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# IncREO
# **Inc**reasing **R**esilience through **E**arth **O**bservation

Collaborative project
Grant agreement no.: 312461

## *Deliverable 303-6: User validation report of the RiskChanges Spatial Decision support system*

Work Package 303 Partners:
ITC
geomer
GeoVille

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| 19/12/14 | CvW | ITC | Lead WP 303 |
| | MM | SISA | Project coordinator |
| | | | |
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# ACRONYMS

| | |
|---|---|
| EC | European Commission |
| REA | Research Executive Agency |
| AoI | Area of interest |
| SDSS | Spatial decision support system |
| CBA | Cost & Benefit analysis |
| IRR | Internal Rate of return |
| NPV | Net Present Value |
| BCR | Benefit-Cost Ratio |
| RRA | Risk Reduction Alternative |
| RM | Risk Module |
| SEI | Software Engineering Institute |
| AU | Administrative Unit |
| AUM | Administrative Unit Map |
| EUO | European Union Organization |
| EAR | Element at Risk |
| MCDM | Multi-Criteria Decision Making |
| AU | Administrative Unit |
| AUM | Administrative Unit Map |
| EUO | European Union Organization |
| AAL | Average annualized losses |

## Contents

# 1. Executive Summary

Within the framework of the EU FP7 Marie Curie Project CHANGES (www.changes-itn.eu) and the EU FP7 Copernicus project INCREO (http://www.increo-fp7.eu) a spatial decision support system was developed with the aim to analyse the effect of risk reduction planning alternatives on reducing the risk now and in the future, and support decision makers in selecting the best alternatives. The Spatial Decision Support System is composed of a number of integrated modules. The Risk Assessment module allows to carry out spatial risk analysis, with different degrees of complexity, ranging from simple exposure (overlay of hazard and assets maps) to quantitative analysis (using different hazard types, temporal scenarios and vulnerability curves) resulting into risk curves. The system does not include a module to calculate hazard maps, and existing hazard maps are used as input data for the risk module. The second module of the SDSS is a data input and management module. This module includes the definition of risk reduction alternatives (related to disaster response planning, risk reduction measures and spatial planning) and links back to the risk assessment module to calculate the new level of risk if the measure is implemented. The third module is a cost-benefit module to compare the alternatives and make decision on the optimal one. The fourth module of the SDSS is a multi-criteria evaluation module that uses the risk data and cost-benefit data in combination with user defined criteria in order to make the selection of the optimal risk reduction measure.. The fifth module is a communication and visualization module, which can compare scenarios and alternatives, not only in the form of maps, but also in other forms (risk curves, tables, graphs). The envisaged users of the system are organizations involved in planning of risk reduction measures, and that have staff capable of visualizing and analysing spatial data at a municipal scale.

The system is online, and can be accessed through the following URL:
http://changes.itc.utwente.nl/RiskChanges/
The documentation for the system can be accessed through the system itself, or directly from the following URL:
http://www.changes-itn.eu/RiskChanges/tabid/158/Default.aspx
There the user can find the User Guide for each of the components, and a tutorial on the use of the system.

# 2. Introduction

A Spatial Decision Support System (SDSS) is a "*Interactive computer systems designed to support a user or a group of users in achieving a higher effectiveness of decision making while solving a semi-structured spatial decision problem*" (Sugumaran et al. 2007). An SDSS has an explicit geographic component; it is supporting rather than replacing the user's decision making skills, and facilitates the use of data, models and structured decision processes in decision making. A spatial decision support system has been developed with the aim to analyse the effect of risk reduction planning alternatives on reducing the risk now and in the future, and support decision makers in selecting the best alternatives.

The SDSS is able to analyse the effect of risk reduction planning alternatives on reducing the risk now and in the future, and support decision makers in selecting the best alternatives. Error: Reference source not found shows a concept of the SDSS.

Central to the SDSS are the stakeholders. The envisaged users of the system are organizations involved in planning of risk reduction measures, and that have staff capable of visualizing and analyzing spatial data at a municipal scale. The SDSS should be able to function in different countries with different legal frameworks and with organizations with different mandates. These could be subdivided into:

- Civil protection organization with the mandate to design disaster response plans.
- Expert organizations with the mandate to design structural risk reduction measures (e.g. dams, dikes, check-dams etc).
- Planning organizations with the mandate to make land development plans.

Another set of users are those working in organizations that are responsible for providing hazard maps related to flooding and landslides. These are different from the end –users, and they should provide relevant information on request of the end-users. These users are information –providers and are not using the system to make new hazard maps.

A third set of users are those that provide data on elements-at-risk. They are related to organizations related to cadastral data, transportation organizations, etc.

Risk modeling is the central module of the SDSS. It could be carried out by the main stakeholders or by special organizations that deal with risk assessments. In the SDSS design both options are possible.

The SDSS can be used in different ways (See figure 1):

**A. Analyzing the current level of risk**. In this workflow the stakeholders are interested to know the current level of risk in their municipality. They request expert organizations to provide them with hazard maps, asset maps, and vulnerability information, and use this information in risk modeling. They use the results in order to carry out a risk evaluation.

**B. Analyzing the best alternatives for risk reduction**. In this workflow the stakeholders want to analyze the best risk reduction alternative, or combination of alternatives. They define the alternatives, and request the expert organizations to provide them with updated hazard maps, assets information and vulnerability information reflecting the consequences of these scenarios. Note that we do not envisage in the SDSS that these maps are made inside of the system, as they require specialized software and expert knowledge. Once these hazard and asset maps are available for the scenarios, the new risk level is analyzed, and compared with the existing risk level to estimate the level of risk reduction. This is then evaluated against the costs (both in terms of finances as well as in terms of other constraints) and the best risk reduction scenario is selected. The planning of risk reduction measures (alternatives) involves:

- **Disaster response planning**: focusing on analyzing the effect of certain hazard scenarios in terms of number of people, buildings and infrastructure affected. It can also be used as a basis for the design of early warning systems.

- **Planning of risk reduction measures**, which can be engineering measures (such as dikes, check-dams, sediment catchment basins), but also non-structural measures such as relocation planning, strengthening/protection of existing buildings etc.
- **Spatial planning**, focusing on where and what types of activities are planned and preventing that future development areas are exposed to natural hazards.

C. **The evaluation of the consequences of scenarios to the risk levels**. The scenarios are related to possible changes related to climate, land use change or population change due to global and regional changes, and which are not under the control of the local planning organizations. The systems will evaluated how these trends have an effect on the hazard and assets (again here the updated maps should be provided by expert organizations) and how these would translate into different risk levels.

D. **The evaluation how different risk reduction alternatives will lead to risk reduction under different future scenarios** (trends of climate change, land use change and population change). This is the most complicated workflow in the SDSS, as it requires to calculate the present risk level, the effect of different risk reduction alternatives, and the overprinting of these on the scenarios. For each of these combinations of alternatives & scenarios new hazard, assets and risk maps need to be made.

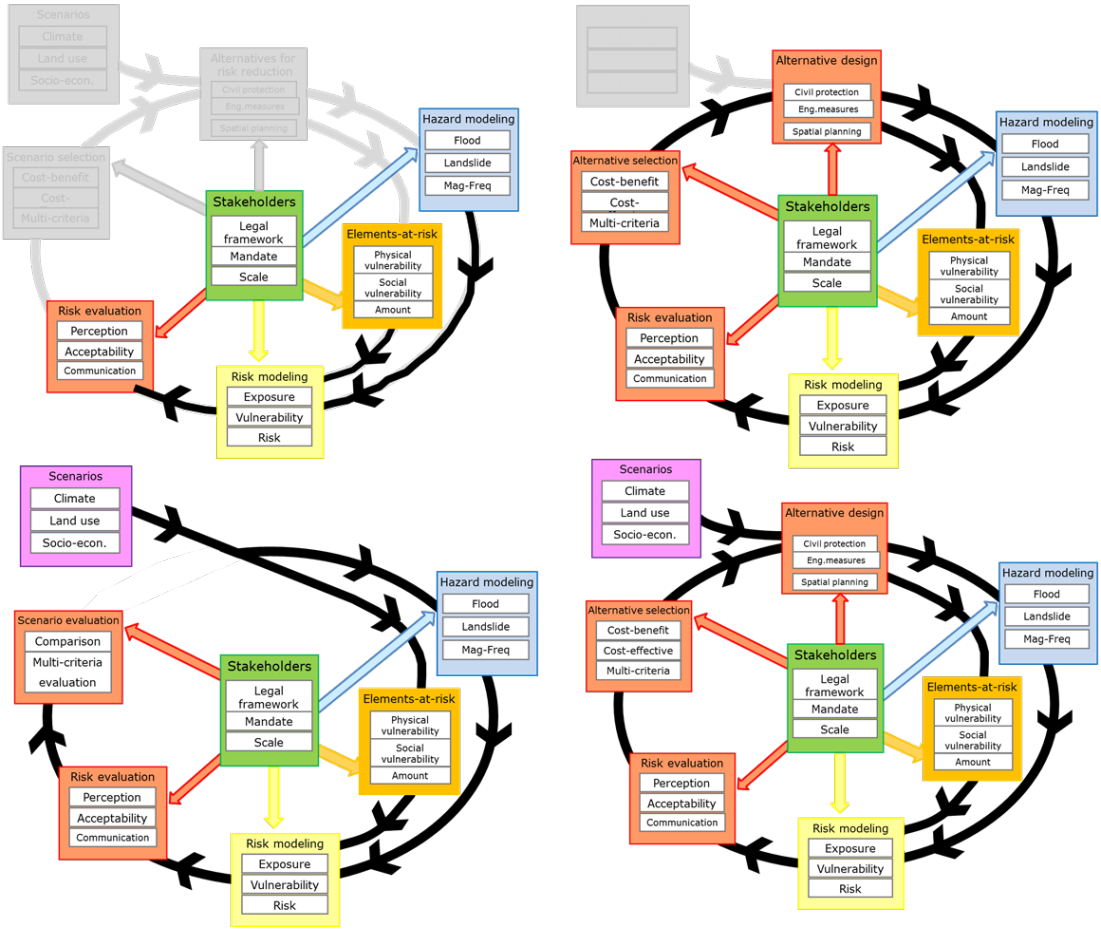


*Figure 1: Different uses of the RiskChanges SDSS. Different colours refer to different components: **green** = stakeholders, **Blue** = organizations responsible for providing hazard maps. **Orange** = organizations responsible for providing elements at risk maps, **Yellow** = organizations responsible for providing risk modeling, **Violet** = Organizations that are working on the analysis of trends related to climate changes, land use change and population change, **Red** = end-users of the platform that use the information from the other. Upper left: analysing the current level of risk. Upper right: analysing different risk reduction measures. Lower left: analysing the effect of future scenarios on the risk. Lower right: analysing the behaviour of risk reduction measures under future scenarios.*

# 3. Dissemination meetings

Results of SDSS were disseminated to various user communities through the organization of training events, amongst others.

## *3.1 Enschede training*

One such IncREO training event took place at ITC in Enschede, the Netherlands, from June 23 to 27, 2014. IncREO partners ITC, SISA and ITD conducted one week of training contributing as "special session" to a three week training course on "Spatial Data for Disaster Risk Management" (Module 12). The participants consisted of Master of Science students and short course participants from technical organizations from many different countries (Thailand, Nigeria, Vietnam, Indonesia, Ethiopia, Denmark, Bosnia, India, Nepal and China).
Given the fact that we were able to use almost one week to go through the method used in the SDSS and that the participants had a technical background, they were able to get a good impression of the method and the SDSS and were generally very positive.

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|---|---|---|---|
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| Likhit | Pollayos | Female | Thai |
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| Hoang Son | Nguyen | Male | Vietnamese |
| Rahmat Aris | Pratomo | Male | Indonesian |
| Anne Chinyere | Uwakwe | Female | Nigerian |
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| Mujeeb | Alam | Male | Pakistani |
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| Vidhi | Bharti | Female | Indian |
| Sanjaya | Devkota | Male | Nepali |
| Fengchao | Gu | Female | Chinese |


*Figure 2: Training event in Enschede where the methodology for the SDSS was used in a one week workshop.*

## *3.2 Bangkok training*

Four months after the "European" training event in Enschede, The Netherlands, IncREO successfully conducted its "international" training event at GISTDA (Geo-Informatics and Space Technology Development Agency, Ministry of Science and Technology) premises in Bangkok, Thailand. The training events are part of IncREO's "Dissemination and Communication" Work Package and were led by ITC with contributions from SISA and ITD.
The Bangkok event's objective was to present an audience of experts for disaster management with solutions elaborated in a European project but which are ready for export in terms of application to other areas with differing physical settings from the ones in Europe. The overall objective was to foster the user uptake of IncREO services and service components, respectively, by Thai stakeholders from the disaster management and civil protection communities.
The immediate feedback received from the students, organizer and lecturers allow speaking of a "successful event" that resulted in increased competences on the participants' side and a promising partner network in view of potential future collaborations related to R&D and capacity building activities, respectively.

Even though the entire SDSS was not demonstrated during the Bangkok event, the methodology for multi-hazard risk assessment was demonstrated in day 1 and day 2:

- Day 1: Geo-Information for Disaster Risk Management (ITC) with lectures to provide understanding about the general concepts of hazards and its spatial temporal characteristics and how spatial data - and Earth Observation data in particular - can be used in their assessment.
- Day 2: Disaster Risk in a Changing World (ITC) In the morning there will be a lecture about how risk is continuous changing because of man-made (mitigation) interventions and developments and because of global changes and long-term trends. Floods will be used to exemplify the concepts. In the afternoon a hands-on exercise will be given to demonstrate the assessment of changing risk in a changing world for planning and decision-making


*Figure 3: Training event in Bangkok where the methodology for the SDSS was used in a one week workshop.*

The feedback from the participants of the Bangkok training was very positive. However, time was too short for them to actually work with the SDSS and get a good impression from it.

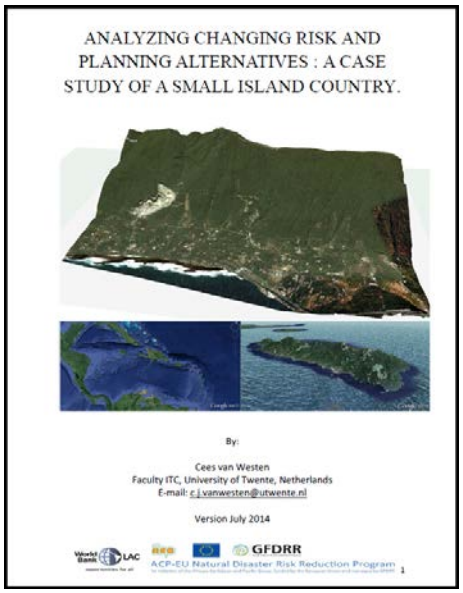
## *3.3 LARAM*

The International School: Landslide risk Assessment and Mitigation (LARAM) is an annual “summer school” for 40 PhD researchers from all over the world, which get an advanced training for two weeks on new methods for landslide hazard and risk assessment by a team of international experts. The LARAM school is organized by the university of Salerno. This year the SDSS and the method behind it was also taught during a one-day workshop in the LARAM school. We demonstrated the use of the demo data set, which is related to the Nocera case study, one of the test sites, close to Salerno. Also the University of Salerno has been very active in further research in the area. The participants were very pleased with the method that was pre3sented for estimating multi-hazard risk, and for the evaluation of risk reduction alternatives. Given the fact that the participants were all PhD researchers, it was possible for them to grasp the concept of the SDSS in a relatively short period of time. A list of participants can be found on http://www.laram.unisa.it/school/2014/students

## *3.4 Caribbean training course*

From 29 September to 3 October 2014 a workshop was organized in Saint Vincent (Caribbean island) as part of a World Bank sponsored project. For the workshop the following persons were invited from each country:

- Chief Engineers. The workshop was in the same period as the meeting of the OECS Engineering Association Meeting, which is also taking place in St. Vincent and the Grenadines. The chief engineers were invited to participate in the CHARIM workshop on October 2 and 3 in continuation of the OECS Engineering Association Meeting which will take place from Monday September 29 to Wednesday October 1.
- Chief planners. The chief planners from the five target countries were invited to participate for the whole duration.
- Geospatial experts. One GeoNode manager or key coordinator of geospatial data from each of the five countries was invited to participate for the whole duration.


ANALYZING CHANGING RISK AND PLANNING ALTERNATIVES : A CASE STUDY OF A SMALL ISLAND COUNTRY.

By:
Cees van Westen
Faculty ITC, University of Twente, Netherlands
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Version July 2014

GFDRR
ACP-EU Natural Disaster Risk Reduction Program

Representatives of all the target countries were in attendance: Dominica, Belize, Saint Lucia, Grenada, and St. Vincent and the Grenadines. The following participants from the target countries attended the workshop:

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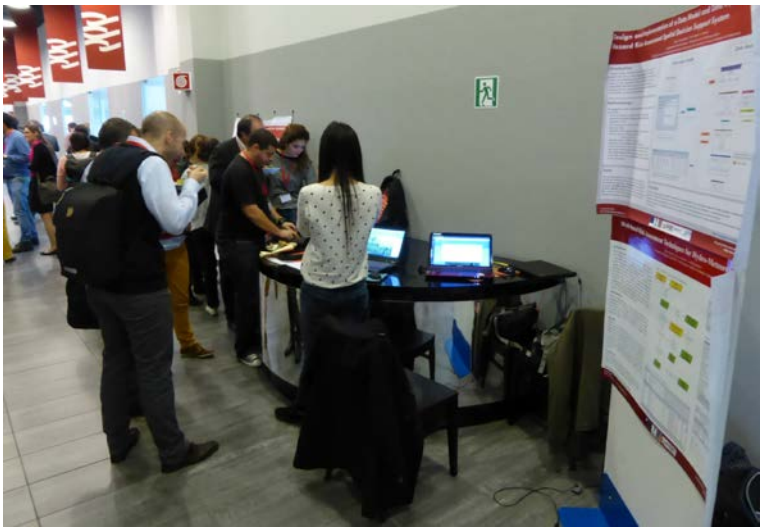
During this event one day was used for presenting the methodology for the SDSS. The participants were very interested but indicated that they were quite overwhelmed with the amount of information provided and that it would take them longer to better grasp the idea.

We are also planning that these persons are further trained in a 1-month training in the Netherlands in February 2015.

### *3.5 International Conference*

The International Conference on the Analysis and Management of Changing Risk for Natural Hazards was organized to present and discuss research results in the above mentioned fields. The conference was held on 18 and 19 November, in Padua, Italy. The conference provided an opportunity to discuss multi-hazard risks and multi-disciplinary research results on the effects of changing hydro-meteorological risks and their effects on planning strategies. The conference focus was put both 1) on technical sessions presenting the state of the art research in the understanding of the natural processes and in the development of innovative methodologies for quantitative hazard and risk forecasts, and 2) on the practical integration of natural, engineering, economical and human sciences within multi-scale methodologies for risk management and prevention planning.



The conference represented the culmination of the EC's co-funded projects CHANGES (Changing Hydro-meteorological risks as Analysed by a New Generation of European Scientists, www.changes-itn.eu), and IncREO (Increasing Resilience through Earth Observation, www.increo-fp7.eu). The SDSS was presented in an oral presentation and in a number of poster presentations. Also during a lunch break a demonstration session was organized.
During this session the system was presented by the developers. And we received positive feedback from several of the participants. However, time was generally too short to get a real directed feedback from the participants.

### *3.6 Internal presentation ITC*

The system was also presented during a lunchtalk at ITC in Enschede on 9 December 2014. The lunchtalk was attended by about 30 staff and students, including technical staff, and the ITC Dean. The feedback was very positive and the ITC Dean expressed his interest in further development of the system.

## *3.7 User dissemination meeting in Poland*

A dissemination workshop for local stakeholders was organized on 2 and 3 July 2014 in the case study area in the Municipality of Wieprz (case study of the CHANGEs project). The purpose of this meeting was to provide an overview of the CHANGES project dissemination activates in the Polish case study site (Wieprzówka Catchment in the Małopolska Voivodeship). The dissemination activities were conducted in two days with one meeting at the regional level in Krakow which was kindly hosted by the Instytut Rozwoju Miast (IRM) which is the region planning institute and the other at the local level, kindly hosted by the Municipality of Wieprz. Presentations were given, highlighting summaries of the research results from several CHANGES project Early Stage Researchers (ESRs), with discussion encouraged following. The meeting was attended by:

- Laura Klimczak – RM, Mariusz Grabowski – Regional Water Board (RZGW),
- Tomasz Dymura and Colleague of Tomasz Dymura – Krakow Police Department,
- Jadwiga Jeleśniańska – RDOŚ (Regional Environmental Directorate),
- Józef Kulesza - Regional authority,
- Grażyna Korzeniak – IRM,
- Katarzyna Gorczyca – IRM,
- Piotr Ogórek – IRM,
- 4 students from IRM (3 female, 1 male student)
- (From CHANGES: Wiktor Głowacki, Janusz Komenda, Magdalena Zalasińska, Kathrin Prenger-Berninghoff, Teresa Sprague, Zar Chi Aye, Irina Cristal, Roya Olyazadeh)

Some discussion and feedback also occurred following the presentation of the SDSS. A comment was first made by a municipal representative who stated that what was presented (creating the tool) seems like a difficult task and that it seems almost impossible to make something universally applicable for everywhere. The stakeholder asserted that it is not possible to do this because some things may be in common by practice but the natural events are difficult to predict. The response was that this is one of the challenges in the platform. However, she further stated that the decision-maker is the one who indeed defines alternatives (implying that this is a tool to assist and provide a mechanism in which decision-makers and other stakeholders can provide their specific information for their area and make decisions on different alternatives). A follow up comment from the same stakeholder stated that additionally not everyone is aware of the consequences or is an expert who contributes to the system. The statement provided highlighted, and repeated, a previously addressed issue that non-experts would also be contributing inputs into the system.

## *3.8 User dissemination meeting in Romania*

Two dissemination meetings were organized n the Buzau case study area in Romania, One on the 3rd of July in the town of Nehoiu and on the 16th of September in ISU Buzău. Both of the dissemination meeting were relatively short, and the participation of the relevant stakeholders was a bit problematic with people having to leave early. On both occasions the SDSS was presented in a presentation of about half an hour. For the stakeholders this was probably too short, as it was difficult for them to fully grasp the concept of the SDSS. Nevertheless there was a positive reaction of the Civil Protection stakeholders who inquired whether such a system could be installed locally in their organization. Another dissemination meeting was organized on 13 October 2014 in combination with the organization of an exhibition on "How does risk communication influences risk awareness", which was organized by the CHANGES project. Stakeholders were present from :

- Buzau County Prefecture
- Buzau County Council
- General Inspectorat for Emergency Situations and „Neron Lupascu" Inspectorate for Emergency Situations of Buzau County
- Romanian Academy

## *3.9 User dissemination meeting in Fella Area, Italy*

The meeting was organized on Thursday, November 20th/2014 - 09:30/15:45 in the Palazzo Veneziano (Comune di Malborghetto - Valbruna, UD. The workshop was coordinated by the CNR – IRPI, Padova with the support of technical services and Civil Protection of Friuli Venezia Giulia region. During this meeting the results from the CHANGES and INCREO projects were presented and the maps produced were handed over. Also the SDSS was presented to the stakeholders. Again , there was a positive reaction, but the stakeholders indicated that time was too short to fully comprehend the usability of the system.

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# 4. Potential users

For a proper user validation of the RiskChanges SDSS there were several difficulties encountered, that relate to the following aspects:

- The development of the system took a lot of time, and therefore it was difficult to present a fully working system to the stakeholders in the user dissemination meetings which were organized while the system was under development;
- The duration of the dissemination meeting was too short for the stakeholders to get a good overview of the functionality of the system, and therefore to make useful feedback to the different components it would take much more time than the short presentations slots that were available in the meetings. During the training courses more time was allotted and the participants showed much more interest, although even for them it was difficult to give proper feedback;
- The background of many of the stakeholders may not be in line with the expected capabilities of users of the SDSS, which would be generally not from a local level authority but rather from technical organizations providing support.

Therefore we didn't distribute evaluation forms as the basis for this validation report.

The SDSS will be further developed and used:

- Market segment: risk assessment tool that allows planners to evaluate changes in risk
- Product competitiveness: there is currently no similar system. Others deal only with risk assessment (INASAFE, CAPRA)
- Upcoming projects / business opportunities: product as such is OpenSource. But added value is in projects using the tool & capacity building projects

During the development of the SDSS we were also in contact with international organizations, such as the World Bank and the Red Cross. In February 2014, the World Bank launched the Caribbean Risk Information Program with a grant from the ACP-EU Natural Disaster Risk Reduction Program. This project is carried out by a consortium led by the University of Twente (ITC), with a number of partners (University of the West Indies, University of Bristol and Asian Institute of Technology). The consortium is responsible for conducting capacity-building workshops, generating training materials, and creating hazard maps to expand the capabilities within participating infrastructure and spatial planning ministries to use hazard and risk information for decision-making. Kick-off workshops, training and data collection activities were organized in the five target countries Belize, Dominica, Saint Lucia, Saint Vincent and the Grenadines, and Grenada. Also the SDSS was presented to the World Bank team, which showed their interest in further development, as evidenced by the support letter below.
Therefore we feel that the SDSS has a good potential for use with technical partners that are able to understand the concepts of risk assessment, cost-benefit analysis and multi-criteria evaluation. If international organizations like the World bank and the Red Cross are willing to support the development of the system further, it has the potential to become an important tool in the analysis and management of changing risk in an international context.

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**The World Bank**
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INTERNATIONAL DEVELOPMENT ASSOCIATION

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November 13, 2014

*Letter of support: RiskCHANGES*

**To whom it may concern:**

The World Bank is currently supporting the Caribbean Region in the creation and use of hazard and risk information for physical and infrastructure planning in the framework of the Caribbean Risk Information Program. The University of Twente ITC has been contracted to support the elaboration of a handbook, carry out flood and landslide hazard analyses and provide capacity building to the national governments of the participating countries.

In this context the University of Twente ITC introduced the RiskCHANGES platform and the World Bank sees a great potential in adjusting this tool to the Caribbean context and using it in order to complement the handbook as well as support local users to understand their risk and the impact of mitigation measures, climate change etc.

RiskCHANGES has been created in the context of the two EU projects InCREO and CHANGES under the coordination of the University of Twente ITC. This web-based system for analysing risk to hydro-meteorological hazards enables the user to study how this risk may change due to risk reduction intervention as well as under future scenarios of climate change and land use change.

The SDSS consists of a number of modules:

- **A data management module** where users can upload hazard maps, elements-at-risk maps and vulnerability curves for their own area of interest. Users can also define risk reduction alternatives and future scenarios and upload the hazard maps, elements-at-risk maps and vulnerability data for these;
- A **risk assessment module** which allows the users to calculate the losses for specific combinations of hazard maps and elements-at-risk maps, and combine these into a quantitative risk assessment both for economic as well as population risk;
- A **cost-benefit module** where users can analyse the CBA for different risk reduction measures that are proposed to reduce the risk;
- A **multi-criteria decision module** where users can evaluate the best risk reduction option based on the quantitative information calculated from the risk and CBA modules, and from user defined additional criteria;
- A **visualization module** where users can visualize input information, loss maps and risk maps.

Sincerely,

Fernando Ramirez
Senior Disaster Risk Management Specialist
Social, Urban, Rural and Resilience Global Practice
Latin America & Caribbean Region