クロアチア国
土砂・洪水災害軽減プロジェクト

終了時評価調査報告書

平成 25 年 12 月
(2013 年)

独立行政法人国際協力機構
地球環境部

環境
JR
13-021

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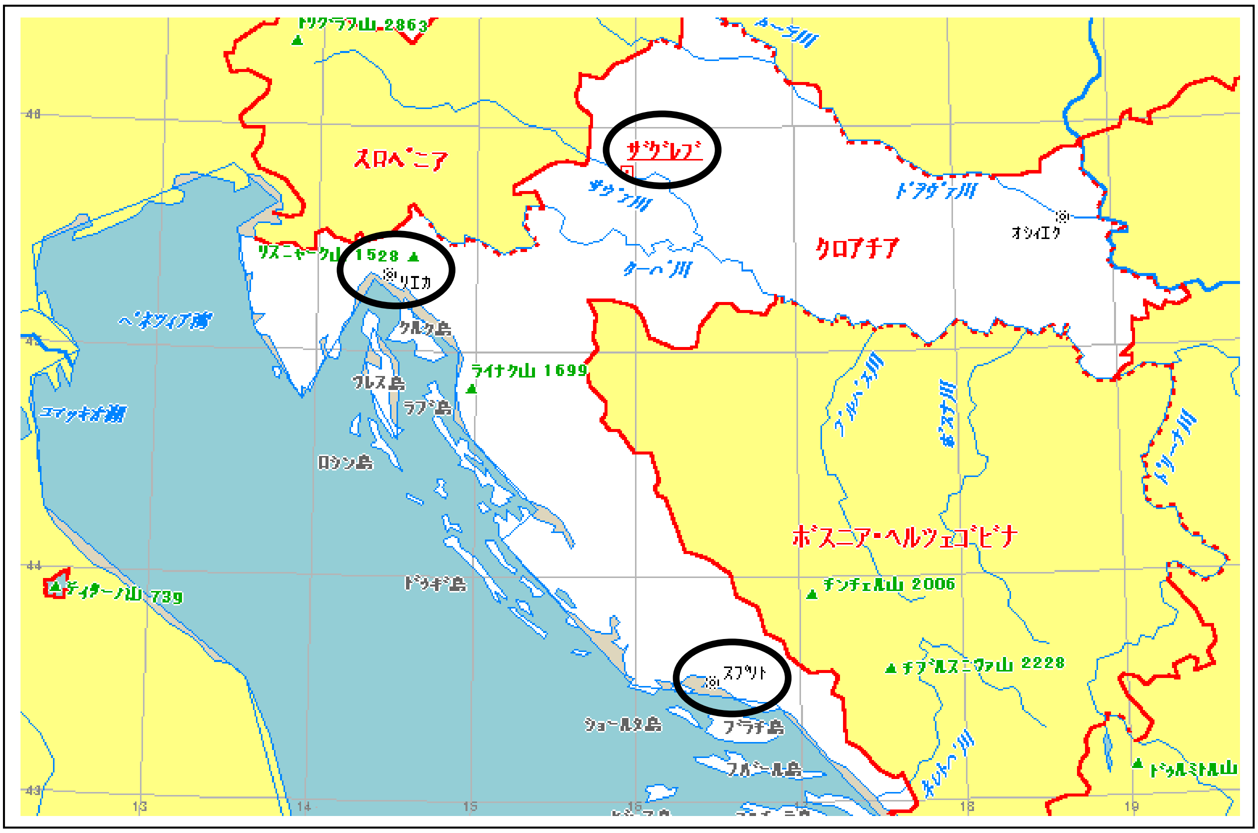
調査対象地域位置図

出典：http://www.sekaichizu.jp/atlas/europe/index.html



現地調査写真

地すべりで家の前にできた亀裂
（コスタニエク、ザグレブ）

コスタニエク地すべり地モニタリング設備

プロジェクトで設置した土質試験機材
（リエカ大学）

グロホボ地すべり地（リエカ）の
モニタリング設備

オミシュ市（スプリット）の
落石現場

ミニッツへの署名

略　語　表

AHP	Analytical Hierarchy Process　階層構造分析法
CGS	Croatian Geological Survey　クロアチア地質調査所
CW	Croatian Water　クロアチア水公社
DEM	Digital Elevation Model　数値標高モデル
DPRI	Disaster Prevention Research Institute, Kyoto University　京都大学防災研究所
DUZS	*Državna uprava za zaštitu i spašavanje*　(National Protection and Rescue Directorate) 国家保安・救援局
EMO	Emergency Management Office, City of Zagreb　ザグレブ市危機管理室
GIS	Geographic Information System　地理情報システム
HRK	Croatian Kuna (international abbreviation)　クロアチアクーナ
ICL	International Consortium on Landslides　国際斜面災害研究機構
JCC	Joint Coordination Committee　合同調整委員会
JPY	Japanese Yen　日本円
JICA	Japan International Cooperation Agency　独立行政法人国際協力機構
JST	Japan Science and Technology Agency　独立行政法人科学技術振興機構
LiDAR	Laser Imaging Detection and Ranging　レーザー測量（レーザー画像検出と測距）
M/M	Minutes of Meetings　協議議事録
MZOS	*Ministarstvo obrazovanja, znanosti i sporta*　(Ministry of Science, Education and Sport) 科学教育スポーツ省
PO	Plan of Operation　活動計画
R/D	Record of Discussion　討議議事録
SATREPS	Science and Technology Research Partnership for Sustainable Development 地球規模課題対応国際科学技術協力
UR	University of Rijeka, Faculty of Civil Engineering　リエカ大学土木工学部
US	University of Split, Faculty of Civil Engineering, Architecture and Geodesy スプリット大学土木工学・建築・測地学部
UZM	University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering ザグレブ大学鉱業・地質・石油工学部
UZA	University of Zagreb, Faculty of Agriculture　ザグレブ大学農学部
VAT	Value Added Tax　付加価値税
WG	Working Group　ワーキンググループ

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付属資料

終了時評価調査結果要約表

1. 案件の概要	
国名：クロアチア	**案件名：**土砂・洪水災害軽減プロジェクト
分野：防災	**協力形態：**地球規模課題対応国際科学技術協力（SATREPS）
所轄部署：地球環境部水資源・防災グループ	**協力金額：**約 3.78 億円（JICA 予算ベース）
協力期間：(R/D) 2009 年 3 月～2014 年 3 月	**先方実施機関：**MZOS（科学教育スポーツ省）、ザグレブ大学、リエカ大学、スプリット大学、クロアチア水公社、クロアチア地質調査所
日本側協力機関：新潟大学、京都大学、国際斜面災害研究機構、東北学院大学、山形大学	

1-1 協力の背景と概要

クロアチアの国土は、断層・褶曲の影響を受けた複雑で脆弱な地形・地質構造を有し、地震が頻繁に発生する。また、アドリア海沿岸部を中心として全般的に降水量が多く、年平均降水量が 3500mm を超えている地域もある。こうした地震や降雨が引き金となり、風化しやすい砂岩[1]・頁岩[2]（けつがん）互層[3]や、摩擦角の低い粘土を多量に含んだ泥灰岩層のある斜面・渓流においては、地すべり、斜面崩壊、土石流等の土砂災害が多発し、また地層中に水みちが形成されやすい石灰岩地域においては局所的洪水（フラッシュ・フラッド）が発生する。

このような災害リスクの高い地域は、都市周辺部に多く見られるが、無秩序な開発により人口増加や資産の蓄積が進んでおり、土砂災害やフラッシュ・フラッドによる被害の増加が懸念されている。また、今後、気候変動による降雨パターンの変化で、地域によっては災害リスクがさらに高まる恐れもある。

しかしながら、クロアチアにおいては土砂災害やフラッシュ・フラッドのリスクを的確に評価し、それに基づく対策を講じるために必要な手法と仕組みが整備されていないことから、開発規制や災害予警報・避難体制の構築はほとんど行われていないのが実情であり、これを可能にするためには、これらの現象の科学的理解に基づく信頼しうる危険度評価手法やハザードマップ作成手法の開発、及び災害リスクを考慮した土地利用の改善に資する研究の実施が求められている。

このような背景において、2008 年に創設された「地球規模課題対応国際科学技術協力」の制度の下で、本案件がクロアチア政府から要請され、2009 年 1 月に詳細計画策定調査が実施された。また、2009 年 3 月に実施協議調査団が派遣され、2009 年 3 月 27 日に討議議事録（Record of Discussion：R/D）が署名された。プロジェクト終了予定は 2014 年 3 月 31 日であり、2013 年 12 月に R/D の第 V 項に従って終了時評価が実施された。

1-2 協力内容

(1) プロジェクト目標

クロアチア国内で適用可能な土砂・洪水災害統合ハザードマップ作成手法、及びハザードマップに基づく土砂・洪水災害軽減のための土地利用ガイドライン作成手法が開発される。

(2) 成果

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[1] 主に砂が堆積作用により固結してできた岩石
[2] 泥が水中で水平に堆積したものが脱水・固結してできた岩石のうち、堆積面に沿って薄く層状に割れやすい性質があるもの
[3] 岩質の違う単層が交互に繰り返し重なり合っている層

<table>
<tr><td colspan="4">
1) クロアチア国の水文、地質条件に適応した地すべりの危険度評価手法、地すべり運動予測手法及び早期警戒システムが開発される。
2) クロアチア国の水文、地質条件に適応した局所的洪水（フラッシュ・フラッド）、土石流のシミュレーションモデル、及び早期警戒システムが開発される。
3) 土砂・洪水災害統合ハザードマップ、及びこれに基づく被害軽減のための土地利用ガイドラインが、調査対象地域で作成される。
(3) 投入（終了時評価時点）
（日本側）短期専門家（研究者）: 18 名（計 1,384 日間）、長期専門家（業務調整）: 1 名
本邦研修 : 2010～13 年計 18 名
供与機材費 : 1 億 6802 万円（2010～13 年 11 月時点までの合計）
プロジェクト活動費 : 3 億 7758 万円（2010～13 年 11 月時点までの合計。供与機材費のほか、専門家派遣費用、本邦研修費用、現地活動費など）
（クロアチア側）カウンターパート : MZOS（科学教育スポーツ省）、ザグレブ大学、リエカ大学、スプリット大学、クロアチア水公社、クロアチア地質調査所、事務所スペース・備品の提供
(4) プロジェクトサイト
調査対象地域 : ザグレブ、リエカ、スプリット
</td></tr>
<tr><td colspan="4">2. レビュー調査団の概要</td></tr>
<tr><td>調査団構成</td><td colspan="3">1. 江尻幸彦（団長/総括）JICA 地球環境部　専任参事
2. 北村浩一（協力企画）JICA 地球環境部防災第一課
3. 青木裕子（評価分析）国際航業株式会社</td></tr>
<tr><td>（以下オブザーバー）</td><td colspan="3">4. 本藏義守（科学技術評価）JST 地球規模課題対応国際科学技術協力事業研究主幹
5. 増田勝彦（科学技術評価）JST 地球規模課題国際協力室</td></tr>
<tr><td>調査期間</td><td>2013 年 12 月 1 日～2013 年 12 月 18 日</td><td colspan="2">調査種類：終了時評価</td></tr>
<tr><td colspan="4">3. 進捗の確認</td></tr>
<tr><td colspan="4">
3-1 成果レベルの実績
1) 成果 1
・ コスタニエク（ザグレブ）、グロホボ（リエカ）、ドゥチェ及びオミッシュ（スプリット）の計 4 カ所のモデルサイトが選択されている。成果 1 は達成された。
・ 地すべり危険度評価法に関するマニュアルは 2012 年度の段階で完成している。（指標 1－1 は達成された）
・ 地すべりダイナミックスに基づく地すべり移動のシミュレーションはコスタニエクおよびグロホボの 2 箇所に関して実施済みである。（指標 1－2 は達成された）
・ 地すべり早期警戒システムの配備はコスタニエクおよびグロホボの 2 箇所に関して完了している。（指標 1－3 は達成された）
2) 成果 2
・ レジナ川流域、ドブラチナ川流域、モセニツカ・ドラガ（リエカ）、イモツキ、スティナ・カラカティカ（スプリット）の 5 カ所のモデルサイトが選択されている。成果 2 は終了時評価時点では達成されていないが、プロジェクト完了時までには達成される見込みである。
</td></tr>
</table>

・ 各モデル地域に適用するフラッシュ・フラッド、土石流のシミュレーションモデルは開発されている。レジナ川流域およびドブラチナ川流域ではフラッシュ・フラッドのシミュレーションを実施中であるが、他地域に関しても残期間中に実施予定である。（指標 2－1）
・ 早期警戒システムの開発は終了している。当初予定のレジナ川流域をソルト・クリークに変更し、同地域に対してはレーダー雨量計に基づく早期警戒システムを配備する。一方、モセニツカ・ドラガ流域に対しては通常雨量計に基づく早期警戒システムを配備する 。（指標 2－2）

3) 成果 3

・ メドヴェニカ丘陵地帯（ザグレブ）、レジナ川流域、ドブラチナ川流域（リエカ）、ドゥチェ、オミシュ（スプリット）の計 5 カ所のモデルサイトが選択されている。成果 3 は終了時評価時点では達成されていないが、プロジェクト完了時までには達成される見込みである。
・ 現時点では、洪水災害ハザードマップの作成が完了していないが、土砂災害ハザードマップは最も広域で地すべりが多数分布するザグレブ地域に関して完了している。リエカ地域に関しても土砂災害ハザードマップは完了している。なお、スプリット地域に関しては岩盤崩落に関するハザードマップを作成中である。（指標 3－1）
・ 現時点では、洪水災害ハザードマップが完了していないため、土砂災害ハザードマップに基づくガイドラインを作成した段階である。主として人口密集地域であるザグレブ地域を対象として作成しており、他地域への適用に関わるヴァージョン変更を検討中である。スプリット地域では、岩盤崩落が主対象となるために、斜面点検カルテを作成中である。（指標 3－2）

3-2 プロジェクト目標の達成度

プロジェクト目標の指標は、中間レビュー調査時点で設定され合同調整委員会（Joint Coordination Committee : JCC）で合意された。プロジェクトは各成果レベルで着実に研究活動が進展している。プロジェクトの総合的な進捗から、活動開始の遅れや資機材設置の遅れはあったものの、プロジェクトは 2014 年 3 月までの終了期間までに目標を達成する可能性は十分あると見込まれる。

4. ５項目評価の概要

4-1 妥当性

プロジェクトの妥当性は高い。

・ クロアチアには、保安・救援に関する計画（官報 96/10）、自然災害からの保護に関する法律（官報 73/97）など、災害被害軽減に関するいくつかの政策・法律があり、本プロジェクトはこれら政策・法律に整合しているたけでなく、その実現に貢献している。
・ モデルサイトは、クロアチア側の研究者の提案に基づき決定されている。ザグレブ市コスタニエクは、クロアチアで最大の地すべり地帯であり、ザグレブ市危機管理室の主要懸案事項となっている。リエカ市がその河口に位置するレジナ川は、洪水が起きた場合には市に大きな被害が及び、グロホボで同時に地すべりが起これば土石流により更に被害が拡大することも予想される。スプリットのオミシュ及びドゥチェは、頻繁に起こる落石により多くの家屋と人々が被害を受ける恐れがある。本プロジェクトは、こうした地方自治体や住民の災害軽減のニーズにも応えるものである。

4-2 有効性

プロジェクトの有効性はやや高い。

・ プロジェクトの 3 つの成果はプロジェクト目標を達成するために必要なコンポーネントであ

り、これら成果とプロジェクト目標との関係は明確である。
・ 終了時評価時点では、プロジェクト目標を達成していないが、残期間で達成できる見込みが高い。
・ コスタニエクに配備した地すべり計測機器により観測された地すべり移動データに従って、2013 年 3 月に検知した異常値に対して、実際に緊急対応を実施することが出来た。

4-3 効率性

プロジェクトの効率性は中程度である。

・ R/D 署名は 2009 年 3 月 27 日であったが、クロアチア側で内部調整に時間がかかったため口上書交換が終了したのは 2010 年 3 月 9 日であり、プロジェクトの開始が 1 年遅れた。
・ またプロジェクト機材の調達については、付加価値税（Value Added Tax：VAT）免税が R/D に記載されていたものの、VAT 免税の手続きについて、日本側・クロアチア側双方の関係機関でこれまで実際に行った経験がなかった。その結果、研究に必要な機材の調達・設置が遅れ、さらにプロジェクト活動の進捗に影響を与えることとなった。
・ プロジェクト開始当初より、日本側研究者・クロアチア側研究者はワーキンググループ（Working Group：WG）1、2、3 に属し、それぞれ成果 1、2、3 を担当してきた。しかしスプリット大学は、ザグレブ大学およびリエカ大学から距離的に離れているため、これら WG の一部として速やかな打ち合わせや調整が困難であった。このため、第 1 回 JCC 後にスプリット大学に新たに WG4 が設置され、今後はプロジェクト・マネジャーと直接連絡を取ること等によるプロジェクト調整の効率化が図られた。
・ 本邦研修を受けた元研修員は、研修でマスターしたことを帰国後も実践、研究に活用している。
・ 供与機材はすべて各大学の備品として登録され、管理されており、活用されている。

4-4 インパクト

プロジェクトのインパクトは高い。

・ プロジェクトにより、地方自治体と大学との関係が開始され、強化されている。地方自治体は R/D にはカウンターパートとして記載されていないが、今では研究者によりプロジェクト目標の達成に向け欠かせないパートナーであると認識されている。
・ プロジェクトが実施した国際会議では、セルビア、ボスニア・ヘルツェゴビナ、コソボ、マケドニア、スロベニアといった隣国からの研究者も参加し、地すべりと局所的洪水・土石流に関する研究成果と知見が共有されている。

4-5 持続性

プロジェクトの持続性はやや高い。

・ 人材的、技術的な観点からみたプロジェクトの持続可能性の見込みは高い。現在、9 人の若手研究者が科学教育スポーツ省（Ministarstvo obrazovanja, znanosti i sporta：MZOS）の予算によりプロジェクトに従事し博士号を取得する予定で、プロジェクト期間終了後も、また博士号取得後も MZOS による支援が継続される予定である（研究者支援プログラムがある）。
・ 制度的な観点からは、研究成果がどのように土地利用ガイドラインといった行政政策に反映されるのか、その道筋が現時点では明確ではない。地方自治体と大学との関係については災害リスク管理に向けた連携の仕組み作りが必要で MoU の締結などがあることが望ましい。また、研究成果がクロアチア国内の災害管理政策に貢献していくためには、国家保安・救援局の巻き

込みも今後必要である。

・ 今後の研究費用や機材のメンテナンスコストなどは、大学側が積極的にプロジェクトに応募していくことで資金を獲得していく必要がある。

4-6 プロジェクトの効果発現を促進・阻害した主な要因

(1) 促進要因

クロアチア側の人材的・技術的な高いキャパシティに加え、両国の研究者がプロジェクト当初の遅れを取り戻すべく鋭意活動を実施してきていること、また日本の研究者が頻繁にクロアチアに赴き、研究及び関係者間の調整活動を行ってきたことが、主な促進要因として挙げられる。

(2) 阻害要因

クロアチアでの技術協力プロジェクトの実施例は少なく、また現地事務所や兼轄する周辺事務所もないという状況での事業実施となったことが、国際約束の締結や供与機材の免税といったプロジェクト業務手続きの遅れの主要因として認められた。

5. 評価結果の要約

5-1 結論

プロジェクトは、災害軽減に関するクロアチアの法律・政策と整合しているだけでなく、対象地域の地方自治体・人々のニーズにも合致しており、その妥当性は高い。プロジェクトの有効性については、プロジェクトの開始および機材供与の遅れがあったが、活動自体はスムーズに実施されたので、やや高いと判断した。プロジェクトの効率性は中程度と判断されたが、これはプロジェクト開始の遅れ、続く機材設置の遅れがあったためである。本邦研修および機材供与の効率性は高かった。インパクトについては高く、負のインパクトはなかった。プロジェクトの持続性については、人材的・技術的な観点からは活動の十分な維持が見込まれるが、制度的・財政的な観点からは、防災に関わる政府機関と正式な取り決めを交わすなど、また研究資金の獲得の目処をつけることが望まれる。

5-2 提言

プロジェクト目標達成に向けて活動促進について

プロジェクト終了までの残期間で完了する予定の成果品や指標達成の目処はたっており、両国の研究者は、それに向けてより一層活動に専念することが期待される。

プロジェクト成果の有効活用について

クロアチア側の各大学と地方自治体の連携がより一層促進されることが期待される。地方自治体と大学との関係については災害リスク管理に向けた連携の仕組み作りが必要であり、MoU の締結などがあることが望ましい。

プロジェクト終了後の研究のフォローアップや連携について

研究のより一層の発展のため、プロジェクト終了後も両国の研究者は、データや観測結果の共有など研究を継続していくことを提言する。

プロジェクト終了後の機材管理について

クロアチア側の各大学に供与された機材について、特に運用・維持管理費の獲得が必要である。

EU 加盟による免税措置の適用について

クロアチアが 2013 年 6 月より EU に加盟したことにより、免税が適用されなくなり現時点で機材供与が停止していることから、早期解決を図る必要がある。

事後評価の実施について

JICA による事後評価を実施することを提言する。終了時評価時点からプロジェクト完了時までの間に出されるプロジェクトの成果が評価される機会が必要である。

5-3 教訓

JICA 技プロ協力プロジェクトの実施例が少ない国でのプロジェクト形成・実施について

本プロジェクトでは事業実施のための国際約束の締結及び機材供与にかかる VAT の免税について、事業準備段階で通常以上にきめの細かい説明や現地事情の調査を行うことによって、プロジェクト立ち上げの遅れは回避または相当程度軽減することができたと考えられる。プロジェクトの実施に関して、現地での JICA によるサポートができないことから、在外事務所のある国での事業以上の本部からのサポートを行う必要がある。

社会の持続的発展について

防災に関する研究成果は実社会に適用されなければならない。地方自治体や中央政府の関連機関・組織は JCC メンバーとして組み込まれているべきであった。プロジェクトの計画時点で関連機関・組織を特定し、プロジェクト開始時点より JCC メンバーとして組み込んだほうがよい。

以上

Terminal Evaluation Summary Sheet

1　Outline of the Project	
Country: Republic of Croatia **Thematic Area：** Disaster Management **Division in Charge：** Disaster Management Division II, Water Resources and Disaster Management Group, Global Environment Department	**Project Title：** Project on Risk Identification and Land-use Planning for Disaster Mitigation of Landslides and Floods in Croatia **Cooperation Scheme：** SATREPS (Science and Technology Research Partnership for Sustainable Development)
Project Period： Mar 2009～Mar 2014	**Total Cost：** 350 million JPY (JICA budget)
Supporting Organization in Japan： Niigata University, Kyoto University, ICL(International Consortium on Landslides), Tohoku Gakuin University, Yamagata University	**Counterpart Agency：** MZOS (Ministry of Science, Education and Sport), UZ (University of Zagreb), UR (University of Rijeka), US (University of Split), Croatian Water, Croatian Geological Survey

1.1 Background of the Project

Croatia has frequent earthquakes and, along the Adriatic coast, has a large amount of precipitation. At some places, average annual rainfall is 3,500mm and more. Triggered by such earthquakes and rainfall, sediment disasters occur quite often such as landslides, slope failure, and debris flow. The land of Croatia has a complex, fragile terrain and geological structure affected by earth faults and folds. Sediment disaster are common at the alternation of sandstone-shale strata that is prone to weathering, as well as at slopes with marl layer containing large amounts of clay with low friction angle prone to land sliding. Local flood (flash flood) occurs at limestone regions where water roads are easily formed in the strata.

Sprawling of cities is causing the accumulation of assets and population growth in sub-urban areas, but many of these areas are at high risk of such disasters in Croatia, thus raising concerns about increasing damages by flash floods and landslides. In some areas, disaster risk is likely to become even higher with a change in rainfall patterns due to climate change.

In Croatia, however, techniques to assess flash-flood/landslide risk and mechanisms to take measures on the risk assessment are not yet developed. Sprawling control as well as disaster warning systems and evacuation rules are not in place yet, either. Towards such disaster risk management, researches are required to develop methodologies for hazard mapping and risk assessment based on scientific data of these phenomena, and to improve the land use taking into consideration such disaster risks.

In this context, this Project was requested by the Government of Croatia. Based on a detailed planning survey in January 2009 and a following consultation mission in March 2009, the R/D of the Project was signed on 27 March 2009 under the scheme of SATREPS for 5 years. In December 2013, about 4 months before the termination of the Project period, a terminal evaluation is to be conducted as dictated by the Article V of the signed R/D.

1.2 Project Overview

1) Project Purpose

Integrated landslide/flood hazard mapping technology and land-use guidelines formulation methodologies are developed for nation-wide application in Croatia.

2) Outputs

1. Methodologies for landslide risk assessment, prediction of affecting areas, and early warning systems are developed adapting to hydrological and geological conditions in Croatia.
2. Flash-flood/debris-flow simulation models and early warning systems are developed adapting to hydrological and geological conditions in Croatia.
3. Integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation are developed for study areas.

3) Inputs

(Japanese Side)

Experts: 18 researchers (total1, 384 days), and 1 project coordinator.

Counterpart Training in Japan: Total 18 professors and young researchers from 2010 to 2013

Provision of Equipment: 168 million JPY (2010 - 2013)

Project Cost: 377.6 million JPY (2010 – 2013 for Dispatch of Experts, Trainings, Equipment, Local Costs, and others)

(Croatian Side)

Counterpart: Project Director (MZOS), Project Manager (UR), Deputy Project Manager (UZ), Project Coordinator (UZ), and 42 researchers/personnel.

Local Operational Cost: lump sum of 307,500 Kuna/year, salaries of 9 young researchers working for the Project, shipment and installation costs of equipment provided, and meeting and travel costs.

4) Target Area

Study Areas: Zagreb, Rijeka, and Split

2 Review Team		
Member of the Review Team	1. Mr. Yukihiko Ejiri (Leader) Senior Advisor to the Director General, Water Resources and Disaster Management Group, Global Environment Department, JICA 2. Mr. Koichi Kitamura (Survey Planning) Water Resources and Disaster Management Group, Global Environmental Department, JICA 3. Dr. Yuko Aoki (evaluation and Analysis) Kokusai Kogyo co. ltd,.	
(Observer)	4. Dr. Yoshimori Honkura (SATREPS Evaluation) Program officer of Natural Disaster Prevention, Research Partnership for Sustainable Development Division, JST 5. Mr. Katsuhiko Masuda (SATREPS Evaluation) Staff, Research Partnership for Sustainable Development Division, JST	
Review Period	1December 2013 ～ 18December 2013	**Type of Evaluation：** Terminal Evaluation

3 Project Performance

3.1 Achievements of Outputs

(Output 1)

- There are four model sites selected: Kostanjek Landslide (a part of Medvednica Hilly Area, City of Zagreb), Grohovo Landslide (a part of Rječina River Basin, Primorsko-Goranska County, Rijeka), Duće and Omiš (Split-Dalmatian County).
- The land risk assessment is composed of two manuals, one is for wider areas as Hilly area of the Medvednica Mountain back of Zagreb city and Rječina basin by analyzing aerial photos and risk assessment using AHP, and another is using LS-RAPID computer simulation for specific landslide area as Kostanjek and Grohovo, and both were completed. (The indicator 1-1 is achieved.)
- Simulations for landslide predictions on dynamics for 2 model sites, Kostanjek, Grohovo were conducted. (The indicator 1-2 is achieved.)
- Landslide early warning systems for 2 model sites, Kostanjek, Grohovo were established. (The indicator 1-3 is achieved.) The Establishment of early warning system of the Project indicates that setting the necessary monitoring equipment for data collection and establishing the basic flow and procedures for early warning.

(Output 2)

- There are five model sites selected: Rječina River Basin, Dubračina River Basin, and Mošćenička Draga (Primorsko-Goranska County, Rijeka), Imotski and Sutina-Karakašica (Split-Dalmatian County). Besides, at Daruvar, the UR is conducting a research to clarify essential factors on flash-flood/debris-flow simulation model, considering sustainable land management to mitigate water erosion on different tillage treatments.
- The simulation model was already developed. At the moment, an application of the simulation model in Rječina River Basin, Dubračina River Basin and Imotski have been conducted, and for Mošćenička Draga, and Sutina-Karakašica, they are almost completed. (Indicator 2-1 is not achieved yet though, will be achieved by the end of Project period.)
- The development of a basis of flash-flood early warning system was completed. The system was applied to Dubračina River Basin (Salt Creek) first as data was collected more than others and the early warning system is going to be established based on data of the RADAR.
- For Mošćenička Draga river basin where the higher risk of flood, the early warning system is almost established. It has been collecting data though, due to the small rainfall since starting measurement, more data and time needed for tuning. While, Rječina River Basin has completed establishing the system. (Indicator 2-2 is not achieved yet though, will be achieved by the end of Project period.) As explained above, the Establishment of early warning system of the Project indicates that setting the necessary monitoring equipment for data collection and establishing the basic flow and procedures for early warning.

(Output 3)

- There are five model sites selected: Hilly area of the Medvednica Mountain (Zagreb), Rječina River and Dubračina River basin (Primorsko-Goranska County, Rijeka) and Duće and Omiš areas

(Split-Dalmatian County).

- At the moment, only the hazard map of landslide for Zagreb where many landslides were found in wide area was completed while the flood hazard map is not completed yet, it's almost completed though. In Rijeka, the landslide hazard map was completed. As for the Split, the hazard map of rock fall is in the process of making. Development of integrated landslide/flood hazard map for model sites is going to be completed in the rest of Project period. (Indicator 3-1 is not completed yet.)
- At the moment, only the guide line for land used based on Landslide Hazard map was developed as the flood risk hazard map has not completed yet. The hazard map developed was mainly for Zagreb area where the densely populated area, while the modified versions for other areas are planning to be developed. As for Split area, the checking slope carte has been developing. For Rijeka, the risk assessment was completed in the main part of Rječina River Basin. The result of the risk assessment was finished plotting and it can be converted into hazard map as the land-use is simple. Making the land-use guidelines are going to be finished in the rest of Project period. (Indicator 3-2 is not completed yet.)

3.2 Achievements of Project Purpose

At present, the project is making a steady progress of research activities at each output level as summarized in the above section. Considering the overall progress towards attaining the Project Purpose, in spite of the delay of launching the Project and setting up the monitoring equipment at model sites, thanks to the great efforts of both Japanese and Croatian sides, the Project has a good potential to achieve its goal by the end of project period, March 2014. This evaluation took into consideration that there is the effect of delay on starting the project, procurement and installation of equipment, as all the research activities require some period of time for accumulation of data collection for analysis and technology transfer.

4 Review Based on the 5 Criteria

4.1 Relevance

The relevance of the Project is high.

- There are several laws and policies speaking to the importance of disaster mitigation in Croatia such as Protection and Rescue Plan for Croatia (Official Gazette 96/10) and Law on Protection from Natural Disasters (Official Gazette 73/97). The project is aligned with these Croatian laws/policies, and contributes to their realization.
- The model sites of the Project were proposed by Croatian researchers. The Kostanjek in Zagreb is the largest landslide in Croatia, and one of primal concerns of the Emergency Management Office in the City of Zagreb. At the downstream of Rječina River located the city of Rijeka, and the flood waters can cause significant damage to the city; it could be an even higher hazard in case of concurrent rock avalanche at Grohovo landslide. The model sites in Split are Omiš and Duće where a rock fall is quite frequent, causing damages and posing threats to many houses and population in the towns. The project can also meet the needs and expectation of these local authorities and population.

4.2 Effectiveness

The effectiveness of the Project is medium/high.

- The basic design of the Project is clear as per summarized in the Master Plan, and the three outputs are essential components for the Project to achieve its purpose.
- The project was developed methods and models such as landslide risk assessment, prediction of landslide affecting areas, flashflood/debris-flow simulation model, and integrated landslide/hazard mapping technology. The verification of these methods and models are conducted with measurement and data from physical experiments while actual hazardous events don't occur so often. Within the project period, the verification by natural events depends on weather, but refinement of methods and models will continue.
- In March 2013, the installed monitoring equipment detected unusual movement at Kostajek landslide. Japanese researchers visited the sites urgently with Croatian researchers and discussed the counter measures. The correspondence of the researchers against this event can be said one of the effectiveness of the Project.

4.3 Efficiency

The efficiency of the Project is medium.

- The R/D of the project was signed on 27 March 2009, but it was 9 March 2010 when the Note Verbal was exchanged for launching the Project as it took long time for Croatian side to conduct necessary inter-organizational coordination.
- For project implementation, MZOS has prepared a counter-budget, which includes the lump-sum 307,500 HRK/year (total fund 1,230,000HRK), salary payments of nine young researchers (9,700 HRK/moth/researcher) who are expected to obtain doctor's degree through researches in the Project, and payment for equipment installation and maintenance. And travel allowance & accommodation for researchers are ensured by each university. Each faculty of the three universities implementing project activities also has borne a part of operational costs such as conference and travel.
- All researchers who took the training in Japan highly appreciated what they had leant and fully utilizing for their research, so as business trips of Croatian professors and the EMO management.
- All equipment donated is also fully utilized.

4.4 Impact

The impact of the Project is high.

- Positive impacts such as measures against natural hazard and disaster risk mitigation can be expected once the Project achieves its purpose and the application of research results to local/national government policies starts realized. At the time of Terminal Evaluation, Croatian counterparts have already started working towards such expected impacts.
- It is widely indicated that the relationship between the universities and the local governments has been forged and strengthened due to the presence of the Project.
- Through international conference organized by the Project, research results and findings on landslides and flash-floods/debris-flow are shared among researchers from neighboring countries such as Serbia, Bosnia and Herzegovina, Kosovo, Macedonia, and Slovenia, where studies on disaster risk

management are important and required for societies.

4.5 Sustainability

The prospect of sustainability of the Project is medium/high.

<Institutional sustainability>

- From an institutional viewpoint, as described at the Impact, the relationship between the universities and the local governments has become close through the Project activities. It is still further clarified how the research results will be incorporated into the local government policy such as the preparation of land-use guideline.
- The relationship between the local authorities and the universities is still at the personal level though; local governments are fully aware and understand of the importance of the research of Project. The relationship should be institutionalized or concluded a kind of agreement as a system for disaster risk management between the two entities.

<Technical sustainability>

- Prospect of sustainability from the viewpoints of human resource and technical capacity is indicated almost high. Currently, nine young researchers, doctoral students, are sponsored by MZOS to work for the Project. It will lead to a significant human resource capacity when they obtain doctorates. Equipment installed in model sites is currently well maintained; a container of monitoring observatory, pore pressure gauge and GNSS/GPS, a fence around solar panels, concrete base of a pole for the prism, and insurance policy for equipment. MZOS bears the costs of these protective and maintenance measures at the moment. Follow-on arrangement for maintenance of equipment after the end of the Project is currently being explored by the implementing universities, most probably though getting other projects that are going to be applied.

<Financial sustainability>

- At present, MZOS has prepared a counter-budget, financing a part of project operation. From a financial viewpoint, the prospect of sustainability is high according to the MZOS. MZOS will continue to support researchers.
- About the fund from EU, EU horizon 2020, application due is next year for environment science, the discussion for the application has already started among the professors of UZM, UZA, UR and US. They will make a team like the Project, and there is possibility to involve Japanese researchers as advisers. Once funded, those young researchers will be sponsored for their further research.
- UR is applied the bilateral project with Slovenia by January 2014, with updated and latest outcomes of the Project.

4.6 Factors that have promoted or hindered the implementation of project

(1) Promoting factors

Efforts of both Japanese and Croatian researchers to make up for the initial delay of project progress, and frequent visits of Japanese researchers to Croatian for research coordination and cooperation are recognized as promoting factors for the Project.

(2) Hindering factors

Little experience in Croatian side to conduct JICA technical cooperation before and the absence of

JICA branch office in Croatia are mainly attributed to the initial delays of Project implementation such as the exchange of Note Verbal and the procurement of equipment.

5 Results of the Terminal Evaluation

5.1 Conclusion

The relevance of the Project is high - the Project is not only aligned with national laws and policies associated with disaster mitigation, but also meets the needs of local authorities and society. The effectiveness of the Project is medium/high as the Project is properly constructed, but due to the delay of procurement of equipment, data accumulation using the equipment is not enough regardless the Project activity itself is smoothly conducted. The efficiency of the project to date is rated medium mainly due to the initial delay of project launching and further delay of equipment installation. There are several positive impacts of the Project and no negative impact. The prospect of sustainability of the Project is medium/high as technical and human resource capacity are indicated enough to sustain Project activities, but it is still in the mid of process of getting the institutional and financial sustainability. The efforts by the Croatian counterparts for the sustainability of outcomes on the Project are practical, strategic and highly appreciated.

5.2 Recommendations

Accelerate the activities to achieve the Project Purpose

The evaluation team encourages accelerating the Project activities. To achieve the Project Purpose, some more works should be intensively conducted such as finalization of hazard maps, guidelines and manuals.

Maximization of the outcomes of the Project

Strengthen collaboration between Universities and Local government is recommended. The formulation of the institutional framework based on memorandum of understanding between each university and local government should be accelerated for the official use of these outcomes of the Project in local government.

Follow up, collaborating research after the Project period

For further development of the researches, continuing researches with both Japanese and Croatian side is recommended, such as sharing the data collected and observation.

Sustainability of equipment after the Project period

Each University needs to secure the maintenance cost of equipment procured in the Project after the termination of the Project.

Issue of tax exemption after the EU accession

After Croatia became the member of the EU in June 2013, tax exemption again became the issue. Croatian side should proceed the procurement as soon as possible.

Ex-post evaluation is expected

It is strongly recommended that JICA conducts the Ex-post evaluation. Project activities planned to be implemented in the final 3 months of the Project period are expected to make a significant impact on the project outcomes.

5.3 lessons learned

The project formulation in the countries which are unaccustomed with technical cooperation Project

This project of The Record of Discussion, a basic document to implement the project, was signed on 27 March 2009, but it was 9 March 2010 when the Note Verbal was exchanged for launching the Project. In addition, due to the absence of referential precedence on VAT exemption procedure in concerned agencies in Croatia, it took time to procure equipment necessary to conduct research.

When the project is formulated in the countries which are unaccustomed with technical cooperation project, JICA has to confirm envisage preconditions and obstacles carefully and make clear the roadmap to solve them prior to the launching of the project. Especially, the project in the countries where JICA doesn't have representative office needs to cooperate more closely with JICA headquarters or neighboring country's office.

For sustainable development of society

Research results of disaster prevention should be practically applied to the society. Related agencies/organization, such as local and central government level should be included in JCC. It is ideal that related agencies should be identified at the stage of detailed planning survey and assign them as JCC members from the beginning of the Project.

第１章　評価調査の概要

１－１　背景

クロアチアの国土は、断層・褶曲の影響を受けた複雑で脆弱な地形・地質構造を有し、地震が頻繁に発生する。また、アドリア海沿岸部を中心として全般的に降水量が多く、年平均降水量が3,500mm を超えている地域もある。こうした地震や降雨が引き金となり、風化しやすい砂岩[4]・頁岩[5]（けつがん）互層[6]や摩擦角の低い粘土を多量に含んだ泥灰岩層のある斜面・渓流においては、地すべり、斜面崩壊、土石流等の土砂災害が多発し、また地層中に水みちが形成されやすい石灰岩地域においては局所的洪水（フラッシュ・フラッド）が発生する。

このような災害リスクの高い地域は、都市周辺部に多く見られるが、無秩序な開発により人口増加や資産の蓄積が進んでおり、土砂災害やフラッシュ・フラッドによる被害の増加が懸念されている。また、今後、気候変動による降雨パターンの変化で、地域によっては災害リスクがさらに高まる恐れもある。

しかしながら、クロアチアにおいては土砂災害やフラッシュ・フラッドのリスクを的確に評価し、それに基づく対策を講じるために必要な手法と仕組みが整備されていないことから、開発規制や災害予警報・避難体制の構築はほとんど行われていないのが実情であり、これを可能にするためには、これらの現象の科学的理解に基づく信頼しうる危険度評価手法やハザードマップ作成手法の開発、及び災害リスクを考慮した土地利用の改善に資する研究の実施が求められている。

このような背景において、2008 年に創設された「地球規模課題対応国際科学技術協力」の制度の下で、本案件がクロアチア政府から要請され、2009 年 1 月に詳細計画策定調査が実施された。また、2009 年 3 月に実施協議調査団が派遣され、2009 年 3 月 27 日に討議議事録（R/D）が署名された。プロジェクト終了予定は 2014 年 3 月 31 日であり、プロジェクト終了 3 カ月前である 2013 年 12 月に、R/D の第 V 項に従って終了時評価調査を実施した。

１－２　評価調査の目的

終了時評価調査の目的は次の通りである。

1)　「新 JICA 事業評価ガイドライン（2010 年 6 月）」に基づき、マスタープランの達成度について、評価 5 項目（妥当性、有効性、効率性、インパクト、持続性）の観点から、終了時段階にあるプロジェクトのレビューを行う。
2)　プロジェクトの残り期間における対応について提言をまとめる。
3)　プロジェクトの指標について、関係者間での共通認識を得る。
4)　現在実施中あるいは今後実施予定の類似案件に対する教訓を導き出す。
5)　終了時評価調査の結果、提言及び指標等の内容をレビューレポートに取りまとめ、クロアチア側関係者と協議を行い、合意形成した上で、ミニッツ署名により確認する。

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[4] 主に砂が堆積作用により固結してできた岩石
[5] 泥が水中で水平に堆積したものが脱水・固結してできた岩石のうち、堆積面に沿って薄く層状に割れやすい性質があるもの
[6] 岩質の違う単層が交互に繰り返し重なり合っている層

１－３　評価調査団の構成

終了時評価調査は、以下の団員から構成された調査団により実施された。

名前	役割	所属
江尻　幸彦	団長/総括	JICA 地球環境部　専任参事
北村　浩一	協力計画	JICA 地球環境部防災第一課
青木　裕子	評価分析	国際航業株式会社
【以下、オブザーバー】		
本藏　義守	科学技術評価	JST 地球規模課題対応国際科学技術協力事業　研究主幹
増田　勝彦	科学技術評価	JST 地球規模課題国際協力室

１－４　調査日程

日程は付属資料 1 Annex3 の通りである。

１－５　評価調査の手法

終了時評価調査は、OECD が発行した「開発援助の評価のための諸原則（1991）」を踏まえて準備された「新 JICA プロジェクト評価ガイドライン第 1 版（2010 年 6 月）」に基づいて実施された。プロジェクトに対する評価調査の基準としたのは、プロジェクト目標、成果、指標、活動が記載された当該プロジェクトのマスタープランである。（付属資料 1 Annex 1）

まず、プロジェクトに関する報告書や関連資料を参照しながら、JICA ガイドラインに提示された評価判断のための情報を整理するためのフレームワークとして、活動状況・進捗表と評価グリッドを用意した。そして、活動状況・進捗表については日本側研究者に記入を依頼するとともに、評価グリッドについては情報収集のためクロアチア側研究者・日本側研究者向けの質問票を作成・配布した。現地調査中は、質問票に基づいてクロアチア側関係者にインタビューし、関連文献および資料を収集し、モデルサイトおよび関連地方自治体を訪問した。（付属資料 1 Annex 3/Annex 4）

こうして報告書、活動状況・進捗表、インタビュー、質問票、サイト訪問などから情報・データを集め、これらの整理と分析に基づいて、プロジェクトの実績を確認するとともに 5 項目に基づくレビューを実施し、提言を抽出した。

5 項目（妥当性、有効性、効率性、インパクト、持続性）については次の通りである。

妥当性	プロジェクト目標が、クロアチアの開発政策や課題ニーズ、日本の援助方針に対して、どの程度関連性があるかを評価した。
有効性	プロジェクトが目的を達成するために効果的に組み立てられ、その結果として、活動の進捗によるプロジェクト目標の達成の見込みを分析した。
効率性	成果の産出に向けた投入の内容・量・質・タイミング等を整理して、これらが活動を通していかに効率的に成果に転換されたかを評価した。
インパクト	プロジェクトの実施によって生じた、プロジェクトの枠組み外における正・負の影響を調べた。
持続性	達成される成果や便益がプロジェクト終了後も維持されるかどうかについて、制度、技術、人材、財政の各観点から現時点での見通しを示した。

第２章　プロジェクトの概要

２－１　プロジェクト目標

クロアチア国内で適用可能な土砂・洪水災害統合ハザードマップ作成手法、及びハザードマップに基づく土砂・洪水災害軽減のための土地利用ガイドライン作成手法が開発される。

２－２　成果

1. クロアチア国の水文、地質条件に適応した地すべりの危険度評価手法、地すべり運動予測手法及び早期警戒システムが開発される。
2. クロアチア国の水文、地質条件に適応した局所的洪水（フラッシュ・フラッド）、土石流のシミュレーションモデル、及び早期警戒システムが開発される。
3. 土砂・洪水災害統合ハザードマップ、及びこれに基づく被害軽減のための土地利用ガイドラインが、調査対象地域で作成される。

第３章　プロジェクトの進捗

３－１　投入実績

プロジェクトの R/D は 2009 年 3 月 27 日に署名されたが、プロジェクト開始の前提条件となる国際約束の締結に際して、クロアチア側が内部調整に多大な時間を要し、ようやく 2010 年 3 月 9 日に口上書交換が完了した。当初開始予定から 1 年遅れ、プロジェクトへの投入は 2010 年 5 月の日本人専門家の派遣により開始された。

（日本側）

1)　専門家（日本側研究者）の派遣

2010 年 5 月から 2013 年 12 月までの間、18 人の研究者が、日数にして 1384 日間クロアチアに派遣された。それぞれの研究者はワーキンググループ（Working Group：WG）1、2 または 3 のいずれかに属している。加えて、2010 年 5 月から業務調整専門家 1 名が JICA より派遣されている。（付属資料 1 Annex 5）

2)　カウンターパート（クロアチア側研究者）本邦研修

ザグレブ大学、リエカ大学、スプリット大学、およびクロアチア地質調査所から、6 名の大学教授および自治体職員、12 人の若手研究者が、2010～13 年の間に、 東北学院大学、山形大学、新潟大学、国際斜面災害研究機構（International Consortium on Landslides：ICL）および京都大学で実施された本邦研修に参加した。（付属資料 1 Annex 6）

3)　供与機材

プロジェクト活動は、R/D 署名から 1 年遅れて 2010 年 5 月より開始された。加えて、クロアチア側実施機関に付加価値税（Value Added Tax：VAT）免税手続きの経験がなかったことから、求められる手続き解明に時間がかかっていた。このため、当初クロアチアで現地調達する予定であった機材を急きょ本邦調達に変更してクロアチアに輸送することとなり、この変更で機材の納入がさらに遅れることとなった。土砂災害、フラッシュ・フラッドの研究のため供与された資機材の金額は、2010-13 年の合計で 848,476.84HRK となっている。（付属資料 1 Annex 7）

4)　プロジェクト活動費

日本側はプロジェクトを実施するための活動費の一部を負担した。先に記述した供与機材費のほか、日本人研究者・業務調整専門家の派遣、クロアチア側研究者の本邦研修、現地活動費（クロアチア国内の旅費、ローカルコンサルタント傭上費、会議費など）を含む全額は、2010 年～2013 年のプロジェクト全期間で 377,538,000 円（2013 年 12 月時点見込み）となっている。（付属資料 1 Annex 8）

（クロアチア側）

1)　カウンターパートの選任

プロジェクト・ディレクター（クハール氏）[7]は科学教育スポーツ省（*Ministarstvo obrazovanja, znanosti i sporta*：MZOS）から、プロジェクト・マネジャー（オザニッチ教授）はリエカ大学土木工学部（University of Rijeka, Faculty of Civil Engineering：UR）から、それぞれ選任されている。副プロジェクト・マネジャー（ミハリッジ准教授）はザグレブ大学鉱業・地質・石油工学部（University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering：UZM）から、プロジェクト・コーディネーター（キシッチ教授）はザグレブ大学農学部（University of Zagreb, Faculty of Agriculture：UZA）から、それぞれ選任されている。MZOS による 2012 年 3 月 28 日付けのレターにより、プロジェクト・マネジャーのボナッチ教授からオザニッチ教授への変更、副プロジェクト・マネジャーのオザニッチ教授からミハリッジ准教授への変更がプロジェクト関係者に伝えられた。その他のカウンターパートについては、これまでレターなどによって選任が通知されてきたわけではないが、終了時評価の時点では 44 名の研究者がカウンターパートと認められている。（付属資料 1 Annex 9）

2）　現地活動費

MZOS は、プロジェクトに対しては年間 31 万クーナの定額金、プロジェクトで働く 9 人の若手研究者の給与、供与機材の郵送・設置費用、研究者の旅費などの費用を負担している。プロジェクトを実施しているザグレブ大学鉱業・地質・石油工学部、リエカ大学土木工学部、スプリット大学土木工学・建築・測地学部もまた、会議費など活動費の一部を負担している。（付属資料 1 Annex 8）

３－２　活動実績と進捗

1）成果レベルでの実績

（成果 1）

コスタニエク（ザグレブ市メドヴェニカ丘陵地帯の一部）、グロホボ（リエカのプリモスコ・ゴランスカ郡レジナ川流域の一部）、ドゥチェ、オミッシュ（スプリット・ダルマシアン郡）の計 4 カ所のモデルサイトが選択されている。成果 1 は達成された。

指標 1-1: Number of manual book of methodologies for landslide risk assessment (1 manual) 1-2: Number of model sites to develop a simulation for landslide predictions on dynamics (2 model sites; Kostanjek, Grohovo) 1-3: Number of model sites to establish landslide early warning systems (2 model site; Kostanjek, Grohovo)

- 地すべり危険度評価法に関するマニュアルは 2012 年度の段階で完成している。（指標 1－1 は達成された）
- 地すべりダイナミックスに基づく地すべり移動のシミュレーションはコスタニエクおよびグロホボの 2 箇所に関して実施済みである。（指標 1－2 は達成された）
- 地すべり早期警戒システムの配備はコスタニエクおよびグロホボの 2 箇所に関して完了している。（指標 1－3 は達成された）

[7] プルガー氏は、プロジェクト開始時点からプロジェクト・ダイレクターを務めていたが、2013 年 9 月の異動をもってクハール氏に交代した。

・ 地すべり再現試験が可能な非排水リングせん断試験機の開発が終了し、またクロアチア若手研究者 2 人×2 カ月×2 回の、当該試験機を用いて試験方法に関する習熟訓練が実施された。クロアチア側若手研究者のみで試験可能な状況である。（活動 1-1 については終了した。）
・ モデル・サイト（コスタニエク、グロホボ）から採取した地すべり土試料が日本に配送され、当該試験機による土質試験が実施された。クロアチアのモデルサイトから採取した地すべり土試料を日本に配送し、当該試験機を用いて、土質試験を実施した。活動 1-2 については終了した。（活動 1-2 については終了した。）当該試験機のクロアチア現地への設置を 2012 年度に完了し、クロアチア側研究者が、モデルサイトの地すべり土試料の追加土質試験を実施している。（活動 1-2 については終了した。）
・ 複数のモデルサイトに関して、現地調査を数次に亘って実施した。リエカ近郊のグロホボ地すべりに関しては、計画していた総合モニタリング・システムの設置を完了し、観測を継続中である。一方、ザグレブ地域のコスタニエク地すべりに関しても、GPS モニタリング・システムおよび地震動観測システムの設置を完了し、観測を継続中である。（活動 1-3 については終了した。）
・ 1-4 項と 1-5 項は本来連動して実施されるものである。地すべり動力学に基づく地すべり危険度評価手法並びに地すべり運動予測手法は昨年度の段階で開発済みであり、適用可能な段階にあった。1-2 項で得られた土質試験結果を用い、ザグレブ地域のコスタニエク地すべりおよび、リエカ地域のグロホボ地すべりに関して 1-4 項の危険度評価並びに 1-5 項の運動予測を完了した。（活動 1-4, 1-5 については終了した。）
・ 2012 度の段階で早期警戒システムの根幹となる伸縮計をモデルサイトに設置し、観測を継続中である。ザグレブ地域のコスタニエク地すべりにおいては、既設の伸縮計および GPS による移動観測結果に基づき、4 月に早期警戒対応を実際に発動した。一方、リエカ地域のコスタニエク地すべりにおいても、既設伸縮計に基づく警戒システムを構築している。（活動 1-6 については終了した。）

（成果 2）

レジナ川流域、ドブラチナ川流域、モセニツカ・ドラガ（いずれもプリモスコ・ゴランスカ郡）、及びイモツキ、スティナ・カラカティカ（いずれもスプリット・ダルマシアン郡）の 5 カ所のモデルサイトが選択されている。また、ドゥルブルでは、持続的土地利用に向けて耕種法の違いによる土壌流出軽減に関する研究をリエカ大学が行っており、フラッシュ・フラッド、土石流のシミュレーションモデルのための要因解析に貢献することから、これを加えて計 6 カ所となる。成果 2 については、まだ達成していないが、プロジェクト残期間中に達成する見込みである。

指標 2-1: Number of model sites to formulate a flash-flood/debris-flow simulation model (5 model sites; Rječina River Basin, Dubračina River Basin, Mošćenička Draga, Imotski, Sutina-Karakašica) 2-2: Number of model sites to establish a flash-flood early warning system at Rijeka (2 model sites; Rječina River Basin, Mošćenička Draga)

- 各モデル地域に適用するフラッシュ・フラッド、土石流のシミュレーションモデルは開発されている。レジナ川流域およびドブラチナ川流域ではフラッシュ・フラッドのシミュレーションを実施中であるが、他地域に関しても残期間中に実施予定である。
- 早期警戒システムの開発は終了している。当初予定のレジナ川流域をソルト・クリークに変更し、同地域に対してはレーダー雨量計に基づく早期警戒システムを配備する。一方、モセニツカ・ドラガ流域に対しては通常雨量計に基づく早期警戒システムを残期間中に配備する予定である。
- 既存の気象・水文データを収集し、モデルサイトの降雨・流出特性を解析した。さらに、通常の雨量計に加えてリエカ大学土木工学部に設置したレーダー雨量計による計測データに基づき解析精度の向上を図っている。リエカ近郊ではドブラチナ川流域のソルト・クリーク並びにモセニツカ・ドラガ流域およびレジナ川流域に降雨計測装置の設置を終了し、降雨データを収集中である。また、昨年度の段階で、降雨計測用レーダーをリエカ大学土木工学部に設置し、広域の降雨データを収集中である。（活動 2-1 および 2-2 は完了した。）
- 土石流の物理試験が、クロアチア研究者も参加して京都大学で実施されている。その結果に関する 2 本の論文が査読に受理された。また、フラッシュ・フラッド、土石流のシミュレーション・モデル（Hydro-Debris 3D）の開発が終了している。特に、ドブラチナ川流域を対象としてフラッシュ・フラッドのシミュレーションを実施中である。引き続き、複数のモデルサイトに対してフラッシュ･フラッド並びに土石流のシミュレーションを試みる。（活動 2-3 についてはまだ完了していない。）
- リエカにおける 3 カ所のモデルサイトをカバーする降雨計測用レーダー（Furuno）の調達が完了し、稼動中である。リエカ大学土木工学部に設置されて早期警戒システムの一部として用いられる予定である。フラッシュ・フラッド、土石流の早期警戒システムの開発は終了した。通常雨量計による警戒システムをモセニツカ・ドラガ流域に設置し、レーダー雨量計による早期警戒システムをソルト・クリークに設置する。本年度残期間中において、モデルサイトに対してフラッシュ・フラッド、土石流の早期警戒システムを配備する。（活動 2-4 についてはまだ完了していない。）

（成果 3）

メドヴェニカ丘陵地帯（ザグレブ市)、レジナ川流域、ドゥブラチナ川流域（いずれもプリモスコ・ゴランスカ郡)、ドゥチェ、オミシュ（いずれもスプリット・ダルマシアン郡）の計 5 カ所のモデルサイトが選択されている。成果 3 については、まだ達成していないが、プロジェクト残期間中に達成する見込みである。

指標 3-1:	Number of study areas to develop an integrated landslide/flood hazard map (3 areas; Rijeka, Split, Zagreb)
Note):	Indicator 3-1 for Split area means two individual hazard maps for landslide and flashflood.
3-2:	Number of study areas to develop land-use guidelines for landslide/flood risk mitigation (3 areas; Rijeka Split, Zagreb)

- 現時点では、洪水災害ハザードマップの作成が完了していないが、土砂災害ハザードマ

ップは最も広域で地すべりが多数分布するザグレブ地域に関して完了している。リエカ地域に関しても土砂災害ハザードマップは完了している。なお、スプリット地域に関しては岩盤崩落に関するハザードマップを作成中である。（指標 3－1）

- 現時点では、洪水災害ハザードマップが完了していないため、土砂災害ハザードマップに基づくガイドラインを作成した段階である。主として人口密集地域であるザグレブ地域を対象として作成しており、他地域への適用に関わるヴァージョン変更を検討中である。スプリット地域では、岩盤崩落が主対象となるために、斜面点検カルテを作成中である。（指標 3－2）
- ザグレブとリエカにおいては、主として空中写真を用いてモデルサイトおよびその周辺地域の地形判読が終了した。また、必要箇所については数値地形図を作成し、一部抽出空域については航空レーザー測量（Laser Imaging Detection and Ranging：LiDAR）による地形判読が実施されている。さらにスプリットでは、WG4 では、地上からのレーザー測量（LiDAR）によるサイトの観測を 2011 年 9 月から継続している。（活動 3-1, 3-2 については、終了した。）
- 活動 3-4 は、活動 3-3 の統合ハザードマップに基づき作成することになる。土地利用ガイドラインの具備すべき要件の検討は終了している。現在は、活動 2-3 の結果に基づく洪水ハザードマップが完成していないため、土砂災害ハザードマップに基づく土地利用ガイドラインを作成した段階である。
- 活動 3-5 は、活動 3-4 の土地利用ガイドラインに基づき作成することになる。マニュアルの具備すべき要件の検討は終了している。現在は、活動 2-3 の結果に基づく洪水ハザードマップが完成していないため、土砂災害ハザードマップに基づく土地利用ガイドラインに関わるマニュアルを作成した段階である。

2) プロジェクト目標に向けた進捗

プロジェクト目標は、「クロアチア国内で適用可能な土砂・洪水災害統合ハザードマップ作成手法、及びハザードマップに基づく土砂・洪水災害軽減のための土地利用ガイドライン作成手法が開発される。」である。プロジェクト目標のための指標は署名された R/D 中のマスタープランの中では設定されていない。上のセクションで整理したとおり、現在のところプロジェクトは、各成果レベルで着実に研究活動が進展している。プロジェクトの総合的な進捗から、活動開始の遅れや資機材設置の遅れはあったものの、プロジェクトは 2014 年 3 月までの終了期間までに目標を達成する可能性は十分あると見込まれる。

３－３　実施プロセス

プロジェクト開始当初より、日本側研究者・クロアチア側研究者はワーキンググループ 1、2、3 に属し、それぞれ成果 1、2、3 を担当してきた。WG1 は詳細な地すべり研究、WG2 はフラッシュ・フラッド/土石流の研究、WG3 は広域の地すべり研究である。2012 年 2 月 23 日の合同調整委員会（Joint Coordination Committee：JCC）ののち、スプリット大学との連絡調整の促進のために新たに WG4 が形成されることとなった。

第４章　５項目による評価

４－１　妥当性

プロジェクトの妥当性は高い。

- クロアチアでは、災害被害軽減に関する幾つかの法律・政策がある。例えば、クロアチア保安・救援に関する計画（官報 96/10）、クロアチア自然災害危険性評価、クロアチア災害被害軽減、保安、救援のための基本法（官報 127/10）、自然災害からの保護に関する法律（官報 73/97）、自然災害時における保安と救援に関するいくつかの国際約束である。プロジェクトは統合ハザードマップ作成手法と、土地利用ガイドラン作成手法のクロアチア国内での適用を目指すものであり、これらクロアチアの法律・政策に整合しているたけでなく、その実施に貢献するものである。

- モデルサイトは、クロアチア側の研究者の提案に基づき決定されている。ザグレブ市のコスタニエクは、クロアチアで最大の地すべり地帯であり、ザグレブ市危機管理室の主要懸案事項ともなっている。現在ザグレブ市には土地利用計画はあるが、地すべり災害評価を含んだものとはなっていない。レジナ川の河口にはリエカ市が位置し、洪水が起きた場合には市に大きな被害が及び、さらにグロホボにおいて同時に地すべりが起これば土石流により更に大きな災害になることも予想されている。リエカ市は建設目的のための土地利用ガイドラインはあるが、これはハザードマップを含んだものとはなっていない。スプリットのモデルサイトであるオミシュおよびドゥチェは、落石が頻繁におこり、多くの家屋と人々に被害が及ぶ恐れが大きい。プロジェクトは、危険サイトをモニタリングし、早期警戒システムを設置し、ハザードマップや土地利用ガイドランを作成することから、こうした地方自治体や住民の災害軽減のニーズにも応えるものである。

- 「防災」は、我が国の ODA の重点課題「地球規模の問題の取り組み」の一つに挙げられ、2005 年 1 月に神戸で発表された「防災協力イニシアティブ」は我が国の「分野別開発政策」の一つとなっている。JICA の防災分野課題別指針においては、「災害に強いコミュニティ・社会づくり」を最も重要な戦略目標に位置づけ、具体的取組みとしてハザードマップによる災害リスクの把握や早期警戒体制の整備などを掲げている。本プロジェクトでは、土砂災害やフラッシュ・フラッドなどに対する先進的なハザードマップ作成手法及び早期警戒システムを開発し、その成果を土地利用ガイドラインの作成を通じて反映させていくこととしており、このような手法や技術は、JICA が他の開発途上国で実施する防災分野協力にも有効活用できる。

４－２　有効性

プロジェクトの有効性はやや高い。

- プロジェクトの 3 つの成果はプロジェクト目標を達成するために必要なコンポーネントであり、これら成果とプロジェクト目標との関係は明確である。前章でも見たように、プロジェ

クトは観測機材を設置し、観測データの収集・解析を進めている。現時点までで、プロジェクトは各成果レベルで確実に進展しており、活動開始の遅れや機材設置の遅れにも関わらず、2014 年 3 月のプロジェクト予定終了時期までに、目標を達成する可能性は十分にあると考えられる。

- 成果 1 と成果 2 が統合される成果 3 については、すべてのモデルサイトに適用されるわけではない。本プロジェクトは下表のとおり 8 つのモデルサイトから構成されている。土砂・洪水災害統合ハザードマップの作成と、統合ハザードマップに基づく土地利用ガイドラインが WG3 の成果品となっている。しかしザグレブ市においては洪水災害の可能性は少ないことから、WG2 はザグレブ市では洪水・土砂災害の研究を行っていない。したがってザグレブ市における WG3 の成果は、洪水の要素を含まないハザードマップおよび土地利用ガイドラインになる見込みである。また、WG4 に関しては、成果 3 では、（地すべりの特殊なケースとしての）落石に関する評価のためのハザードマップとガイドラインを作成する予定である。
- ハザードマップやガイドラインの原型となるものは日本側研究者によって作成されており、各サイトの状況に合わせて調整される。社会実装にあたっては、EU の規制にも従う必要がある。

			1 :Number of manual book to develop integrated landslide/flood hazard map (1 manual) 2 : Number of manual book to develop land-use guideline for landslide/flood risk mitigation (1 manual)							
			Output1			Output2			Output3	
			Manual for methodologies for landslide risk assessment (1Manual)	Model sites to develop a simulation for landslide predictions on dynamics (2 sites)	To establish landslide early warning system (2sites)	flash-flood/debris-flow simulation model (5 sites)	flash-flood early warning system (2 sites)	to clarify essential factors on flash-flood/debris-flow simulation model (Daruwar only)	integrated landslide/flood hazard map (3 area)	land-use guidelines for landslide/flood risk mitigation (3area)
UZM	WG1	Monitoring System	1 manual completed	Simulation completed	1st implementation was conducted April2013, ready to apply	no flush flood but rain	no flush flood but rain	—	Wider Zagreb	Wider Zagreb
UZM	WG3		—	—	—	no flush flood but rain	no flush flood but rain	—		
UZA	WG2		—	—	—	—	—		—	—
UR	WG1, WG3	Monitoring System	1 manual completed	Simulation completed	basic system is completed	flush flood for Rjecina Basin has applied	X-band radar system and Hydro-debris3D, Satellite image 3D mapping system	Comprehensive monitoring for groundwater has completed	Rječina basin	Rječina Basin
UR	WG2		—	—	—	Sediment yield model and flush flood for downstream of Salt Creek	X-band radar system and Hydro-debris3D	Comprehensive monitoring for surface and groundwater has completed	—	—
UR	WG2		—	—	—	prepared	X-band radar system , rain guage sytem, Satelliteimage 3D mapping system	Changes in river perfil and outlet of the river has surveyed	Moscenicka Draga (in Rijeka area) means individual hazard map for flash flood	—
US	WG4		—	—	—	—	—	—	for rock fall (Omiš)	for rock fall (Omiš)
US	WG4		—	—	—	—	possiblity of flood in Catchment Sutina Karakašica	—	flood (Catchment Sutina Karakašica)	flood (Catchment Sutina Karakašica)

- プロジェクトは地すべり危険度評価や、地すべり予測、局所的洪水・土石流シミュレーションモデル、ハザードマップ作成手法を開発することになっている。実際の災害は頻繁には発生しないことから、こうした手法やモデルの検証は物理実験で得られた計測とデータに基づき実施されている。プロジェクト期間内に実際の災害に基づくモデルの検証が可能かどうか

は気象条件に拠るが、モデルと手法の調整は継続している。

- 2013 年 3 月に、コスタニエクに設置したモニタリング機器が異常値を検知した。日本側研究者は緊急に現地に派遣され、クロアチア側研究者と対応を協議した。その後、数値は落ち着いたが、コスタニエクの地すべりリスクが明らかなことがわかり、実際の対応策が検証される機会となったといえる。プロジェクトが有効であることを示すことになった。観測機器を追加し、引き続きモニタリングを行っている。

４－３　効率性

プロジェクトの有効性は中程度である。

- R/D 署名は 2009 年 3 月 27 日であったが、クロアチア側で内部調整に時間がかかったため、口上書交換が終了したのは 2010 年 3 月 9 日であり、プロジェクトの開始が 1 年遅れることとなった。本プロジェクトは 2009 年 3 月開始、2014 年 3 月終了として予定された 5 年間のプロジェクトであり、開始が 1 年間遅れたことから、現在すべての活動を 4 年間で終了させる必要が出ている。

- プロジェクト機材の調達については、VAT（25%）免税が R/D に明記されているが、VAT 免税の実際の手続きについて日本側・クロアチア側双方で、これまで実際に行った経験がなかった。その結果、手続きの判明に時間がかかっていたことから、クロアチア国内で調達の予定であった機材を急きょ本邦調達してクロアチアに輸送することとなった。こうした手続き変更による遅れの結果、グロホボに機材が設置されたのは、2010 年 5 月のプロジェクト開始から更に 1 年後の 2011 年 8 月となった。このモデルサイトへの機材設置の遅れは、さらにプロジェクト活動の進捗に影響を与えることとなった。

- プロジェクトの実施に際し、MZOS は予算を手当てし、年間 307,500 Kuna の一括金、このプロジェクトを通して博士号をとる予定の 9 人の若手研究者の給与、資機材の配送と設置、研究者の旅費・宿泊費を支払っている。プロジェクトを実施している各大学の学部も、会議費や旅費といった費用を負担している。

- プロジェクトは研究の進展と知見を共有するための国際ワークショップを毎年開催している。第 1 回目は、2010 年 11 月にドブロクニクで開催、第 2 回目は 2011 年 12 月にリエカ大学で、第 3 回目は 2013 年 2 月にザグレブ大学で、第 4 回目はスプリット大学で実施された。日本人研究者とクロアチア研究者の間での研究調整のための打ち合わせややり取りは、必要に応じて適切に実施されてきている。一方、WG 間の研究者間のやりとりは日常的なメール等での情報交換のほかは、こうした国際ワークショップや JCC での場に限られている。

- プロジェクトの最初の JCC は、2012 年 2 月 23 日に、各大学およびクロアチア地質調査所（Croatian Geological Survey：CGS）からのカウンターパート、地方自治体〔ザグレブ市危機管理室（Emergency Management Office, City of Zagreb：EMO）〕代表の参加を得て、ザグレブ大農学部にて開催された。この JCC が、資機材や調達などプロジェクト実施に関する説明が、プロジェクト参画者全員と共有された最初の会議であった。こうしたアドミニストレーション目的のための会議は、プロジェクトの開始直後に開催され、プロジェクト実施に関する規

則やルールが共有されていれば、非常に有益であったと思われる。

- カウンターパートについては、例えば所属組織からの任命状あるいは JCC での承認など、何らかの手続きにより固定されてきているわけではない。カウンターパートについては、研究の進捗やその時の状況に応じて柔軟な選定がなされている。

- スプリット大学土木工学・建築・測地学部（University of Split, Faculty of Civil Engineering, Architecture and Geodesy : US）と US/UZM は距離的に離れていることから、US の研究者が WG1、2、3 の一部としてほかの研究者と打ち合わせ、すみやかなやり取りを行うのが難しかった。こうしたプロジェクト調整への対応として、US に WG4 が設置された。WG4 の設置により、US の研究内容や活動内容が変わったわけではないが、今後は、WG4 のリーダーは UR のプロジェクト・マネジャーと直接連絡できるようになり、プロジェクト調整の効率化が期待される。日本側研究者は WG4 には割り当てられていないが、必要に応じて共同で研究を行っている。

- 終了時評価時のインタビューによれば、すべての本邦研修参加者が本邦研修のタイミング・研修内容に満足しており、帰国後も研修の成果を活用・発展させている。

４－４　インパクト

プロジェクトのインパクトは高い。

- プロジェクトにより、地方自治体と大学間の関係が開始され、強化されている。地方自治体の代表者は、R/D にはカウンターパートとして記載されていないが、今では研究者によりプロジェクト目的の達成に向け欠かせないパートナーと認識されている。例えば、ザグレブ市の EMO は 2009 年に新たに設置され、地震を中心とするザグレブ市のすべての自然災害に対応することを職務としている。プロジェクト開始前は、EMO は地すべりの問題に対処する重要性をあまり感じていなかったが、特に本邦研修参加後は実際に日本のモニタリング・システムを視察したことにより、今は重要課題と認識している。プロジェクトに対しては市有地における観測機材設置に対する許可を発行するなど、プロジェクトへの支援も行っている。

- 設置された資機材のメインテナンスも、EMO と UZM の間では検討が始まっている。2014 年度からは、モニタリング・システムの保険代を負担するための予算を獲得しており、UZM との間で予算と役割を明記した Contract を近々結ぶことになっている。UZM は機材を定期的に検査し、そこで得られるモニタリングデータを市に提供していくことになっており、このようなプロジェクト終了後の体制に向けた取り組みもすでに進んでいる。

- オミシュ町は、町で頻発する落石を防止するためのプロジェクト・ドキュメントを作成した。WG4 のリーダーは、このプロジェクト・ドキュメントの審査者の一人となっており、本プロジェクトで現在実施しているモデルサイトの LiDAR 解析結果が、落石の可能性が高い箇所を特定する手助けとなることが期待されていた。プロジェクト・ドキュメントは、2013 年（終了時評価時あたり）に署名に至った。これはクロアチア政府の環境基金で、5 千万 HRK の予算が、落石防止措置に充てられることになった。期限はない。プロジェクトの供与機材は現実の問題解決のため、より広い範囲での観測に活用される予定である。スプリット大学土木

工学・建築学部はオミシュ町と共同調査・研究のための Agreement と結ぶべく、大学の弁護士とともに手続きをすすめている。

- プロジェクトが実施した国際会議では、セルビア、ボスニア・ヘルツェゴビナ、コソボ、マケドニア、スロベニアといった隣国からの研究者も参加し、地すべりと局所的洪水・土石流に関する研究成果と知見が共有されている。

- こうした隣国との国際協力については、ICL 地域ネットワーク（アドリア海・バルカン地域）および課題ネットワーク（地すべりモニタリング）の枠組みにおいて、公式化されつつある。これらネットワークは、2010 年 11 月のドブロブニクでの第 1 回国際会議で提案されたものである。UZ と UR の学部が ICL のメンバーとなり、本プロジェクトに参画していることをもってネットワークコーディネーターとして選任されている。

- このプロジェクトのプロジェクト・マネジャー（リエカ大学研究開発副学長、WG2 のリーダー）は、プロジェクトにおける役割のため、MZOS を代表して、2012 年より、国家保安・救援局（Državna uprava za zaštitu i spašavanje：DUZS）の構成員となっている。

- リエカ市もプロジェクト成果の重要性を理解しており、プロジェクト活動への便宜をはかっており、UR もデータを共有するなど、協力関係を築いている。また、クロアチア電力会社は、グロホボ地すべり地域にある河川にダムを所有しているが、ダムへの供与機材の設置にあたっての便宜、電力の供給を行っている。また、観測データの共有をしている。

４－５　持続性

プロジェクトの持続性の見込みはやや高い。

＜制度面＞

- 制度的な観点からは、研究成果がどのように土地利用ガイドラインの作成といった行政政策に反映されるのか、その道筋が現時点では明確ではない。地方自治体と大学との関係については、現時点では個人的なつながりに留まっている。これら 2 者の関係は、災害リスク管理に向けた連携の仕組みとして、今後制度化されるか、Agreement や Contract など公式な文書を交わす取り決めをしていくことが望まれる。さらに、研究成果がクロアチア国内の災害管理政策に貢献していくためには、DUZS の巻き込みも今後重要である。

＜技術面＞

- 人材的、技術的な観点からみたプロジェクトの持続可能性は、中程度以上である。現在、9 人の若手研究者が MZOS の予算によりプロジェクトに従事し博士号を取得する予定である。これは人材的な面では大きな能力開発になることが期待される。

- モデルサイトに設置された機材は、傾斜計や間隙水圧計の収納箱、太陽光パネルの周りのフェンス､プリズム柱を支えるコンクリート土台､機材に対する保険の適用に見られるように、現時点では良好に維持されている。供与機材はすべて大学の備品として登録されており、適切に管理されている。

＜財政面＞

- MZOS は、若手研究員を雇用している。MZOS には、彼らが博士号取得後も引き続き研究を続けられるための支援プログラムがあり、その適用を推進している。
- プロジェクト期間中は、MZOS が供与機材の保護・維持のための対策費用を負担している。さらに、プロジェクト終了後の機材維持にむけた支援の仕組みについても、各大学により検討が開始されている。
- 研究資金の獲得については、EU horizon 2020 という基金の環境科学部門への応募を検討している。プロジェクトに関わった 3 大学の 4 学部がチームを組み、来年初めの応募締め切りに向けて準備をすすめている。プロジェクトの日本側研究者がアドバイザーとなる可能性もある。

第５章　科学技術視点からの評価

総合評価（A：所期の計画と同等の取組みが行われている）

本プロジェクトでは、国際共同研究の開始に必要な、両国間の口上書の交換までに長期間を要し、さらに現地購入機材の VAT 免税交渉でも時間を費やした。そのため、本格的な研究活動開始は大幅に遅れたが、関係者の多大な努力の結果、現時点では、当初計画の水準までキャッチアップできたと判断される。

地すべり・洪水挙動の解明を目指した主な現地観測機器の設置や、動的載荷非排水リングせん断試験機（地すべり再現試験機）の開発が順調に進んでいる。また、リエカ地域等を対象に、我が国が開発した階層構造分析法（Analytical Hierarchy Process：AHP）による地すべり危険度評価や、洪水シミュレーションが進められている。

本プロジェクトは、計画段階から詳細な学術研究がターゲットになっていたこともあり、ワークショップ開催、プロシーディング発行、論文執筆などが重点的に行われ、多くの研究業績が得られている。

また人材育成に関しては、博士前期課程の学生の参加も見られ、研究者のシーズづくりとして評価できる。クロアチア側では、日本で開発された技術の習得等を通して、若手研究者が育成されており、相手国への貢献度は大きい。ただし、全体としては若手研究者の参加が少ないように思われ、今後は日本人人材の組織的な育成が期待される。

政策への反映という視点においては、クロアチアの開発地域・社会的価値の高い地域を対象として、土砂・洪水災害を軽減するための土地利用基本計画ガイドラインの策定、現地の地盤構造・水文特性の科学的解明に立脚した信頼し得る危険度評価法の確立、といった目標はクロアチア国の政策と合致する。現時点では本プロジェクトの成果が政策に広く反映される状況にはないが、今後の社会実装に向けた取り組みの強化により、研究成果の利活用を通して政策に反映される見込みは十分にあるものと判断される。

一方、本プロジェクトでは、我が国の最先端の防災科学技術とリーダーシップのもとで、クロアチアと同様、地すべり多発に悩む周辺西バルカン諸国（スロベニア、セルビア、モンテネグロ、ボスニア・ヘルツェゴビナ、アルバニア）を結ぶネットワーク構築を目指している。具体的には、2000 年 12 月に外務省の主催で開催された国際ワークショップにこれら周辺諸国関係者を招聘し、グループリーダー（主たる共同研究者）が座長をつとめるなどして、プロジェクト成果の波及と、南東欧地域の協力促進に向けたアウトリーチ活動を行っている。

これらの進捗状況を鑑み、研究計画は適切であり、その計画が着実に実施されていると評価する。

なお、今後は、引き続き真摯に研究に取り組むとともに、「グローバル」の名に見合った大きさと迫力が備わり、研究全体としての太い筋を打ち出せるよう、各研究グループの活動結果をまとめて、土砂･洪水統合ハザードマップを整備していくことが必要である。

まずはプロジェクト目標に掲げる「ガイドラインの作成」に、全メンバーが連携して優先的に取り組むべきである。そこで真に活用されるガイドラインを纏め上げた後に、その公表・普及をめざしてシンポジウム等の開催に取り組むことが望まれる。

５－１　国際共同研究の進捗状況について

口上書および VAT 免税の問題を解決したのちは、全体として順調に進捗していると判断できる。

リエカ市郊外のグロホボの地すべりサイトでは、伸縮計 11 台からなる連続長スパン伸縮計測システム、連続計測 GPS と自動計測トータルステーションの組み合わせ、さらに無線を利用したデータ伝送による地すべり監視などの高度なシステムが構築されており、予想される成果とあいまって高い科学的・技術的インパクトが期待される。ポータブル地すべり再現試験機の開発では、基本的性能を削ぐことなく、小型化、低価格化に成功しており、我が国及び開発途上国の地すべり研究にとっても重要なツールとなることが期待される。本プロジェクトにおいては、モデルサイトで採取されたサンプルを用いた本試験機による分析結果と実際の地震波形データを組み合わせることで、新しい知見につながる可能性もある。

現段階でのシミュレーションモデルの開発に関しては、学術的、技術的成果は認められるものの、地震という特殊な原因の想定を除けば、流出解析と地すべりモデルという個別要素の結合に過ぎず、クロアチアの地域特性等を考慮する中で、社会実装の観点からの成果に新規性を出すことが期待される。

５－２　国際共同研究の実施体制について

研究代表者が、外交上の手続き等の遅れなどに対しても適切な対応を行っている点はリーダーとして優れていると判断できる。また、日本側及びクロアチア側研究者を適切にまとめるなどのリーダーシップも見られる。今後の土砂・洪水統合ハザードマップの作成に向け、一層のリーダーシップが求められる。研究チームについては、現状、大学の研究者だけで構成されていることから、社会実装に向けた活動を視野に入れて、クロアチア側に政府関係者を入れるなど、体制の見直しが必要と思われる。また、地球規模課題対応国際科学技術協力（Science and Technology Research Partnership for Sustainable Development : SATREPS）の趣旨に鑑み、本プロジェクトがクロアチア側の若手研究者の単なる論文業績の機会にとどまらないよう、クロアチア側の社会実装意識を高めると共に、日本側にも若手研究者を増やすなどの取り組みが望まれる。研究費の執行状況は概ね問題なく、適材適所に順調に執行されている。伸縮計・GPS・トータルステーションを組み合わせた地すべり監視用モニタリング･システムは適切に現地観測地域に配置されており、有効に活用されている。地すべり再現試験機についても同様の対応が望まれる。

５－３　科学技術の発展と今後の研究について

基本的には研究志向のプロジェクトであり、豊富な実績を有する研究者がプロジェクトを主導していることからも研究の進め方としては妥当であるといえる。我が国の地すべり観測技術およびすべり面のせん断試験技術は世界トップレベルにある。とくに、本プロジェクトで開発した比較的安価な地震地すべり再現試験機は、国内における地すべり研究に貢献するだけでなく、諸外国における有効活用が期待できる。この意味で、地すべり再現試験機に所要の改良を加え、クロ

アチアへ供与するための試験機を製作した上で、クロアチアの若手研究者を対象とした本格的研修を実施し、地震による地すべりに関する研究の向上を図っている点は高く評価できる。

科学技術の発展への貢献という観点からは、クロアチアのような地域の洪水・地すべりへの理解を高めることが必須と思われる。現在は、基本的には従来のモデルの利用にとどまっているが、クロアチアの地域特性をより明確にすることによって、日本の科学技術の発展に寄与することが期待される。

５－４　持続的研究活動等への貢献の見込みについて

クロアチアの科学技術という点で言えば、基本的に日本で開発された技術を用いることでクロアチアの若手研究者が育ってきていることを考慮すれば、現段階でも十分貢献している。具体的には、クロアチア研究者が本プロジェクトで得られたデータを用いて筆頭論文（プロシーディング）を公表し始めている。また、クロアチアの若手研究者を定期的に招聘して各種研修を実施しており、ボスニア・ヘルツェゴビナ、ブルガリア、マケドニア、セルビア、スロベニア、コソボ等の国々からの研究者に対しても有効な技術伝達が行われていることから、クロアチア及び周辺諸国の研究者の自立性・自主性の向上が期待できる。

クロアチアの開発地域・社会的価値の高い地域を対象として、土砂・洪水災害を軽減するための土地利用基本計画ガイドラインの策定、現地の地盤構造・水文特性の科学的解明に立脚した信頼し得る危険度評価法の確立、といった目標を維持する限りにおいて、研究成果の利活用を通した持続的発展はある程度は見込める。地すべり滑動は長期にわたる現象である。観測設備は適切に設置されていることから、プロジェクト終了後もクロアチア側による継続的な観測が見込まれ、持続的研究活動につながると思われる。

一方、社会実装あるいは政策等への成果の反映という点では、現地研究グループや JCC への政府機関の関与を高めるとともに、今後作成する「ガイドライン」を有効なものとする必要がある。

５－５　今後の研究に向けての要改善点および要望事項

本プロジェクトの大目標として、「クロアチアの開発地域・社会的価値の高い地域を対象として、土砂・洪水災害を軽減するための土地利用基本計画ガイドラインを策定し、同国の発展の鍵となる持続可能な国土開発に貢献する」を掲げているが、個々の成果がどのように相手国側の行政施策に反映されていくのかという点については見通しを明確にする必要がある。特に、JCC への行政機関の積極的な参加を促すなどの対応が求められる。ポータブル地すべり再現試験機の利点が地震波特性の入力にあるのだとすると、現地ターゲット地域における想定地震波特性の把握が当然必要となる。現地での観測を計画しているようであるが、必ずしも研究期間内に想定地震が発生するとは限らないため、過去事例の調査からターゲット地域における地震波特性を把握することなども検討されたい。

本プロジェクトにおける「地すべりダイナミクス」の位置付けをさらに明確化するべきである。降雨による地すべりの予測にはシンプルな伸縮計が有効とするのならば、本プロジェクトにおける地震時の地すべり数値計算の比重を軽くするなどの見直しが必要であるように思われる。また、クロアチア側の地震学者、地震工学エンジニアなどの人的資源を有効に活かす努力にさらに傾注

するとともに、JCC を研究者間の打合せ以上のものにするなどの工夫を望みたい。

リエカ地域における地すべりの観測データは、リエカ大学に伝送されているが、社会実装や行政の防災意識向上を目指し、行政の防災担当事務所等にも伝送されることを期待する。

第６章　終了時評価の結果

６－１　結論

プロジェクトは、災害軽減に関するクロアチアの法律・政策と整合しているだけでなく、対象地域の地方自治体・人々のニーズにも合致しており、その妥当性は高い。プロジェクトの有効性については、プロジェクトの開始および機材供与の遅れがあったが、活動自体はスムーズに実施されたので、やや高いと判断した。プロジェクトの効率性は中程度と判断されたが、これはプロジェクト開始の遅れ、続く機材設置の遅れがあったためである。本邦研修および機材供与の効率性は高かった。インパクトについては高く、負のインパクトはなかった。プロジェクトの持続性については、人材的・技術的な観点からは活動の十分な維持が見込まれるが、制度的・財政的な観点からは、防災に関わる政府機関と正式な取り決めを交わすなど、また研究資金の獲得の目処をつけることが望まれる。

６－２　提言

プロジェクト目標達成に向けて活動促進について

プロジェクト終了までの残期間で完了する予定の成果品や指標達成の目処はたっており、両国の研究者は、それに向けてより一層活動に専念することが期待される。

プロジェクト成果の有効活用について

クロアチア側の各大学と地方自治体の連携がより一層促進されることが期待される。地方自治体と大学との関係については災害リスク管理に向けた連携の仕組み作りが必要であり、MoU の締結などがあることが望ましい。

プロジェクト終了後の研究のフォローアップや連携について

研究のより一層の発展のため、プロジェクト終了後も両国の研究者は、データや観測結果の共有など研究を継続していくことを提言する。

プロジェクト終了後の機材管理について

クロアチア側の各大学に供与された機材について、特に運用・維持管理費の獲得が必要である。

EU 加盟による免税措置の適用について

クロアチアが 2013 年 6 月より EU に加盟したことにより、免税が適用されなくなり現時点で機材供与が停止していることから、早期解決を図る必要がある。

事後評価の実施について

JICA による事後評価を実施することを提言する。終了時評価時点からプロジェクト完了時までの間に出されるプロジェクトの成果が評価される機会が必要である。

６－３　教訓

JICA 技プロ協力プロジェクトの実施例が少ない国でのプロジェクト形成・実施について

本プロジェクトでは事業実施のための国際約束の締結及び機材供与にかかる VAT の免税について、事業準備段階で通常以上にきめの細かい説明や現地事情の調査を行うことによって、プロジェクト立ち上げの遅れは回避または相当程度軽減することができたと考えられる。プロジェクトの実施に関して、現地での JICA によるサポートができないことから、在外事務所のある国での事業以上の本部からのサポートを行う必要がある。

社会の持続的発展について

防災に関する研究成果は実社会に適用されなければならない。地方自治体や中央政府の関連機関・組織は JCC メンバーとして組み込まれているべきであった。プロジェクトの計画時点で関連機関・組織を特定し、プロジェクト開始時点より JCC メンバーとして組み込んだほうがよい。

６－４　団長所感

終了時評価調査における 5 項目評価結果は、妥当性及びインパクトは「高い」という評価で、有効性及び持続性は「やや高い」で、効率性については中程度という評価結果となった。

しかしながら、本プロジェクトは 2009 年 3 月 27 日に R/D が署名されたが、その後口上書交換に期間を要し、およそ 1 年間のプロジェクト開始の遅れが発生し、その後機材調達についてもクロアチア側の免税に関する国内手続きに時間がかかり、さらに遅れて機材が設置されるという致命的といってもよい外部条件の影響を受けながら実施されたものである。プロジェクト実施遅延の影響により、今般の評価時点では一部成果の未達成が確認されているが、3 カ月後のプロジェクト期間の終了時までには、ほぼ計画通りの成果を上げることができる予定であり、これはプロジェクト関係者の努力の賜物であり、大いに評価して差し支えないと思う。また、総合的に見ると、本プロジェクトは大変良いプロジェクトであると評価することが可能と考える。

また、当該プロジェクトは SATREPS 開始後、間もない時期に採択され、プロジェクト成果の社会実装について今ほど強く意識されておらず、結果として防災を担当する関連地方自治体や国レベルの防災機関への関与が遅れたため、今後の社会実装に多少懸念がある。そのため、評価調査団はザグレブ市危機管理室の表敬訪問の際、今後も大学との連携を続け、プロジェクトの実測データ、ハザードマップ及び土地利用ガイドライン等の成果を活用することを要望した。

最後に、当該プロジェクトの特徴として、ワークショップにおいてスロベニアやボスニア・ヘルツゴビナ等の近隣国の研究者を招き研究発表を実施するなど、地すべり災害や洪水災害に対する防災もこの地域の共通問題とし研究協力を進めており、今後バルカン半島の各国において当該プロジェクトの成果を活用して防災に貢献することが期待される。

付　属　資　料

1.　協議議事録（Minutes of Meeting）（英文）および Terminal Evaluation Report（英文）

MINUTE OF MEETINGS BETWEEN THE JAPANESE TERMINAL EVALUATION TEAM AND THE AUTHORITIES CONCERNED OF THE CROATIA ON JAPANESE TECHNICAL COOPERATION (SATREPS) FOR THE PROJECT ON RISK IDENTIFICATION AND LAND-USE PLANNING FOR DISASTER MITIGATION OF LANDSLIDES AND FLOODS IN CROATIA

The Japanese Terminal Evaluation Team (hereinafter referred to as "the Team"), organized by Japan International Cooperation Agency (hereinafter referred to as "JICA") headed by Mr. Yukihiko Ejiri jointly with Japan Science and Technology Agency, visited Croatia from Dec 1, 2013 to Dec 19, 2013 for the purpose of conducting the terminal evaluation on the Japanese technical cooperation (SATREPS: Science and Technology Research Partnership for Sustainable Development) for the Project on Risk Identification and Land-use Planning for Disaster Mitigation of Landslides and Floods in Croatia (hereinafter referred to as "the Project").

During its stay, the Team exchanged views and had a series of discussion with the Croatian authorities concerned. And the second Joint Coordinating Committee (hereinafter referred to as "JCC") was held on Dec 17, 2013.

As the result of the discussion, the Team submitted the terminal evaluation report as attached hereto and both sides agreed upon on the description of the report.

Zagreb, Dec 17, 2013

Mr. Yukihiko Ejiri
Team Leader
Terminal Evaluation Team
Japan International Cooperation Agency

Ms. Mljenka Kuhar
Project Director of Croatia side
Ministry of Science, Education and Sports of Croatia

Prof. Dr. Hideaki Marui
Project Leader,
Chief Advisor of the Project
Niigata University

Prof. Dr. Nevenka Ožanić
Project Manager,
University of Rijeka

Terminal Evaluation Report

for

the Project on Risk Identification and Land-use Planning for Disaster Mitigation of Landslides and Floods in Croatia

December 2013

Terminal Evaluation Team

Abbreviations

AHP	Analytical Hierarchy Process
CGS	Croatian Geological Survey
CW	Croatian Water
DEM	Digital Elevation Model
DPRI	Disaster Prevention Research Institute, Kyoto University
DUZS	*Državna uprava za zaštitu i spašavanje* (National Protection and Rescue Directorate)
EMO	Emergency Management Office, City of Zagreb
GIS	Geographic Information System
HRK	Croatian Kuna (international abbreviation)
ICL	International Consortium on Landslides
JCC	Joint Coordination Committee
JPY	Japanese Yen
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency
LIDAR	Laser Imaging Detection and Ranging
M/M	Minutes of Meetings
MZOS	*Ministarstvo obrazovanja, znanosti i sporta* (Ministry of Science, Education and Sport)
PO	Plan of Operation
R/D	Record of Discussion
SATREPS	Science and Technology Research Partnership for Sustainable Development
UR	University of Rijeka, Faculty of Civil Engineering
US	University of Split, Faculty of Civil Engineering, Architecture and Geodesy
UZM	University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering
UZA	University of Zagreb, Faculty of Agriculture
VAT	Value Added Tax

Contents

Chapter 1: Outline of the Review Study

1.1 Background

Croatia has frequent earthquakes and, along the Adriatic coast, has a large amount of precipitation. At some places, average annual rainfall is 3,500mm and more. Triggered by such earthquakes and rainfall, sediment disasters occur quite often such as landslides, slope failure, and debris flow. The land of Croatia has a complex, fragile terrain and geological structure affected by earth faults and folds. Sediment disaster are common at the alternation of sandstone-shale strata that is prone to weathering, as well as at slopes with marl layer containing large amounts of clay with low friction angle prone to land sliding. Local flood (flash flood) occurs at limestone regions where water roads are easily formed in the strata.

Sprawling of cities is causing the accumulation of assets and population growth in sub-urban areas, but many of these areas are at high risk of such disasters in Croatia, thus raising concerns about increasing damages by flash floods and landslides. In some areas, disaster risk is likely to become even higher with a change in rainfall patterns due to climate change.

In Croatia, however, techniques to assess flash-flood/landslide risk and mechanisms to take measures on the risk assessment are not yet developed. Sprawling control as well as disaster warning systems and evacuation rules are not in place yet, either. Towards such disaster risk management, researches are required to develop methodologies for hazard mapping and risk assessment based on scientific data of these phenomena, and to improve the land use taking into consideration such disaster risks.

In this context, this Project was requested by the Government of Croatia. Based on a detailed planning survey in January 2009 and a following consultation mission in March 2009, the R/D of the Project was signed on 27 March 2009 under the scheme of SATREPS for 5 years. In December 2013, about 4 months before the termination of the Project period, a terminal evaluation is to be conducted as dictated by the Article V of the signed R/D.

1.2 Objectives of the Terminal Evaluation Study

The objectives of the Terminal Evaluation are to:

1) To confirm actual inputs, activities and implementation process, the degree of achievements of the outputs, and the prospect of achieving the project purpose according to the Master Plan.
2) To assess the Project from the five evaluation criteria - Relevance, Effectiveness, Efficiency, Impact and Sustainability – based on the JICA's guideline for project evaluation.
3) To make recommendations on the measures to be taken for the remaining and after the Project period
4) To make lessons leant for similar on-going projects and future projects.
5) To conclude the minutes of meeting (M/M) between Japanese side and Croatian side about the recommendations and lessons leant above in consultation with agencies concerned.

1.3 Members of the Terminal Evaluation Team

The study was conducted by the joint evaluation team composed by the following members:

Name	Position	Title
Mr. Yukihiko Ejiri	Leader	Senior Assistant Director, Water Resources and Disaster Management Group, Global Environment Department, JICA
Mr. Koichi Kitamura	Survey Planning	Water Resources and Disaster Management Group, Global Environmental Department, JICA
Dr. Yuko Aoki	Evaluation and Analysis	Consultant, Kokusai Kogyo co. ltd.,
Dr. Yoshimori Honkura	SATREPS Evaluation	Program officer of Natural Disaster Prevention, Research Partnership for Sustainable Development Division, JST
Mr. Katsuhiko Masuda	SATREPS Evaluation	Senior Staff, Research Partnership for Sustainable Development Division, JST

Name	Position	Title
Ms. Miljenka Kuhar	Project Director	Head of Division for Science and Technology Projects Directorate for Science and Technology, MZOS
Ms. Morana Kovačević	Evaluation	Program officer, Department for International Cooperation, Directorate for Science and Technology, MZOS

1.4 Schedule of the Mission

The schedule of the mission is attached (Annex 3)

1.5 Methodology of the Terminal Evaluation

The Terminal Evaluation is carried out in accordance with "the JICA New Guideline for Project Evaluation, Ver. 1 (June 2010)", which mainly follows "the Principles for Evaluation of Development Assistance, 1991" issued by OECD-DAC. The master plan in the R/D with the statement of the project purpose, outputs and activities is used as the basic reference point for the evaluation. (Annex 1 is a revised master plan approved by JCC at the time of Mid-term Evaluation).

As a framework to collect and sort out relevant data and information as prescribed in the JICA Guideline, two types of grid - Result Grid and Evaluation Grid - were prepared in reference to reports and documents on the Project. To collect information for the Evaluation Grid, questionnaires were prepared and forwarded in advance to the counterpart organizations. During the evaluation mission, the team conducted interviews with counterparts based on the questionnaires, hearings with JICA experts, and visited target areas (Annex 3, 4).

Findings and information from reports, interviews, questionnaire survey and site visits were collected and analyzed in the grids. The team confirmed the achievements, assessed the Project based on the five criteria, made recommendations, and drew lessons learned.

The criteria used for the evaluation are the following five criteria: relevance, effectiveness, efficiency, impact and sustainability.

Relevance	Relevance is reviewed by the validity of the Project Purpose in light of Croatia's development policies and needs and Japanese cooperation policies.
Effectiveness	Effectiveness is assessed to what extent the Project is achieving the Project Purpose, clarifying the relationship between the Project Purpose and Outputs.
Efficiency	Efficiency is analyzed with emphasis on the relationship between Outputs and Inputs in terms of timing, quality, and quantity.

Impact	Impact is assessed in terms of positive/negative and intended/unintended influence caused by the Project.
Sustainability	Sustainability is assessed in terms of institutional, financial, and technical aspects by examining the extent to which the achievements of the Project will be sustained after the Project is completed.

Chapter 2: Outline of the Project

2.1 Project Purpose

Integrated landslide/flood hazard mapping technology and land-use guidelines formulation methodologies are developed for nation-wide application in Croatia.

2.2 Output

1. Methodologies for landslide risk assessment, prediction of affecting areas, and early warning systems are developed adapting to hydrological and geological conditions in Croatia.
2. Flash-flood/debris-flow simulation models and early warning systems are developed adapting to hydrological and geological conditions in Croatia.
3. Integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation are developed for study areas.

Chapter 3: Achievements of the Project

3.1. Results of Inputs

The R/D of the project was signed on 27 March 2009, but it was 9 March 2010 when the Note Verbal was exchanged for launching the Project as it took long time for Croatian side to conduct necessary inter-organizational coordination. Behind the original schedule by one year, inputs as per agreed in the Master Plan begun with the dispatch of Japanese expert in May 2010.

(Japanese side)

1) Dispatch of Japanese researchers

Since May 2010 until December 2013, total 18 researchers have been dispatched, totaling 1384 days. Each researcher is attached to working group 1, 2 or 3. In addition, one project coordinator has been dispatched by JICA since May 2010. (Annex 5)

2) Counterpart Training

6 professors/local government staff and 12 researchers from EMO, CGS, UZM, UR and US attended short-term business trips and trainings in Japan in 2010-2013, respectively, conducted in Tohoku Gakuin University, Yamagata University, Niigata University, ICL, and Kyoto University (Annex 6).

3) Provision of Machinery and Equipment

Activities of the Project started in May 2010, one year behind the signature of the R/D. In addition, due to the absence of referential precedence on VAT exemption procedure in concerned agencies in Croatia and resulting delay of administrative clearance, a piece of equipment which was planned to be procured in Croatia ended up being purchased in Japan and shipped to Croatia instead. Machinery and equipment for landslide and flash-flood analysis was provided by the Japanese side, the total amount of which are 848,476.84HRK for 2010 to 2013. (Annex 7)

4) Local Costs

Japanese side provided a part of necessary expenses for carrying out project activities. Apart from the costs of machinery and equipment, the expenses include the dispatch of Japanese researchers and project coordinator, training of Croatian Researchers in Japan, Operational expenses such as travel expenses in Croatia, local consultant fee, and meetings. The total amount of expenses, including that of machinery and equipment, will be 377,538,000 JPY for 2010 and 2013. The details are shown in Annex 8.

(Croatian side)

1) Assignment of Counterpart Personnel

Project Director (Ms. Miljenka Kuhar)[1] and Project Manager (Prof. Ožanić) have been assigned by MZOS and UR, respectively. The Deputy Project Manager (Assoc.Prof. Mihalić Arbanas) and Project Coordinator (Prof Kisić) have been assigned by UZM and UZA, respectively. The change of the Project Manager from Prof. Bonacci to Prof Ožanić, and the Deputy Project Manager from Prof. Ožanić to Assoc.Prof. Mihalić Arbanas was officially announced with a letter dated 28 March 2012 issued by MZOS. Although there is no official letter on the assignment of counterpart, so far 44 researchers have been recognized as counterpart personnel at the time of Terminal Evaluation. (See Annex 9)

2) Local Operational Cost

MZOS has been financing the project – lump sum of 307,500 HRK/year including salaries of 9 young researchers working for the Project (9,700 HRK/moth/researcher), shipment and installation costs of purchased equipment. Each faculty engaged in the Project – Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Faculty of Civil Engineering, University of Rijeka, and Faculty of Civil Engineering, Agriculture Architecture and Geodesy, University of Split – has also borne a part of operational costs (travel of researchers, other costs). (See Annex 8)

3.2. Progress and Achievements of the Project

1) Achievement of the Project outputs

(Output 1) Methodologies for landslide risk assessment, prediction of affecting areas, and early warning systems are developed adapting to hydrological and geological conditions in Croatia. (Indicators) 1-1: Number of manual book of methodologies for landslide risk assessment (1 manual) 1-2: Number of model sites to develop a simulation for landslide predictions on dynamics (2 model sites; Kostanjek, Grohovo) 1-3: Number of model sites to establish landslide early warning systems (2 model site; Kostanjek, Grohovo)

- There are four model sites selected for Output1: Kostanjek Landslide (a part of Medvednica Mt. Hilly Area, City of Zagreb), Grohovo Landslide (a part of Rječina River Basin, Primorsko-Goranska County, Rijeka), Duće and Omiš areas (Split-Dalmatian County).

[1] Mr. Vinko Purgar was initially assigned to be the project director but has been replaced by Ms. Kuhar as he left his post at the Ministry in September 2013.

- The land risk assessment is composed of two manuals, one is for wider areas as Hilly area of the Medvednica Mountain back of Zagreb city and Rječina basin by analyzing aerial photos and risk assessment using AHP, and another is using LS-RAPID computer simulation for specific landslide area as Kostanjek and Grohovo, and both were completed. (The indicator 1-1 is achieved.)
- Simulations for landslide predictions on dynamics for 2 model sites, Kostanjek, Grohovo were conducted. (The indicator 1-2 is achieved.)
- Landslide early warning systems for 2 model sites, Kostanjek, Grohovo were established. (The indicator 1-3 is achieved.) The Establishment of early warning system of the Project indicates that setting the necessary monitoring equipment for data collection and establishing the basic flow and procedures for early warning.
- A low-cost undrained shear test apparatus was developed in Japan, and two Croatian researchers were trained for the operation of and the testing with the apparatus (Activity 1-1). Activity 1-1 was completed.
- Soil samples from model sites (Kostanjek landslide and Grohovo landslide) were sent to Japan and tested with the apparatus (Activity 1-2). As for the apparatus procured, one part of pore pressure control seemed not showing correct results. It was found that it was due to the characteristics of the soil of Grohovo. The solution was explained by Prof. Sassa to Croatian researchers. Activity 1-2 was completed.
- Researchers indicated that the installation of monitoring equipment (GPS, extensometers, total station, prism, pore pressure gauge) has completed at Grohovo site and the monitoring has been in progress. As for the Kostanjek landslide model site (Zagreb), extensometer, seismic monitoring system and GPS monitoring system were installed and the monitoring has been conducting (Activity 1-3). Activity 1-3 was completed.
- The activity 1-4 and 1-5 are linked and to be undertaken concurrently. Methods of landslide risk assessment and the prediction of landslide affecting areas based on landslide dynamics were completed development in JFY2012, and they were actually applied.
- Landslide risks assessment (Activity 1-4) and the prediction of affecting areas (Activity 1-5) were completed at model sites (Kostanjek in Zagreb and Grohovo in Rijeka), based on parameters obtained through the soil tests in Activity 1-2.
- At Kostanjek model site (Zagreb), the early warning measure was set in motion as monitoring results of the installed system in April 2013. For Grohovo in Rijeka, the early warning system is going to be developed based on the installed extensometers. Activity 1-6 is completed.

(Output 2) Flash-flood/debris-flow simulation models and early warning systems are developed adapting to hydrological and geological conditions in Croatia.
(Indicators)
Indicator 2-1: Number of model sites to formulate a flash-flood/debris-flow simulation model (5 model sites; Rječina River Basin, Dubračina River Basin, Mošćenička Draga, Imotski, Sutina-Karakašica)
2-2: Number of model sites to establish a flash-flood early warning system at Rijeka (2 model sites; Rječina River Basin, Mošćenička Draga)

- There are five model sites selected: Rječina River Basin, Dubračina River Basin, and Mošćenička Draga (Primorsko-Goranska County, Rijeka), Imotski and Sutina-Karakašica (Split-Dalmatian County) for Output2.
- The simulation model was already developed. At the moment, an application of the simulation model in Rječina River Basin, Dubračina River Basin and Imotski have been conducted, and for Mošćenička Draga, and

Sutina-Karakašica, they are almost completed. (Indicator 2-1 is not achieved yet though, will be achieved by the end of Project period.)

- The development of a basis of flash-flood early warning system was completed. The system was applied to Dubračina River Basin (Salt Creek) first as data was collected more than others and the early warning system is going to be established based on data of the RADAR.
- For Mošćenička Draga river basin where the higher risk of flood, the early warning system is almost established. It has been collecting data though, due to the small rainfall since starting measurement, more data and time needed for tuning. While, Rječina River Basin has completed establishing the system. (Indicator 2-2 is not achieved yet though, will be achieved by the end of Project period.) As explained above, the Establishment of early warning system of the Project indicates that setting the necessary monitoring equipment for data collection and establishing the basic flow and procedures for early warning.
- Rainfall measurement equipment was installed at model sites in Rijeka and the data are being collected. The analysis of rainfall-discharge characteristics continues with new hydro-meteorological data. Since 2011, the data has been collected and accumulated for analysis. Meteorological measurement device has been installed in the municipality office building of Mošćenička Draga, where the data also has been utilized by the local authority. (Activity 2-1, 2-2 were completed)
- Physical experiments of debris-flow have been carried out in Kyoto University where the Croatian trainees jointed the experiments. The development of flashflood and debris flow simulation model (Hydro-Debris 3D) for Dubračina River is completed. The simulation model will be applied to other model sites, Dubračina River Basin (Salt Creek) and Zagreb area, and it is also going to be applied in Cetina River Basin (Split), Rječina River Basin, Mošćenička Draga (Rijeka) in the rest of Project period. (Activity 2-3 are almost completed)
- The RADAR (Furuno) to cover the three model sites in Rijeka is procured and installed, which contributes the early warning system to be established. (Activity 2-4 was completed.)

(Output 3) Integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation are developed for study areas.
(Indicators)
Indicator 3-1: Number of study areas to develop an integrated landslide/flood hazard map (3 areas; Rijeka, Split, Zagreb)
Note): Indicator 3-1 for Split area means two individual hazard maps for landslide and flashflood.
3-2: Number of study areas to develop land-use guidelines for landslide/flood risk mitigation (3 areas; Rijeka Split, Zagreb)

- There are three model sites selected: Hilly area of the Medvednica Mountain (Zagreb), Rječina River and Dubračina River basin (Primorsko-Goranska County, Rijeka), and Duće and Omiš areas (Split-Dalmatian County).
- At the moment, only the hazard map of landslide for Zagreb where many landslides were found in wide area was completed while the flood hazard map is not completed yet, it's almost completed though. In Rijeka, the landslide hazard map was completed. As for the Split, the hazard map of rock fall is in the process of making. Development of integrated landslide/flood hazard map for model sites is going to be completed in the rest of Project period. (Indicator 3-1 is not completed yet.)

- At the moment, only the guide line for land used based on Landslide Hazard map was developed as the flood risk hazard map has not completed yet. The hazard map developed was mainly for Zagreb area where the densely populated area, while the modified versions for other areas are planning to be developed. As for Split area, the checking slope carte has been developing. For Rijeka, the risk assessment was completed in the main part of Rječina River Basin. The result of the risk assessment was finished plotting and it can be converted into hazard map as the land-use is simple. Making the land-use guidelines are going to be finished in the rest of Project period. (Indicator 3-2 is not completed yet.)
- In Zagreb and Rijeka, topography interpretation of model sites and surrounding areas, mainly based on aerial photos, were completed. In addition, digital topography maps are being created based on LiDAR scanning with airplane. In Split, WG4 is conducting ground-based LiDAR scanning once a month since September 2011 (Activity 3-1, 3-2 were completed).
- Integrated hazard map (Activity 3-3) will be prepared by synthesizing the wide-area landslide risk assessment using AHP (Activity 3-2), results of flashflood and debris flow simulation (Activity 2-3), landslide risk assessment on landslide dynamics (Activity 1-4), and prediction on landslide affecting areas (Activity 1-5).
- At present, development of the hazard map on flashflood and debris flow simulation models in model sites (Activity 2-3) is in the stage of finalization, the hazard map for land slide is completed.
- For 2 model sites (Kostanjek in Zagreb and Grohovo in Rijeka) where larger the affected areas, the assessments have been conducted by the results of assessment of landslide dynamics (1-4) and prediction of landslide affecting areas (1-5). While the hazard map for flood risk has not completed yet. (Activity 3-3 is not completed yet.)
- Land-use guidelines (3-4) will be prepared based on the integrated landslide/flood hazard map (3-3). At the moment, only the guide line for land used based on Landslide Hazard map was developed as the flood risk hazard map has not completed yet. (Activity 3-4 is not completed yet.)
- At the moment, only the manual for the guide line of land used based on Landslide Hazard map was developed as the flood risk hazard map has not completed yet. (Activity 3-5 is not completed yet.)

2) Achievement towards the Project Purpose

The project purpose is "integrated landslide/flood hazard mapping technology and land-use guidelines formulation methodologies are developed for nation-wide application in Croatia.

Indicator 1: Number of manual book to develop integrated landslide/flood hazard map (1 manual)

Indicator 2: Number of manual book to develop land-use guideline for landslide/flood risk mitigation (1 manual)

The basis of the manual to develop landslide hazard map and land-use guideline were already made though, it will still take time to make it applicable to pilot sites. As seen in the progress of Output3, flood hazard map and land-use guideline were not finalized yet. For practical application in Croatian society, hazard-mapping and flood risk mapping requires meeting the EU's legislations as Croatia became an EU member country.

At present, the project is making a steady progress of research activities at each output level as summarized in the above section. Considering the overall progress towards attaining the Project Purpose, in spite of the delay of launching the Project and setting up the monitoring equipment at model sites, thanks to the great efforts of both Japanese and Croatian sides, the Project has a good potential to achieve its goal by the end of project period, March 2014. This evaluation took into consideration that there is the effect of delay on starting the project, procurement and installation of equipment, as all the research activities require some period of time for accumulation of data collection for analysis and technology transfer.

3.3 Implementation Process

The project formed three working groups (WG) – WG1 for detailed landslide investigation, WG2 for flash-floods and debris-flows, and WG3 for regional landslide investigation. After the 1st JCC on 23rd February 2012, the formation ofWG4 was proposed in order to accelerate the research activities in Split by direct contact between the project manager and the leader ofWG4.

Each WG and each University has been working toward their goals, detail activities of each WG are shown in Annex 11: Result Grid (Pilot Site).

Chapter 4: Evaluation by the Five Criteria

4.1 Relevance

The relevance of the Project is high.

- There are several laws and policies speaking to the importance of disaster mitigation in Croatia; they are: Protection and Rescue Plan for Croatia (Official Gazette 96/10), Evaluation of Endangerment of Croatia from Natural and Technological Disasters, Croatian National Platform for Disaster Risk Reduction, Protection and Rescue Law (Official Gazette 127/10), Law on Protection from Natural Disasters (Official Gazette 73/97), and also various international agreements on protection and rescue in case of natural disaster. The project, aiming at the development of integrated landslide/flood hazard mapping technology and land-use guidelines formulation methodology for nation-wide application in Croatia, is aligned with these Croatian laws/policies, and contributes to their realization.
- The model sites of the Project were proposed by Croatian researchers. The Kostanjek in Zagreb is the largest landslide in Croatia, and one of primal concerns of the Emergency Management Office in the City of Zagreb. At present, the physical plan of the City of Zagreb doesn't include the assessment of landslide risk. At the downstream of Rječina River located the city of Rijeka, and the flood waters can cause significant damage to the city; it could be an even higher hazard in case of concurrent rock avalanche at Grohovo landslide. The City of Rijeka has a land-use guideline for construction purpose, but it does not contain a hazard map. The model sites in Split are Omiš and Duće where a rock fall is quite frequent, causing damages and posing threats to many houses and population in the towns. The project can also meet the needs and expectation of these local authorities by monitoring the sites, setting up early warning systems, preparing hazard maps as well as land-use guidelines incorporating disaster risk mitigation.
- Disaster reduction is identified as one of specific issues Japan's ODA gives priority. The Initiative for Disaster Reduction through ODA was announced at the United Nations World Conference on Disaster Reduction held in Kobe, Hyogo prefecture, in January 2005. Furthermore, JICA's Issue-specific Guideline for Disaster Reduction sets out "building disaster-resilient communities and societies" as one of development strategy goals to be achieved. This Project aims at the development of landslide/flood hazard mapping technology and early warning system, thus applying these outputs to land-use guidelines prepared by local

authorities for disaster reduction. The Project is aligned with Japan's ODA policy, and such methods and technologies can also be utilized for other disaster risk management projects.

4.2 Effectiveness

The effectiveness of the Project is medium/high.

- The basic design of the Project is clear as per summarized in the Master Plan, and the three outputs are essential components for the Project to achieve its purpose. As described in the above section, the Project has set up equipment, accumulating monitoring data and analysis. At present, the project is making a steady progress of research activities at each output level, and in spite of the delay of launching the project and setting up monitoring equipment at model sites, it is widely indicated that the project has a good potential to achieve its goal by the end of project period, March 2014. On the other hand, all the equipment installed need more time at least a year to accumulate enough data for analysis and comparison, especially for the early warning system.
- The development of integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation (the outcomes/indicators of WG3) are not for all pilot areas but two areas of Zagreb and Rijeka. As seen the table below, there are 8 pilot sites for the Project. The base of the map and guide-lines and technologies were made by Japanese researchers and will be applied to the pilot sites. For actual application, it has to be done with each local authority where the pilot site located and also required to follow EU legislations.

			1 :Number of manual book to develop integrated landslide/flood hazard map (1 manual) 2 : Number of manual book to develop land-use guideline for landslide/flood risk mitigation (1 manual)							
			Output1			Output2			Output3	
			Manual for methodologies for landslide risk assessment (1Manual)	Model sites to develop a simulation for landslide predictions on dynamics (2 sites)	To establish landslide early warning system (2sites)	flash-flood/debris-flow simulation model (5 sites)	flash-flood early warning system (2 sites)	to clarify essential factors on flash-flood/debris-flow simulation model (Daruwar only)	integrated landslide/flood hazard map (3 area)	land-use guidelines for landslide/flood risk mitigation (3area)
UZM	WG1	Monitoring System	1 manual completed	Simulation completed	1st implementation was conducted April2013, ready to apply	no flush flood but rain	no flush flood but rain	—	Wider Zagreb	Wider Zagreb
UZM	WG3		—	—	—	no flush flood but rain	no flush flood but rain	—		
UZA	WG2		—	—	—	—	—		—	—
UR	WG1, WG3	Monitoring System	1 manual completed	Simulation completed	basic system is completed	flush flood for Rjecina Basin has applied	X-band radar system and Hydro-debris3D, Satellite image 3D mapping system	Comprehensive monitoring for groundwater has completed	Riječina basin	Riječina Basin
UR	WG2		—	—	—	Sediment yield model and flush flood for downstream of Salt Creek	X-band radar system and Hydro-debris3D	Comprehensive monitoring for surface and groundwater has completed	—	—
UR	WG2		—	—	—	prepared	X-band radar system , rain guage sytem, Satelliteimage 3D mapping system	Changes in river perfil and outlet of the river has surveyed	Moscenicka Draga (in Rijeka area) means individual hazard map for flash flood	—
US	WG4		—	—	—	—	—	—	for rock fall (Omiš)	for rock fall (Omiš)
US	WG4		—	—	—	—	possiblity of flood in Catchment Sutina Karakašica	—	flood (Catchment Sutina Karakašica)	flood (Catchment Sutina Karakašica)

- The project was developed methods and models such as landslide risk assessment, prediction of landslide affecting areas, flashflood/debris-flow simulation model, and integrated landslide/hazard mapping technology. The verification of these methods and models are conducted with measurement and data from physical experiments while actual hazardous events don't occur so often. Within the project period, the verification by natural events depends on weather, but refinement of methods and models will continue.

- In March 2013, the installed monitoring equipment detected unusual movement at Kostajek landslide. Japanese researchers visited the sites urgently with Croatian researchers and discussed the counter measures. The correspondence of the researchers against this event can be said one of the effectiveness of the Project.

4.3 Efficiency

Efficiency of the Project is medium.

- The R/D of the project was signed on 27 March 2009, but it was 9 March 2010 when the Note Verbal, a form of diplomatic document, was exchanged after a long process of conducting inter-organizational coordination on Croatian side. This is a five-year project, planned to start in March 2009 and end in March 2014, but due to this delay of launching the Project for one year, now all activities need to be completed in four years.
- Concerning the procurement of project equipment, the exemption of VAT (25%) was agreed on the R/D but administrative procedures for this VAT's exemption to become effective was not clear among concerned agencies both in Japanese and Croatian side. As a result, the first batch of equipment installation was in August through September 2011 at Grohovo Landslide due to the change of procedures - from domestic procurement in Croatia to international procurement in Japan - and the associated time it took for this change. This delay in setting up equipment at model sites has affected the research plan.
- For project implementation, MZOS has prepared a counter-budget, which includes the lump-sum 307,500 HRK/year (total fund 1,230,000HRK), salary payments of nine young researchers (9,700 HRK/moth/researcher) who are expected to obtain doctor's degree through researches in the Project, and payment for equipment installation and maintenance. And travel allowance & accommodation for researchers are ensured by each university. Each faculty of the three universities implementing project activities also has borne a part of operational costs such as conference and travel.
- The Project organizes annual international conferences to share the research progress and findings. The 1st conference was at the University of Zagreb (Centre for Advanced Academic Studies - CAAS, Dubrovnik) in November 2010 and the 2nd conference was at the University of Rijeka in December 2011. The 3rd conference was at the University of Zagreb in March 2013, and 4th was at the University of Split in December 2013, inviting more participants from local authorities as well as promoting public relations. Meetings and communication for research coordination between Japanese researchers and their Croatian counterparts have been properly held as and when necessary. On the other hand, communication of researchers among different working groups is less and confined to such opportunities as the annual international conferences and JCC.
- The project held the 1st JCC on 23rd February 2012 at the Faculty of Agriculture, UZ, where counter personnel from the three universities and Croatian Geological Survey attended, including representatives of local community (City of Zagreb's EMO). This JCC was the first meeting where administrative instructions for the project such as equipment and procurement were shared among all those who were involved in the Project. Meetings for administrative purpose could have been very helpful if it had been held at the very beginning of the Project to share the knowledge, rules and regulations associate with Project implementation.
- Counterpart personnel have not been fixed by, for example, an assignment letter by organizations or an

acknowledgement at JCC. Assignment of counterpart personnel has been flexible, subject to change in accordance with the situation and progress of researches. Details are shown in Annex9.

- The formation of WG4 based in US is a response to administrative issues of project coordination such as the distance between US and UR/UZM and resulting difficulty for US to have meetings and smooth communication as a part of WG1, WG2 and WG3. Research subject and activities remain unchanged, though, in US with the formation of WG4, and the leader of WG4 as US is now able to directly contact with Project Manager in UR. Partner researchers from Japanese side are not assigned to WG4, but work together as and when necessary.
- All researchers who took the training in Japan highly appreciated what they had leant and fully utilizing for their research, so as business trips of Croatian professors and the EMO management.
- All equipment donated is also fully utilized.

4.4 Impacts

The impact of the Project is high.

- Positive impacts such as measures against natural hazard and disaster risk mitigation can be expected once the Project achieves its purpose and the application of research results to local/national government policies starts realized. At the time of Terminal Evaluation, Croatian counterparts have already started working towards such expected impacts.
- It is widely indicated that the relationship between the universities and the local governments has been forged and strengthened due to the presence of the Project. Representative of local governments are not listed as counterpart in the R/D, but they are now recognized as essential partners of the Project by researchers towards achieving the Project goal. For example, EMO in the City of Zagreb was newly established in 2009 to take responsibility for all Zagreb's natural disaster, among which an earthquake is the major disaster. Before the Project, EMO was not very much aware of the importance of addressing landslide issue, but now has become concerned and has provided the Project with support such as issuing a permit for equipment installation.
- The maintenance of installed equipment is also discussed among EMO and UZM. From March 2014, end of the Project, the City of Zagreb will bear the cost of its insurance, the City have got the budget for it, while UZM will maintain the equipment and provide the City with monitoring data collected. As such, efforts to promote the application of research results and to seek an arrangement for follow-on support have already been undertaken. Especially after the business trip to Japan, EMO management aware the importance of the research for civil protection.
- The town of Omiš prepared a project document to contain potential rock falls in the town to an environmental fund of Croatian Government. The leader of WG4 of the Project is a reviewer of the project document, and expects that the LiDAR scanning conducted in the Project will also help identify critical points of potential rock falls, and will contribute to the implantation of the town's project. The Ministry of Finance of Croatian Government finally signed the project document, after 10 years of approach. The City was funded 50 million HRK for civil protection from rock fall. It was the good timing that the latest equipment for measurement for it was donated and the researchers of US leant how to use through the Project for practical application. It is going to be utilized wider area in addition to the current sites of the Project. The City of Omiš and US is going to conclude an agreement to cooperate and collaborate to continue the research.

- City of Rijeka is also understanding the importance of research in the Project, and cooperating with UR. And Croatian Electricity Company which locates its dam (accumulation) at the Project site, bottom of Grohovo land slide area has been also cooperating with UR, data and research results has been shared between them.
- Through international conference organized by the Project, research results and findings on landslides and flash-floods/debris-flow are shared among researchers from neighboring countries such as Serbia, Bosnia and Herzegovina, Kosovo, Macedonia, and Slovenia, where studies on disaster risk management are important and required for societies.

4.5 Sustainability

The prospect of sustainability of project activities is medium/high.

<Institutional sustainability>

- From an institutional viewpoint, as described at the Impact, the relationship between the universities and the local governments has become close through the Project activities. It is still further clarified how the research results will be incorporated into the local government policy such as the preparation of land-use guideline.
- The relationship between the local authorities and the universities is still at the personal level though; local governments are fully aware and understand of the importance of the research of Project. The relationship should be institutionalized or concluded a kind of agreement as a system for disaster risk management between the two entities.
- UZM and UR has been already approached to the National Protection and Rescue Directorate (DUZS) through inviting the round table of "Application of Croatian-Japanese Project Results in the System of Land-Use Planning, Construction and Civil Protection "at the 3rd workshop. UZM also provided the GIS data to DUZS. For research results to feed into disaster management policies, an involvement of DUZS will become more important in future.

<Technical sustainability>

- Prospect of sustainability from the viewpoints of human resource and technical capacity is indicated almost high. Currently, nine young researchers, doctoral students, are sponsored by MZOS to work for the Project. It will lead to a significant human resource capacity when they obtain doctorates. Equipment installed in model sites is currently well maintained; a container of monitoring observatory, pore pressure gauge and GNSS/GPS, a fence around solar panels, concrete base of a pole for the prism, and insurance policy for equipment. MZOS bears the costs of these protective and maintenance measures at the moment. Follow-on arrangement for maintenance of equipment after the end of the Project is currently being explored by the implementing universities, most probably though getting other projects that are going to be applied.
- Equipment donated by the Project is strictly managed by each University as all of them are registered as the equipment of the university.

<Financial sustainability>

- At present, MZOS has prepared a counter-budget, financing a part of project operation. From a financial viewpoint, the prospect of sustainability is high according to the MZOS. MZOS will continue to support researchers.
- About the fund from EU, EU horizon 2020, application due is next year for environment science, the

discussion for the application has already started among the professors of UZM, UZA, UR and US. They will make a team like the Project, and there is possibility to involve Japanese researchers as advisers. Once funded, those young researchers will be sponsored for their further research.

- UR is applied the bilateral project with Slovenia by January 2014, with updated and latest outcomes of the Project.

Chapter 5: Results of the Terminal Evaluation

5.1 Conclusion

The relevance of the Project is high - the Project is not only aligned with national laws and policies associated with disaster mitigation, but also meets the needs of local authorities and society. The effectiveness of the Project is medium/high as the Project is properly constructed, but due to the delay of procurement of equipment, data accumulation using the equipment is not enough regardless the Project activity itself is smoothly conducted. The efficiency of the project to date is rated medium mainly due to the initial delay of project launching and further delay of equipment installation. There are several positive impacts of the Project and no negative impact. The prospect of sustainability of the Project is medium/high as technical and human resource capacity are indicated enough to sustain Project activities, but it is still in the mid of process of getting the institutional and financial sustainability. The efforts by the Croatian counterparts for the sustainability of outcomes on the Project are practical, strategic and highly appreciated.

5.2 Recommendations

- **Accelerate the activities to achieve the Project Purpose**
  The evaluation team encourages accelerating the Project activities. To achieve the Project Purpose, some more works should be intensively conducted such as finalization of hazard maps, guidelines and manuals.
- **Maximization of the outcomes of the Project**
  Strengthen collaboration between Universities and Local government is recommended. The formulation of the institutional framework based on memorandum of understanding between each university and local government should be accelerated for the official use of these outcomes of the Project in local government.
- **Follow up, collaborating research after the Project period**
  For further development of the researches, continuing researches with both Japanese and Croatian side is recommended, such as sharing the data collected and observation
- **Sustainability of equipment after the Project period**
  Each University needs to secure the maintenance cost of equipment procured in the Project after the termination of the Project.
- **Issue of tax exemption after the EU accession**
  After Croatia became the member of the EU in June 2013, tax exemption again became the issue. Croatian side should proceed the procurement as soon as possible.
- **Ex-post evaluation is expected**
  It is strongly recommended that JICA conducts the Ex-post evaluation. Project activities planned to be

implemented in the final 3 months of the Project period are expected to make a significant impact on the project outcomes.

5.3 lessons learned

- **The project formulation in the countries which are unaccustomed with technical cooperation Project**

  This project of The Record of Discussion, a basic document to implement the project, was signed on 27 March 2009, but it was 9 March 2010 when the Note Verbal was exchanged for launching the Project. In addition, due to the absence of referential precedence on VAT exemption procedure in concerned agencies in Croatia, it took time to procure equipment necessary to conduct research.

  When the project is formulated in the countries which are unaccustomed with technical cooperation project, JICA has to confirm envisage preconditions and obstacles carefully and make clear the roadmap to solve them prior to the launching of the project. Especially, the project in the countries where JICA doesn't have representative office needs to cooperate more closely with JICA headquarters or neighboring country's office if there is.

- **For sustainable development of society**

  Research results of disaster prevention should be practically applied to the society. Related agencies/organization, such as local and central government level should be included in JCC. It is ideal that related agencies should be identified at the stage of detailed planning survey and assign them as JCC members from the beginning of the Project.

Annex 1: Master Plan (Revision was made and approved by JCC at the time of Mid-term Review)

1. Project Purpose

Integrated landslide/flood hazard mapping technology and land-use guidelines formulation methodologies are developed for nation-wide application in Croatia.

Indicator 1 :Number of manual book to develop integrated landslide/flood hazard map (1 manual)

Indicator 2 : Number of manual book to develop land-use guideline for landslide/flood risk mitigation (1 manual)

2. Outputs

(1)Methodologies for landslide risk assessment, prediction of affecting areas, and early warning systems are developed adapting to hydrological and geological conditions in Croatia.

Indicator 1-1: Number of manual book of methodologies for landslide risk assessment (1 manual)

Indicator 1-2: Number of model sites to develop a simulation for landslide predictions on dynamics (2 model sites: Kostanjek, Grohovo

Indicator 1-3: Number of model sites to establish landslide early warning systems (2 model site: Kostanjek, Grohovo)

(2)Flash-flood/debris-flow simulation models and early warning systems are developed adapting to hydrological and geological conditions in Croatia.

Indicator 2-1: Number of model sites to formulate a flash-flood/debris-flow simulation model (5 model sites: Rječina River Basin, Dubračina River Basin, Mošćenička Draga, Imotski, Sutina-Karakašica)

Indicator 2-2: Number of model sites to establish a flash-flood early warning system at Rijeka (2 model sites: Rječina River Basin, Mošćenička Draga)

Indicator 2-3: Number of model site to clarify essential factors on flash-flood/debris-flow simulation model, considering sustainable land management to mitigate water erosion on different tillage treatments (1 model site: Daruvar)

(3)Integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation are developed for study areas.

Indicator 3-1: Number of study areas to develop an integrated landslide/flood hazard map (3 areas: Zagreb, Rijeka and Split)

Indicator 3-2: Number of study areas to develop land-use guidelines for landslide/flood risk mitigation (3 areas: Rijeka, Split, Zagreb)

Note 1): Indicator 3-1 for Split area means two individual hazard maps for landslide (rock fall) and flash flood.

Note 2):Indicator 3-1 for Moscenicka Draga (in Rijeka area) means individual hazard map for flash flood

3. Activities

(1)-1. Development of a low-cost undrained shear test apparatus.

(1)-2. Soil tests using the shear test apparatus.

(1)-3. Field survey and monitoring at landslide risk sites in model sites.

(1)-4. Development of landslide risk assessment methods based on landslide dynamics, and their application to the model sites.

(1)-5. Development of methods for the prediction of landslide affecting areas, and their application to the model sites.

(1)-6. Development of land slide early warning systems, and their application to the model sites.

(2)-1. Collection of existing hydro-meteorological data and analysis of rainfall-discharge characteristics in model sites.

(2)-2. Installation of rainfall measurement equipment, and collection of rainfall data.

(2)-3. Development of flashflood and debris flow simulation models in model sites.

(2)-4. Development of flashflood and debris flow early warning systems and their application to the model sites.

(3)-1. Preparation of digital topography maps of the study areas and the model sites based on the photo interpretation.

(3)-2. Development of wide-area landslide risk assessment methods using the Analytical Hierarchy Process (AHP) method, and their application to the study areas.

(3)-3. Development of integrated landslide/flood hazard mapping technology, and formulation of integrated hazard maps for the study areas and model sites.

(3)-4. Development of land-use guidelines formulation methodology, and formulation of land-use guidelines for disaster mitigation in study areas.

(3)-5. Preparation of a manual of integrated landslide/flood hazard mapping, and a manual of land-use guidelines formulation that are applicable nation-wide in Croatia.

Annex 2: Plan of Operation (Revision was made and approved by JCC at the time of Mid-term Review)

Plan of Operation

Outputs and Activities		1st JFY 2009/2010	2nd JFY 2010/2011	3rd JFY 2011/2012	4th JFY 2012/2013	5th JFY 2013/2014
	JCC			①	② ③	④ ⑤
②:with mid-term review mission (Jul. 2012), ③:with 3rd conference(Mar. 2013), ④:with final evaluation mission(Dec. 2013), ⑤:with final conference(Mar. 2014)						
Output 1: Methodologies for landslide risk assessment, prediction of affecting areas, and early warning systems are developed adapting to hydrological and geological conditions in Croatia.						
1-1	Development of a low-cost undrained shear test apparatus					
1-2	Soil tests using the shear apparatus					
	① Set up the undrained shear test apparatus in UR					
	② Conduct additional soil tests of samples from the 2 model sites (Kostanjek, Grohovo)					
1-3	Field survey and monitoring at landslide risk sites in model sites					
	① Procurement and Set up GPS and other monitoring system for Kostanjek landslide					
	② Monitoring Kostanjek landslide and Grohovo					
1-4	Development of landslide risk assessment methods based on landslide dynamics, and their application to the model sites					
	① Obtain the parameters thorough the soil tests in 1-2					
	② Carry out the landslide risk assessment at the 2 model sites (Kostanjek, Grohovo) with using the parameters					
1-5	Development of methods for the prediction of landslide affecting areas, and their application to the model sites					
	① Obtain the parameters thorough the soil tests in 1-2					
	② Carry out the prediction of affecting area at the 2 model sites (Kostanjek, Grohovo) with using the parameters					
1-6	Development of landslide early warning systems, and their application to the model sites					
	① Fix the necessary standard data for establishment of early warning system at Kostanjek and Grohovo landslide and development the early warning system					
	② Fix the contents of manual book of methodologies for landslide risk assessment					
	③ Development the manual book of methodologies for landslide risk assessment and share it with necessary organizations					

Output 2:Flash-flood/debris-flow simulation models and early warning systems are developed adapting to hydrological and geological conditions in Croatia.						
2-1	Collection of existing hydro-meteorological data and analysis of rainfall-discharge characteristics in model sites					
	① Analysis of rainfall-discharge characteristics in 5 model sites (Rjecina River Basin, Dubracina River Basin, Moscenicka Draga, Imotski, Stinakarakaticka)					
2-2	Installation of rainfall measurement equipment, and collection of rainfall data					
	① Installation of rainfall measurement equipment at UR					
	② Collection and analysis of rainfall data					
2-3	Development of flashflood and debris flow simulation models in model sites					
	① Development of flashflood and debris flow simulation model (Hydro-Debris3D)					
	② Application the simulation model into 5 model sites (Rjecina River Basin, Dubracina River Basin, Moscenicka Draga, Imotski, Sutina-Karakasica)					
	③ Development of the flashflood and debris flow simulation model considering sustainable land management to mitigate water erosion ondifferent tillage treatments					
	④ Application of the simulation model considering sustainable land management to mitigate water erosion ondifferent tillage treatments					
2-4	Development of flashflood and debris flow early warning systems, and their application to the model sites					
	① Procurement and set up of radar to cover the 2 model sites (Rjecina River Basin, Moscenicka Draga)					
	② Fix the necessary standard data for establishment of early warning system at Rijeka (2 model sites; Rjecina River Basin, Moscenicka Draga)					
	③ Development the early warning system and share it with necessary organizations					

Output 3: Integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation are developed for study areas.	
3-1	Preparation of digital topography maps of the study areas and the model sites based on the photo interpretation
3-2	Development of wide-area landslide risk assessment methods using the Analytical Hierarchy Process (AHP) method, and their application to the study areas
	① Preparation of landslide inventory and risk assessment by applying the AHP method for 3 areas (Medvednica, Rjecina River Basin, Dubracina River Basin, Duce, Omis)
	② Fix the contents of manual book of methodologies for landslide risk assessment
3-3	Development of integrated landslide/flood hazard mapping technology, and formulation of integrated hazard map for the study areas and model sites
	① Arrange the work scheme to synthesize the landslide and flashflood/debris flow
	② Development of integrated landslide/flood hazard map for 2 model sites (Rjecina River Basin, Dubracina River Basin) by synthesizing the wide-area landslide risk assessment using AHP method (3-2), result of flashflood and debris flow simulation (2-3), landslide risk assessment on landslide dynamics (1-4), and prediction on landslide affected area (1-5)
	③ Development of sepalate landslide/flood hazard map for 3 areas (Rijeka, split, Zagreb) by synthesizing the wide-area landslide risk assessment using AHP method (3-2), result of flashflood and debris flow simulation (2-3), landslide risk assessment on landslide dynamics (1-4), and prediction on landslide affected area (1-5)
	④ Share the integrated and sepalate hazard map with necessary organizations
3-4	Development of land-use guidelines formulation methodology, and formulation of land-use guidelines for disaster mitigation in study areas
	① Fix the contents of land-use guideline for disaster mitigation for 3 areas (Rijeka, Zagreb, Split)
	② Development of land-use guideline for 3 areas (Rijeka, Zagreb, Split)
	③ Share the land-use guideline with necessary organizations
3-5	Preparation of a manual of integrated landslide/flood hazard mapping, and a manual of land-use guidelines formulation that are applicable nation-wide in Croatia
	① Fix the contents of manual of integrated landslide/flood hazard mapping, and a manual of land-use guidelines formulation that are applicable nation-wide in Croatia
	② Development of manual of integrated landslide/flood hazard mapping, and a manual of land-use guidelines formulation that are applicable nation-wide in Croatia, and share them with necessary organization

Original plan ←→ Past activity —— On going activity - - - →

Annex 3: Schedule of Review Mission

Date	Mr. Ejiri, Mr. Kitamura	Ms. Aoki	JST members
1 Sun Dec	-	12:25 Narita – 16:30 Vienna 17:00 Vienna– 18:00 Zagreb	-
2 Mon	-	09:30 Interview with UZM (WG3) 14:00 Interview with UZM (WG1)	-
3 Tue	-	9:00 Site visit of Zagreb (Kostanjek Landslide) 13:00 Interview with EMO, City of Zagreb	-
4 Wed	-	09:00 Zagreb → Rijeka (by car) 13:00 Courtesy call to UR	-
5 Thu	-	09:00 Interview with UR (WG 1&3) 14:00 Field visit (Grohovo Landslide)	
6 Fri	-	9:00 Interview with UR (WG2) 14:00 Interview with City of Rijeka	
7 Sat	-	12:00 Rijeka → Split (by car)	
8 Sun		Report Preparation	
9 Mon		09:30 Interview with Mr. Miscevic, Ms.Knezic and WG4	
10 Tue		10:00 Courtesy Call to the Mayor of the Town of Omiš 11:00 Field visit (Omiš, Duće)	Mr.Masuda: 1:10 Haneda - 5:25 Frankfurt 12:05 Frankfurt – 13:45 Split
11 Wed	12:25 Narita - 16:15 Vienna 19:35 Vienna - 20:30 Zagreb 21:10 Zagreb - 21:55 Split	9:00 Site Visit (Imotski)	"Prof.Honkura: 1:10 Haneda - 05:25 Frankfurt" 12:05 Frankfurt – 13:45 Split
12 Thu	Workshop Day1		
13 Fri	Workshop Day2		
14 Sat	Workshop Field trip 11:30 AM Courtesy call to Omis city (Mayor Ivan Kovačić; Deputy Mayor Ivo Tomasović and Mayor Adviser Neven Lelas)		
15 Sun	13:15 Split - 14:05 Zagreb		
16 Mon	10:00 - 15:00 Joint Evaluation Meeting (with Miljenka Kuhar and Morana Kovačević at MZOS)		"Prof.Honkura: 13:30 Zagreb - 14:35 Munchen" 15:45 Munchen - 11:30+1 Narita
17 Tue	10:00 - 15:30 JCC & MM		
18 Wed	9:30 Courtesy call to MZOS (Assistant Minister for High Education Prof. Ružica Beljo Lučić) 14:00 Courtesy call to OEM 15:30 Courtesy call to Embassy of JP		"Mr.Masuda: 17:20 Zagreb - 18:25 Munchen" 19:55 Munchen - 15:40+1 Narita
19 Thu	8:25 Zagreb - 9:25 Vienna 13:05 Vienna - 8:15 +1 Narita		

Annex 4: List of Interviewees

1	Ms. Snježana Mihalić Arbanas	Associate Professor, UZM (Deputy PM, Leader WG3, WG1)
2	Mr. Martin Krkač	Assistant, UZM (WG1)
3	Mr. Željko Miklin	Adviser, Engineering Geologist, CGS (WG3)
4	Ms. Jasmina Martinčević	Researcher, CGS (WG3)
5	Mr. Laszlo Podolszki	Researcher, CGS (WG3)
6	Ms. Sanja DUGONJIĆ	Assistant, UR (WG1&3)
7	Ms. Sanja Bernat	Assistant, UZM (WG 1&3)
8	Mr. Ivica Kisić	Associate Professor, UZA (Project Coordinator)
9	Ms. Maja OŠTRIĆ	Croatian Water (WG1), Ph.D. in Japan
10	Ms. Karolina Gradiški	Assistant, UZM (WG1)
11	Ms. Nevenka Ožanić	Vice-Rector for R&D, Professor, UR (Project Manager, Leader WG2)
12	Mr. Elvis ŽIC	Assistant, UR (WG2)
13	Ms. Barbara Karleuša	Professor, UR (WG2)
14	Ms. Nevena Dragičević	Assistant, UR (WG2)
15	Mr. Elvis Žic	Assistant, UR (WG2)
16	Ms. Ivana Sušanj	Assistant, UR (WG2)
17	Mr. Željko Arbanas	Vice-dean for studies and students, Associate professor, UR (Leader WG1) MZOS Project Coordinator
18	Ms. Martina Vivoda	Assistant, UR (WG1)
19	Mr. Vedran Jagodnik	Assistant, UR (WG1)
20	Mr. Josip Peranić	Assistant, UR (WG1)
21	Mr. Ivan Vrkljan	Vice President at Large, International Society for Rock Mechanics, UR (WG1)
22	Mr. Predrag Miščević	Professor, Faculty of Civil Engineering, Architecture and Geodesy (Leader WG4)
23	Ms. Snježana Knezić	Professor, US (WG4)
24	Mr. Goran Vlastelica	Assistant, US (WG4)
25	Ms. Suzana Antunović	Assistant, US (WG4)
26	Mr. Ivo Andrić	Assistant, US (WG4)

1	Mr. Pavle Kalinić	Principal of Office, EMO, City of Zagreb
2	Ms. Kristina Martinovic	Head of Communication and GIS, EMO City of Zagreb
3	Mr. Goran Šarić	City of Rijeka

1	Ivan Kovačić	Mayor of the Town of Omiš
2	Neno Mimica	Head of the Department for communal and residential issues, urban planning and environment
3	Zora Lelas-Ković	Advisor for public procurement and leasing

1	Mr. Hideaki Marui	Director, Research Institute for Natural Hazards and Disaster Recovery, Niigata University
2	Mr. Chunxiang Wang	Associate Professor, Niigata University
3	Mr. Yosuke Yamashiki	Associate Professor, Disaster Prevention Research Institute, Kyoto University
4	Mr. Hideaki Komiyama	Project Coordinator
5	Ms. Ana Zakosek	Assistant to Project Coordinator

Annex 5: List of Japanese Experts Dispatched

As of Dec 2013

Arrival Date and Departure Date (number of days in Croatia)

WG	Name and Field	FY2010(H22)					FY2011(H23)					FY2012(H24)				FY2013(H25)				
		1st (6th)	2nd	3rd	4th	5th	1st (6th)	2nd (7th)	3rd	4th	5th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
1	Kyoji SASSA	5/15-27(13)	9/16-25(10)	11/20-27(8)			4/25-29(5)	2/22-26(5)						9/4-9 (6)	3/5-10(6)		9/10-15(6)			59
1	Osamu NAGAI	5/19-27(9)	7/13-23(11)	9/14-28(15)	3/17-27(11)		5/25-6/4(11)	10/10-21(12)	12/13-19(7)					9/4-11(8)			9/10-15(6)			90
1	Hiroshi FUKUOKA	9/18-7(10)					9/25-10/2(8)										9/24-28(5)			32
1	Bin HE						4/25-29(5)							9/4-9/9(6)	3/5-12(8)		9/10-15(6)			25
1	Kouji MATSUNAMI						9/26-10/2(7)							11/29-12/3(5)		7/4-12(9)	9/18-28(11)			32
1	Gen FURUYA	5/19-27(9)	7/12-23(12)	9/14-28(15)	11/21-27(7)	3/16-27(12)	5/22-6/4(14)	7/16-30(15)	9/6-10/2(27)	10/10-21(12)	1/27-2/5(10)			9/14-24(11)			9/7-21(15)	10/17-24(8)		167
1	Hiroyuki YOSHIMATSU																	12/10-19(12)		12
1	Naoki WATANABE						7/16-28(13)	9/5-20(16)	11/17-27(11)	12/14-18(5)	3/19-25(7)	6/1-17(17)			3/6-12(7)			12/11-14(4)		80
2	Yosuke YAMASHIKI	7/15-22(8)	9/13-21(9)	11/20-1/30(11)			4/21-28(8)	7/13-18(6)	9/12-22(11)			5/10-17(8)	7/6-10(5)	10/26-11/9(15)		4/24-30 (7)	9/16-22(7)	12/6-17(12)		112
2	Takahiro SAYAMA	7/17-23(7)																		7
2	Tamotsu TAKAHASHI	9/13-21(9)					9/12-22(11)													20
2	Shigeo FUJIKI	9/13-21(9)	11/19-11/30(12)	2/24-3/7(13)			9/12-22(11)					5/9-17(9)		10/25-11/10(17)			9/17-23(7)	10/17-24(8)		86
2	Naoko KIMURA	11/17-26(10)	2/24-3/7(15)				4/21-27(7)	9/12-22(11)	12/13-18(6)	1/23-2/13(22)		5/5-13(9)		10/29-11/9(12)	3/4-13(10)			9/9-16(8)	12/11-19(9)	97
3	Hideaki MARUI	5/20-25(6)	7/12-23(12)	9/14-28(15)	11/20-27(8)	1/16-20(5)	5/22-27(6)	7/16-28(13)	9/7-11(5)	9/16-21(6)	12/13-19(7)	7/8-14(7)		9/14-24(11)	3/5-12(8)	4/9-13(5)	9/7-13(7)	12/10-19(12)		151
3	Hideaki MARUI	3/19-26(8)					2/19-25(7)	3/9-11(3)												
3	Chunxiang WANG	3/16-27(12)					5/2-29(28)	6/9-7/20(42)	9/4-10/2(29)	10/10-11/29(20)	1/8-2/25(49)	5/24-7/24(62)		11/11-12/11(31)	3/5-12(8)	4/10-13 (4)	6/24-7/12(19)	9/9-26(18)	12/10-19(12)	334
3	Toyohiko MIYAGI	9/18-28(11)					5/1-8(8)	12/14-17(4)												23
3	Hiroshi YAGI	9/18-28(11)					5/1-14(14)													25
3	Eisaku HAMAZAKI	9/18-28(11)					10/10-21(12)													23

TOTAL (1384)

Long- term Hideaki KOMIYAMA 11 May 2010 – 10 May 2013

Annex 6: List of Trainings and Business Trip for Counterpart in Japan

As of July 2012

Scheme	Term	Name	Institution	Period (Departure and Arrival)	Visited Institutions and Course
Business Trip	Short-term	Ms. Snježana Mihalić	Associate Professor, UZM (WG3)	6 Nov 2011 – 26 Nov 2011	Tohoku Gakuin University, Niigata University, Yamagata University
				15 Jan 2012 – 28 Jan 2012	Kyoto University, ICL
		Mr. Željko Arbanas	Associate Professor, UR (WG1)	13 Nov 2011 – 26 Nov 2011	Niigata University, Yamagata University
				9 Jan 2012 – 28 Jan 2012	Kyoto University, ICL
				17 May 2012 – 27 May 2012	Kyoto University, ICL
		Mr. Ognjen Bonacci	Professor, US (WG2)	10 Apr 2012 – 15 Apr 2012	Niigata University
		Ms Nevenka Ožanić	Professor, UR (WG2)	10 Apr 2012 – 17 Apr 2012	Niigata University
		Mr. Ivica Kisić	UZA (WG2)	10 Apr 2012 – 17 Apr 2012	Niigata University
		Mr. Ivan Vrkljan	UR (WG1)	10 Apr 2012 – 17 Apr 2012	Niigata University
		Mr. Željko Miklin	CGS (WG3)	10 Apr 2012 – 17 Apr 2012	Niigata University
		Ms Nevenka Ožanić	Professor, UR (WG2)	20 Apr 2013- 01 May 2013	DPRI of Kyoto University; Disaster Reduction and Human Renovation Institution Kobe; Tokyo Office of Niigata University; ICHARM of Public work Research Institute in Tokyo
		Mr. Ivica Kisić	UZA (WG2)	20 Apr 2013- 01 May 2013	DPRI of Kyoto University; Disaster Reduction and Human Renovation Institution Kobe; Tokyo Office of Niigata University; ICHARM of Public work Research Institute in Tokyo
		Mr. Ivan Vrkljan	UR (WG1)	20 Apr 2013- 01 May 2013	DPRI of Kyoto University; Disaster Reduction and Human Renovation Institution Kobe; Tokyo Office of Niigata University; ICHARM of Public work Research Institute in Tokyo
		Mr. Željko Miklin	CGS (WG3)	20 Apr 2013- 01 May 2013	DPRI of Kyoto University; Disaster Reduction and Human Renovation Institution Kobe; Tokyo Office of Niigata University; ICHARM of Public work Research Institute in Tokyo
		Mr. Predrag MIŠČEVIĆ	Professor, US (WG4)	20 Apr 2013- 01 May 2013	DPRI of Kyoto University; Disaster Reduction and Human Renovation Institution Kobe; Tokyo Office of Niigata University; ICHARM of Public work Research Institute in Tokyo
		Mr. Ognjen Bonacci	Professor, US (WG4)	20 Apr 2013- 01 May 2013	DPRI of Kyoto University; Disaster Reduction and Human Renovation Institution Kobe; Tokyo Office of Niigata University; ICHARM of Public work Research Institute in Tokyo
		Mr. Pavle KALINIĆ	Principal, EMO	22 July 2013- 28 July 2013	Niigata University
		Ms. Kristina MARTINOVIĆ	Head of Communications, EMO	22 July 2013- 28 July 2013	Niigata University
C/P Training	Short-term	Mr. Laszlo Podolszki	Researcher, CGS, (WG3)	6 Oct 2010 – 6 Dec 2010	Tohoku Gakuin University (aerial photo interpretation, AHP, ADCALC) Yamagata University (aerial photo interpretation) Niigata University (integrated landslide hazard map)
				18 Oct 2011 – 7 Dec 2011	Tohoku Gakuin University (aerial photo interpretation, AHP, ADCALC) Yamagata University (aerial photo interpretation) Niigata University (integrated landslide hazard map)

		Mr. Martin Krkač	Assistant, UZM (WG1)	6 Oct 2010 – 6 Dec 2010	Tohoku Gakuin University (aerial photo interpretation, AHP, ADCALC) Yamagata University (aerial photo interpretation) Niigata University (integrated landslide hazard map)
				30 Nov 2011 – 30 Jan 2012	ICL (shear test apparatus, simulation of landslide affecting area)
		Mr. Goran Vlastelica	Assistant, US, (WG1)	6 Oct 2010 – 6 Dec 2010	Tohoku Gakuin University (aerial photo interpretation, AHP, ADCALC) Yamagata University (aerial photo interpretation) Niigata University (integrated landslide hazard map)
		Mr. Sanja Dugonjić	Assistant, UR, (WG1)	6 Oct 2010 – 6 Dec 2010	Tohoku Gakuin University (aerial photo interpretation, AHP, ADCALC) Yamagata University (aerial photo interpretation) Niigata University (integrated landslide hazard map)
		Mr. Pavle Ferić	Assistant, UZM, (WG3)	18 Oct 2011 – 7 Dec 2011	Tohoku Gakuin University (aerial photo interpretation, AHP, ADCALC) Yamagata University (aerial photo interpretation) Niigata University (integrated landslide hazard map)
		Mr. Ivana Sušanj	Assistant, UR, (WG2)	6 Nov 2011 – 25 Jan 2012	DPRI, Kyoto University (sediment discharge, its flow and change flood/debris-flow analysis, 3D program software)
		Mr. Ivo Andrić	Assistant, US, (WG2)	6 Nov 2011 – 20 Dec 2011	DPRI, Kyoto University (sediment discharge, its flow and change flood/debris-flow analysis, 3D program software)
		Mr. Kristijan Ljutić	Assistant, UR, (WG1)	30 Nov 2011 – 30 Jan 2012	ICL (shear test apparatus, simulation of landslide affecting area)
				11 Apr 2012 – 1 Jun 2012	ICL (shear test apparatus, simulation of landslide affecting area)
		Mr. Darija Bilandžija	Assistant, UZA, (WG2)	11 Jan 2012 – 14 Feb 2012	DPRI, Kyoto University (sediment discharge, its flow and change flood/debris-flow analysis, 3D program software)
		Ms. Vivoda Martina	Assistant, UR, (WG1)	11 Apr 2012 – 1 Jun 2012	ICL (shear test apparatus, simulation of landslide affecting area)
		Ms. Karolina GRADIŠKI	Assistant, UZM, (WG1)	Jan 7 2013- Feb 22 2013	DPRI, Kyoto University (Joint research on the development of ring shear apparatus and the landslide hazard assessment using the apparatus)
		Mr. Elvis ŽIC	Assistant, UR	Jan 15 2013- Feb 28 2013	DPRI, Kyoto University (Training for Early Warning System Development and Management on Floods and Debris-Flow)
		Ms. Sanja BERNAT	Assistant, UZM, (WG3)	Feb 17 2013- Mar 19 2013	Tohoku Gakuin University (Risk Identification of landslides)
		Mr. Petra ĐOMLIJA	Assistant, UR,(WG3)	Feb 17 2013 Mar 19 2013	Tohoku Gakuin University (Risk Identification of landslides)
		Mr. Igor RUŽIĆ	Assistant, UR	May 1 2013- June 30 2013	Kyoto University; DPRI-KU Observatory (Training for Early Warning System Development and Management on Floods and Debris-Flows)
		Mr. Nino KRVAVICA	Assistant, UR	May 1 2013- June 30 2013	Kyoto University; DPRI-KU Observatory (Training for Early Warning System Development and Management on Floods and Debris-Flows)

Annex 7: List of Machinery and Equipment Provided

(FY2010)

No.	Item (brand/maker and model)	Allocation	Delivery date
1	Extensometer NetLG-501E	UZ	24 Jun
2	Network Controller NetCT-1E	UZ	24 Jun
3	RS232C Converter NetGW-1E	UZ	6/24
4	Hub NetHUB-1E	UZ	6/24
5	Water Level Detector DS-1	UZ	6/24
6	Water Level Data Logger NetLG-001E	UZ	6/24
7	Rain Gauge and Transmitter RS-1	UZ	6/24
8	Precipitation Data Logger NetLG-201E	UZ	6/24
9	Alarm Unit AL-Type AE	UZ	6/24
10	NetLG501 Container SUS2	UZ	6/24
11	Invar Wire	UZ	6/24
12	Invar Wire	UR	9/19
13	Communication Cable	UR	9/19
14	Extensometer NetLG-501E	UR	11/11
15	Network Controller NetCT-1E	UR	11/11
16	RS232C Converter NetGW-1E	UR	11/11
17	Hub NetHUB-1E	UR	11/11
18	Water Level Detector DS-1	UR	11/11
19	Water Level Data Logger NetLG-001E	UR	11/11
20	Rain Gauge and Transmitter RS-1	UR	11/11
21	Precipitation Data Logger NetLG-201E	UR	11/11
22	Alarm Unit AL-Type AE	UR	11/11
23	NetLG501 Container SUS2	UR	11/11
24	Extensometer NetLG-501E	UR	12/22
25	Hub NetHUB-1E	UR	12/22
26	NetLG501 Container SUS2	UR	12/22
27	Communication Cable	UR	12/22
28	Portable Direct Shear Apparatus MIS-233-1-71	UR	1/17
29	Constant-volume Direct Shear Test Apparatus MIS-233-1-72	UR	1/17
30	Water level pressure sensor（Schlumberger: Mini Diver）	UR	3/2
31	Water level pressure sensor (Fondriest:RuggedTROLL100)	UR	3/2
32	Weather station（Davis: Vantage Pro2）	UR	3/23
33	Current Meter（Teledyne RD:ADCP Sentinel (WHSZ1200)）	UR	3/23
34	Surface current meter （RYUKAN WJ7661）	UR	3/2
35	3D photograph chart making and counting system（Kuraves-G2）	UR	3/2
36	Ion measuring instrument（HORIBA W-23XD）	UR	3/3
37	Ion measuring instrument（CTD Diver）	UR	3/2
38	VAIO Notebook PC VPCZ14 (data collection)	UR	3/2
39	Camera to collect photo data（Cannon KISS X4）	UR	3/2
40	Water level pressure sensor（Fondriest:RuggedTROLL100）	US	3/4
41	Weather station（Davis: Vantage Pro2）	US	3/4
42	Current Meter（Teledyne RD:ADCP Monitor (WHMZ1200)）	US	3/4
43	Surface current meter（RYUKAN WJ7661）	US	3/4
44	3D photograph chart making and counting system（Kuraves-G2）	US	3/4
45	Ion measuring instrument（HORIBA W-23XD）	US	3/4
46	VAIO Notebook PC VPCZ14 (data collection)	US	3/4
47	Camera to collect photo data（Cannon KISS X4）	US	3/4
48	Piezometer KPB-500KPA	UR	4/6

(FY2011)

No.	Item (brand/maker and model)	Allocation	Delivery date
1	Reflection Stereoscope	Univ. of Zagreb	5/1
2	Cone penetration testing apparatus	Univ. of Zagreb	7/29
3	Extensometer NetLG-501E	Univ. of Zagreb	9/15
4	Inclinometer	Univ. of Zagreb	8/1
5	Laser Scanner	Univ. of Split	8/10
6	Landslide Simulation Software × 2	Univ. of Zagreb	5/26
7	A set of GPS and Total Station	Univ. of Rijeka	7/29
8	Extensometer Container	Univ. of Rijeka	Local procurement
9	Extensometer Pole	Univ. of Rijeka	Local procurement
10	Pole for GPS	Univ. of Rijeka	Local procurement
11	Boring for Borehole (Without Core, L=90m)	Univ. of Rijeka	Local procurement
12	Boring for Accelerometer(Without Core L=10m)	Univ. of Rijeka	Local procurement
13	Dell PC	Univ. of Rijeka	6/20
14	ArcGIS Software	Univ. of Rijeka	6/20
15	Workstation	Univ. of Rijeka	11/8
16	Inclinometer Casing	Univ. of Rijeka	6/20
17	Dell PC	Univ. of Zagreb	6/20
18	ArcGIS Software	Univ. of Zagreb	6/20
19	DEM (Altitude Data) of Model sites	Univ. of Zagreb	6/20
20	Aerial photographs	Univ. of Zagreb	6/30
21	Workstation	Univ. of Zagreb	8/25
22	Pole and Pulleys	Univ. of Zagreb	11/8
23	Copy Machine	Univ. of Zagreb	12/20
24	LPS Software	Univ. of Zagreb	8/25
25	Notebook PC × 2	Univ. of Zagreb	Local procurement
26	LIDER data of model sites	Univ. of Zagreb	Local procurement
27	Inclinometer Casing	Univ. of Zagreb	Local procurement
28	Dell PC	Univ. of Split	6/20
29	Tripod for Laser Scanner	Univ. of Split	9/23

Note) Procurement of No.7 was delayed to respond to VAT issues.

After the Mid Term Review

No.	Date od DL	Description	Total without PDV (HRK)	WG	Affiliation
1	2012/9/7	equipment for landslide monitoring (Poles and pulleys)	11,561.85	1	UZM
2	2012/9/7	equipment for landslide monitoring (Poles for GPS)	25,986.40	1	UZM
3	2013/1/9	equipment for landslide monitoring (materials for drilling)	21,480.00	1	UZM
4	2013/1/9	equipment for landslide monitoring (Poles and pulleys)	11,670.00	1	UZM
5	2012/9/7	equipment for landslide monitoring (Poles and pulleys)	4,629.95	1	UR
6	2012/10/11	equipment for landslide monitoring (Moxa)	9,377.10	1	UR
7	2012/9/7	material for hazard mapping (ArcGIS software)	21,546.00	4	US
8	2012/10/11	equipment for landslide analysis (PolyWorks softvare)	88,218.00	4	US
9	2013/3/14	equipment for GIS analysis (PC)	7,357.35	4	US

Expenses for local services

No.	Service	Cost	Payment Date
1	Chemical analysis for groundwater	5,904.00 HRK	September 13, 2010
2	Chemical analysis for groundwater	1,107.00 HRK	October 28, 2010
3	Chemical analysis for groundwater	1,020.00 HRK	May 18, 2011
4	Drilling on Grohovo site	163,200.00 HRK	June 10, 2011
5	Drilling on Kostanjek	13,400.00 EUR ~ 101,500.00 HRK	March 19,2013
6	Drilling on Salt Creek	31,350,00 HRK	March 27,2013
7	Drilling on Kostanjek	106,280.00 HRK	March 28,2013
8	Drilling on Kostanjek	21,763,50 HRK	July 10,2013
	TOTAL	**432,124.50 HRK**	

Annex 8: Operational Costs

Japanese Side

(Currency: JPY×1,000)

Items	2010.4.16-2011.8.31	2011.9.1- 2012.12.31	2013.1.1-2014.3.31(Planned)	Total
Dispatch of Japanese Researchers	40,716	57,335	34,035	132,086
Machinery and Equipment (Procurment in Japan)	74,915	85,453	6,141	166,509
Total	115,631	142,788	40,176	298,595

Items	FY2010	FY2011	FY2012	FY2013 (Planned)	Total
Machinery and Equipment (Procurment in Croatia)	0	11,818	3,689	0	15,507
Dispatch of Mission	478	7,637	3,281	1,500	12,896
Training of Croatian Researchers in Japan	0	7,267	5,047	2,107	14,421
Operational Expenses (Ordinary Expenses, Travel Expenses, Local Consultant Fee, Staff Salary, Meeting, etc.)	13,879	8,552	4,283	9,445	36,159
Total	14,357	35,274	16,300	13,052	78,983
				Total	377,578

Croatian Side

(Currency: HRK)

Items	FY2010	FY2011	FY2012	FY2013	Total
Lump sum (MZOS)	307,5000	307,500	307,500	307,500	1,230,000
Salary for 9 researchers (MZOS)					
Costs for installation of equipment, insurance policy (MZOS)					
Total					

Annex 9: List of Counterpart Personnel

As of December 2013
as of Nov. 2013

			Name	Title and Organization	Role / Responsibility in the Project	Remarks
1		Ms	Miljenka Kuhar	Head of Division for Science and Technology Projects, MZOS	Project Director	
2	Prof	Ms	Nevenka OŽANIĆ	Vice Rector, Professor, UR	Project Manager, WG2 Leader	Business Trip to Japan
3	Prof	Ms	Snježana MIHALIĆ ARBANAS	Associate Professor, UZM	Deputy Project Manager, WG3 Leader	Business Trip to Japan
4	Prof	Mr	Ivica KISIĆ	Professor, UZA	Project Coordinator	Business Trip to Japan
5	Prof	Mr	Željko ARBANAS	Vice Dean, Associate Professor, UR	WG1 Leader	Business Trip to Japan
6	Prof	Mr	Predrag MIŠČEVIĆ	Professor, US	WG4 Leader	Business Trip to Japan
7	Prof	Ms	Snježana KNEZIĆ	Professor, US	WG4, Representative of the Faculty of Civil Engineering, Architecture and Geodesy, US	
8	Prof	Mr	Ivan VRLJAN	Professor, UR	WG1	Business Trip to Japan
9	Prof	Mr	Čedomir BENAC	Professor, UR	~~WG1, WG2,~~ WG3	
10		Ms	Sanja DUGONJIĆ	Assistant, UR	WG1	Training in Japan
11		Ms	Martina VIVODA	Assistant, UR	WG1	Employed by MZOS budget for the Project; Training in Japan
12		Mr	Vedran JAGODNIK	Assistant, UR	WG1	
13		Mr	Josip PERANIĆ	Assistant, UR	WG1	
14		Mr	Martin KRKAČ	Assistant, UZM	WG1	Training in Japan
15		Ms	Karolina GRADIŠKI	Assistant, UZM	WG1	Employed by MZOS budget for the Project; Training in Japan
16		Ms	Sanja BERNAT	Assistant, UZM	WG1&3	Employed by MZOS budget for the Project; Training in Japan
17		Ms	Maja OŠTRIĆ	CW	WG1	PhD in Japan
18		Ms	Ivana SUŠANJ	Assistant, UR	WG2	Employed by MZOS budget for the Project; Training in Japan
19		Mr	Elvis ŽIC	Assistant, UR	WG2	Training in Japan
20		Ms	Nevena DRAGIČEVIĆ	Assistant, UR	WG2	
21	Prof	Ms	Barbara KARLEUŠA	Vice Dean, Associate Professor, UR	WG2	
22	Prof	Mr	Nenad BIČANIĆ	Full professor UR	WG2	
23	dr	Mr	Ivan MAROVIĆ	Researcher UR	WG2	
24		Mr	Nino KRVAVICA	Assistant, UR	WG2	Training in Japan
25		Mr	Igor RUŽIĆ	Assistant, UR	WG2	Training in Japan

26		Mr	Josip RUBINIĆ	Researcher, UR	WG2	Employed by MZOS budget for the Project; Training in Japan
27	dr.	Mr	Goran VOLF	Researcher, UR	WG2	
28		Mr	Vanja TRAVAŠ	Researcher, UR	WG2	
29		Ms	Darija BILANDŽIJA	Assistant, UZA	WG2	
30		Mr	Danko BIONDIĆ	Principal, CW	WG2	
31		Ms	Bojana HORVAT	Officer, CW	WG2	
32		Mr	Pavle FERIĆ	Assistant, UZM	WG3	Training in Japan
33		Ms	Petra ĐOMLIJA	Assistant, UR	WG3	Employed by MZOS budget for the Project; Training in Japan
34		Mr	Željko MIKLIN	Researcher, CGS	WG3	Business Trip to Japan
35		Mr	Laszlo PODOLSZKI	Researcher, CGS	WG3	Training in Japan
36		Ms	Jasmina MARTINČEVIĆ	Researcher, CGS	WG3	Employed by MZOS budget for the Project
37	Prof	Mr	Ognjen BONACCI	Professor Emeritus	WG4	Project Manager until March 2012; Business Trip to Japan
38		Mr	Ivo ANDRIĆ	Assistant, US	WG4	Training in Japan
39		Mr	Goran VLASTELICA	Assistant, US	WG4	Training in Japan
40		Ms	Suzana ANTUNOVIĆ	Assistant, US	WG4	Employed by MZOS budget for the Project
41		Ms	Ana KADIĆ	Assistant, US	WG4	Employed by MZOS budget for the Project
42		Dr	Pavle KALINIĆ	Principal, OEM	Local Administration	Business Trip to Japan
43		Ms	Kristina MARTINOVIĆ	Head of Communications, OEM	Local Administration	Business Trip to Japan
44		Ms	Neven MIMICA	Engineer, City of Omiš	Local Administration	

Annex 10: Result Grid (Progress of the Project)

As of December 2013

Project Purpose: Integrated landslide/flood hazard mapping technology and land-use guidelines formulation methodologies are developed for nation-wide application in Croatia.
Indicator 1 : Number of manual book to develop integrated landslide/flood hazard map (1 manual) The manual was not completed yet.
Indicator 2 : Number of manual book to develop land-use guideline for landslide/flood risk mitigation (1 manual) The manual was not completed yet.

Activity	Progress of activities to date	Responsible Researchers	Progress (%)	Way forward for completion
Output 1 : Methodologies for landslide risk assessment, prediction of affecting areas, and early warning systems are developed adapting to hydrological and geological conditions in Croatia.				
Indicator 1-1: Number of manual book of methodologies for landslide risk assessment (1 manual) One manual for methodologies for landslide risk assessment was completed in 2012. (The indicator was achieved.) 1-2: Number of model sites to develop a simulation for landslide predictions on dynamics (2 model sites; Kostanjek, Grohovo) Simulations for landslide predictions on dynamics for 2 model sites, Kostanjek, Grohovo were conducted. (The indicator was achieved.) 1-3: Number of model sites to establish landslide early warning systems (2 model site; Kostanjek, Grohovo) Landslide early warning systems for 2 model sites, Kostanjek, Grohovo were established. (The indicator was achieved.)				
1-1 Development of a low-cost undrained shear test apparatus.	• The development of undrained shear test apparatus that can conduct landslide reproduction tests was completed in JFY2012. • Two Croatian researchers were trained in Japan (2 researchers × 2 months × 2 times) for the operation of and the tests with the apparatus. • Croatian researchers are proficient in conducting the tests for themselves. • The shear test apparatus shipped from Japan was at the custom office on 2 July, 2012, and is to be in Rijeka in the same week.	Sassa Arbanas	100%	The apparatus was provided to Croatian side, currently young researchers have been utilizing it at UR.
1-2 Soil tests using the shear test apparatus.	• Soil samples from model site were sent to Japan and tested with the undrained shear test apparatus. • Soil samples were from Kostanjek in Zagreb and Grohovo in Rijeka, both soil tests were completed.	Sassa Arbanas	100%	The apparatus is set up in Croatia in JFY2012, Croatian researchers have been conducting additional soil tests of samples from the model site.
1-3. Field survey and monitoring at landslide risk sites in	• Field surveys were conducted several times for the model sites. • As for the Grohovo model site (Rijeka), real-time	Sassa, Marui, Watanabe,	100%	For Kostanjek landslide, extensometer, seismic monitoring system and GNSS/GPS monitoring system were

model sites.	comprehensive monitoring equipment was installed and the monitoring is going on. • As for the Kostanjek landslide model site (Zagreb), extensometer, seismic monitoring system and GPS monitoring system were installed and the monitoring has been conducting.	Furuya, Nagai Arbanas, Mihalić Arbanas		installed and the monitoring has been conducting.
1-4. Development of landslide risk assessment methods based on landslide dynamics, and their application to the model sites.	• The activity 1-4 and 1-5 are linked and to be undertaken concurrently. Methods of landslide risk assessment and the prediction of landslide affecting areas based on landslide dynamics were completed development in JFY2012, and they were actually applied. • Landslide risks assessment (1-4) and the prediction of affecting areas (1-5) were completed at model sites (Kostanjek in Zagreb and Grohovo in Rijeka), based on parameters obtained through the soil tests in 1-2.	Sassa, Nagai Arbanas	100%	
1-5. Development of methods for the prediction of landslide affecting areas, and their application to the model sites.	• (see activity 1-4)		100%	
1-6. Development of land slide early warning systems, and their application to the model sites.	• At Kostanjek model site (Zagreb), extensometers were installed(in JFT2012) largely depending on which an early warning system is to be developed. • The monitoring is going on to accumulate data to feed into the establishment of early warning system. • At Kostanjek model site (Zagreb), the early warning measure was set in motion as a monitoring results of the installed system in April 2013. • For Grohovo in Rijeka, the early warning system is going to be developed based on the installed extensometers.	Sassa, Nagai, Marui, Furuya Arbanas, Mihalić Arbanas	100%	• Additional extensometers were introduced to the model site as there are many houses/residents in the area, for more acculate prediction of movement of the landslides.

Output 2: Flash-flood/debris-flow simulation models and early warning systems are developed adapting to hydrological and geological conditions in Croatia.

Indicator 2-1: Number of model sites to formulate a flash-flood/debris-flow simulation model (5 model sites; Rječina River Basin, Dubračina River Basin, Mošćenička Draga, Imotski, Sutina-Karakašica)

The simulation model was already developed. At the moment, an application of the simulation model in Rječina River Basin, Dubračina River Basin have been conducted, and for it is going to be conducted for other 3 model sites in the rest of Project period.

2-2: Number of model sites to establish a flash-flood early warning system at Rijeka (2 model sites; Rječina River Basin, Mošćenička Draga)

The development of a flash-flood early warning system was completed. The system was applied to Dubračina River Basin (Salt Creek) first as data was collected more than others and the early warning system is going to be established based on the radar rain gauge. For Mošćenička Draga river basin, the early warning system

is going to be established based on the normal rainfall measurement. Rječina River Basin is in the process of setting the system.				
2-1. Collection of existing hydro-meteorological data and analysis of rainfall-discharge characteristics in model sites.	• Existing hydro-meteorological data were collected, and rainfall-discharge characteristics in model sites were analyzed. • Accuracy of analytical data has been improving by the data from normal hyetometer and the rader rain gauge installed at University of Rijeka.	Yamashiki, Kimura Ožanić, Kisić	100%	The analysis has continued with additional hydro-meteorological data for improvent of accuracy.
2-2. Installation of rainfall measurement equipment, and collection of rainfall data.	• Rain gauges were installed at model sites Salt Creek at Dubračina River Basin, Mošćenička Draga and Rječina River Basin in Rijeka and the precipitaion data has been collecting. • Rader rain gauge was set up at the University of Rijeka in JFY 2012 and it has been collecting rainfall data of wider area.	Yamashiki, Fujiki, Kimura Ožanić, Kisić	100%	The precipitation data collection has been continuing.
2-3. Development of flashflood and debris flow simulation models in model sites.	• The development of flashflood and debris flow simulation model (Hydro-Debris3D) is completed in JFY 2012. • The flashflood simulation has been conducted specially for Dubračina River Basin.	Yamashiki, Fujiki, Kimura, Ožanić, Kisić	80%	The simulation model will be applied to other model sites, Dubračina River Basin (Salt Creek) and Zagreb area, and it is also going to be applied in Omiš (Split), Rječina River Basin, Mošćenička Draga (Rijeka) in the rest of Project period.
2-4. Development of flashflood and debris flow early warning systems, and their application to the model sites.	• The flashflood and debris flow early warning systems were developed. • The early warning systems are going to be installed by rain gauges in Mošćenička Draga river basin, and the rader gauge will be installed in Salt Creek.	Yamashiki, Fujiki, Kimura, Ožanić, Kisić	80%	The early warning systems will be installed in the rest of Project period.
Output 3: Integrated landslide/flood hazard maps and land-use guidelines for landslide/flood risk mitigation are developed for study areas.				
Indicator 3-1: Number of study areas to develop an integrated landslide/flood hazard map (3 areas; Rijeka, Split, Zagreb) **Note): Indicator 3-1 for Split area means two individual hazard maps for landslide and flashflood.** At the moment, only the hazard map of landslide for Zagreb where many landslides were found in wide area was completed while the flood hazard map is not completed. In Rijeka, the landslide hazard map was completed. As for the Split, the hazard map of rock fall is in the process of making. **3-2: Number of study areas to develop land-use guidelines for landslide/flood risk mitigation (3 areas; Rijeka Split, Zagreb)** At the moment, only the guide line for land used based on Landlide Harzard map was developed as the flood risk hazard map has not completed yet. The hazard map developed was mainly for Zagreb area where the densely populated area, while the modified versions for other areas are planning to be developed. As for Split area, the checking slope carte has been developing. For Rijeka, the risk assessment was completed in the main part of Rječina River Basin. The result of the risk assessment was finished plotting and it can be converted into hazard map as the land-use is simple.				
3-1. Preparation of digital topography maps of the study areas and the model sites	• Topography interpretation for model sites and surrounding areas, mainly based on aerial photos, were completed. • Digital topographic maps were prepared for sites as necessary.	Sassa, Nagai, Wang,Furuya	100%	

based on the photo interpretation.	• For some sites, digital topography maps were created based on LiDAR scanning with airplane.	Mihalić Arbanas, Arbanas		
3-2. Development of wide-area landslide risk assessment methods using the Analytical Hierarchy Process (AHP) method, and their application to the study areas.	• Basic topography and geological survey were conducted several times for the application of AHP to landslide hazard mapping in Croatia. • Evaluation criteria for AHP application were prepared. • The drafts of manuals to develop landslide inventory and risk assessment were prepared.	Hamazaki, Marui, Furuya, Wang Mihalić Arbanas Arbanas,	100%	
3-3. Development of integrated landslide/flood hazard mapping technology, and formulation of integrated hazard maps for the study areas and model sites.	• Integrated hazard map (3-3) will be prepared by synthesizing the wide-area landslide risk assessment using AHP (3-2), results of flashflood and debris flow simulation (2-3), landslide risk assessment on landslide dynamics (1-4), and prediction on landslide affecting areas (1-5). • At present, development of the hazard map on flashflood and debris flow simulation models in model sites (2-3) is in the stage of finalization, the hazard map for land slide is completed. • For 2 model sites (Kostanjek in Zagreb and Grohovo in Rijeka) where larger the affected areas, the assesments have been conducted by the results of assessment of landslide dynamics (1-4) and prediction of landslide affecting areas (1-5).	Marui, Sassa, Yamashiki, Wang, Furuya, Watanabe, Hamasaki, Nagai Arbanas Mihalić, Arbanas, Ožanić	100%	Development of integrated landslide/flood hazard map for model sites is going to be completed in the rest of Project period.
3-4. Development of land-use guidelines formulation methodology, and formulation of land-use guidelines for disaster mitigation in study areas.	• Land-use guidelines (3-4) will be prepared based on the integrated landslide/flood hazard map (3-3). • The contents that should be included in the land-use guidelines was investigated. • At the moment, only the guide line for land used basede on Landslide Harzard map was developed as the flood risk hazard map has not completed yet.	Marui, Sassa, Yamashiki, Herath, Wang, Furuya, Watanabe, Hamazaki, Nagai Mihalić Arbanas, Arbanas, Ožanić	80%	Making the land-use guidelines are going to be finished in the rest of Project period.
3-5. Preparation of a manual of integrated	• Manuals (3-5) will be prepared based on the land-use guidelines (3-4).	Marui, Sasssa,	80%	Developing the manuals is going to be completed in the rest of Project period.

landslide/flood hazard mapping, and a manual of land-use guidelines formulation that are applicable nation-wide in Croatia.	• The contents that should be included in the land-use guidelines was investigated. • At the moment, only the manual for the guide line of land used based on Landslide Hazard map was developed as the flood risk hazard map has not completed yet.	Yamashiki, Herath, Wang, Furuya, Watanabe, Hamazaki, Nagai Ožanić, Arbanas, Mihalić,		

Annex 11: Result Grid (Pilot Site)

Study Area / WG	Zagreb City of Zagreb (county) (640km²)	Rijeka Primorsko-Goranska County (3,800km²)
WG 1 Detailed Landslide Investigation Prof. Arbanas (UR)	**Kostanjek Landslide (1.2km²) - Medvednica Hilly area.** 1.2 One borehole for soil sampling and inclinometer (100m, Feb 2012) 1.3 Equipment installed 15 GNSS 9 extensometers 3 piezometers 6 accelerometers 3 water level sensors in well 2 water level sensors in weirs 1 rain gauge 1 inclinometer casing • Area of landslide: cca 1 km2 • Estimated sliding mass:cca 32x106 m3 • Lanslide activity state:active, activated in 1963 • Main cause (triggering factor) of sliding: human activity: mining works • displacement from 3 to 7 m • An efficient EWS should comprise the following activities(DiBiagio and Kjekstad, 2007): • monitoring, including data acquisition, transmission and maintenance of the instruments;	**Grohovo Landslide** (0.5km²) - **Rječina River Basin** 1.2 Two boreholes for soil sampling (20m and 25m, May 2011) 1.3 Equipment in place 10(9+1) GPS 15 extensometers (3 short span) 4 vertical extensometers 1 total station 25 prisms 4 pore pressure gauge 1 water level gauge 1 rain gauge • One part of pore pressure control seems not showing the correct results. • Apparatus is special one in Kyoto and another in Rijeka.. • The monitoring system was designed to consist of geodetic and geotechnical monitoring. • Geodetic monitoring includes geodetic surveys with a robotic total station (25 prisms) and displacement measurements of 9 GPS rovers. • Equipment for the geotechnical monitoring includes vertical inclinometers (2) in combination with vertical wire exstensometers (4), long and short-span extensometers (12+3), pore pressure gauges (4), and weather station. • Pore pressure gauges, inclinometers and vertical extensometers are

	• analysis and forecasting, which can be done by using thresholds values, expert judgment, forecasting methods and so on; • warning and response, i.e. actions taken in the case of a dangerous event • • monitoring, including data acquisition, transmission and maintenance of the instruments • installation of monitoring equipment almost completely finished • the data transmission is set up for 15 GNSS sensors and Osasi Technos Inc. sensors (3 pore pressure gauges, 4 vertical extensometers and a rain gauge) located at the main monitoring station in the central part of the landslide • raw data from the GNSS in real-time and data from Osasi devices (every hour) are delivered over communication lines (using routers) to an application/data server at the University of Zagreb • in order to integrate data from all the sensors in the GIS (Geographic Information System), customized GIS application is currently under development (Baučić et al. 2013) • Analysis and forecasting, which can be done by using thresholds values, expert judgment, forecasting methods • The forecasting of landslide failure in the periods of landslide reactivation, at first will be based on the Fukuzono (1985) method of inverse velocities • The Saito (1969) method of tertiary creep using data from the extensometer and GNSS sensors after a longer period of monitoring, data analysis should enable an estimation of the relationship between landslide causal factors and landslide displacement rates this relationships will be used for the establishment of the threshold values for the setup of EWS • Warning and response should be made in collaboration with the Emergency Management Office of the Zagreb City (deals with protecting activities against natural hazards) • Zagreb City Office for Physical Planning, Construction of the City, Utility Services and Transport (deals with landslide remediation)	installed at two locations inside the central part of the landslide body. • Extensometers are installed from Rječina riverbed to the limestone mega-blocks at the top of the slope. • Intentionally installed different type of equipment in one area for comparison, to research from various directions. 95% of installation has completed. • Extensometers is also needed some improvement. • Equipment for Weather station is for WG2, but WG1 is also using at the moment. The weather station will be installed in few months. • It has been about 2 years of data collection though, there were some interruptions due to lack of power supply. A wind mill was broken because of the strong wind in winter; there was no insurance for it. Additional solar panels are going to be installed. And it is planned to introduce the stronger wind mill from Spain, maximum capacity of 170km/hr. • To add some more equipment to the existing equipment is planned for further data collection and data accuracy. 1.6 • Data transmission of GPS was being done with existing system. • Downloading data from extensometer and pore pressure gauge at sites takes lots of time. It requires for all the data to be automatically transmitted and connected for EWS. • Data transferring is not completed yet. As GPS is of Leica, Leica should support us. While installation of the equipment is the responsibility of MZOS, completion of installation will be made by the end of the Project. **Achievement of Indicators (Output1):** **1-1 Manual for methodologies for landslide risk assessment:** • This indicator is more for WG3, and there is no manual yet. • Methodologies were developed by WG3 • Hazard is one of the components of risk assessment. **1-2 Model sites to develop a simulation for landslide predictions on dynamics.** • The simulation was conducted for Grohovo site by LS-RAPID software. • Parameter from boreholes, and some test at lab etc.. The simulation was suitable for Rijeka. Geometric and other conditions are far different each other between Kostajek and Grohovo. • Measurements are not difficult but it needs time to accumulate the data.

	<u>Achievement of Indicators (Output1):</u> **1-1 Manual for methodologies for landslide risk assessment:** The Manual is not made. **1-2 Model sites to develop a simulation for landslide predictions on dynamics.** A simulation was completed but the results was very different from actual situation (far from reality), and the data obtained from the simulation was unable to use for making a model. **1-3 To establish landslide early warning system** It will take at least another year to develop the landslide early warning system, as it is still lack of data accumulation to design the system. Only one borehole is not enough to collect those data, one bore hole was found broken and unable to use anymore. The weather station is the most needed for comparing and reference of the collected data. As for the data transmission, currently they borrow it from a private company which is the supplier of other equipment (Trimble's GNSS).	**1-3 To establish landslide early warning system** ・ More equipment (especially extensometers) is needed to complete the landslide early warning system. ・ Data transmission as the weather is bad, unable to go and collect data. Displacement correlates with bad weather. ・ More accumulation of data is needed, at least 1 more year needed. ・ Mechanism about displacements is that increment data 1 borehole (6m) shows large move while 2nd borehole shows small, then analyses the displacement. ・ As for the early warning system, even though the local government understands its importance, they do not have specific plan what action should be taken when it warns. Nor US has idea, and together with the local government, the plan for the actions in case of emergency will be made. ・ The local government of Rijeka has 3-4 staff for civil protection, and there are also some in the county. ・ The early warning system will be made by March 2014. ・ Work hard for the progress. ・ WG1 waiting for equipment for power supply, measurement thresholds for EWS.
WG 2 Flash-floods and debris-flows Prof. Ožanić (UR)	・ Zagreb is not likely to have flash flood. ・ Flash flood is not the one of the factors of landslide in Zagreb, but rainfall especially during January to March. ・ There is no Hydrologist in UZM. **<u>UZA (Prof. Kisic Ivica)</u>** **<u>Site: Freivogel's Hill near Daruvar, out of Zagreb.</u>** The investigation at the site has started since 1994. The equipment installed was financially supported by MZOS at the time; no equipment was procured by the Project. Data is collected and accumulated for research. As a part of the Project, one Ph.D researcher who is sponsored by MZOS is assigned and conducting survey for the erosion by extreme rain, following the advice of Prof. Yamashiki. Out of the Project, Prof. Kisic Ivica has been conducting the social survey about the historical flood and preparation for unforeseen flood risk in Zagreb city.	**<u>Rječina River Basin</u>** <u>($22km^2$)</u> <u>2.1 - 2.2(Elvis Zic)</u> ・ <u>Equipment in place</u> 1 weather station ・ Another new meteorological station was set up in Oct 2013. ・ 5 bore halls which are CW's bore halls are utilized for mini divers, in exchange collected data is provided to CW. ・ 3years has passed since measurement with the equipment of 35 parameters in a equipment at dam, Numerical station,3mini-divers for surface water. Goal is to make mathematical model what will happen big water wave, in 2D&3D numerical model(Elvis) ・ Smooth Partical Hydrominamic (SPH), Mud flow and debris flow propagation was also made. ・ It is possible to apply to other area by putting other condition, and calibration. ・ In the process of making a paper with Prof. Yamashiki about the debris flow physical model Grohovo. Debris flow is not the big problem in Croatia though, the methodology is useful for flash flood. ・

<u>Dubračina River Basin (Salt Creek)</u> <u>(43km^2)</u>

- Dominant natural hazard are landslide and erosion, and not flash food

2.1 - 2.2 (Ivana Sušanj)

- Equipment in place

  11 mini divers (water level pressure sensor)

  2 weather stations

- With the work of WG2 for Dubračina River Basin (Salt Creek) is just from one part, WG2for model not hazard map (WG3).
- Ivana in charge of finding the triggering parameters, Connection hydro meteorological mathematical model.
- In big erosion area, connect all parameter to make mathematical model.
- Using SOLFEC program, a model was created using ArcGIS for Salt Creek.

Mošćenička Draga (11km^2)

- There are no landslides, but erosion.

2.1 - 2.2 (70%, Igor Ružić)

- Equipment in place

  7 rugged TROLL100 (water level pressure sensor

  1 rugged TROLL100 (for calibration)

  2 weather stations

- Additional equipment are rain bucket and 1 electrical metrological station

2.3 – 2.4 (Ožanić, Karleuša, Dragičević, Krvavica)

- RADAR started measurements since Nov. 2012, the equipment was installed at UR and has been measuring KVARNER REGION including 3 project sites. And in Nov. 2013 the new equipment was installed.
- RADAR data analysis with other 3 pilot areas. There was unexpected results though, good interaction.
- Radar (Furundo) was set up and connected to EWS.
- Terrestrial scanning, new approach SfM methodology, analyses almost finished.

Achievement of Indicators (Output2):
Indicator 2-1: Number of model sites to formulate a <u>flash-flood/debris-flow simulation model</u> (model sites; Rječina River Basin, Dubračina River Basin, Mošćenička Draga)

		• Flash-flood/debris flow simulation model for Salt Creek (Dubračina River Basin) is completed (Application of solfec program written in Python Cod) once but it has not completed yet. Prof. Yamashiki is going to develop special model for that. • A model developed by Prof. Yamashiki was input other model. They make together and apply to each area. • More time for measurement is needed to establishment for modeling. **2-2: Number of model sites to establish a <u>flash-flood early warning system</u> at Rijeka (2 model sites; Rječina River Basin, Mošćenička Draga)** • One EWS should be done for all 3 area (Salt creek erosion, Grohovo land slide, flash flood, and Mošćenička Draga for debris flow) • 1 problem, took long time custom, installation was a big project (2.5 month RADAR training, how to measure, and deal). • Problems of software occurred later and took time to settle down, Now it's OK. And it is just start connecting modelling (2months ago), Need time to accumulation data. • Development of EWS is ongoing. • It is sufficient for EWM especially RADAR, but actual rainfall needed. • Need to decide the range of data for EWS. • For Local Government and CW, we gave them technical solution, working thing better for EWS. • our metrological station was introduced on the LG's website. • To work with Local government or municipality, EWS work is need to be adjusting for working correctly. 3-4 yrs ago too short for EWS development. Data might need at least until next summer 2014.
WG 3 Regional landslide Investigation Prof. Mihalić (UZM)	<u>**Hilly area of the Medvednica Mountain** (180km²)</u> 3.1 – 3.2 – 3.3 • Landslide inventory based on aerial photo interpretation and landslide susceptibility analysis using AHP methodology • Landslide inventory based on LiDAR interpretation and landslide susceptibility analysis using statistical analysis methodology • Landslide causal factor – geological (lithology) based on soil/rock sampling from Kostanjek and mineralogical analysis. • Landslide causal factor – morphological and land-cover based on spatial analysis of DEM and aerial photos. • Output is to be a landslide susceptibility/hazard map, not including flash-flood analysis.	**Rječina River** (22km²) If landslide occurred, it might brock Rijecina river and creates the dam, and with other conditions to break the dam, Rijeka city could be flooded. It happened in 1893. 3.1 – 3.2 • Landslide inventory based on aerial photo interpretation (Japanese researchers). It is necessary to check additionally. • Landslide causal factor – geological (lithology) based on compilation of existing data/maps (Đomlija) • Landslide causal factor – morphological and land-cover based on spatial analysis of DEM and aerial photos (Đomlija) • Landslide inventory based on LiDAR interpretation and landslide

3.4
- Output is to be a land-use guideline taking into consideration the landslide maps (inventory and susceptibility) (Mihalić, Arbanas)

3.5
- Output is to be a manual for production of landslide inventory and susceptibility maps for use in the system of land-use and emergency management. (Mihalić, Arbanas)

- The advantage of the methodology conducted for the Project is reasonable the cost for investigation and analysis.

Achievement of Indicators (Output3):
3-1 integrated landslide/flood hazard map
- As the flood is unlikely occurred in Zagreb, "flood" hazard map is not made.
- Aerial photo interpretation of the landslides in the wider area of the City of Zagreb (2 sets of aerial photos, geomorphological approach), database of the identified landslide is prepared and landslide inventory maps are produced.

3-2 land-use guidelines for landslide/flood risk mitigation
- The image of the guide line is not fully clear, though it will be how to use the map/Output 1. At least the guide line should show the list of what have to be done, this will help when apply the budget. Or it recommends some methodologies. Also, the users of the guidelines are still not clear yet, they will be departments of civil protection, land use and city offices etc...
- Guidelines are in preparation.
- Prepration of Manuale for production of landslide inventory map and landslide susceptibility map with characterictic examples.

susceptibility analysis using statistical analysis methodology

3.3
- Integrated map will be developed when flash-flood map is derived in GIS optionally from WG2.

3.4 – 3.5
- Guideline and manual (Mihalić Arbanas, Arbanas,Benac)

Dubračina River Basin (43km^2)

3.1 – 3.2 – 3.3

Landslide inventory based on aerial photo interpretation (Japanese researchers). Not appropriate methodology due to the scale of photos (Toševski)

Landslide causal factor – morphological and land-cover based on spatial analysis of DEM and aerial photos (Đomlija)
Landslide inventory based on LiDAR interpretation and landslide susceptibility analysis using statistical analysis methodology (Đomlija)
- Output is to be a landslide susceptibility/hazard map, not including flash-flood analysis.

3.4 -3.5
- Same as those of Medvednica Mountain, Zagreb.

Achievement of Indicators (Output3):
3-1 integrated landslide/flood hazard map
< Rječina River >
- Landslide hazard map (Mihalić Arbanas, Arbanas)
- For Rječina River, by using software how to define the hazard has been conducted.
- Different hazard scenarios have to be made and the hazard assessment has to be conducted to make the map. The map itself has not made yet.
- The work Is not with WG2.
- Interpretation aerial photo, landslide map were completed, though complete assessment has not done yet.
- Integrated map will be developed when flash-flood map is derived in GIS optionally from WG2. WG2 gave hydro data to WG3 for the map.

<Dubračina River Basin (Salt Creek)>
UNKNOWN

		3-2 land-use guidelines for landslide/flood risk mitigation **< Riječina River >** · The guide line is not made yet. · Good basis is done, using installed equipment, somehow successfully collected data. · To Connect all data is needed · Need to be summarized towards to conclusion by all the groups get together. **<Dubračina River Basin (Salt Creek)>** UNKNOWN
Split Split-Dalmatian County		
WG 4 Split for all outputs Prof. Miscevic (US)	Rock falls (Output 1 & Output 3) **Duće** (0.1km^2), **Omiš** '(0.3km^2) · Ground-based scanning of the model sites with portable LiDAR equipment once or twice a month depending on weather since September 2011. · WG4 purchased a software, and started working on it 2 months ago, to compare the scanned data in a constant way, working progress. · Hazard assessments for both sites were conducted preliminary, and will be presented at the 4th workshop of the Project (12-14 Dec. 2013). Methodology was already developed at US. · The methodology which couples GIS and MCA has been adapting to the Project's pilot sites areas. AHP was found to be inapplicable for rock falls of Duće and Omiš after the trial of application. · Advantage of the equipment is ability to cover wider area. · Every 6 months, measurement (scanning) is conducted. **Achievement of Indicators (Output1):** **1-1 Manual for methodologies for landslide risk assessment:** **1-2 Model sites to develop a simulation for landslide predictions on dynamics.** **1-3 To establish landslide early warning system** **Achievement of Indicators (Output3):** **3-1 integrated landslide/flood hazard map** **3-2 land-use guidelines for landslide/flood risk mitigation** · About the land use guideline, Croatia became a member of EU	(Flash) Flood (Output 2) **Imotski** – Blue Lake, Red Lake · Red Lake (0.14km2) (In 2013 300m depth, hight lider measurement and sonor generatate the team and company donate the equipment and personal sub surface and surface, submerge, high accuracy made) · In Red Lake in Imotski an hourly data set is obtained for the whole hydrological year. The analysis of collected data resulted with publication in international scientific journal. · Metrological station (sensor), 4 mini divers were donated by JICA and other type of diver (CTR Diver) was from another PJ · There were several problems to make all conditions stable to get steady collection of data. There is energy supply though, no internet link to send the data etc… · Continuing recording for Clear view for future event. · Imotski is the good model site to apply the findings to other area, · Blue and Red lakes are 100 years of mysteries. The local government and local people are hoping that the lakes would be the resources of tourism after scientific researches. **Sutina-Karakašica** (13km^2) · Mouth of Cetina River located the town of Omiš. · The data record on water level and water temperature in the Sutina Karakašica basin is present since March of 2011 at 5 different stations. · Meteorological data is provided by Meteorological and hydrological institute of Croatia, a governmental service. · Event based measurements on water quality are carried out on different points of studied watershed.

	since June 2013, EU regulations regarding land use or risk assessment hazardous assessment are probably required to be applied. ・ The outcomes of the Project should be delivered to Local Government of Omis and Imostski ・ The problem for the local government is that where the area is private property, it is difficult to intervene, even if it is for civil protection. Hard to persuade the people about the importance of prevention. ・ By the end of PJ, WG4 will finish the map and preliminary EWS. ・ As the Prof of US is a state's reviewer for Omis, US and Omis govenernment are in the good relationship. New mayor has just come 6 months ago though, he understands the importance of the PJ very well. ・ Omis government is well aware of the importance of the prevention and its research. The Project is a part of Omis's watching area. It can be said that one part is already involved ・ Geologist who is a PhD candidate might come to use the PJ equipment LiDAR scanning. Collaboration with other experts is to merge the knowledge ・ Not only articles but many papers are/going to be published. ・ It is only 2 years though, new methodology was developed. We could learn each other. ・ Use the equipment for one side at the moment to apply to other side. Main road is there on the other side ・ Framework of Agreement is going to be concluded. ・ About the MOE fund, the budget is 50mil kn total amount for protection of people and city. There is no limit of period only the amount of budget. ・ People do not know yet officially but Omis is a small community, they might know. ・ Hazard map is not disclosed yet. But will be given by US to City. ・ For protection measures, needs to relocation during the protection construction works, this will be difficult. Fully covered by housing area. ・ For the local people, perception of them is that responsibility Is totally on the local government. ・ In anyway, there is not money for that before, but finally got the fund. This is the first case to get the fund in this specific purpose. ・ Some private companies involved, CONEX scanning is one and others for public works. ・ During the submission process of the fund, the plan and map were	**Achievement of Indicators (Output2):** **Indicator 2-1: Number of model sites to formulate a <u>flash-flood/debris-flow simulation model</u> (Imotski, Sutina-Karakašica)** ・ Models will be prepared by Prof. Yamashiki. ・ Imotski was added at the latter half of PJ period. ・ Imoski there is concern about economic loss in case of hazard. But it's hard to predict. As not much buildings and houses in the area of Imotski site, only agriculture there, winter flood very complicated mechanism of river flood area no body build the house due to twice a year of flood. ・ EWS might not necessary and the map will be enough. Disaster mitigation for crops is the main objective.

	already prepared. ・ US and City has been collaborating for 4 years. ・ For rock fall, prevention is needed than early warning system. ・ Equipment donated is for various purpose, will be very useful. ・ City of Omis, there is a department of economy and social activity, 3 staff are assigned. ・ The MOE fund is not used for flood, nor for raising awareness of local people. ・ Omis city has been trying to solve the problem of rock fall for long, the PJ came and finally got the fund. All the conditions to solve the problem are met now.	

Annex 11: Evaluation Grid based on the 5 Criteria

Evaluation Criteria	Evaluation Question	Source	Findings through Questionnaire, Interview and relevant reports
1. Relevance	1.1 National and development policies/strategies associated with disaster mitigation of landslide and floods in Croatia		• Protection and Rescue Plan for Croatia (Official Gazette 96/10) • Evaluation of Endangerment of Croatia from Natural and Technological Disasters, Croatian National Platform for Disaster Risk Reduction, Protection and Rescue Law (Official Gazette 127/10) • Law on Protection from Natural Disasters (Official Gazette 73/97)
	1.2 Changes of mandate/structure and staff of implementing agencies that may affect the Project implementation		• Various international agreements on protection and rescue in case of natural disaster • MZOS issued a letter dated 28 March 2012, announcing the change of Croatian administrative personnel from Annex V of the R/D: • Prof. Nevenka Ožanić, Dean of the Faculty of Civil Engineering, UR, is a new Project Manager, • Assoc. Prof Snjezana Mihalić, Faculty of Mining, Geology and Petroleum Engineering, UZ, is a Deputy Project Manager. • Additional working group 4 was created in order to accelerate the research activities in Split by direct contact between the project manager and the leader of WG4. • Prof. Ognjen Bonacci (former Project Manager) retired in Oct. 2012.
	1.3 Alignment of the Project with the needs and expectation of the implementing agencies. (Research plan and priority)		• In a social context, the project would fall within a scope of duties performed by National Protection and Rescue Directorate. On the other hand, this is a scientific project and it's under the authority of MZOS • MZOS doesn't have any other project related disaster management. • The Kostanjek is the largest landslide in Croatia. The project initiated the cooperation between the EMO and UZM. • There are many hazard maps prepared, but there is so far only one official landslide inventory map, which is available in the internet. The city, however, hasn't utilized the map. https://geoportal.zagreb.hr/Karta • According to the one official landslide inventory, there are 770 landslide areas in Zagreb. The Kostanjek is displacing from 1963 over more than 50 years and the city has set some remedial measure design. Kostanjek is not a catastrophic landslide, usually very slow, but EMO neither know a proper management nor have standardized operational procedures. EMO doesn't t have data, either. • The physical plan of the City of Zagreb should include a landslide inventory map which is based on more scientific research. • The city doesn't have a land-use guideline taking landslide into consideration. There is one available in Official Gazette, but it is for the construction and not incorporating risk assessment. This guideline should be revised reflecting this project. http://www1.zagreb.hr/SlGlasnik.nsf/VPD/45D18FA1A71D6EB3C1256DDD00491EA1?OpenDocument&19

		• CW is responsible for all the water body in Croatia. The project is receiving necessary data from CW, and the Project is also providing CW with new data. • City of Rijeka has a land use guideline for construction purpose, but it does not contain a hazard map. There is no rule/regulation on torrent flow. • Spatial Planning Document of the City of Rijeka is available on the open site. http://www3.rijeka.hr/gup1/framesetup.asp • Research assistants can get a job, be educated, have a dissertation topic, acquire knowledge through trainings in abroad, work as a teaching assistant, cooperate with other researchers, and publish scientific papers. • The results of the project will be beneficial to local communities, so the faculty has an opportunity to improve the professional cooperation between local authorities and faculty itself.
	1.4 Priority areas of the Government of Japan for the development assistance to Croatia.	• The Initiative for Disaster Reduction through ODA was announced at the United Nations World Conference on Disaster Reduction held in Kobe, Hyogo prefecture, in January 2005. • JICA's Issue-specific Guideline for Disaster Reduction sets out "building disaster-resilient communities and societies" as one of development strategy goals to be achieved
	1.5 Appropriateness of the selection of model sites	• The Kostanjek is the largest landslide in Croatia and also one of primal concerns of EMO. • At present, the physical plan of the City of Zagreb doesn't include the assessment of landslide risk • In the Adriatic Sea catchment area, there are no big rivers. It is all torrent area. • The researchers from Croatian side proposed the model site. (pilot areas) • At the downstream of Rječina River located the city of Rijeka, and the flood waters can cause significant damage to the city; it could be an even higher hazard in case of concurrent rock avalanche at Grohovo landslide. • The model sites in Split are Omiš and Duće where a rock fall is quite frequent, causing damages and posing threats to many houses and population in the towns • The model sites of the Project were proposed by Croatian researchers. The Kostanjek in Zagreb is the largest landslide in Croatia, and one of primal concerns of the Emergency Management Office in the City of Zagreb. At the downstream of Rječina River located the city of Rijeka, and the flood waters can cause significant damage to the city; it could be an even higher hazard in case of concurrent rock avalanche at Grohovo landslide. The model sites in Split are Omiš and Duće where a rock fall is quite frequent, causing damages and posing threats to many houses and population in the towns. Selection of the model sites is appropriate.
2. Effectiveness	2.1 Progress of Outputs See Annex10 and Grid by sites(above)	
	2.2 promoting/hindering factors that may have affected the Project implementation	• Installation of monitoring systems in Zagreb and Rijeka, and the early warning system and prediction of movement of the landslides are the correlated measuring components. At the event of unusual movement occurred, the researches of both sides could response emergency according to the data from the equipment installed. • Integration with the results of flood analysis will be the issue to be done. • The delay of procurement and installation of equipment due to the problems of VAT is seriously affecting the progress of the Project activities.

	2.3 Prospect of the Project Purpose to be achieved by the end of project period.	• The project start-up was delayed, but a major achievement to date is 1) the good cooperation among Croatian universities and good team work, and 2) involvement of local authorities. • Project is most likely to be able to achieve its purpose.
3. Efficiency	3.1 Clarity of the overall plan of the Project. Master Plan and PO	• Activity of WG1 is very clear from the beginning. • Different from the beginning of the Project, now, the activities and goal is very clear. • Plan is necessary to prepare the activities well and conduct monitoring.
	3.2 Inputs of Japanese side – dispatch of experts/researchers.	• Japanese professors and researchers when visiting Croatia, had conducted discussion and site visits, and giving advice to Croatian researchers.
	3.3 Inputs of Japanese side – trainings.	• Trainings were very useful, narrow and focused. • Trainings for shear test apparatus was very good, • "Portable ring shear apparatus ICL-1 Manual" (Kyoto 2012) was prepared. • All researchers trained in Japan are fully utilizing what they leant especially how to use the equipment etc…for their researches. • Training in Japan was useful very much, experience, idea, new knowledge, technology and development of academic research. It is also good for teaching to the students, not only for research. • Training for 2 months (2012) in Kyoto, how to work with equip Grohovo, installation of monitoring equipment Data monitoring system. • The gain from the training in Japan was big and professional. It was a good program. • Training in Japan has been very important for young researchers, who were introduced to landslide issues and exposed to a new apparatus. There are no similar apparatus in Croatia.
	3.4 Inputs of Japanese side – provision of machinery/equipment.	• Sometimes wrong amount in donation letters and until recently no distinction in donation letter whether it's local purchase or purchase in Japan. • Until recently local purchase were not in line with national VAT (25%) regulation, and purchase in Japan were not in line with needs in the field (e.g. need for heavy-duty laptops for field research). • It's unclear who decide on the Japanese side what is needed (JICA, JST, Niigata University?) • We didn't know the administration of implementing an international project. This is a delay of administration, not a delay of procurement. Researchers applied a purchase but we didn't know that tax extensive exemption is required. Regarding local purchase for universities, it requires of invoice, donation letter, and VAT exemption letter. Now it's been settled and the delay will not recur any more. • Installation of the sets of equipment is big meaning as the base of research was prepared, it will be utilize fully even after the PJ period, and develop the research. • Provision of equipment was a milestone for the research. • Lots of paper published using the equipment for analysis.
	3.5 Inputs of Croatian side – assignment of counterpart personnel (University researchers and other staff, Officials of municipalities)	• MZOS finances: 1) Lump-sum of 307,500 Kuna / year including, 2) payment for 9 young researchers (their salaries are paid by MZOS, and they are supposed to get doctors' degree), 3) payment for equipment installation and maintenance.

	3.6 Inputs of Croatian side – share of operational costs.	• It is very important to finish the installation of equipment, in particular at Kostanjek. • Shipment and installation of equipment cost money. In 2010, no equipment and no budget set aside were used. In contrast, in 2011, lots of equipment, requiring budget, too. For 2012 and 2013, we don't know and it's not easy to prepare budget on Croatian side. We only know the equipment for the next six month. • After became the EU in June 2013, tax exemption again became the issue. Croatian side needs to solve the issue by the end of PJ as some equipment is stopped at the custom. • 1st JCC was held on 23rd Feb 2012 at the Faculty of Agriculture, UZ. • The Project held four international workshops. 1) 1st WS at Dubrovnik in November 2010 (paid by JICA budget) 2) 2nd WS at Rijeka University in December 2011 (paid by JST budget through Niigata University) 3) 3rd WS was in Zagreb in March 2013, inviting more participants from local administration, EMO, more public promotion. 4) 4th was held in December, 2013 in Split.
	3.7 Communication (periodical and daily) for project coordination – between JICA and implementing agencies.	• As Japanese professors came for short period each time, mostly communication was by e-mail. But good communication. • When professors came, there were discussion and advice. • Enough technology transfer was made from Japanese Professors. • It would be better if more other Japanese Professors involved in the WG2. • Communication helped to spread knowledge. • Some problems of communication because of distances. • Sometimes, it takes time to receive response from Japanese researchers via email. • The Japanese researchers were dispatched when necessary and frequently, and conducted research meetings. They tried to create opportunity to have those meeting as possible, and it was effective. • In Jan 2012, there was a conference in Kyoto, Japan, and ICL financed EMO and researchers travel. •
	3.8 Communication (periodical and daily) for project coordination – among Croatian agencies.	• EMO are providing permissions to install monitoring system in city lands (as for private lands, private permission), and may provide financial support to maintain installed equipment. In return, UZM can introduce new data to city's land management. • At the 1st JCC, Representative of local communities (City of Rijeka, City of Split, and EMO of City of Zagreb) attended as observers. • As each research has been conducted individually, and each researcher has been working for its own topic, communication among researchers is limited in each University. Continuous communication and joint research on landslides between UZM and UR researchers is established as 'Croatian Landslide Group' which is member of International Consortium on Landslides (IC). • JCC and workshops were the opportunities for communication and information exchange among Croatian researchers. • All researchers can attend the once-a-year workshop, but probably meeting at every six-month, not only among WG leaders but all researchers, can facilitate the cooperation among WG2 and other WGs.

	3.9 Methods and contents of technology transfer from JICA experts to Croatian researchers.	• Complete lack and understanding of what is needed at the start of project. Project started on a wrong premise that no funds or involvement from MZOS are necessary. • Croatian side is to need an agency which could appoint project director and do extra work for the project. • Project Director (Croatian Side) and Project Coordinator (Project Coordinator) had to fill in the gap between the preliminary study and actual implementation. Because of the gap, a year was lost at the project start-up, but the job was done and the Croatian sides are satisfied, expecting now to make it up.
4. Impact	4.1 Any positive/negative impact brought about by the Project (Policy and research development, Poverty reduction, environmental protection, and gender equality.)	• Positive impact is the research development of young researchers. Also, raised awareness of the public as well as the commitment of municipalities. • 9 PhD students being trained in Japan is one of best effects in Project. • Through international conference organized by the Project, research results and findings on landslides and flash-floods/debris-flow are shared among researchers from neighboring countries such as Serbia, Bosnia-Herzegovina, Kosovo, Macedonia, and Slovenia, where studies on disaster risk management are important and required for societies.
	4.2 Activities beyond the scope of Master Plan.	• The town of Omiš prepared a project document to contain potential rock falls in the town. The leader of WG4 of the Project is a reviewer of the project document, and expects that the RiDAR scanning conducted in the Project will also help identify critical points of potential rock falls, and will contribute to the implantation of the town's project. The Ministry of Finance of Croatian Government finance the project as the project document was signed. • One of researcher got Ph.D. in Japan and another got it in Croatia. And there are some others are going to get soon. Those researchers will continue their researches after the Project period as they are employed by MZOS to conduct not only researches but lectures.
	4.3 Ongoing/possible collaborations, if any, with multi/bi-lateral development partners (UN, NGO, civil society, and private sector).	• Project of rock fall protection in Omiš city (Conex-st, Split) • Collecting of meteorological data (Meteorological and Hydrological Service, Croatia) • Maintenance and meteorological station (CROMETEO, NGO) • International Programme on Landslides (IPL, part of ICL) ON Going since 2012 Nov and its 4 years project.
5. Sustainability	5.1 Prospect from institutional viewpoint (Legislation and policies Rule and regulation, standard operational procedures Responsible organization and division, Participation of stakeholders)	• DUZS/UZM have started to make the Landslide data base at National level few months ago. Regulations and law will be necessary. Importance of civil protection is fully aware by DUZS. • The portal site was made by Universities for the Project, data base is constructed on it and managed by UZM and UR. • City of Zagreb, EMO has been working together with UZM. • City of Rijeka has been collaborating with UR. • City of Omis has been keeping good relationship with US and will work more closely for rock fall problem as the city just got the fund of MOE of Croatia.
	5.2 Prospect from technical viewpoint (Technology/knowledge and its update Equipment and its maintenance Educational materials Training opportunities)	• There is no specific future plan for supporting research on disaster related project by MZOS. • There is no collaboration or discussion between MZOS and DUZS (National protection and rescue directorate). MZOS's role is to make a strategy for promoting researches. • Preparation of different landslide thematic maps will be benefit to local community. • It is possible to transmit the outcomes of the Project to other area/sites.

	5.2 Prospect from technical viewpoint (Technology/knowledge and its update Equipment and its maintenance Educational materials Training opportunities)	• UZM has been already approached to the National Protection and Rescue Directorate (DUZS) through inviting the round table of "Application of Croatian-Japanese Project Results in the System of Land-Use Planning, Construction and Civil Protection "at the 3rd workshop. UZM also provided the GIS data to DUZS. For research results to feed into disaster management policies, an involvement of DUZS will become more important in future. • The maintenance of installed equipment is also discussed among EMO and UZM. From March 2014, end of the Project, the City of Zagreb will bear the cost of its insurance, the City have got the budget for it, while UZM will maintain the equipment and provide the City with monitoring data collected. As such, efforts to promote the application of research results and to seek an arrangement for follow-on support have already been undertaken. Especially after the business trip to Japan, EMO management aware the importance of the research for civil protection. • There is a general agreement between City of Zagreb and UZ but there is no specific agreement regarding the landslide issue. There is no plan for the agreement though; EMO obtained the budget for UZM to support the maintenance of the equipment from 2014. • EMO is the only one office of local authority for the emergency management in Croatia. As Zagreb is the capital city and the largest city in the country, it could be influential to other cities. EMO is also a member of ICL, and attended its conference in 2012. • Development of different thematic maps (landslide susceptibility, hazard and risk assessment) as a standard procedure within CGS. • Croatia became a member of International Consortium on Landslides (ICL) since 2010 and Croatian researchers initiated establishment of regional scientific network ICL Adriatic-Balkan Network(ABN) on landslides (coordinator is Mihalić Arbanas; co-coordinator is Arbanas). As a result of appeal of the outcomes of the Project to ICL through the workshops and conferences and through the information exchanges among neighboring countries, countries in ABN became partners for research. The ICL conference in 2015 (2nd Regional Symposium on Landslides, Belgrade, Serbia) and in 2017 (World Landslide Forum 4 in Ljubljana, Slovenia), Croatia is not the host county though, but are involved in organization and the monitoring system at Kostanjek for the site of field visit. This will be the great opportunity to appeal the outcomes of the Project and continuing research activities in Croatia. • Through the Project, the base of landslide research for Croatia was established. It is a big step, never experienced before, there are many accomplishments. It was unexpected 5 years ago, Italian researchers are showing interests of our research now as our research level was raised. Croatian researchers are now able to develop the research, and keep improving toward new and various directions from here. • The faculty is planning to hold a seminar like summer school, invite students from EU countries utilizing the equipment and researches of the Project. • Equipment donated by the Project is strictly managed by each University as all of them are registered as the equipment of the university. • There is high possibility of academic exchanging opportunity, updating, maintenance and training. • The monitoring system installed in Zagreb is able to play a role of information dissemination to the local people or visitors about the importance of monitoring in landslide area. • The equipment donated Rijeka can play a role of the landslide experimental facility which contributes the advanced research and study.

	5.3 Prospect from Human Resource viewpoint (Number of staff, Assignment of responsible personnel, His/her qualification and motivation, New recruitment and volunteer)	• Total 9 young researchers are sponsored by MZOS to work for the Project. It will lead to a significant human resource capacity when they obtain doctorates. It's 6 years of contract to obtain Ph.D. and after the contract there are several options to take, one is Post-doc for 3 years, employ as a lecturer and work at institutions etc... • Besides those young researchers the assistants who are sponsored from other sources are involved for the Project. • 7 papers are going to be presented at the conference in Beijing (WLF3) and 4 papers are at Torino in 2014 (IAEG Congress).
	5.4 Prospect from Funding viewpoint (Budget allocation for the activities, External financing from donor/private sector)	• At present, MZOS has prepared a counter-budget, financing a part of project operation. There is no plan of continuation. • The prospect of sustainability is more than medium, except for its financial aspect considering the current economic situation. Croatian economy growth recording negative and resulting budget constraints. • There are funds available from Croatian Science Foundation (HRZZ) • UZM applied a fund of MZOS though, just recently it was rejected. • Financial support of the equipment for monitoring by EMO will start from March 2014. To obtain the budget for it, the preparation was conducted in October, 2013 and finally approved. The support covers the insurance and rest of the cost to maintain the equipment requires other sources of financial support. • Follow-on maintenance of equipment after the end of the Project is currently being explored by the implementing universities. • About the fund from EU, EU horizon 2020, application due is next year for environment science, the discussion for the application has already started among the professors of UZM, UZA, UR and US. They will make a team like the Project, and there is possibility to involve Japanese researchers as advisers. Once funded, those young researchers will be sponsored for their further research. • It is already applied to the faculty of UR to extend the research activities, as 10,000 euros/yrs and 8000 euros/yrs are needed. At the moment, MZOS bears those costs. (UR) • UR is applied the bilateral project with Slovenia by January 2014, with updated and latest outcomes of the Project. • In Rijeka city, the local authority is interested in the research of the Project. Rijecina River in Grohovo is also interested in involving the research as the data is interesting for them. There is the possibility to collaborate researching. • EU is going to provide through the EU Project the laboratory soil testing equipment to UR, which is related to the one donated by the Project.