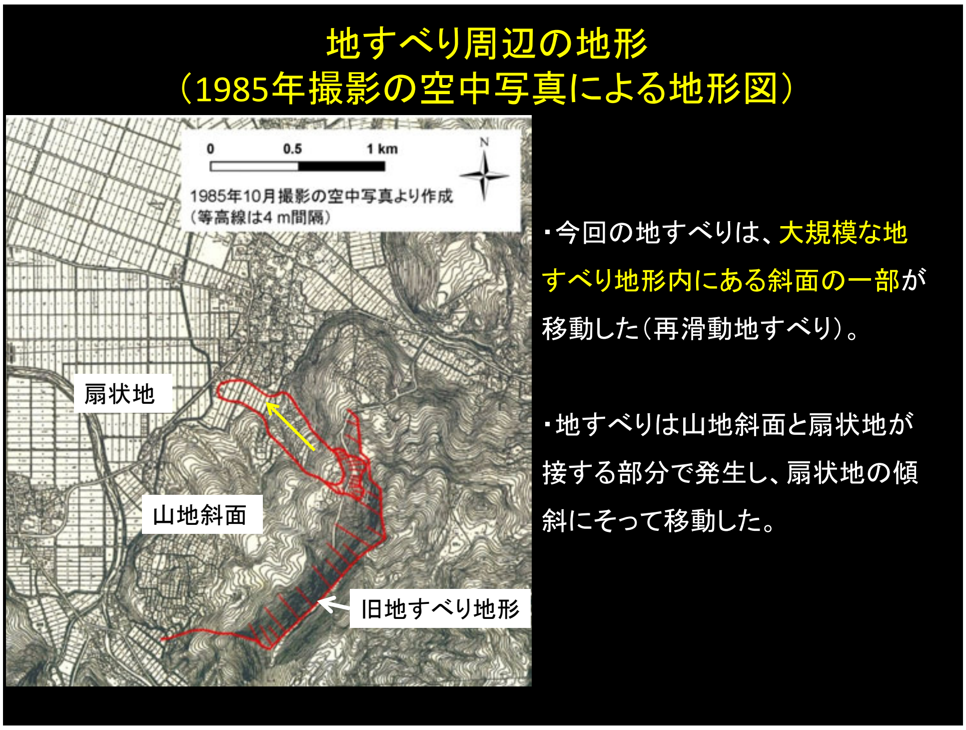


1-4HzのBand pass filterを施すことで、波形が抽出することができる（特に緑色の波形）

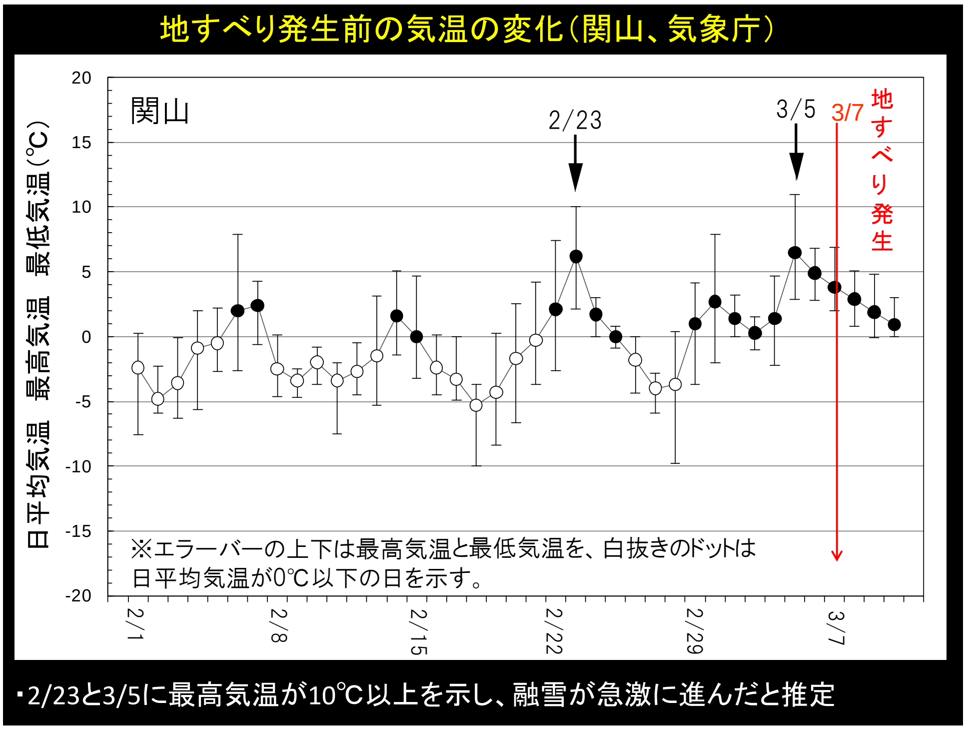
4箇所の地震計で土砂移動現象と考えられる振動を観測。そのうち1箇所は、フィルタ処理により、振動波形を抽出することができた。
地盤のせん断波速度を2km/secと仮定して解析した結果、誤差4.6kmで崩壊発生箇所を推定することができた。



新潟県上越市国川地区地すべり
末端部の移動状況
3/8
3/9
3/10
3/16
10～15m/時間
移動速度(m/日)
到達距離(m)
250
200
150
100
50
0
3/7
3/8
3/9
3/10
3/11
3/12
3/13
3/14
3/15
3/16
3/17
3/18
3/19
3/20
3/21

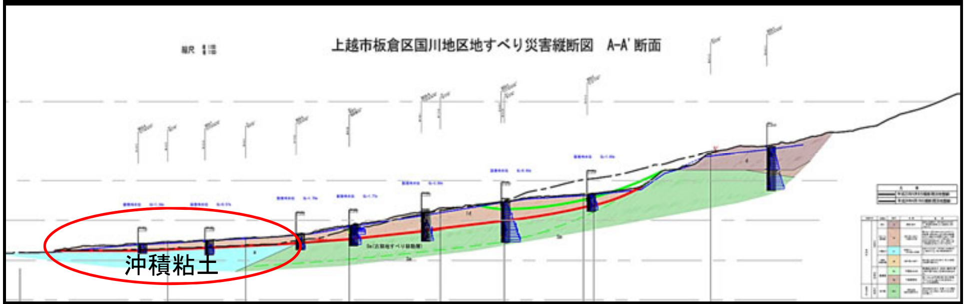


地すべり周辺の地形
（1985年撮影の空中写真による地形図）
0
0.5
1 km
N
1985年10月撮影の空中写真より作成
（等高線は4 m間隔）
扇状地
山地斜面
旧地すべり地形
・今回の地すべりは、大規模な地すべり地形内にある斜面の一部が移動した（再滑動地すべり）。
・地すべりは山地斜面と扇状地が接する部分で発生し、扇状地の傾斜にそって移動した。


地すべり発生前の気温の変化（関山、気象庁）
関山
日平均気温　最高気温　最低気温（℃）
20
15
10
5
0
-5
-10
-15
-20
2/23
3/5
3/7
地すべり発生
※エラーバーの上下は最高気温と最低気温を、白抜きのドットは日平均気温が0℃以下の日を示す。
2/1
2/8
2/15
2/22
2/29
3/7
・2/23と3/5に最高気温が10℃以上を示し、融雪が急激に進んだと推定


国川地すべりの移動メカニズム（考察）
積雪
A'
移動土塊
地すべり移動で押し出された雪の壁が軟弱な移動土塊を拘束する。
積雪に側方を拘束された移動土塊は，地形の最大傾斜方向へ移動する。
現時点での考察
水田上の雪が地すべりに押されて締まり、氷に近い堅い壁
①軟弱な土塊が横に広がるのを妨げた
②土塊からの自然排水を妨げた
移動土塊
雪塊
移動土塊の押し出し
ササの根・茎
水の流出
粘土層
雪塊で閉じ込められていた相当量の水が掘削時に流出

国川地すべりの移動メカニズム（考察）



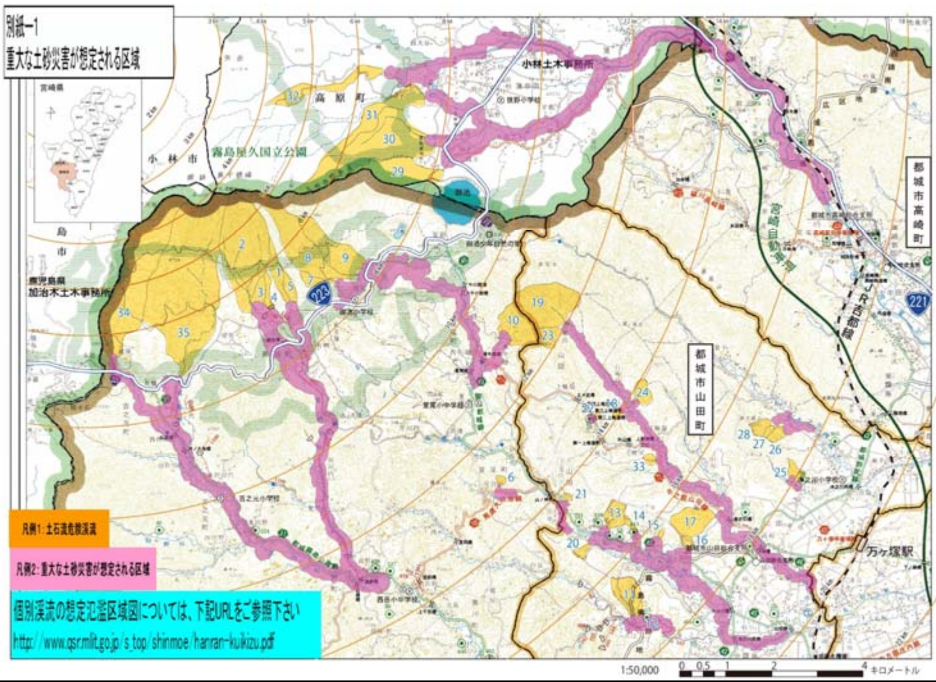
・地すべり斜面下部の移動層は、沖積粘土をすべり面（旧地表面である水田面下約１m）として移動したことが推定される。

・沖積粘土の土かぶり圧は小さく、せん断強さが非常に小さいことが推定される。

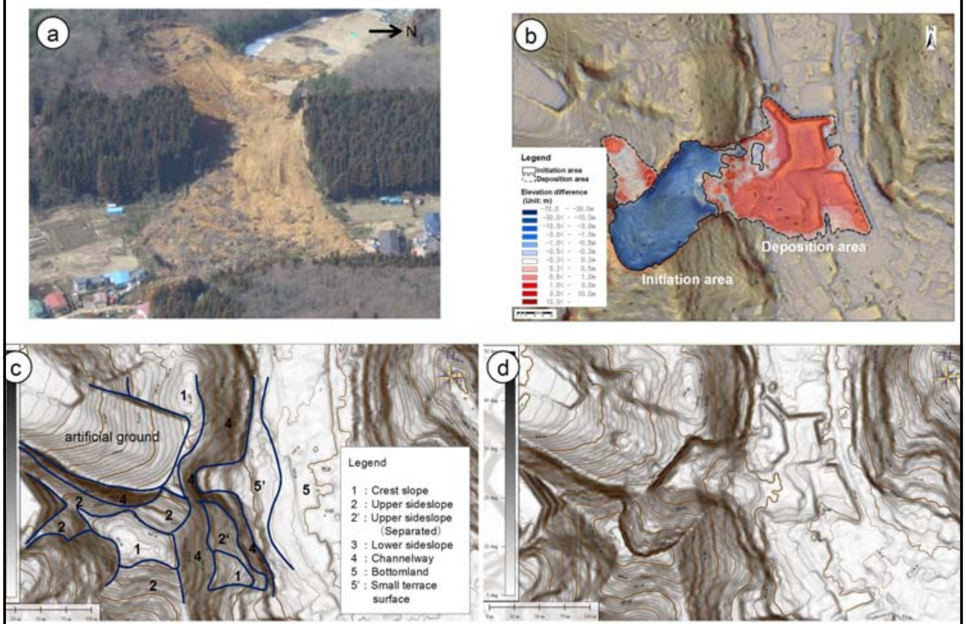
・地すべり斜面下部の勾配はほぼ平坦であるが、すべり面（水田面下約1m）のせん断強さが非常に小さく、滑動力を急減させるような抵抗部とならなかった。

⬇

流動しやすい状況が長時間続き、地すべり土塊が長時間動き続けた

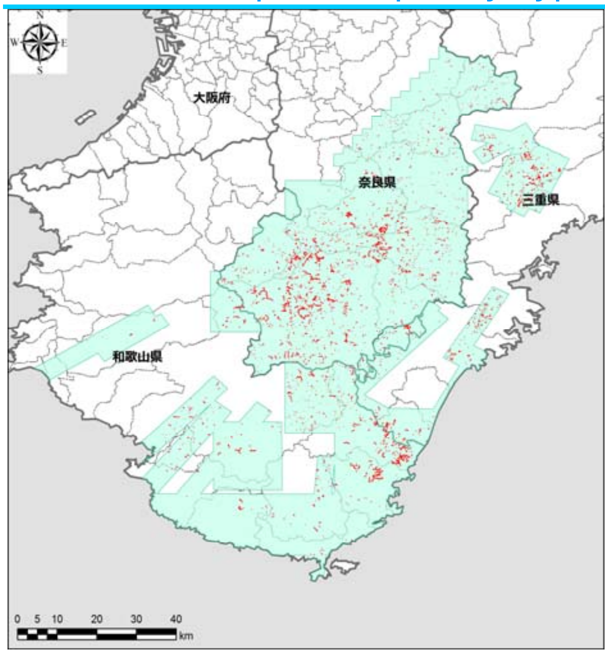


別紙ー1
重大な土砂災害が想定される区域
宮崎県
小林市
高原町
霧島屋久国立公園
小林土木事務所
鹿児島県
加治木土木事務所
都城市高崎町
都城市山田町
万ヶ塚駅
凡例1: 土石流危険渓流
凡例2: 重大な土砂災害が想定される区域
個別渓流の想定氾濫区域図については、下記URLをご参照下さい
http://www.qsr.mlit.go.jp/s_top/shinmoe/hanran-kuikizu.pdf
1:50,000
キロメートル


a
N
b
Legend
Initiation area
Deposition area
Elevation difference (Unit: m)
Deposition area
Initiation area
c
artificial ground
Legend
1 : Crest slope
2 : Upper sideslope
2' : Upper sideslope (Separated)
3 : Lower sideslope
4 : Channelway
5 : Bottomland
5' : Small terrace surface
d


ASIA AIR SURVEY CO.,LTD.

Collapsed slopes by Typhoon No.12



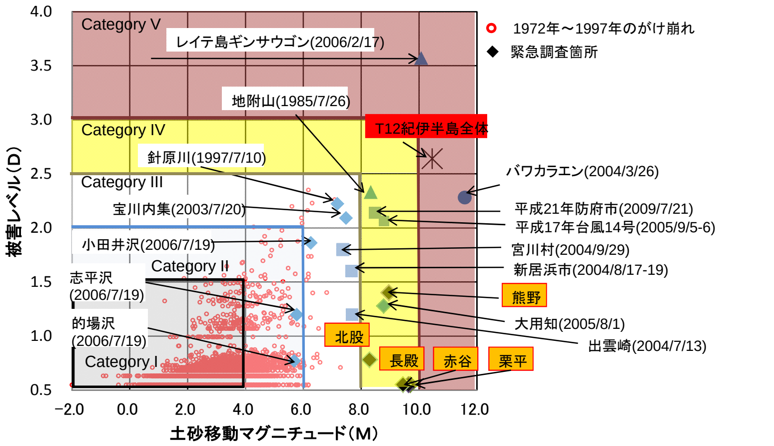
Collapse in the 3 prefecture

Number（N）	3,077
Area（A）	App. 10 millionm^2
Sediment volume（V）（Emergent survey）	App. 100 million m^3 (3,5million m^3)
Arial Photo Area（A_T）	App. 4800 million m^2
Collapse Ration（$A/A_T\times100$）	App. 0.2%

Sediment Volume (Emergency Survey)

Nagatono	6.8 millionm^3
Kuridaira	13.9 milionm^3
Kitamata	1.2 millionm^3
Akadani	9 million m^3
Iya	4.1 million m^3
total	35 million m^3

5



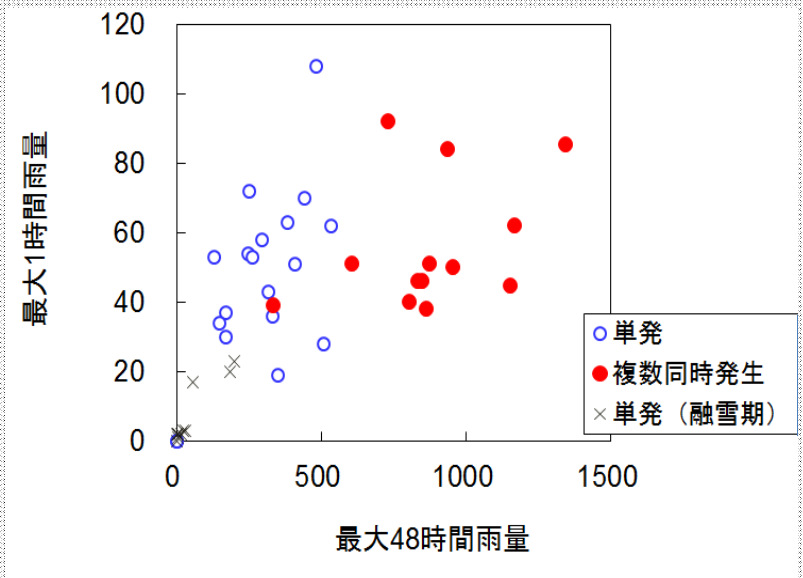
土砂災害規模カテゴリー

X軸； $M=\log_{10}(V\times H)$
M:土砂移動マグニチュード、V:移動土塊の量(m^3)、H:土塊の移動比高差(m)

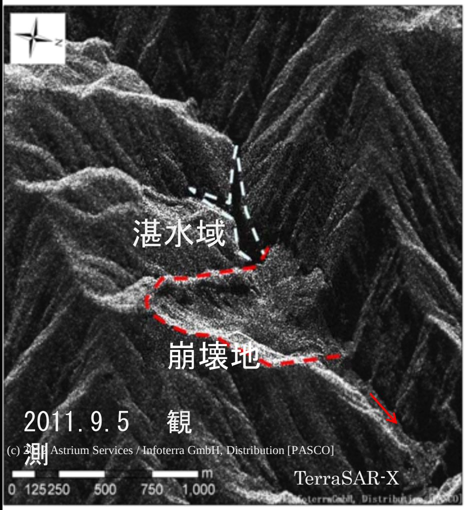
Y軸； $D=0.69\times\log_{10}(x_1)+0.16\times\log_{10}(x_2+x_3+x_4/3)+1.07$
D:被害レベル、x_1:死者・行方不明者数、x_2:負傷者数、x_3:全壊戸数、x_4:半壊・一部損壊戸数
（上記( )内が0の場合、$x_1=0.3$、$x_2+x_3+x_4/3=0.1$を代入する。被害が無い場合にはD=0.55となる。）


赤　谷

清水（宇井）



深層崩壊発生雨量



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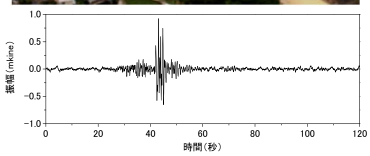
河道閉塞発見のためのチェックリスト

確認範囲	チェック項目	判断基準	評価
河道	湛水域	・湛水域がシャドウとして確認されるか ・上下流の澪筋幅と比べ不自然な幅となっているか ・ダム・取水堰等の人工構造物による湛水では無いか	
周辺地形	斜面勾配	・湛水域近傍に斜面は存在するか ・周辺斜面は発生する程度の急勾配斜面か　等	
崩壊地	滑落崖	・湛水域周辺に滑落崖が確認できるか ・滑落崖周辺に段差によるシャドウ・レイオーバーは確認できるか ・滑落崖の形状は斜面方向に対し円弧状となっているか　等	
	崩壊地内	・滑落崖の下に崩壊形状は確認されるか ・崩壊形状は斜面方向と整合しているか　等	
	崩積土砂（河道閉塞部）	・崩壊地内から下部にかけて崩積土は確認できるか ・崩積土の形状は舌状になっているか ・崩積土の到達範囲は地形形状と整合しているか ・河道閉塞部は谷を埋積する形状となっているか ・河道閉塞部の上流に湛水域は形成されているか ・崩積土上に倒木等の形状は確認されるか　等	
	崩壊規模	・河道閉塞が発生する程度の崩壊規模か	
	画像の肌理	・崩壊地内・崩積土等の表面は周辺林地と比べ平滑になっているか ・周辺斜面にみられる強度パターンと違うパターンとなっているか　等	
相対的位置関係	上下関係等	・滑落崖・崩積土・湛水域等の位置関係に不自然さはないか ・崩積土の到達範囲は地形と整合しているか　等	
	周辺地物	・周辺の道路網に分断はないか ・建物が埋積されているような状況は確認されるか	
総合評価			

大規模土砂移動検知システム

概要

大規模な土砂移動現象が発する地盤振動は遠方まで伝播するため、高感度な振動計で地盤振動を観測することが可能



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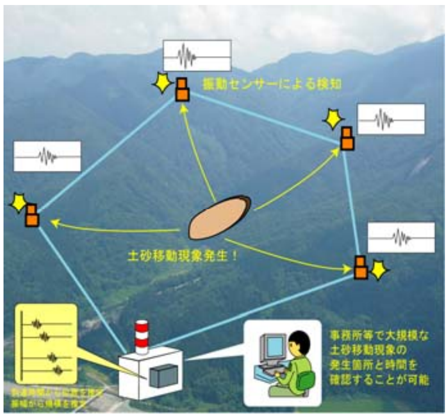
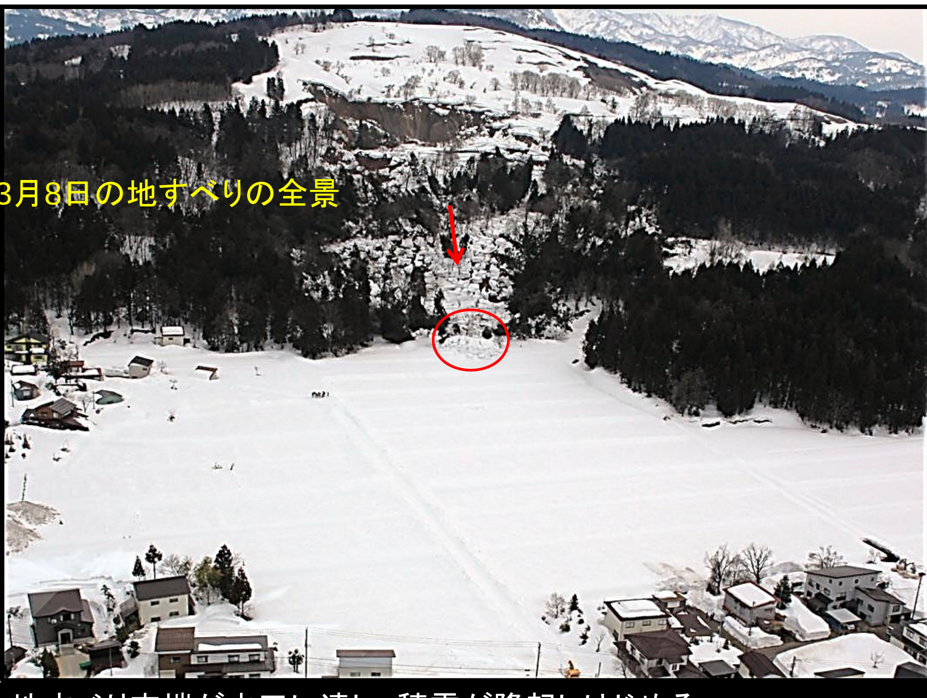


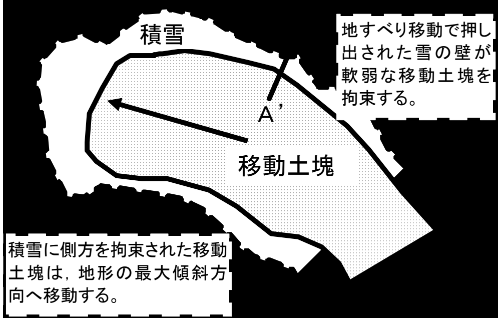
地震計ネットワークを用いて、大規模土砂移動現象の振動を観測し、震源特定解析によって、土砂移動現象の発生箇所と時間を予測するシステム
→大規模な土砂移動現象を広域に監視できる



・地すべり末端が水田に達し、積雪が隆起しはじめる。

発生箇所　新潟県上越市板倉区国川地内
発生日　　平成12年3月7日　13時50分
規　模　　長さ約750m、幅約150m、移動距離約250m、移動土砂量約75万m^3
被　害　　住宅等（11棟損壊）、県道、市道、農業用水、水田など

国川地すべりの移動メカニズム

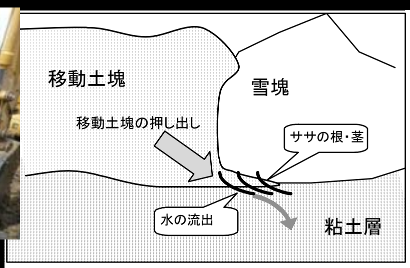


現時点での考察

水田上の雪が地すべりに押されて締まり、氷に近い堅い壁

⬇

①軟弱な土塊が横に広がるのを妨げた
②土塊からの自然排水を妨げた



雪塊で閉じ込められていた相当量の水が掘削時に流出

3.5「降雨による地すべり予測・警戒システム」

水文地質防災研究所ペルージャ支部研究員

シルヴィア・ペルカッチ

SANF: A National Warning System to Forecast Rainfall Induced Landslides

Silvia Peruccacci
Consiglio Nazionale delle Ricerche, Italy

irpi silvia.peruccacci@irpi.cnr.it

MOTIVATION

In Italy, landslides have caused 17,610 casualties (deaths, missing persons, injured people) between 843 and 2012, …

… of which at least 6,505 between 1950 and 2012.

Casualties due to landslides were 36 in 2011, and 17 in 2012.

Giampilieri, 1 Ottobre 2009

GOALS

- **Scientific goal …**

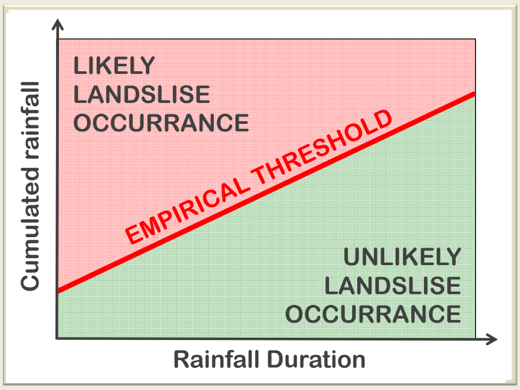
  … study of the conditions that trigger rainfall-induced landslides and the definition of empirical rainfall thresholds.

- **Operational goal …**

  … design of a national warning system to forecast the possible occurrence of rainfall induced landslides.

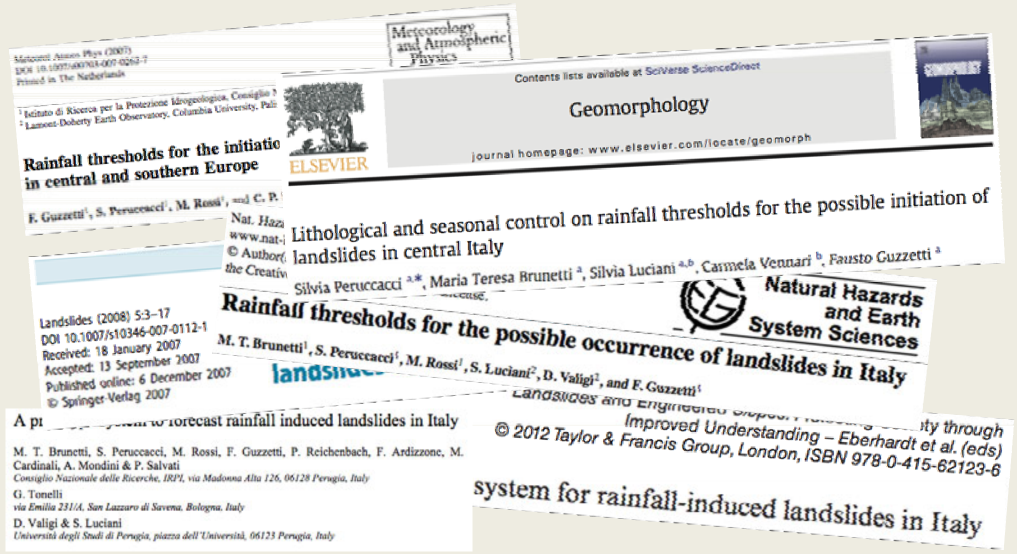
RAINFALL THRESHOLD

For rainfall-induced landslides, a **threshold** may define the amount of rainfall that, when reached or exceeded, is likely to trigger landslides.



- **Empirical** thresholds are obtained analyzing past rainfall events that have resulted in landslides.

RESEARCH & DEVELOPMENT

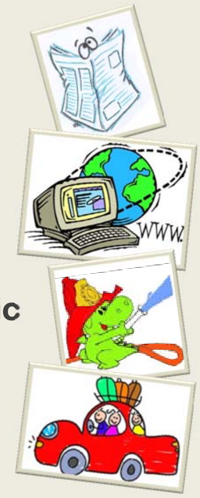


LANDSLIDE CATALOGUE

- Catalogue of more than **2300 rainfall events** that have resulted in **landslides** in Italy.

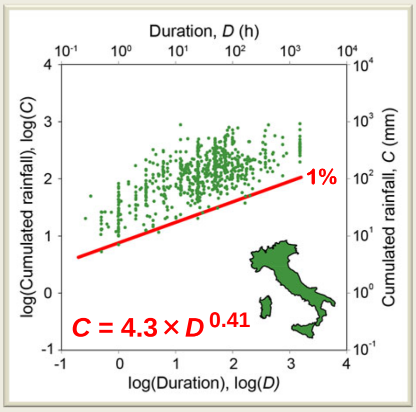
INFORMATION SOURCES

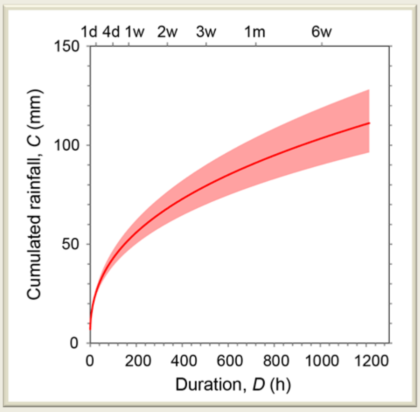
- National, regional and local **newspapers**.
- Blogs and **on-line** sources.
- Reports of local **Fire Brigades**.
- Reports of **CCISS** (agency that provides traffic and travel information).



NATIONAL THRESHOLDS

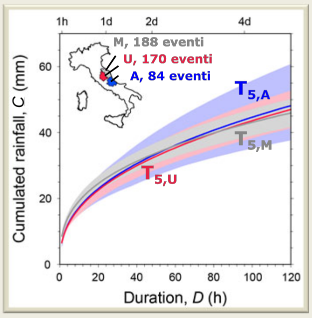
- Reproducible **Cumulated event rainfall–rainfall duration (*CD*) thresholds**, including the parameter **uncertainty**



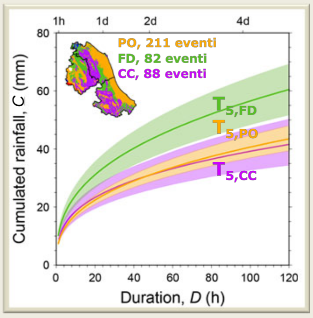


THRESHOLDS FOR CENTRAL ITALY

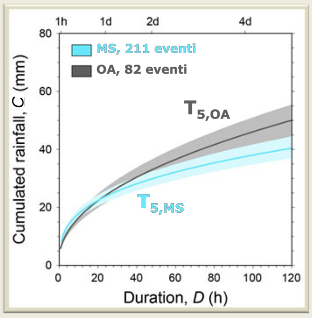
Regional thresholds



Lithological thresholds



Seasonal thresholds



442 rainfall events that triggered **573** landslides between February **2002** and August **2010**.

150 rain gauges.

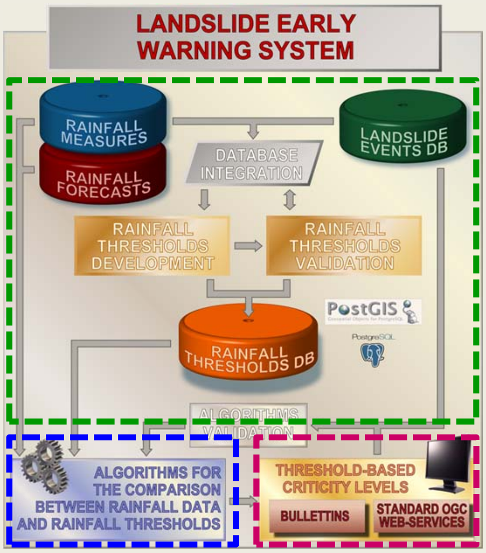
SYSTEM LOGICAL FRAMEWORK

The system compares **rainfall measurements** and rainfall **estimates** with empirical rainfall **thresholds**.

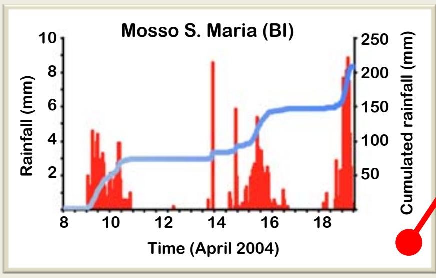
Input and Storage

Analysis

Output and Delivery



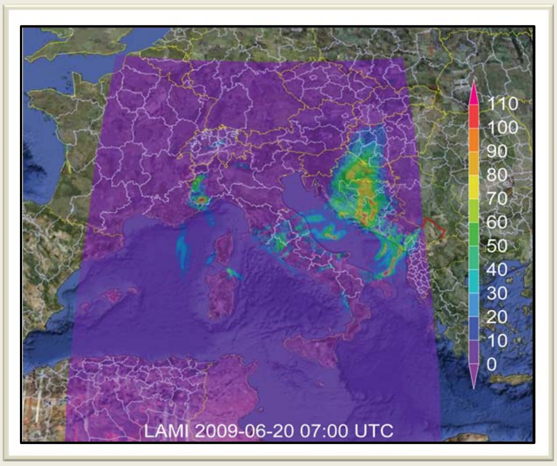
RAINFALL MEASUREMENTS



Every **6 hours**, rainfall **measurements** obtained from **1950 rain gauges** in Italy are stored in the system.

RAINFALL FORECASTS

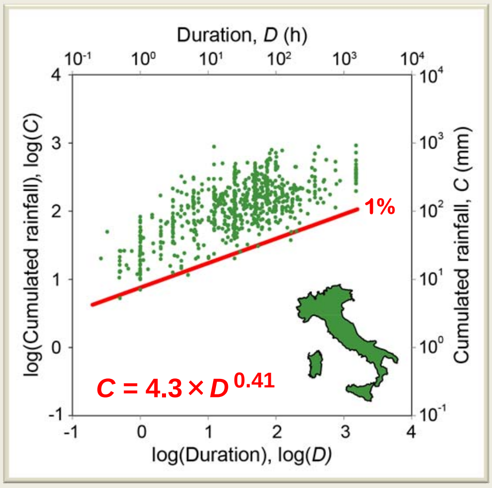
Every **12 hours**, 72-hour rainfall **forecasts** produced by a **Local Area Model** (**LAMI**) are stored in the system.



NATIONAL THRESHOLD

The system uses a single *CD* empirical threshold.

The threshold corresponds to a 1% exceedence probability level.



CRITICAL LEVELS

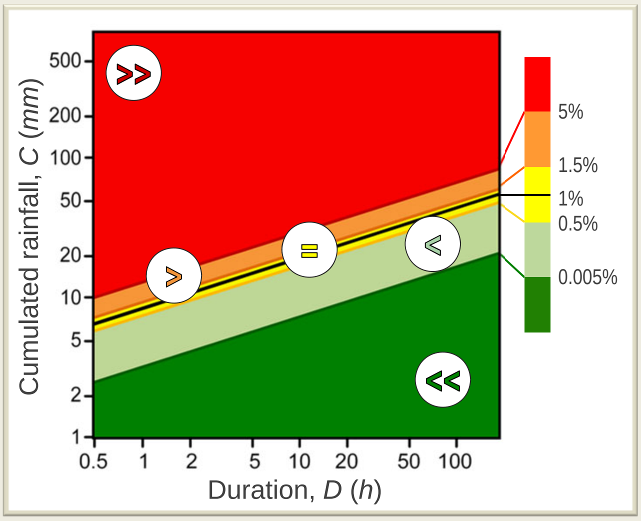
Well above the threshold

Above the threshold

On the threshold

Below the threshold

Well below the threshold



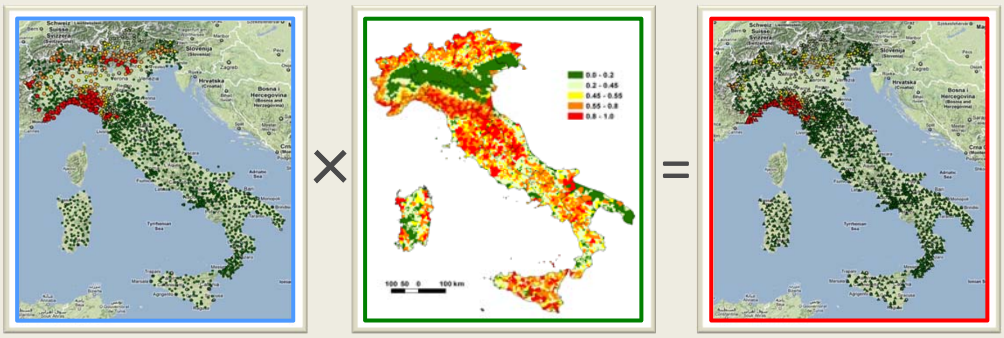
A FORECAST

for 1950 rai... alert zones

irpi A National Warning System to Forecast Rainfall Induced Landslides in Italy 15/21

CONSIDERING SUSCEPTIBILITY

RAINFALL FORECAST × LANDSLIDE SUSCEPTIBILIY = COMBINED FORECAST



irpi A National Warning System to Forecast Rainfall Induced Landslides in Italy 16/21

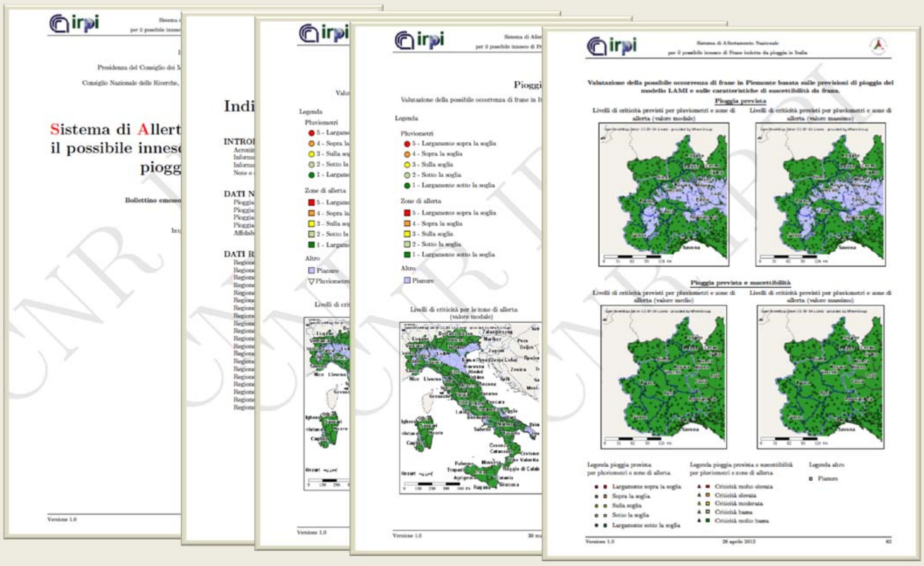
CONSIDERING SUSCEPTIBILITY

RAINFALL FORECAST

COMBINED FORECAST

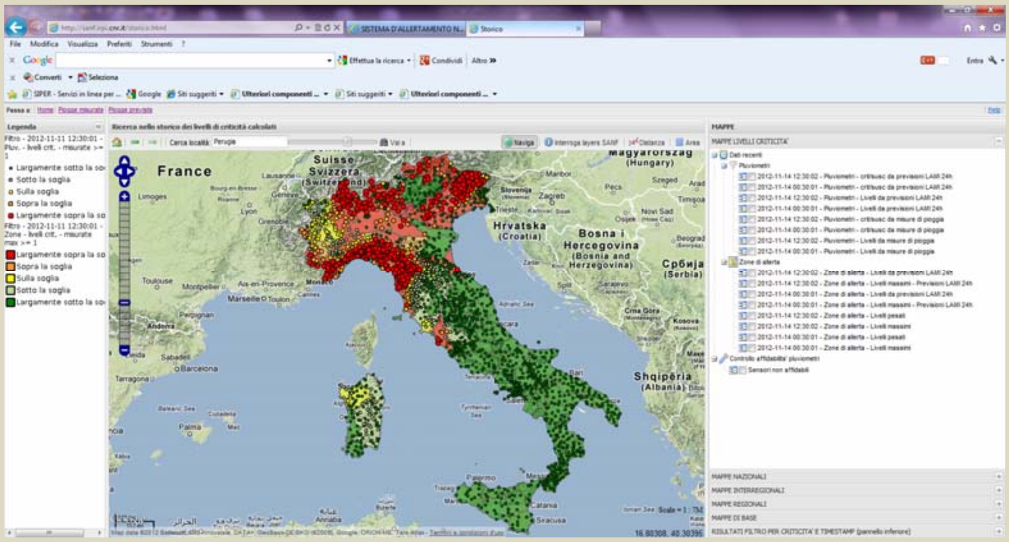
A National Warning System to Forecast Rainfall Induced Landslides in Italy 17/21

BULLETTIN



A National Warning System to Forecast Rainfall Induced Landslides in Italy 18/21

WEB SITE



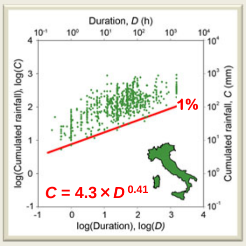
ADVANCEMENTS NEEDED

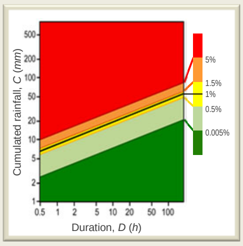
Several **problems** affect the system …

… possible **solutions**:

- **More frequent** forecasts
- Use of new **regional** / local **thresholds**
- Integration of **different** rainfall **forecasts**
- Better integration of landslide **susceptibility**
- Integration with **vulnerability** criteria

… thank you.





Silvia.Peruccacci@irpi.cnr.it

3.6「日本における豪雨に起因する土砂災害」

国総研危機管理技術研究センター砂防研究室長

岡本　敦

Sediment-related Disasters induced by Heavy Rainfall in Japan

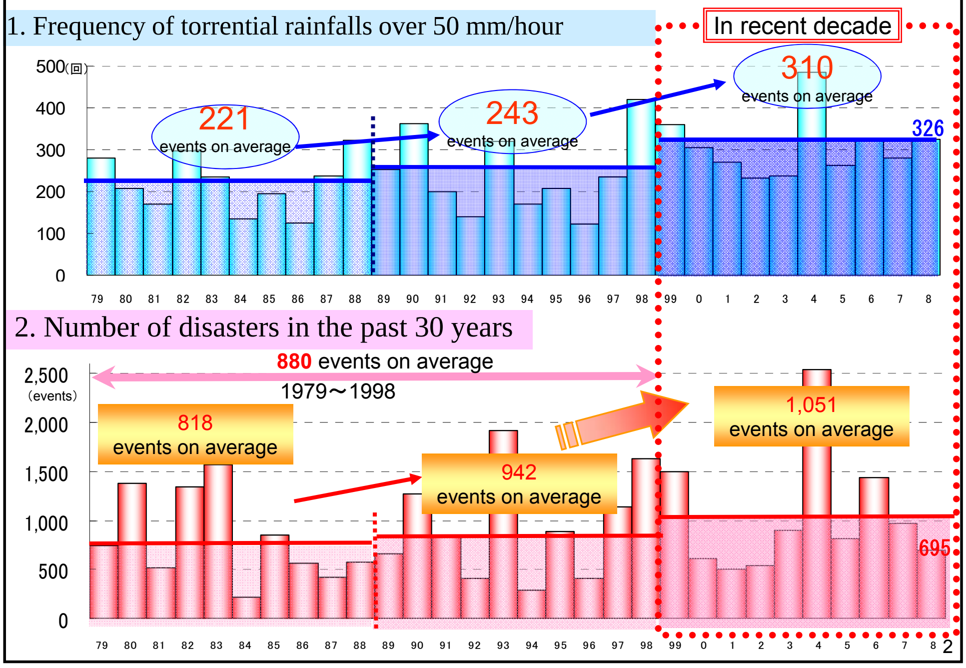
November 30, 2012

Atsushi OKAMOTO

Head of Sabo Division,
Research Center for Disaster Management,
National Institute for Land and Infrastructure Management, MLIT

1

Increase of Torrential Rainfall and Sediment-related Disaster



2

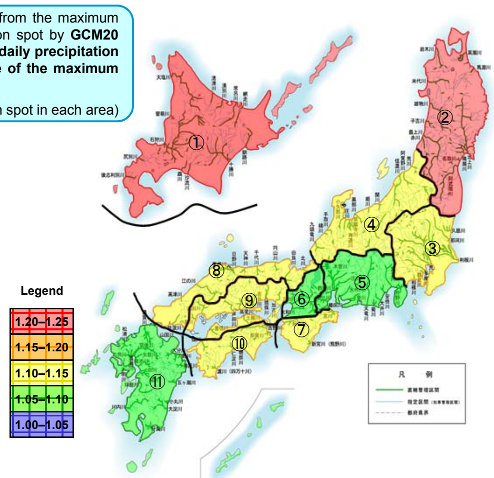
Change in Precipitation Due to Climatic Change Caused by Global Warming

- At 100 years from now, precipitation will generally be **1.1 to 1.3 times as much as the present amount**. It will be up to 1.5 times in some places.
- Estimation of the biggest amount of precipitation in the year at 100 years from now by dividing Japan into 11 areas shows that **the rate of change will tend to be higher in Hokkaido and Tohoku**.

The future precipitation* is estimated by calculating X / Y from the maximum daily precipitation in the year obtained at each investigation spot by **GCM20 (A1B scenario)**, where X is the **average of the maximum daily precipitation between the years 2080 and 2099**, and Y is the **average of the maximum daily precipitation between the years 1979 and 1998**.

(* Median of distribution of averages at each investigation spot in each area)

①	Hokkaido	1.24
②	Tohoku	1.22
③	Kanto	1.11
④	Hokuriku	1.14
⑤	Chubu	1.06
⑥	Kinki	1.07
⑦	Southern Kii	1.13
⑧	San-in	1.11
⑨	Setouchi	1.10
⑩	Southern Shikoku	1.11
⑪	Kyushu	1.07



3

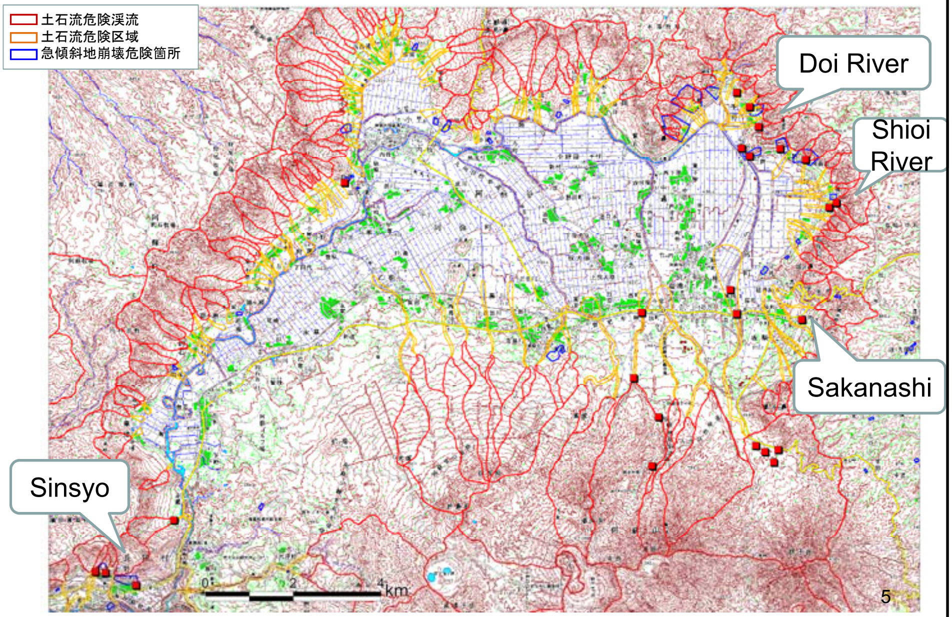
Example of debris flow and slope failures due to torrential rainfall in Japan

Yamaguchi Prefecture ／July 21,2009

Kumamoto Prefecture ／July 12,2012

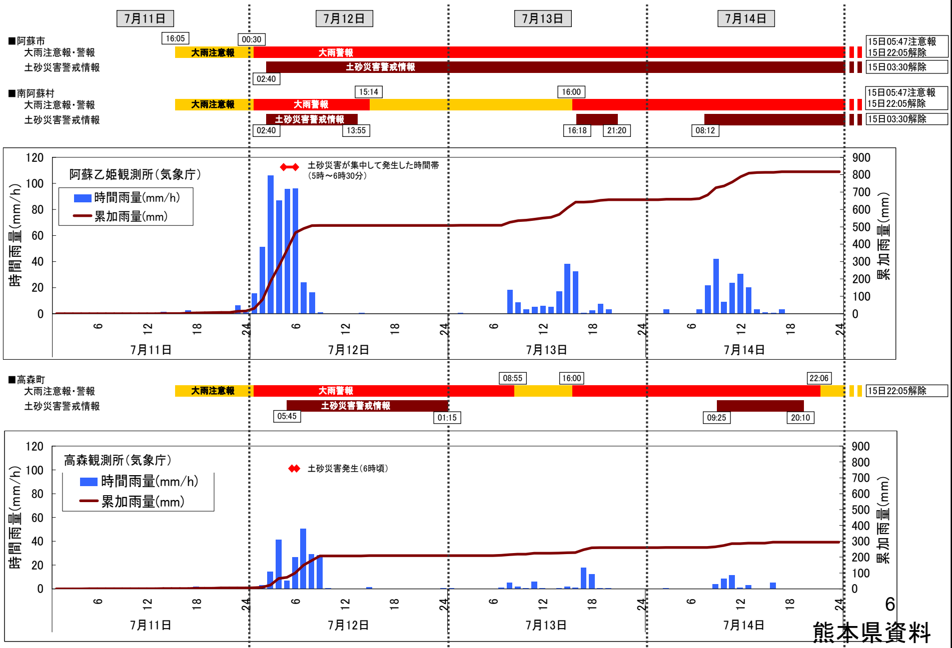
4

Sediment-related disasters around Mt. ASO



5

Time Table of Rainfall and Early Warning Information



6

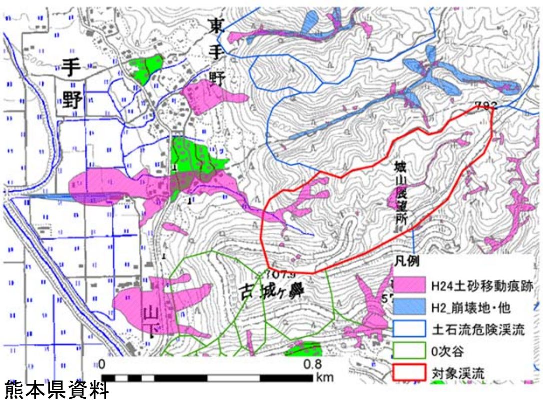
熊本県資料

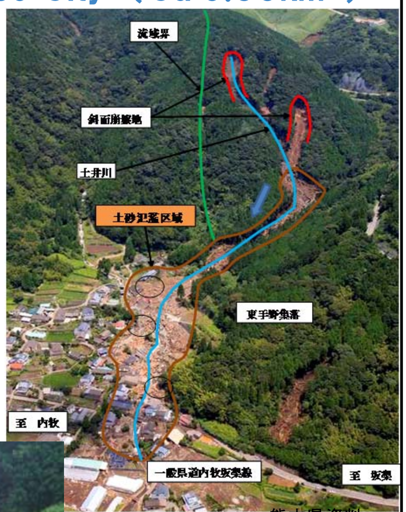
Slope Failure at Sinsyo District, Minami-aso Village

・Slope Failure Size (approx.); width 40m, length 150m, height 60m, depth 1m
・Collapsed sediment deposited behind the retaining wall, thus preventing house damage.
・Retaining wall and stone-guard were partially broken.

7

Doi River in Ichinomiya Town, Aso City（Ca:0.35km²）





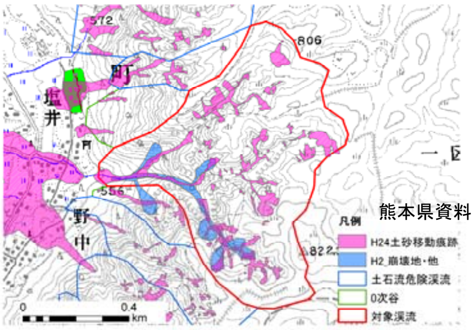
熊本県資料

・14 houses were totally or partially destroyed by the debris flow.

8

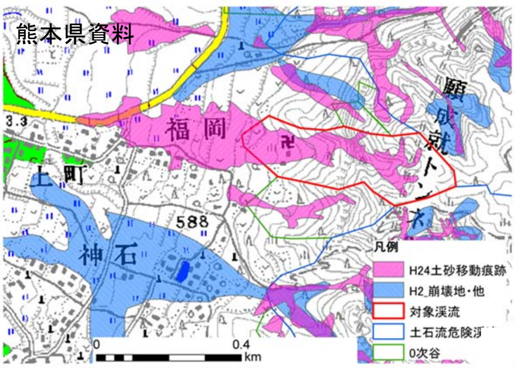
Shioi River in Ichinomiya Town, Aso City（Ca:0.49km²）

熊本県資料



・7 houses were totally destroyed.
・Sabo dam caught part of debris flow and minimize the damage downstream.

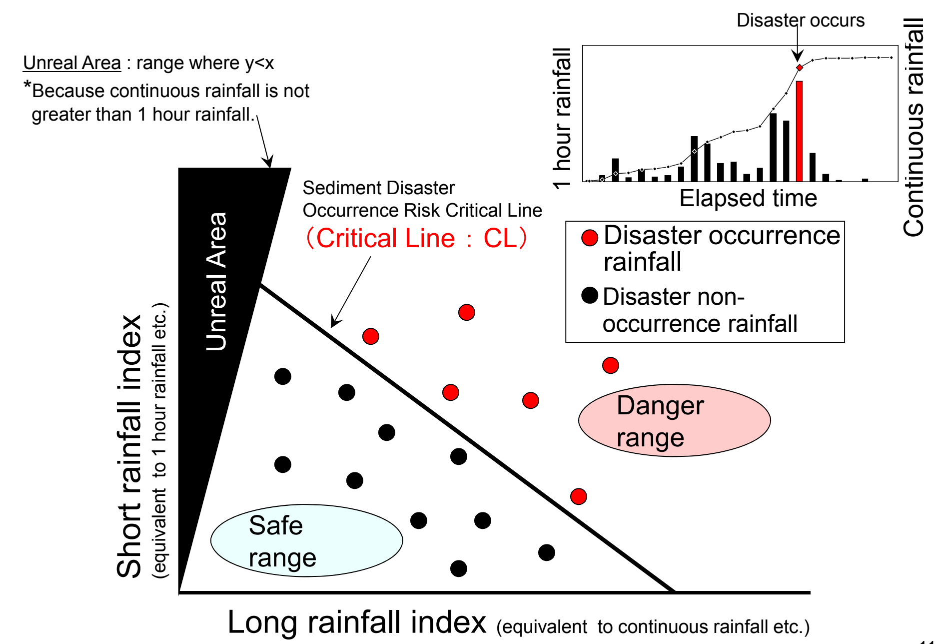
Sakanashi District, Aso City（Ca:0.09km²）



・7 houses totally destroyed, 6 people dead.
・Collapse at hollow of the slope flowed like debris flow.
・Deposited materials mainly consist of volcanic ash. And they also include boulders and drift wood.

10

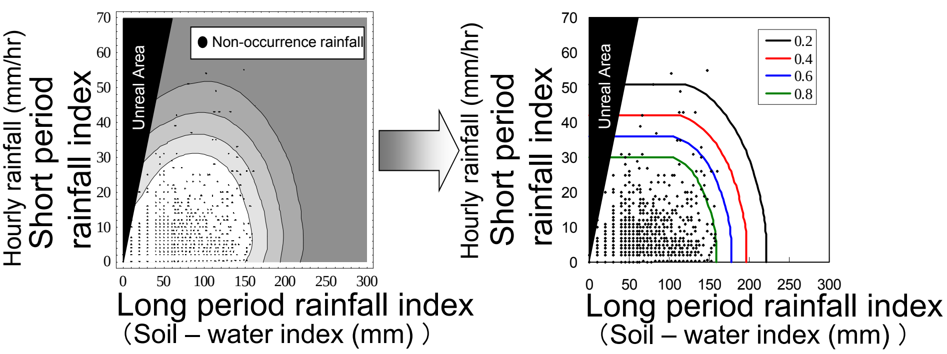
Concept of how to make standard of early warning information



11

Study of a new CL setting method

From the response curved surface set based on non-occurrence rainfall, an optional same probability value line is abstracted (slightly corrected to prevent contradiction with phenomenon)



An same probability value line judged to be suitable according to its relationships with the false alarm rate, frequency warnings are issued, and rainfall warnings is set.

⇒ Objective CL can be easily set.

12

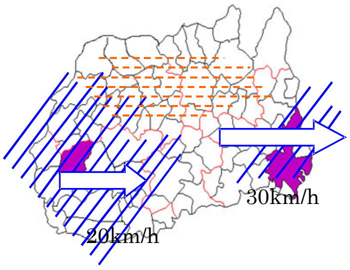
Example of sediment disaster warning information

Sediment disaster warning information for AA Prefecture, item No. X

Time: ΔΔ Date:□□□□
Joint announcement by AA Prefecture and BB Regional Weather Observatory

Municipality in which warning issued: CC district, DD City

It is expected that the danger of sediment disaster due to heavy rains will rise significantly within the next two hours. Please take thorough steps to provide warning in sediment disaster-prone areas and surrounding areas. It is expected that the maximum rainfall in municipalities targeted by this warning could reach 60 mm in some places over the next three hours.



Explanation

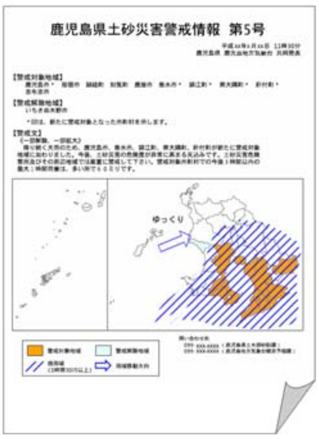
- Municipality in which warning
- Region in which seismic intensity was ?? or more during the EE Earthquake
- Area of actually measured heavy rain (30 mm per hour or more)
- Length of arrow corresponds to hourly movement distance

For inquiries, please contact:
Sabo Office, AA Prefecture: 111-111-1111
BB Regional Weather Observatory: 222-222-2222

13

Procedure for Issuing Sediment Disaster Warning Information

1. Fax and internet (PDF file) information



Information of rainfall forecast and the name of region (city, town or village) which exceeds the warning level

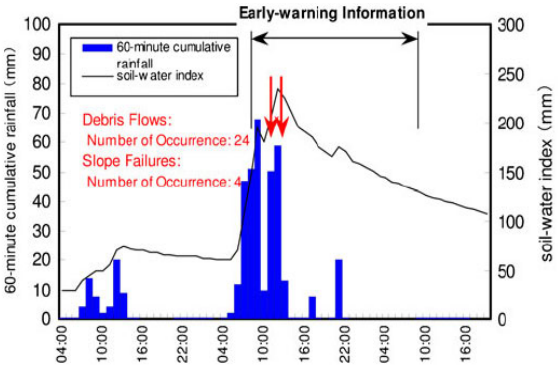
2. Internet or cellular phone information

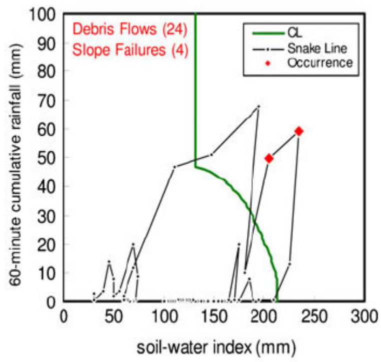
Detailed Information of rainfall forecast and the warning level of the 5×5km mesh

14

Example of snake line progress using RBFN

- On 21st July 2009, 65 debris flows and 105 slope failures occurred in Yamaguchi Prefecture.
- 14 people died as a result of these mass movements.
- The time series of 60-min rainfalls and soil–water index, the timings of occurrence of debris flows and slope failures, and the period of early-warning information issue are shown in the left figure.
- The progress of the snake line and the timing of the disasters (red box) in the damaged area are shown in the right figure.





→CL adequately captured the timing of these disasters occurrences

15

Past 4 years operation of sediment disaster warning information system

	2008	2009	2010	2011	average
Warning information announcement Total number(upper) Number in each area(lower)	1012	906	895	1442	1064
	0.58	0.52	0.51	0.98	0.63
Warning announced & disaster occurred Number(upper) Incidence rate(middle) Capture rate(lower)	23	34	36	55	37
	2.3%	3.8%	4.0%	3.8%	3.5%
	71.9%	69.4%	73.5%	82.1%	75.1%
Warning not announced & disaster occurred Number(upper) Undetected rate(middle) Cases that not exceeded CL(lower)	9	15	13	12	12
	28.1%	30.6%	26.5%	17.9%	24.9%
	—	8	10	10	9

Note:
(1) Incidence rate: The ratio of cases that disaster occurred when warning information being announced.
(2) Capture rate: The ratio of cases that warning information being announced when disaster occurred.
(3) Undetected rate: The ratio of cases that disaster occurred when warning information not being announced.

16

Hydrological and Sediment Transport Observation in Mountain River

All MLIT SABO Offices have started "Hydrological and Sediment Transport Observation in Mountain River". NILIM has studied methodologies to gauge, and provided technical guideline and supports for the SABO Offices.

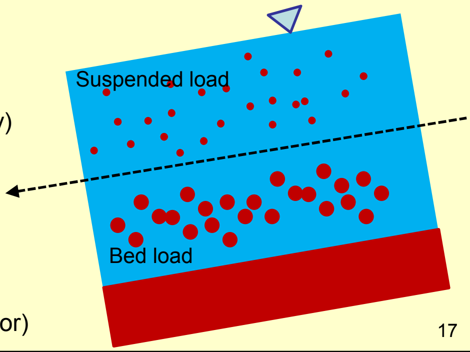
Purposes of the observation;
1) Monitoring sediment load in a watershed
2) Establishment and Evaluation of SABO master plan in a watershed
3) Estimation of runoff coefficient in mountain rivers
(ex. Estimation of water level of landslide-dam -> Early warning downstream)
4) Establishment of comprehensive sediment management plan for national land conservation

<u>Items of observation</u>

A) Hydrological observation
- Precipitation
- Water discharge (Water level and velocity)

B) Suspended load observation
- Gauging by a turbidity meter
- Gauging by sampling river water

C) Bed load observation
- Gauging by a hydrophone (acoustic sensor)



17

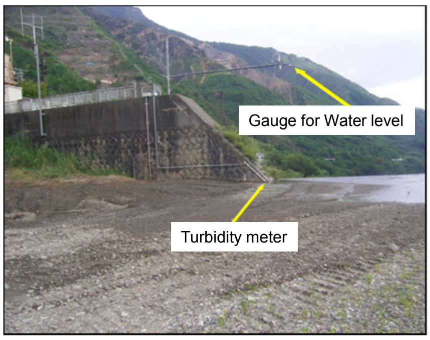
B) Suspended load observation
Gauging by turbidity meter and sampling river water

1) Calibration of turbidity meter with known turbid water made of river bed materials near the meter

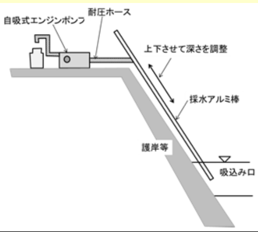
2) Gauging turbidity

3) Converting turbidity to density of suspended load

4) Calculation volume of suspended load by multiplying density of suspended load by water discharge



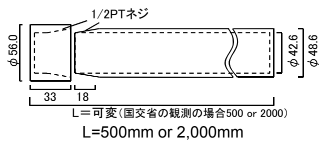
Pump for sampling river water

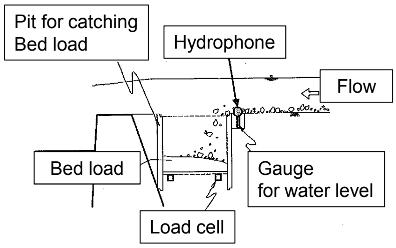


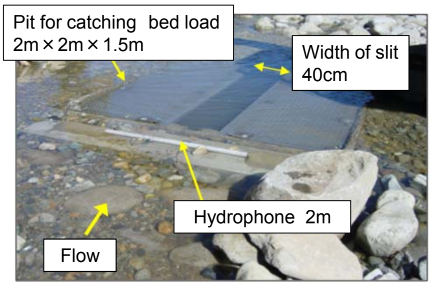
18

C) Bed load observation
- Gauging by a hydrophone

1) Picking up sounds of collision of bed load on a steel pipe by microphone
2) The sounds is recorded on a data logger as acoustic data
3) Converting the acoustic data to the volume of bed load





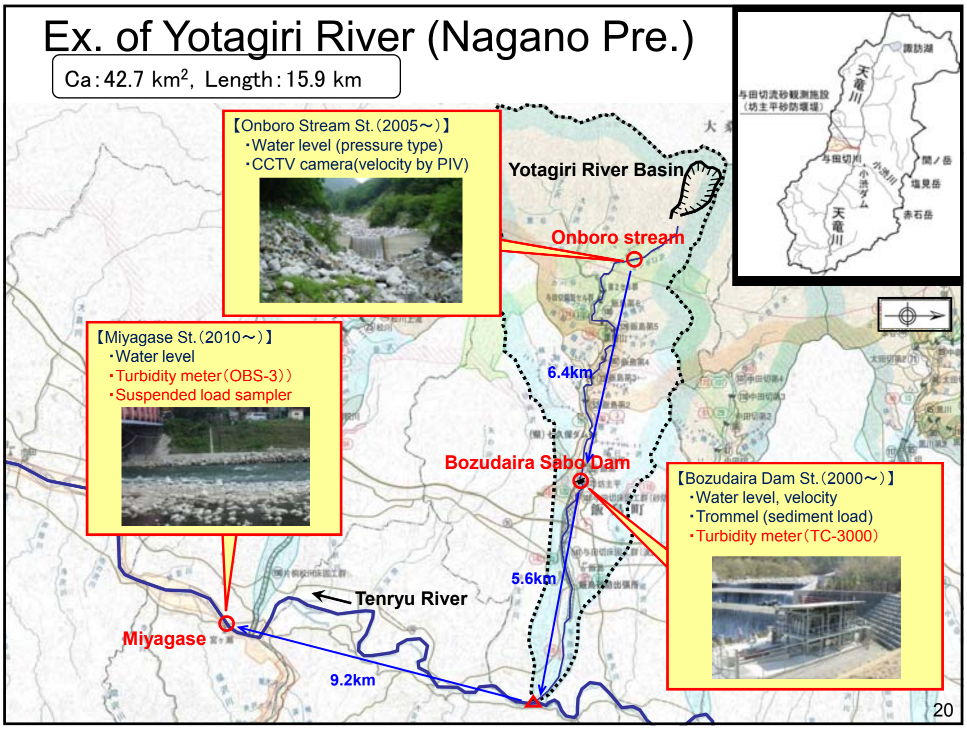


It is preferable to conduct calibration of the volume of bed load from Hydrophone by using volume of bed load caught by pit.

19

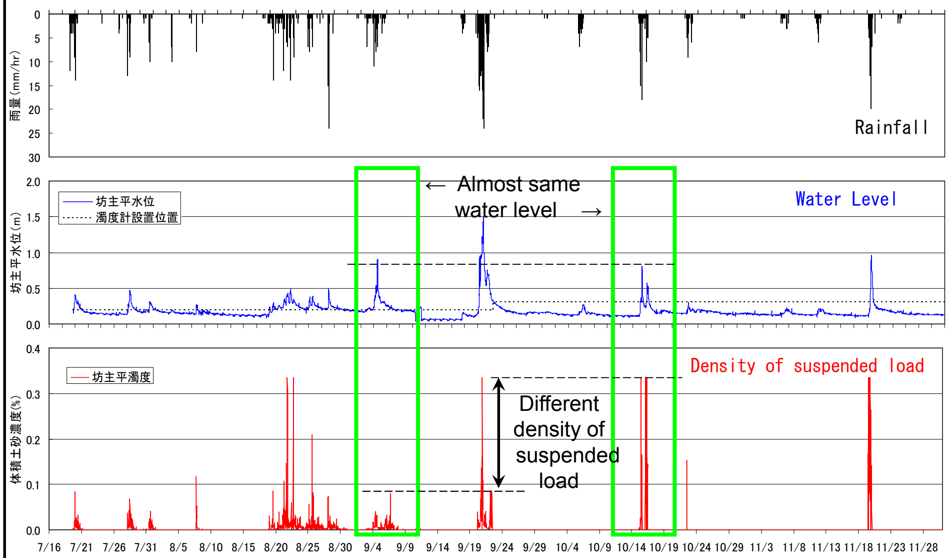
Ex. of Yotagiri River (Nagano Pre.)

Ca : 42.7 km^2, Length : 15.9 km



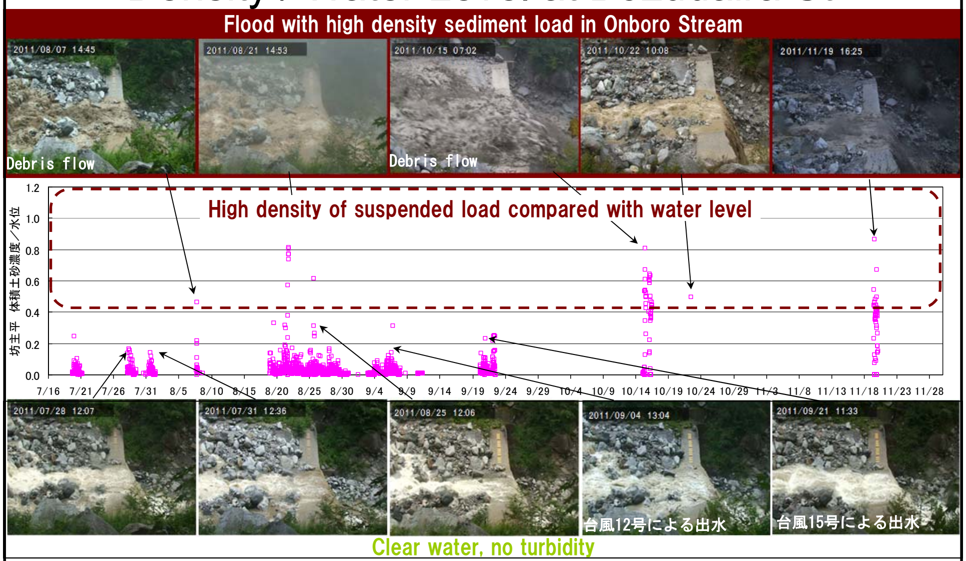
20

Data of Tubidity at Bozudaira Sabo Dam St.



- Almost same water level but different density of suspended load.
- 4 Sep. 0.08%   15 Oct. 0.03%

Density / Water Level at Bozudaira St.

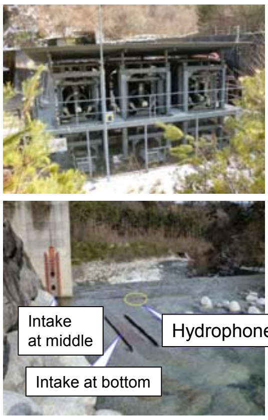


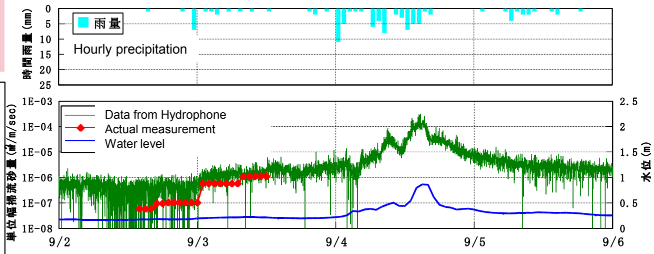
Density/Water level at Bozudaira St. relates to Onboro stream condition.
⇨ Turbidity observation downstream could assume sediment production upstream.

Example of Bed Load Observation : Bozudaira Sabo Dam

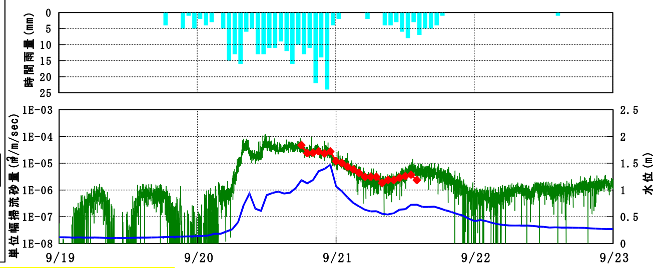
Comparison between the data from Hydrophone and actual measurement

Facility of actual measurement
Trommel





Typhoon 12, 2011



Typhoon 15, 2011

The data from Hydrophone corresponded with the data of actual measurement.

23

Thank you for your attention

24

3.7「15 年間における土砂災害に関する日伊科学技術協力」

水文地質防災研究所パドヴァ支部研究所長

アレッサンドロ・パスート

1998 – 2013

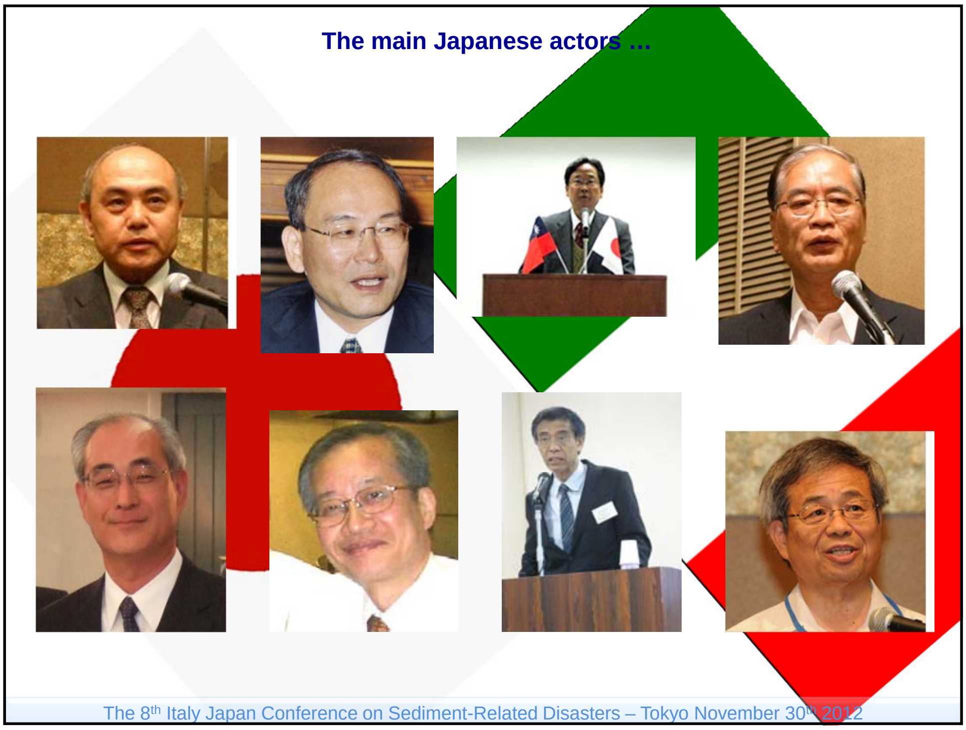
15 years of scientific cooperation between Italy and Japan on sediment related disasters

alessandro pasuto

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

Sarno, May 5th 1998
The beginning

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012


The main Japanese actors …
The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012


… and the Italian one
The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

1999 November 1st - 5th Tokyo, Kagoshima,
1st Joint Conference

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2000 October 18th - 20th Venice, Dolomites
2nd Joint Conference

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2002 April 8th - 12th Tokyo, Hiroshima
3rd Joint Conference

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2003 October 9th Longarone
Opening of GRJL and 40th Anniversary of Vajont slide

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2004 May 20th – 22nd Naples, Salerno
4th Joint Conference

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2004 May 25th Riva del Garda
Signatures of the Cooperation Agreement

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

Longarone, September 6th 2004
Visit of the Minister ISHIHARA



The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2006 October 30th – November 3rd Tokyo, Niigata
5th Joint Conference




The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012


2007 May 29th Tokyo
Italy – Japan Symposium on Crisis Management of Natural Disasters
Italy-Japan Symposium on Crisis Management of Natural Disasters
−New Strategies of Mitigations of Natural Disasters−
Tokyo(Japan)
29th May, 2007
日本におけるイタリア2007・春
PRIMAVERA ITALIANA
ITALIA IN GIAPPONE
The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012


2008 May 23rd - 26th Umbria, Rome
6th Joint Conference
The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2008 November 17th – 21st Tokyo, Tsukuba
Visit of the Umbria Region delegation

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2009 October 27th – 30th Tokyo, Kagoshima
Symposium on Risk Management and Governance to cope with Natural Disasters

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

2010 November 15th – 18th Venice, Carnian Alps
7th Joint Conference

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

Results: *Formal Meetings*

1998	First visit of a Japanese delegation in Italy	
1999	**1st Conference**	Tokyo , Kagoshima
2000	**2nd Conference**	Venice, Dolomites
2002	**3rd Conference**	Tokyo, Hiroshima
2003	40° Vaiont e opening GRJL	Longarone
2004	Visit of Minister ISHIHARA	Longarone
2004	**4th Conference**	Naples, Salerno
2004	Signing of MoU	Riva del Garda
2006	**5th Conference**	Tokyo, Niigata
2007	Symposium on Crisis management of Natural Disasters	
2008	**6th Conference**	Umbria, Rome
2008	Visit of Umbria Region delegation	Tokyo
2009	Symposium on Risk Management and Governance to cope with Natural disasters	
2010	**7th Conference**	Venice, Carnian Alps

The 8th Italy Japan Conference on Sediment-Related Disasters – Tokyo November 30th 2012

Results: *Joint Publications on scientific journals*

Asai, K., Fujisawa, K., Nishimoto, H., Miyajima, K., Noda, T., Mukai, K., Pasuto, A., Marcato, G., 2005. Joint Research by Japan and Italy Concerning Landslide Monitoring Technologies. Proc. 44° Meeting Japan Landslide Society, Sasebo 26-31 August 2005, pp.361-364, (in Japanese).

Higuchi, K., Nomura, Y., Asai, K., Fujisawa, K., Pasuto, A., Marcato, G., Fukuoka, F., Iwao, T., 2005. Development of landslide displacement detection sensor using an optical fiber in the OTDR method. Proc. 44° Meeting Japan Landslide Society, Sasebo 26-31 August 2005, pp.315-318, (in Japanese).

Reichembach, P., Tagliavini, F., Guzzetti, F., Pasuto, A., Fujisawa, K., 2005. Valutazione preliminare della pericolosità da frana nell'area del M. Salta (Prealpi Friulane), con particolare riferimento ai fenomeni di crollo. Giornale di Geologia Applicata, 2, 7-12.

Fujisawa, K., Kamihara, N., Marcato, G., Pasuto, A., 2006. One example of Road Tunnel Route Modification caused by Landslide. Proc. International Seminar on Risk Management for Roads. April 26-28, Hanoi, Vietnam.

Higuchi, K., Fujisawa, K., Asai, K., Pasuto, A., Marcato, G. 2007. Application of new landslide monitoring technique using optical fiber sensor at Takisaka Landslide, Japan. In: V.R. Schaefer, R.L. Schuster, A.K. Turner, Conference Presentations, First North American Landslide Conference, Vail, Colorado, AEG Special Publication No. 23 (ISBN 978-0-975-4295-3-2) (on CD-Rom).

Marcato, G., Fujisawa, K., Mantovani, M., Pasuto A., Silvano, S., Tagliavini, F., Zabuski, L., 2007. Evaluation of seismic effects on the landslide deposits of Monte Salta (Eastern Italian Alps) using distinct element method. Nat. Hazards Earth Syst. Sci., 7, 695-701.

Fujisawa, K., Marcato, G., Nomura, Y., Pasuto, A., 2010. Management of typhoon-induced landslides in Otomura (Japan). Geomorphology, 124, 150-156.

Results: *Oral and poster presentations at International Conferences*

6th International Conference on Geomorphology, Zaragoza, Spain 2005

44th Meeting Japan Landslide Society, Sasebo, Japan 2005

National Meeting of Italian Association of Applied Geology, Bari, Italy 2005

PIARC, International Seminar on Risk Management for Roads, Ha Noi, Vietnam 2006

The 2nd International Workshop on Opto-electronic Sensor-based Monitoring in Geo-engineering, Nanjing, China 2007

1st North American Landslide Conference, Vail, Colorado 2007

European Geosciences Union, General Assembly, Vienna, Austria 2006, 2008

Results: *Long/short term mobility and technical visits*

MIZUNO	Salerno, Trento	Oct. 1999 - Sept. 2000
BOVOLIN	Tsukuba	May – Aug. 1999
BOVOLIN and PASUTO	*Research Award for Foreign Specialists* Tsukuba, Hokkaido	Feb. 2001
MIZUNO and TERADA	Padova, Dolomites	
KAMEE, SUGIURA, TOMOMATSU et al.	Eastern Alps	Oct. 2003
MARCATO	Tsukuba	Aug. 2004, Oct. – Nov. 2006
FUJISAWA	Italian Dolomites	Oct. 2004
MARCATO and PASUTO	*Meeting with NTT,* Tokyo	Aug. 2005
MARCATO and PASUTO	Tokyo, Kobe	Jan. 2006
MARCATO and PASUTO	Gifu, Niigata	Sept. 2006
ISHI, KODA, NOMURA	Italy and Spain	Sept. 2005
MARCATO and PASUTO	Ishinomaki	Oct. 2012

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3.8「近年の日伊土砂災害技術協力」

国総研危機管理技術研究センター長

後藤　宏二

10 years collaboration between Italy and Japan for sediment-related disaster prevention

Kouji GOTO

National Institute for Land and Infrastructure Management (NILIM)
Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

Activities of The sediment disaster prevention technology conference

1998 Sediment disaster in Salerno, Italy
Japanese researchers were dispatched for Salerno
The agreement of establishment
"The sediment disaster prevention technology conference" in 6th Japan-Italy Joint Committee on Cooperation in Science and Technology
1999 1st conference ,Tokyo and Kagoshima, Japan
2000 2nd conference , Roma, Venice and Longarone, Italy
2002 3rd conference, Tokyo and Hiroshima, Japan
Executive program "Establishment of Geo-Risk Joint Lab"
in 7th Japan-Italy Joint Committee on Cooperation in Science and Technology
2004 4th conference, Salerno and Napule, Italy
2006 5th conference, Tokyo, Japan
Japan-Italy Symposium
"Joint research for sediment disaster prevention" , Tokyo, Japan
2007 Japan-Italy Symposium
"Natural disaster risk management ", Tokyo, Japan
an event related 2007 Primavera Italiana
Executive program
"Evaluation and countermeasure regarding hazard map"
in 8th Japan-Italy Joint Committee on Cooperation in Science and Technology
2008 6th Conference, Orvieto, Assisi and Perugia, Italy
2009 Japan-Italy Symposium
"Risk management for sediment disaster", Tokyo, Japan
an event related Italia in Giappone 2009
2010 7th Conference, Venice and Palmanova, Italy

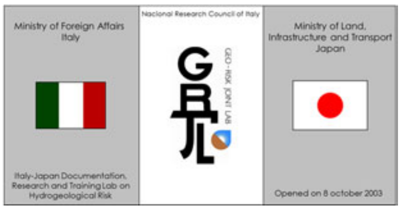

Sediment disaster in Salerno, Italy (1998)


Japan-Italy Symposium
"Risk management for sediment disaster" (2009)


7th Conference in Venice (2010)

GRJL:Geo-Risk Joint Lab

Themes of research
"Developing technologies detection and monitoring for Landslide and Debris flow"



Opening ceremony of GRJL (2004)

Right: the Minister of Land, Infrastructure, Transport and Tourism (At that time)

Building of Geo-Risk Joint Lab in Longaron (At that time)
Now GRJL is in CNR-IRPI Padova branch office.

Interaction of researchers between Japan and Italy

Japan -> Salerno Univ.
Dr. Hideaki Mizuno (NILIM)
Duration: 1 year

Italy -> PWRI(Tsukuba, Japan)
Dr. Vittorio Bovolin
(Salerno Univ.)
Dr. Alessandro Pasuto
(CNR)
etc.

Results of joint research between Japan and Italy

- Risk management for landslide
- Debris-flow monitoring system using ground vibration sensor
- Post-event documentation and clarification of generating mechanisms of flash flood
- Application of Ground-based Synthetic Aperture Radar to the lava dome

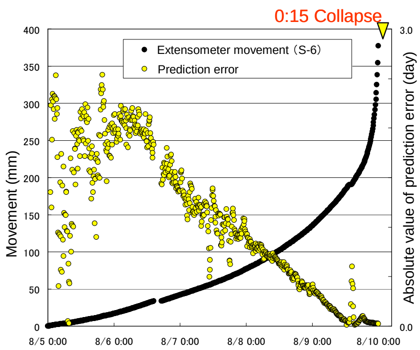
Risk management for landslide

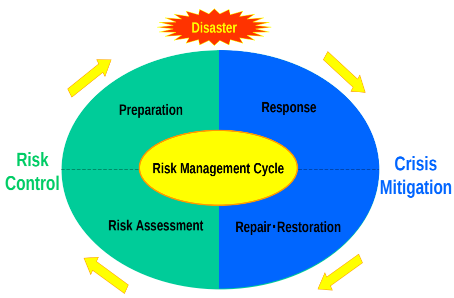
Landslide in Otomura, Nara, Japan, 2004

Risk management for landslide

<u>Technologies for risk management (detection and monitoring)</u>

- Application of prediction methods of the time to landslide failure
  - ･Saito's equation（secondary creep)
  - ･Fukuzono's method
- Video camera analysis
  - ･Maximum speed: 3.5m/s



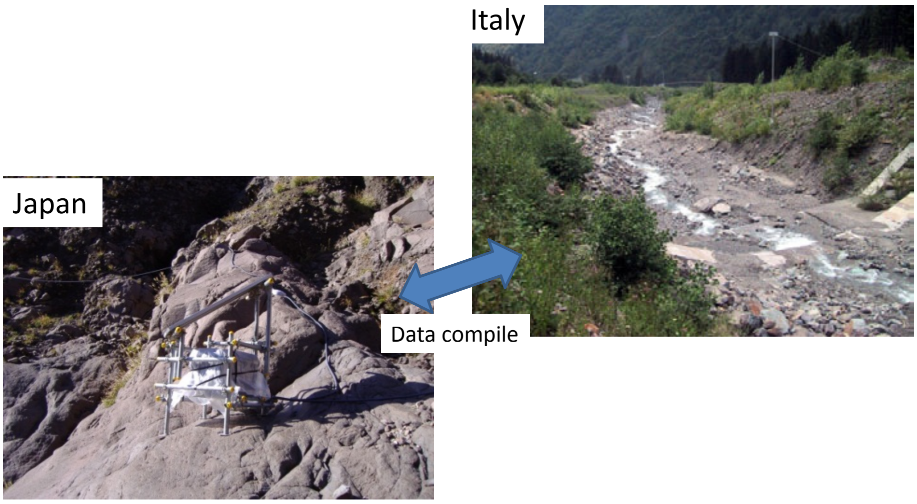


Publications (Japan-Italy Joint Research)

1. Fujisawa, K., Marcato, G., Nomura, Y., Pasuto, A. (2010): Management of a typhoon-induced landslide in Otomura (Japan). *Geomorphology,* 124, 150-156.
2. Marcato, G., Fujisawa, K., Pasuto, A. Silvano, S., Tagliavini, F., Zabuski, L. (2007): Evaluation of seismic effects on the landslide deposits of Monte Salta (Eastern Italian Alps) using distinct element method. *Natural Hazards and Earth System Sciences,* 7, 695-701.

Debris-flow monitoring system using ground vibration sensor

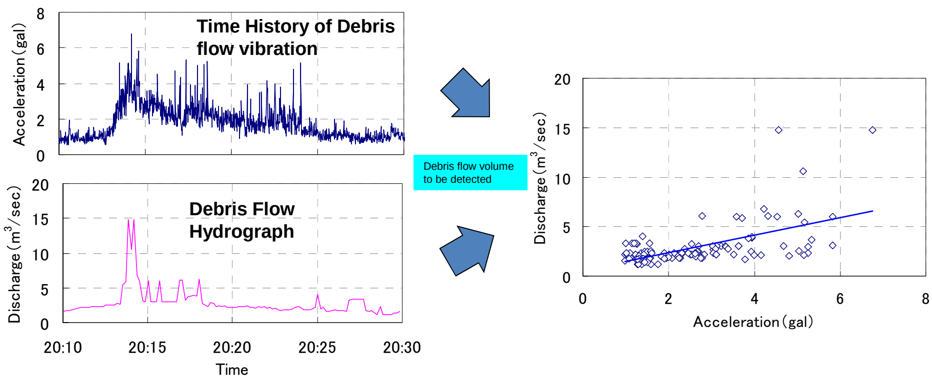
In Japan, ground vibration sensor is used to detect debris flow for evacuation of construction workers and residents.



Debris-flow monitoring system using ground vibration sensor

・The volume of debris-flow is an important factor to predict affected area.

・Japan and Italy share the data of the relationship between debris-flow volume and amplitude of ground vibration.



Japan and Italy are developing advanced debris-flow detecting system which can estimate the volume.

Post-event documentation and clarification of generating mechanisms of flash flood

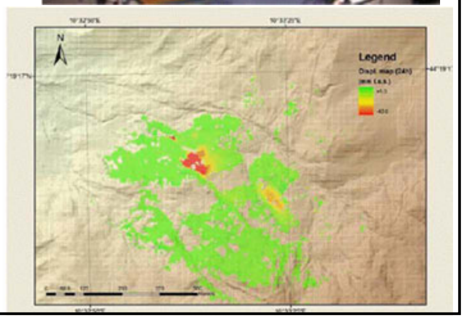
- Climate change is expected to increase the risks of flash floods and the management of them is critical component of public safety and quality of life both in Japan and Italy.
- Both PWRI and CNR-IRPI have been involved in the post-event surveys and documentations vigorously in their own territories.
- In the activities of the Project HYDRATE of the 6th European Framework Programme in which CNR-IRPI has participated as contractor and PWRI as observer, the experiences in Japan and Europe were exchanged.

Toga River, July 28, 2008

Application of Ground-based Synthetic Aperture Radar (SAR) to the lava dome of Mt. Unzen, Japan

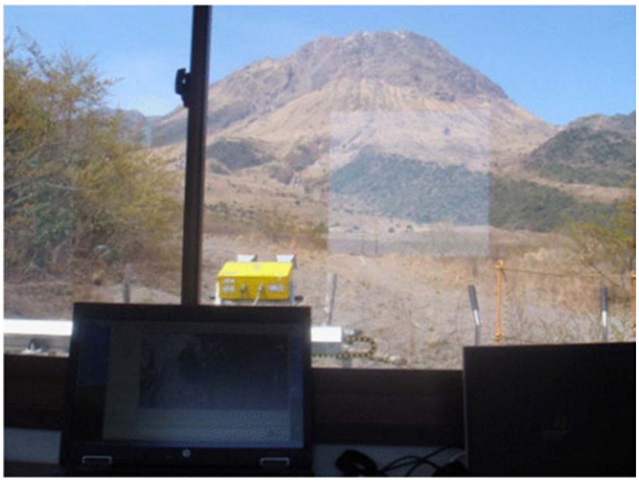
Oct. 2006 The 5th Japan-Italy Technical Conference on Sediment-Related Disaster Prevention

Paolo Farina
(Earth Science Dept., University of Florence)
"Remote sensing technology and sediment disasters: Examples in Italy"



Application of Ground-based Synthetic Aperture Radar (SAR) to the lava dome of Mt. Unzen, Japan

PWRI and Unzen Restoration Office, MLIT are now trying to apply this technique to monitor the lava dome, which is still deforming and posing a serious risk to the community.



The results of the first field test have been jointly presented in the annual meeting of the Japan Society of Erosion Control Engineering, Yokohama in May 2011.

Japan and Italy have
various types of sediment disaster and
same causes of sediment disaster

Due to various types and causes of sediment disaster, it is difficult to collect the data of disaster for case study in short period.

Japan and Italy help each other by sharing disaster data and technical information.

Japan and Italy can accelerate to develop disaster prevention technology against sediment disaster.

Thank you for your attention!

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