WECDRR 2016
Lima - Peru

Abstract Book

World Engineering Conference on Disaster Risk Reduction
December 5-6, 2016

LIMA CONVENTION CENTER
Cultural Center of the Nation

On the corner of Av. Arqueologia and
Av. Del Comercio. District of San Borja
LIMA – PERU

Organized by:

Peruvian Association of Professional Engineers

Co-organized by:

World Federation of Engineering Organizations

Presidency of the Council of Ministers

Secretariat for Disaster Risk Management

Abstract Book

World Engineering Conference on Disaster Risk Reduction

CONTENTS

ACKNOWLEDGMENTS AND THE IMPORTANCE OF THE WORLD ENGINEERING CONFERENCE ON DISASTER RISK REDUCTION

The members of the Organizing Committee of the WFEO World Engineering Conference on Disaster Risk Reduction 2016 (WFEO/WECDRR 2016) express their sincere gratitude to the presenting authors of the Plenary, Oral and Poster sessions. Their great contributions will substantially reduce natural and man-made disasters in Peru. These collaborations are very important at this moment since near Lima, Peru, with its population of 9.75 million, there is a seismic gap according to the Geophysical Institute of Peru (IGP), and severe drought is affecting the country.

Seismic risk investigations for Lima were carried out from 2008 to 2013, by an NGO together with Swiss Cooperation, and Peru's Civil Defense/UNDP with funding from the European Union, as well as CISMID of the National University of Engineering, Lima, Peru, and Chiba University of Japan, under the auspices of JICA. Their conclusions coincide, in that, depending on the seismic scenario: magnitude and distance from its epicenter to Lima, sites' superficial geology characteristics, tsunami run up, vulnerability of buildings and infrastructures, and time of the day; the number of mortal victims may be numerous and material losses may be huge, interrupting Peru's social and economic development, which has been vigorous during the past 15 years. In addition, the Inter-American Development Bank reported that, in the area occupied by the Metropolitan Lima Region, US$ 450,000 million is at seismic risk. Lloyd´s of London has reported that in the event of a large magnitude earthquake near Lima, the material losses could reach US$ 35,500 million.

The last earthquake that affected Lima was in 1974, M 7.6 Richter, so most of the city's inhabitants do not have direct experience of suffering a disaster, and are therefore somewhat indifferent to Lima's high seismic risk. This World Conference will rise everyone's awareness, especially that of the decision makers, who need to know what to do in the next few years, to reduce significantly seismic and climatic risks in Lima and all over the country.

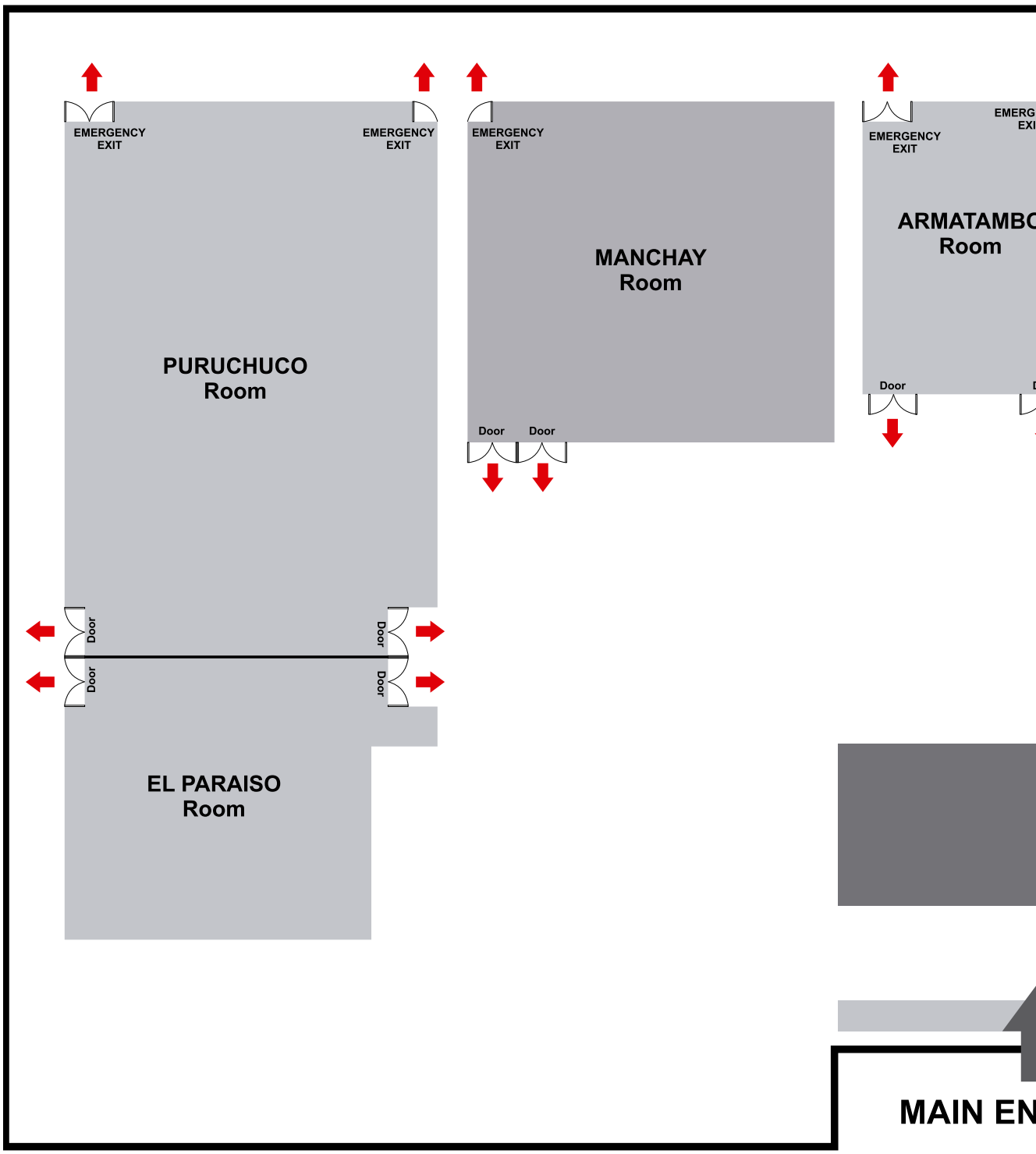
Among the Latin American and Caribbean countries, Peru and Nicaragua are the most vulnerable to global warming. El Niño 1982-1983 and 1997-1998 phenomena in northern Peru caused losses amounting to 6.2% and 3.1% of the 1983 and 1998 GDP, respectively, due to severe flooding. More than 60% of Peru´s total population of 31,488,625 people live in the country´s desert coastal trip, but they have only 2% of Peru´s fresh water. The water scarcity here means that there is less than 1000 m^3 per person in a year, for all uses. Lima and the other large cities along the coast have had drastic water restrictions many times, and in the future this situation will get worse. However, drought is not problem only in the coastal region, but also in the Andean highlands, where the agriculture of Peru and Bolivia is suffering from a severe drought right now. During the two weeks prior to the WFEO/WECDRR, forest fire in some Peruvian regions have resulted in thousands of hectares were burned.

These facts may be one the main reasons why the Executive Committee of WFEO accepted Peru as the organizer of the WFEO/WECDRR 2016. The organization was headed by some ministers and vice-ministers of State of the Peruvian Government, authorities from the official Peruvian institutions relating to disaster risk management, some university authorities and professors who are members of the Organizing Committee of this Conference together with CIP elected representants. Foreign and Peruvian corporations have provided economic assistance.

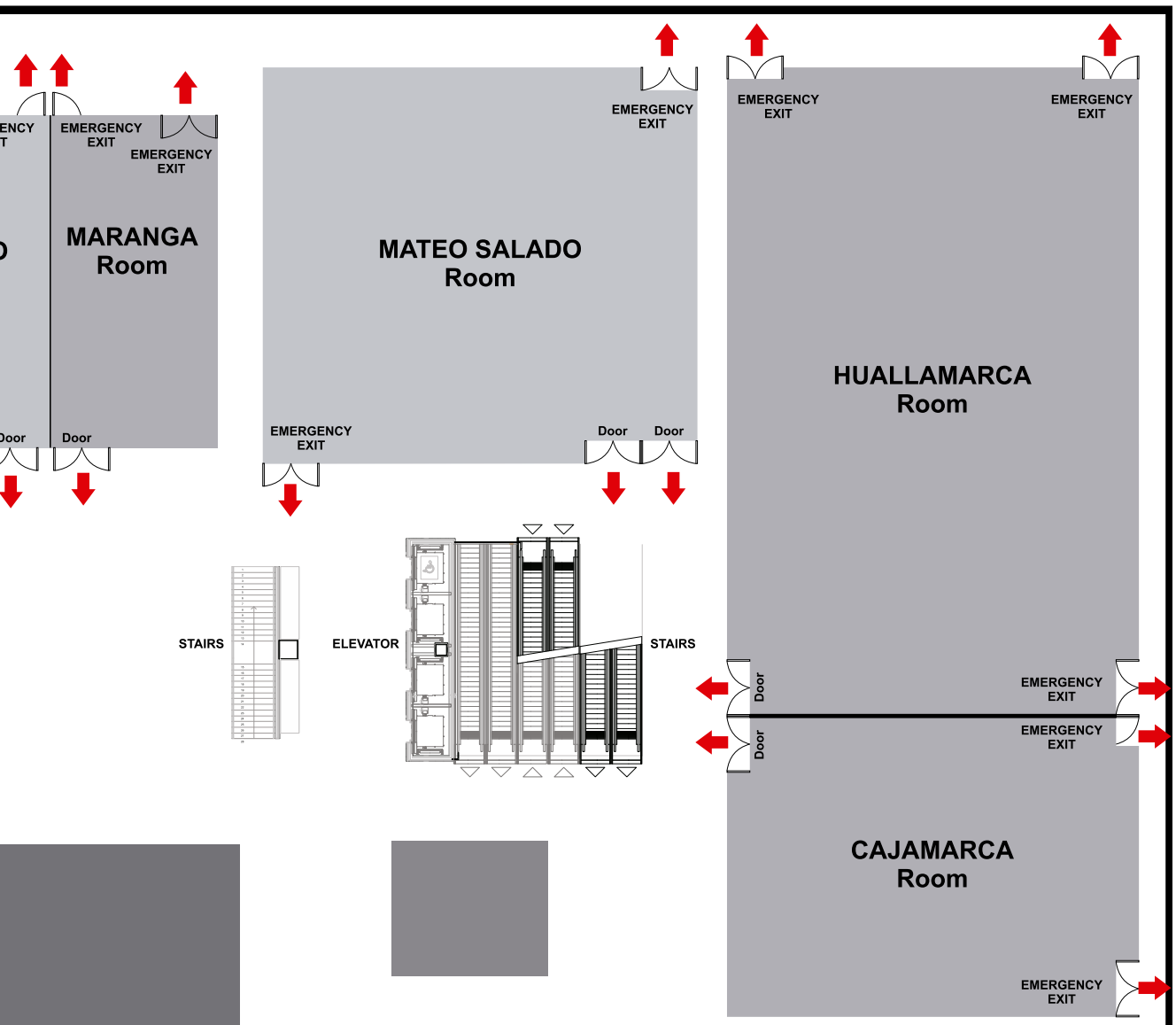
On behalf of all Peruvians, and ourselves: **Thank you very much!**

MAPS

GENERAL MAP



ROOM	AREA	MAX. CAPACITY
Puruchuco	688.09 m²	500 personas
El Paraíso	285.73 m²	200 personas
Manchay	423.24 m²	300 personas
Armatambo	230.60 m²	150 personas



Note: Registration is in the 2nd Floor.
The conference is in the 4th Floor.

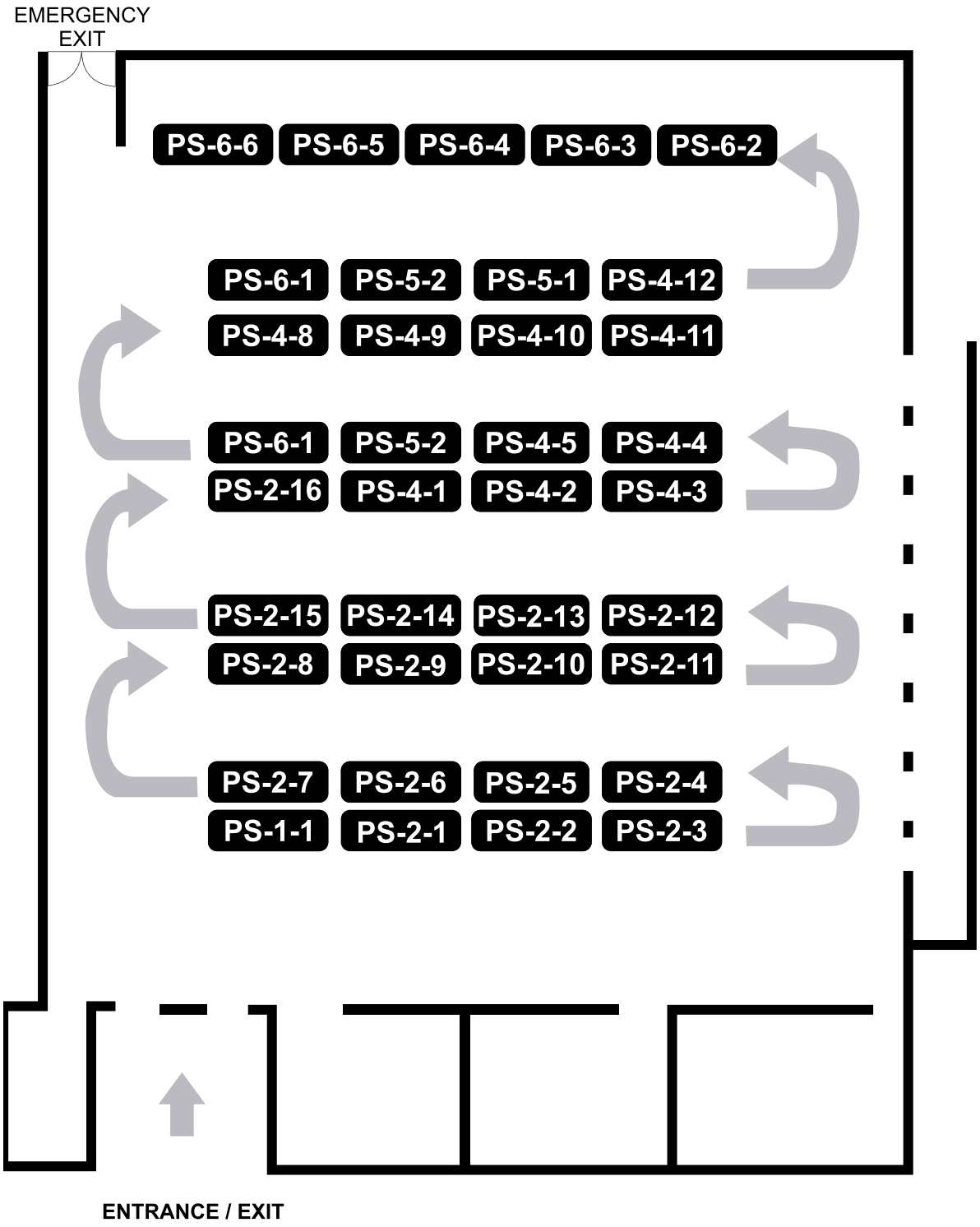
ITRANCE

APE

LOOR

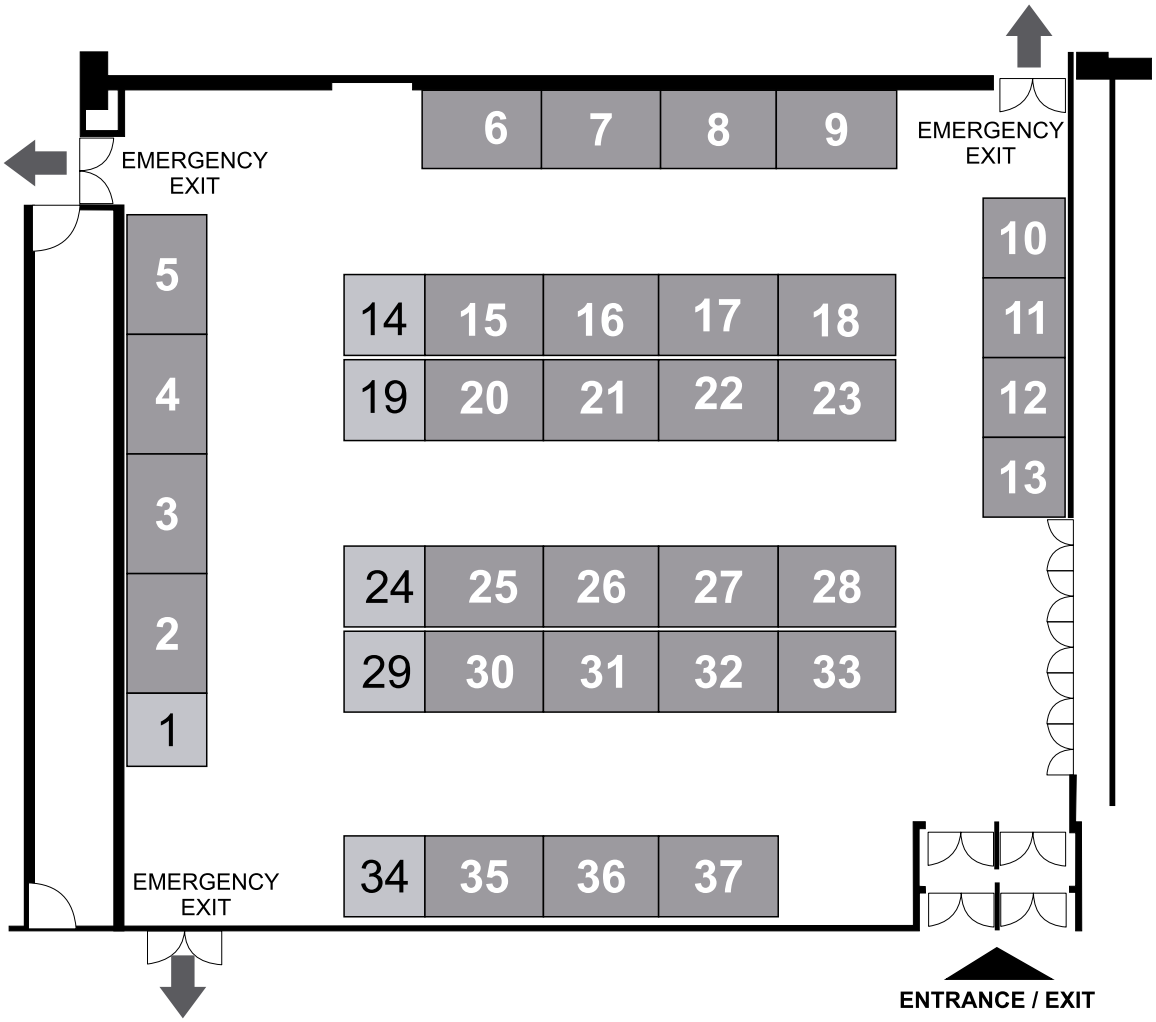
SALA	AREA	MAX. CAPACITY
Maranga	145.08 m²	100 personas
Mateo Salado	425.08 m²	300 personas
Huallamarca	716.60 m²	500 personas
Cajamarquilla	306.50 m²	250 personas

POSTER SESSION DISTRIBUTION



	THEME
PS-1	PROTECTION OF PUBLIC LIFELINE SERVICES
PS-2	DISASTER RISK AND CLIMATE CHANGE
PS-3	BUSINESS CONTINUITY PLAN AND BUSINESS CONTINUITY MANAGEMENT
PS-4	PLANNING OF RESILIENT CITIES
PS-5	PROTECTION OF ESSENTIAL FACILITIES
PS-6	SAFE BUILDINGS

DISASTER REDUCTION INSTITUTIONS ROOM



LEGEND

BASIC STAND DE 3x2x2,45

BASIC STAND DE 2x2x2,45

NRO	INSTITUTION / COMPANY
1	ZAMALÍ
2	INSTITUTO GEOFÍSICO DEL PERÚ
3	INGEMMET
4	INDECI
5	CENEPRED
6	MINISTERIO DE VIVIENDA
7	MINISTERIO DE VIVIENDA
8	INSTITUTO DE INGENIEROS DE MINAS DEL PERU - IIMP
9	INSTITUTO DE ESTUDIOS PERUANOS
10	CIP CD LIMA
11	CIP CD LIMA
12	CIP CD LIMA

NRO	INSTITUTION / COMPANY
13	OFICINA DE LAS NACIONES UNIDAS PARA LA REDUCCIÓN DEL RIESGO DE DESASTRES
14	GEOINSTRUMENTS INTERNATIONAL
15	GEOINSTRUMENTS INTERNATIONAL
16	PROMPERU
17	MINCETUR
18	GRUPO CIVILÍZATE
19	SOLUCIONES PRACTICAS
20	REVISTA CONSTRUCTIVO
21	DESNIVEL
22	UNIVERSIDAD NACIONAL AGRARIA LA MOLINA
23	CISMID
24	PREDES

NRO	INSTITUTION / COMPANY
25	EJERCITO DEL PERÚ
26	CDV PERU
27	CDV PERU
28	UNI
29	EMIN GEOESTRUCTURAS
30	UNIVERSIDAD ESAN
31	MACCAFERRI
32	ABTEL PERU
33	ERN EVALUACIÓN DE RIESGOS NATURALES
35	MTS
36	
37	AQUATHERM – DITEPER

GENERAL PROGRAM

Oral		Paraiso Room	Puruchuco Room	Manchay
Theme		Protection of Public Lifeline Services	Disaster Risk and Climate Change	Business Plan
Dec 5 (Mon)	09:00-10:00	Opening Ceremony (Puruchuco,		
	10:00-10:30	Coffee Break (Lobby & Balcony) /		
	10:30-12:30	Plenary Session: Conference Plenary Lectures		
	12:30-14:00			
	14:00-15:30	Plenary Session: Conference Plenary Lectures		
	15:30-16:00	Coffee Break / Poster Session		
	16:00-19:00	Oral Sessions (Paraiso, Puruchuco, Manchay,		
	20:00	Reception (Lima Convention		

Oral		Paraiso Room	Puruchuco Room	Manchay
Theme		Protection of Public Lifeline Services	Disaster Risk and Climate Change	Business Plan
Dec 6 (Tue)	09:00-11:00	Plenary Session: Conference Plenary Lectures		
	11:00-11:30	Coffee Break / Poster Session		
	11:30-12:30	Oral Sessions (Paraiso, Puruchuco, Manchay,		
	12:30-14:00			
	14:00-16:00	Oral Sessions (Paraiso, Puruchuco, Manchay,		
	16:00-16:30	Coffee Break / Poster Session		
	16:30-18:00	Roundtable [RT-1, 2, 3] (Puruchuco,		
	18:00-19:00	Closing Ceremony (Puruchuco,		
	20:00			

Room	Armatambo Room	Maranga Room	Huallamarca Room
Continuity ning	**Planning of Resilient Cities**	**Protection of Essential Facilities**	**Safe Buildings**
Paraiso & Huallamarca Rooms)			
Poster Session (Cajamarquilla Room)			
[PSL-1, 2, 3, 4] (Puruchuco, Paraiso & Huallamarca Rooms)			
Lunch			
[PSL-5, 6, 7] (Puruchuco, Paraiso & Huallamarca Rooms)			
(Cajamarquilla Room)			
Armatambo, Maranga & Huallamarca Rooms)			
Center Hall)			

Room	Armatambo Room	Maranga Room	Huallamarca Room
Continuity ning	**Planning of Resilient Cities**	**Protection of Essential Facilities**	**Safe Buildings**
[PSL-8, 9,10,11] (Puruchuco, Paraiso & Huallamarca Rooms)			
(Cajamarquilla Room)			
Armatambo, Maranga & Huallamarca Rooms)			
Lunch			
Armatambo, Maranga & Huallamarca Rooms)			
(Cajamarquilla Room)			
Paraiso & Huallamarca Rooms)			
Paraiso & Huallamarca Rooms)			
Dinner			

PLENARY LECTURES PROGRAM

DAY	TIME	CODE	PLENARY SESSION SPEAKERS
Dec 5 (Mon)	10:30-11:00	PSL-1	A. Lavell – Sasakawa Award 2015, England
	11:00-11:30	PSL-2	S. Koshimura – Tohoku University, Japan
	11:30-12:00	PSL-3	V. Mujumdar – ASCE, USA
	12:00-12:30	PSL-4	F. Ramirez – Wolrd Bank, USA
	14:00-14:30	PSL-5	R. Mena – UNISDR, Panama
	14:30-15:00	PSL-6	R. Boroschek –University of Chile, Chile
	15:00-15-30	PSL-7	J. Kuroiwa H. – National Engineering University, Peru
Dec 6 (Tue)	09:00-09:30	PSL-8	C. Luders - Pontifical Catholic University of Chile, Chile
	09:30-10:00	PSL-9	S. You – MTS, USA
	10:30-11:00	PSL-10	K. Gong – WFEO/CEIT, China
	11:00-11:30	PSL-11	F. Miura – Yamaguchi University, Japan

ROUND TABLE PROGRAM

DAY	TIME	ROUND TABLE SPEAKERS
Dec 6 (Tue)	16:30-17:00	E. Mas – Tohoku University, Japan
	17:00-17:30	R. Boroschek – University of Chile, Chile
	17:30-18:00	O. Lara – CONSULSISMICA, Ecuador

PLENARY LECTURE ABSTRACTS

PSL-1

TOWARDS INTEGRAL DISASTER RISK MANAGEMENT: DEFINITION AND CHALLENGES

A. LAVELL

Program Coordinator for the Social Study of Risks and Disasters (FLACSO) and Coordinator for Central America and the Caribbean of the Latin American Network for the Social Study of Disasters (LA RED) - Costa Rica. 2015 United Nations Sasakawa Award for Disaster Risk Reduction.

Abstract

The transition from the topic of Disaster and Emergency Management to the concept and practice of Integral Risk Management has involved paying greater attention to risk reduction and prediction as intervention goals. The notions of corrective, reactive, or compensatory and prospective management engage significantly different, albeit related, objectives. This transition also calls for different information and mechanisms of governance with an increased participation of sectoral and territorial development organizations. The lecture will address the concept and definition, and the challenges implied by the transition to integral management at both the practical and conceptual level.

PSL-2

TSUNAMI SCIENCE AND TECHNOLOGIES FOR SOCIETY - IMPLICATIONS TO TSUNAMI-RESILIENT COMMUNITY

S. KOSHIMURA

Dr. Shunichi Koshimura is a Professor at International Research Institute of Disaster Science (IRIDeS), Tohoku University. He carries out research specifically on tsunami disaster. His main focus is on developing a real-time tsunami inundation forecasting system with HPCI (High Performance Computing Infrastructure) and on estimating social impacts of tsunami inundation by integrating numerical modeling, earth observation and geo-informatics. With his expertise, Dr. Koshimura is now serving 16 committees of tsunami disaster management in local municipalities and the central government of Japan.

Abstract

We revisit the lessons of the 2011 Great East Japan Earthquake Tsunami disaster specifically on the response and impact, and discussed the paradigm shift of Japan's tsunami disaster management policies and the perspectives for reconstruction. Revisiting the modern histories of Tohoku tsunami disasters and pre-2011 tsunami countermeasures, we clarified how Japan's coastal communities have prepared for tsunamis. The discussion mainly focuses on structural measures such as seawalls and breakwaters and non-structural measures of hazard map and evacuation. The responses to the 2011 event are discussed specifically on the tsunami warning system and efforts to identify the tsunami impacts. The nation-wide post-tsunami survey results shed light on the mechanisms of structural destruction, tsunami loads and structural vulnerability to inform structural rehabilitation measures and land-use planning. Remarkable paradigm shifts in designing coastal protection and disaster mitigation measures are introduced, leading with a new concept of potential tsunami levels: Prevention (Level 1) and Mitigation (Level 2) levels according to the level of 'protection'. The seawall is designed with reference to Level 1 tsunami scenario, while comprehensive disaster management measures should refer to Level 2 tsunami for protection of human lives and reducing potential losses and damage. Throughout the case study in Sendai city, the proposed reconstruction plan was evaluated from the tsunami engineering point of view to discuss how the post 2011 paradigm was implemented in coastal communities for future disaster mitigation.

PSL-3

DISASTER RISK REDUCTION THROUGH INTEGRATED COMMUNITY RESILIENCE

V. MUJUMDAR

Member of the Board of Administration of the ASCE (American Society of Civil Engineering). He was the head of operations of the Architecture Division of the State of California; Director of the program of Engineering Research Centers of the National Science Foundation (NSF), U.S.A. He places emphasis on interdisciplinary work in disaster risk reduction.

Abstract

A community is interested in minimizing the loss of daily functionality due to a damaging natural hazard and reduce the disaster risk. If community as a whole, is considered as a large system of systems, one needs to define its components. In a broad sense, it can be argued that it comprises of three major systems: technical systems, social systems, and economic systems.

The technical systems comprise all built environment and are thus static in nature for response to a hazard. Their overall behavior and resilience is built-in as designed and constructed and therefore, cannot be changed intrinsically. The social systems essentially comprise of services, various social networks, and organizations. These systems are dynamic in nature as they determine their responses to a hazard depending on the nature of circumstances and modify it if necessary. The economic systems comprise of economic institutions and are quasi-dynamic, as some economic institutions are able to respond to a hazard depending on the circumstances while others cannot adjust to new circumstances. Thus it makes the overall economic system a quasi-dynamic one. Overarching all three systems is the organizational system as that determines the level of functionality that each system can provide during a hazard event.

Pre-existing conditions and hazards determine the vulnerability of all components of the larger community system. Pre-existing conditions can be assessed in three broad areas: built environment, economic structure and social institutions. Civil infrastructure system is a sub-system in the overall technical systems. To minimize the impact of a hazard, a community needs to develop overall resiliency through proactive efforts of all stakeholders in an integrated fashion. Overall resiliency comprises of resiliency of built environment, resiliency of economic structure, and resiliency of social institutions. Operations of various systems also play a critical role in determining the system resiliency. To increase operational resiliency, a well defined organizational structure and clarity in hierarchical responsibilities is important.- or an acceptable community resilience, all systems need to operate integrally, as many are dependent on each other. It is possible and also desirable to create different levels of community resiliency for different levels of each hazard, or for different hazards, given an acceptable level of desired functionality under each.

Since all systems need to act together synergistically, to minimize the impact due to a hazard, the overall behavioral outcome is difficult to predict, thus making the community system a complex system. This paper presents a framework of this complex community system.

PSL-4

PROTECTION OF ESSENTIAL FACILIDIES IN CASE OF DISASTER: SCHOOL

F. RAMIREZ

Fernando Ramirez is a Colombian engineer with 30 years of experience, including 18 years in the field of natural hazards and disaster risk management (DRM). He is currently Senior DRM Specialist at The World Bank. In this position, he is leading the DRM operations in Peru and the Global Program for Safer Schools (GPSS) with ongoing activities in El Salvador, Peru, Nepal, Turkey, Indonesia, Mozambique, Jamaica, among other countries. He led the Probabilistic Risk Assessment Program (CAPRA). Before joining the Bank, he served as a government official for the Colombian Geological Service and Head of the DRM Directorate for the city of Bogota.

Abstract

The accumulative impact of natural disaster and climate change exacerbates governments' ability to finance and operate a growing stock of school facilities and ensure continuity of educational service especially in poorest areas. Just in the last two years, the 2015 Nepal earthquake damaged 30,000 classrooms, destroying 5,000 schools and disrupting the education of over 1 million children; the 2016 Ecuador earthquake damaged almost 1,000 schools leaving over 120,000 children temporarily without education; and most recently Hurricane Matthew damaged over 730 schools in Haiti in October this year. Low intensity and high frequency events such as floods and storms may have an accumulative impact stronger than a single large scale disaster. Mozambique is an illustrative case where the country is falling short of planned targets for new classrooms, estimated to be between 35,000 to 40,000 classrooms by 2025, and the situation is severely aggravated by the number of schools destroyed as a result of the combination of high exposure and vulnerability to natural hazards. The effect of these recurrent events demonstrate the vulnerability of school buildings, with 200 to 1,000 classrooms destroyed, out of about 400-600 constructed every year. In 2014, the World Bank through the Global Facility for Disaster Reduction and Recovery (GFDRR) launched the Global Program for Safer Schools (GPSS) whose focus is on the integration of risk considerations into education infrastructure investments. In the first two years the program has initiated activities in 11 countries across five regions, including Armenia, El Salvador, Indonesia, Jamaica, Mozambique, Nepal, Peru, Turkey, Samoa, Tonga, and Vanuatu. The presentation at the World Engineering Conference 2016 will discuss this issue from the global perspective and offer example of risk reduction policies in Nepal and Peru with support from the GPSS.

PSL-5

THE GLOBAL AGENDA FOR DISASTER RISK REDUCTION AND ITS APPLICATION IN THE URBAN CONTEXT

R. MENA

Head of the Regional Office for the Americas of the United Nations Office for Disaster Risk Reduction (UNISDR). He holds an M.Sc. in Crisis and Disaster Risk Management from Leicester University, U.K.

Abstract

The Sendai Framework for Disaster Risk Reduction 2015-2030 is the international blue print for reducing disaster risk. Its outcome is the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. To attain this outcome, the Sendai Framework pursues the goal to prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience. It encourages national and local governments, among other activities, to establish the necessary mechanisms and incentives to ensure high levels of compliance with the existing safety-enhancing provisions of sectoral laws and regulations, including those addressing land use and urban planning, building codes, environmental and resource management and health and safety standards, and update them, where needed, to ensure an adequate focus on disaster risk management. Furthermore, it encourages the revision of existing or the development of new building codes and standards and rehabilitation and reconstruction practices at the national or local levels, as appropriate, with the aim of making them more applicable within the local context, particularly in informal and marginal human settlements, and reinforce the capacity to implement, survey and enforce such codes through an appropriate approach, with a view to fostering disaster-resistant structures. It also highlights the need to strengthen, as appropriate, disaster-resilient public and private investments, particularly through structural, non-structural and functional disaster risk prevention and reduction measures in critical facilities, in particular schools and hospitals and physical infrastructures; building better from the start to withstand hazards through proper design and construction, including the use of the principles of universal design and the standardization of building materials; retrofitting and rebuilding; nurturing a culture of maintenance; and taking into account economic, social, structural, technological and environmental impact assessments.

PSL-6

PROTECTION OF ESSENTIAL FACILITIES IN CASE OF DISASTERS: HOSPITALS

R. BOROSCHECK

Associate professor in the Department of Civil Engineering, University of Chile. He did his Master's and Ph.D. studies at the University of Berkeley. His fields of research are: vulnerability assessment of critical installations; base isolators and passive energy dissipation; evaluation of structural damage; vulnerability studies and mitigation of health establishments, and others.

Abstract

Hospital are essential after a severe earthquake, nevertheless, experience has shown that due to its inherent characteristic and dependency from external resources they are extremely vulnerable and in general no able to function at its expected capacity after severe earthquakes. The Chile experience after the Mw 8.8 2010 earthquake is a good example. This mayor natural event affected a significant portion (65% of stock, approximately) of housing and health infrastructures, causing economic losses exceeding 33 billion US dollars, equivalent to 15% Chile's 2010 GDP. Ten percent of these losses resulted from direct damage to the 130 public health facilities affected. Among these hospitals, 83% lost some or all functionality exclusively due to damage to nonstructural systems and components, such as architectural elements, contents and electric and mechanical equipment. Five hospitals needed to be evacuated due to severe structural and nonstructural damage, twelve had greater than 75% loss of function exclusively due to nonstructural damage, eight were operating only partially after the main shock, and eighty needed repairs or replacement. Of the 19,179 beds in public hospitals, 22% were lost during the main shock and 18% continued to be out of service one month after the earthquake. Although structural damage was minimal in hospitals, most suffered nonstructural damage, and frequently, loss of utilities. Evacuating hospital is an extremely difficult task and has caused mayor distress to the society.

This experience show the need to increase earthquake protection of hospital functionally, not only its structural components, this must be done formally introducing modifications into design codes and standards in order to improve seismic design practices, disseminate the use of seismic protection technologies, promote the seismic design of nonstructural components and systems, and include utilities, communication and access redundancy requirements for critical facilities. To avoid unnecessary evacuations a structural health monitoring should be presented in all critical infrastructure allowing the user and stake holders to take informed action about the real status of the infrastructures and possible damage with minimum loss of functionally and lives.

PSL-7

PROTECTION OF WATER AND SEWAGE SERVICES (WSS) FROM EARTHQUAKES, TSUNAMIS AND LANDSLIDES

J. KUROIWA H.

Professor emeritus National Engineering University, Lima, Peru 1990. United Nations Sasakawa UNDRO Award on Disaster Prevention, Geneva. Honorary Member of the International Association for Earthquake Engineering, Tokyo. Member of the Advisory Committee 2010-2015 to UNISDR Making Resilient Cities, Geneva.

Abstract

Disasters that have occurred globally from 1989 to 2016 have shown that lifeline networks, mainly water and energy, were suddenly interrupted from a few days to three months. Lessons from those disasters were investigated by the author mainly by damage survey and interacting with local engineers. Existing literature was also reviewed with the objective of understanding how the most vulnerable components of WSS behave, in order to improve new systems and to reduce rehabilitation time if damaged.

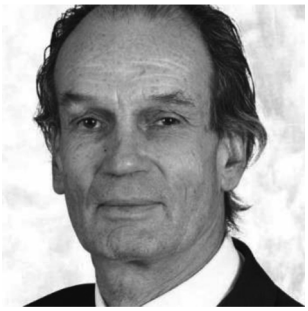
During the 1989 Loma Prieta earthquake, buried water pipes were broken at the Marina District, San Francisco CA, due to large soil deformation in filled soil. The 1994 Northridge earthquake seriously affected the Los Angeles, CA, the Van Norman Water Theatment Complex. Two main and 1160 water distribution pipes were broken, showing a very good correlation between damage locations and the superficial geology. The 1989 Kobe earthquake destroyed the WSS due to liquefaction and high seismic intensity. Because of added problems, the rehabilitation of the water system lasted three months. The lessons were capitalized by water supply companies all over Japan, including Sendai city, where after the 2011 Tohoku earthquake most of the water system components was restored in 10 days.

El Niño 1997-98 affected northern Peru and southern Ecuador. Flooding and landslide damage caused to WSS was studied. The main conclusion of the 2004 Indian Ocean Tsunami, reported by Mathew (2006), was that the maximum erosion depth was 2.0 m. The 2007 Pisco, Peru, earthquake and tsunami occurred in a desert area, and showed that the presence of water is critical for liquefaction to occur. The New Zealand Christchurch 2010-2011 earthquakes serie, as well as the Chile 2010 and Japan 2011 earthquakes, have confirmed that the main cause of damage to buried pipes is the large permanent soil deformation caused by liquefaction. In Japan, soil liquefaction caused damage to WSS in the Chiba, Kanto and Kanagawa prefectures. In the 2016 Ecuador earthquake, three days after the disaster, the main problem was the lack of drinking water.

The great advancement in the understanding of how WSS is affected by intense phenomena, and the improve water pipes and their seismic resistant joints, as the Japanese ductile iron pipes and Kubota joints, and PVC-O pipes, with increased robustness, will make it possible to construct efficient and resistant new WSS, and their rehabilitation time will be substantially reduced. The author's investigations were funded mainly by the World Bank, CONCYTEC, SENCICO, SEDAPAL and JICA. The engineers of Kobe Water Department, LA Department of Water and Energy, and Sendai City Waterworks Bureau provided their valuable time. Thank you very much.

PSL-8

SEISMIC PROTECTION SYSTEMS IMPLEMENTATION IN CHILE AND BEHAVIOR DURING THE MAULE EARTHQUAKE (8.8 MW) OF FEBRUARY 27, 2010



C. LUDERS

Professor and researcher of the Department of Structural Engineering and Geotechnics at the PUC. He has focused his professional and academic career on structural engineering, especially on earthquake-resistant design and the experimental analysis of structures.

Abstract

Chile is one the most seismic country in the world. In the last century it has been hit by two of the six largest earthquakes that have been registered in the world (Valdivia earthquake 1960 Mw 9.5 and Maule earthquake 2010 Mw 8,8). For this reason, there is a seismic culture today in the country that allows facing earthquakes in a relatively good way. However, material and human losses remain very important. At the same time, seismic protection systems (SPS) have been developed in the world, which reduce greatly the seismic effects on structures and their contents, at marginal costs. In 1996, the Department of Structural Engineering of the Pontificia Universidad Catolica de Chile presented a project to develop and implement seismic protection systems, both for Chile and for any other seismic country in the world. This project included theoretical studies, the creation of a Laboratory of Dynamic Tests, experimental studies, the creation of new devices and their implementation in new and existing projects, as well as a preliminary draft of a code for the design of seismically isolated structures.

This presentation gives a brief summary of the activities indicated above, up to 2010. It shows the characteristics of the structures with SPS that were constructed in Chile prior to the February 27, 2010 and his behavior during the 2010 earthquake. Particular aspects that must be taken into account in the design of SPS structures are also highlighted and general recommendations are given for the knowledge of the behavior and development of new SPS.

PSL-9

ADVANCED TESTING METHODS FOR MITIGATING EARTHQUAKE IMPACT ON STRUCTURES

S. YOU

Staff engineer of MTS Systems for 19 years. He has been participating in numerous projects of hybrid simulation and structure tests. He installs hybrid simulation systems and trains people in hybrid simulation in different universities and research institutes.

Abstract

There are mainly three types of tests for studying the impact of an earthquake on structures; shaker table tests, quasi static substructure tests, and hybrid simulation. Over the last decade, new testing methods have been developed to make the simulation tests more accurate and/or more cost effective. This presentation introduces some of these new methods.

Shaker table tests have been conducted for a long time. In order to test larger and larger specimen, shaker table sizes have grown significantly. Multiple table systems that can provide flexible test configurations have become more and more popular. At same time, the control technology has improved significantly. Specimen Dynamic Compensation (SDC) technique has been developed to ensure adequate table tracking without iteration. SDC can effectively remove the effect of a resonant specimen from the motion dynamics of a shake table. As a result, the table behaves like a bare table regardless of attached specimen.

Quasi static substructure tests are still widely used to study the behavior of a component in a structure during an earthquake. To control boundary condition accurately, Multi-Axial-Subassemblage-Testing (MAST) systems are used more and more frequent. With advanced control technology, MAST systems can accurately control all 6 Degree-Of-Freedoms (DOF) at any point in space with a displacement-force mixed control mode even in over-constraint situations.

Hybrid simulation has been proven to be an accurate, efficient, and cost effective way to study the impact of an earthquake. Because of these advantages, hybrid simulation has become more and more popular in studying structures such as buildings and bridges. People have also started to use hybrid simulation in wind energy and nuclear energy industries. There are mainly three kinds of hybrid simulation; quasi static, soft real-time, and real-time hybrid simulation. The latest trend is to couple shaker tables with loading actuators in one test setup to simulate complicated loading conditions, such as earthquake coupled with wave loading. Another trend is to conduct hybrid simulation using MAST systems in order to control all 6 DOF at the boundary between numerical and physical substructures.

PSL-10

INNOVATIVE TECHNOLOGIES FOR DISASTER REDUCTION

K. GONG

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Abstract

Out of 17 SDGs, 10 goals are set related to the disaster risk reduction. To address the severe disaster challenges, such as earthquakes, typhoons, floods and so on, innovative technologies like oberving system, data systems, modeling and simulation, management theory, capacity development, and digital earth have been well studied and implemented.

Earthquake is one of the most devastating disasters, and the earthquake forecasting is still an open scientific & engineering problem. The seimo-electromagnetic radiation observation is important for short – impending earthquake prediction. The first satellite of a space monitoring system in order to investigate the topside ionosphere and gather world-wide data of the near-Earth electromagnetic environment has been launched, named China Seismo-Electromagnetic Satellite (CSES). Followed by a brief introduction of CSES, WFEO-CEIT will propose an initiative for Earthquake Prediction and Disaster Mitigation from Space, with the objectives of: 1) building anelectromagnetic satellite monitoring system;2) constructing world-wide data of space environment of theelectromagnetic field, plasma and energetic particles of the real-time observation; 3) analyzing the features of seismo-ionospheric perturbations forshort-term earthquakeforecasting, and the theoretic studies on the mechanismof the earthquake preparation processes; 4)providing the data sharing service for international cooperation and both scientific and engineering communities.

Keywords: disaster risk reduction, innovative technology, seismo-electromagnetic satellite, short – term earthquake prediction, disaster mitigation

PSL-11

DETECTION OF DAMAGED AREAS CAUSED BY NATURAL DISASTERS BY USING SATELLITE REMOTE SENSING IMAGES

F. MIURA

Vice-president of Yamaguchi University (International cooperation), Professor Emeritus of Yamaguchi University, Specially Designated Professor of Yamaguchi University. He did his Doctoral studies at Kyoto University, Japan. His area of specialization is Disaster management, Disaster information system and Earthquake Engineering, Application of satellite remote sensing to disaster management.

Abstract

Japan is one of the most natural disaster-prone countries in the world. We had severe damage due to strong earthquakes, concentrated heavy rains and typhoons, volcano eruptions. Many people were killed by these natural disasters and, at the same time, learned a lot from them.

The most important lesson is that we need to strengthen and enrich software such as disaster management information system, and so forth as well as hardware.

As for the information system, the important thing is how to acquire and process the information about the damaged areas as soon as possible, and to use the information in decision making for aftermath. One possible methods is the satellite remote sensing. We are developing to detect the damaged areas of slope failure, tsunami inundation and flooding using only satellite images taken after the occurrence of disaster. We will introduce the method in this presentation.

ORAL SESSION LIST

Theme 1: Protection of Public Lifeline Services

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-1-1	ENSURING WATER AND SEWAGE SYSTEM, POST EARTHQUAKE CASE IN LIMA AND CALLAO	J. VARGAS	Dec 05 (Mon)	16:00-16:20	Paraiso Room
OS-1-2	PROPOSAL FOR NOVEL ELECTRICAL SYSTEMS TO ENSURE THE ELECTRICITY SUPPLY IN HOSPITALS DURING DISASTERS: IN THE CASE OF EARTHQUAKES AND FLOODING	J. MIREZ	Dec 05 (Mon)	16:20-16:40	Paraiso Room
OS-1-3	BASE ISOLATION AND SUPPLEMENTAL DAMPING SYSTEMS FOR EARTHQUAKE PROTECTION OF RC WATER STORAGE TANKS	E. MAMANI	Dec 05 (Mon)	16:40-17:00	Paraiso Room
OS-1-4	ANTENNAS ELEVATION SYSTEM, MOBILE, WITH ENERGY AUTONOMY, THAT ALLOWS THE IMMEDIATE REACTIVATION OF EMERGENCY RADIO–COMMUNICATIONS, IN COMMUNICATIONS COLLAPSE CASES	A. BANDA	Dec 05 (Mon)	17:00-17:20	Paraiso Room
OS-1-5	PROPOSED DESIGN AND DEVELOPMENT OF A SYSTEM THAT INTEGRATE THE LOCAL RADIO STATIONS FOR EMERGENCIES AND DISASTERS, IN ORDER TO MEET THE ABSENCE OF A CENTRAL COMMUNICATION WITH A SINGLE EMERGENCY NUMBER TYPE 911, IN THE CITY OF LIMA	A. BANDA	Dec 06 (Tue)	11:50-12:10	Paraiso Room
OS-1-6	INFRASTRUCTURE MANAGEMENT SYSTEM FOR SEISMIC RISK REDUCTION ON BRIDGES AND VIADUCTS OF LIMA CITY	J. OLARTE	Dec 05 (Mon)	17:40-18:00	Paraiso Room
OS-1-7	RISKS IN BRIDGES, VIADUCTS AND TUNNELS BUILT IN ROAD CONCESSIONS IN PERU, URGENT RISK REDUCTION MEASURES	J. LOPEZ	Dec 05 (Mon)	18:00-18:20	Paraiso Room
OS-1-8	EARTHQUAKE DAMAGE AND REHABILITATION OF WATER AND SEWER SYSTEMS: EXPERIENCE OF 2007 ICA EARTHQUAKE	J. RUCOBA	Dec 05 (Mon)	18:20-18:40	Paraiso Room
OS-1-9	DISASTER RISK REDUCTION IN HYDROELECTRIC PLANTS	R. VILLANUEVA	Dec 05 (Mon)	18:40-19:00	Paraiso Room
OS-1-10	GROUND IMPROVEMENT BY JET GROUTING FOR LIQUEFACTION HAZARD MITIGATION IN BRIDGE OVER QUILCA RIVER, AREQUIPA, PERU	S. ORTEGA	Dec 05 (Mon)	17:20-17:40	Paraiso Room
OS-1-11	DISASTER RISK REDUCTION TO ATTEND TO PERU'S MAXIMUM ELECTRICITY DEMAND IN THE EVENT OF A BREAK IN THE CAMISEA GAS PIPELINE	R. SANTILLAN	Dec 06 (Tue)	12:10-12:30	Paraiso Room
OS-1-12	CONSIDERATIONS ON DESIGN AND CHOISE OF MODERN PIPELINES FOR USE IN EARTHQUAKE PRONE AREAS	F. ALFERINK	Dec 06 (Tue)	11:30-11:50	Paraiso Room

Theme 2: Disaster Risk and Climate Change

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-2-1	LEVELS OF RISK AND VULNERABILITY ASSOCIATED WITH FLOODS AND CLIMATE CHANGE ADAPTATION IN BINATIONAL BASIN PUYANGO - TUMBES	B. GARCIA	Dec 05 (Mon)	16:00-16:20	Puruchuco Room
OS-2-2	GROUND-BASED SYNTHETIC APERTURE RADAR (GB-SAR) FOR LANDSLIDE STUDIES AND MONITORING IN PERU	J. FLORENTINO	Dec 05 (Mon)	16:20-16:40	Puruchuco Room
OS-2-3	HUAYCO'S EARLY WARNING SYSTEM	A. VALDEZ	Dec 05 (Mon)	16:40-17:00	Puruchuco Room
OS-2-4	HOLISTIC MODEL FOR DISASTER RISK ASSESSMENT AS A TOOL FOR CLIMATE CHANGE ADAPTATION	M. PEREZ	Dec 05 (Mon)	17:00-17:20	Puruchuco Room
OS-2-5	DYNAMICS OF ALUVIONAL FLOWS IN THE QUINCEMIL TOWN, SUB-BASIN OF ARAZA RIVER	J. CHAHUA	Dec 05 (Mon)	17:20-17:40	Puruchuco Room
OS-2-6	FLOOD RISK MANAGEMENT: CURRENT PERSPECTIVE FLOOD RISK MANAGEMENT PLANS IN SPAIN	T. SANCHO	Dec 05 (Mon)	17:40-18:00	Puruchuco Room
OS-2-7	A FIELD-BASED RELATION TO ESTIMATE RAINFALL EROSIVITY: A CASE STUDY OF RIMAC RIVER BASIN	J. FERNANDEZ	Dec 05 (Mon)	18:00-18:20	Puruchuco Room
OS-2-8	RISK DISASTER AND CLIMATE CHANGE	J. SUAZO	Dec 05 (Mon)	18:20-18:40	Puruchuco Room
OS-2-9	INTEGRATION OF REMOTE SENSING INFORMATION AND GIS-BASED PLATFORMS TO SUPPORT DISASTER RISK MANAGEMENT	B. ADRIANO	Dec 05 (Mon)	18:40-19:00	Puruchuco Room
OS-2-10	CREEPING DISASTERS DUE TO WATER TABLE RISE IN THE CENTRAL COAST OF PERU	J. M. KUROIWA	Dec 06 (Tue)	11:30-11:50	Puruchuco Room
OS-2-11	REPAIR OF FLOOD DAMAGED ROAD INFRASTRUCTURE IN SOUTH AFRICA – A CRITICAL ANALYSIS	A. MENON	Dec 06 (Tue)	11:50-12:10	Puruchuco Room
OS-2-12	DIFFERENTIAL BEHAVIOR OF HUAICOS IN CHOSICA IN THE YEARS 1987, 2012 AND 2015, AND GENERAL ASPECTS OF RISK MANAGEMENT	E. GUADALUPE	Dec 06 (Tue)	12:10-12:30	Puruchuco Room
OS-2-13	IN THE RIMAC RIVER VALLEY, THE DESERTIFICATION PROCESS CONSTITUTES A THREAT?	E. MILLONES	Dec 06 (Tue)	14:00-14:20	Puruchuco Room
OS-2-14	MODELING FLOOD IN THE MIDDLE ZAMBEZI BASIN USING REMOTE SENSING AND HYDROLOGICAL MODELING TECHNIQUES	T. NHARO	Dec 06 (Tue)	14:20-14:40	Puruchuco Room
OS-2-15	ANALYSIS OF THE POTENTIAL OF STRUCTURE-FROM-MOTION TO GENERATE SPATIAL INFORMATION IN DEVELOPING COUNTRIES	M. ASTORAYME	Dec 06 (Tue)	14:40-15:00	Puruchuco Room
OS-2-16	DROUGHT FORECASTING WITH ARTIFICIAL NEURAL NETWORKS AND GENETIC ALGORITHMS USING REMOTE SENSING PRECIPITATION	I. AYALA	Dec 06 (Tue)	15:00-15:20	Puruchuco Room
OS-2-17	MCA APPLICATION IN THE PLANNING FOR FLOOD MITIGATION- DOWNSTREAM CHILLON RIVER	J. CELMI	Dec 06 (Tue)	15:20-15:40	Puruchuco Room

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-2-18	STRUCTURAL VULNERABILITY TO NATURAL HAZARDS IN PUERTO RICO	R. LOPEZ	Dec 06 (Tue)	15:40-16:00	Puruchuco Room
OS-2-19	EVALUATION OF CONTROL WORKS FOR THE DEBRIS FLOW IN THE COLOCAYA GULLY UNDER CLIMATE CHANGE SCENARIOS	J. CABRERA	Dec 06 (Tue)	14:00-14:20	Paraiso Room
OS-2-20	REGIONAL INTEGRAL SOLUTIONS TO REVERSE THE PRESENT CRISIS OF POTABLE WATER	C. DE LA FUENTE	Dec 06 (Tue)	14:20-14:40	Paraiso Room
OS-2-21	GEOHAZARD MAPS OF PROCESS TRIGGERED BY EARTHQUAKES	G. DELGADO	Dec 06 (Tue)	14:40-15:00	Paraiso Room
OS-2-22	ACTIVE FAULT STUDIES FOR EARTHQUAKES DISASTER REDUCTION	C. BENAVENTE	Dec 06 (Tue)	15:00-15:20	Paraiso Room
OS-2-23	DYNAMIC, EVOLUTION AND MULTI-METHOD MONITORING OF SIGUAS LANDSLIDE, AREQUIPA, PERU	P. VALDERRAMA	Dec 06 (Tue)	15:20-15:40	Paraiso Room
OS-2-24	HEAVY RAINS ON THE WESTERN SLOPE OF THE PERUVIAN ANDES ASSOCIATED WITH SYNOPTIC-SCALE CIRCULATIONS: MARCH 22ND AND 23RD, 2015	A. CHANCAFE	Dec 06 (Tue)	15:40-16:00	Paraiso Room

Theme 3: Business Continuity Plan and Business Continuity Management

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-3-1	SHOPPING MALL DISASTER ACCELERATES RISK QUESTIONNAIRE AND PROFESSIONAL EDUCATION FOR ENGINEERS	A. BERGERON	Dec 05 (Mon)	16:00-16:20	Manchay Room
OS-3-2	CRISIS MANAGEMENT CONTINGENCY PLAN IN CALLAO – PROPOSAL OF RESPONSE MEASURES THROUGH INTEGER LINEAR PROGRAMMING MODELS FOR THE DISTRIBUTION OF EMERGENCY KITS TO PROVIDE VICTIMS WITH HUMANITARIAN AID	X. RODRIGUEZ	Dec 05 (Mon)	16:20-16:40	Manchay Room
OS-3-3	ENHANCING CAPACITY BUILDING FOR DISASTER MANAGEMENT.	A. KUMAR	Dec 05 (Mon)	16:40-17:00	Manchay Room
OS-3-4	DEVELOPMENT OF AN INFORMATION SYSTEM FOR DISASTER RISK MANAGEMENT WITH A FOCUS PROCESS	R. VILLON	Dec 05 (Mon)	17:00-17:20	Manchay Room

Theme 4: Planning of Resilient Cities

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-4-1	SOCIAL RISK REDUCTION ALONG THE PERUVIAN COASTAL CITIES	L. RUIZ	Dec 05 (Mon)	16:00-16:20	Armatambo Room
OS-4-2	REDUCING THE RISK VOLCANIC OF AREQUIPA CITY	L. MACEDO	Dec 05 (Mon)	16:20-16:40	Armatambo Room
OS-4-3	STUDY OF A PRIORITY FOR MUNICIPALITIES MAP FOR DISASTER RISK MANAGEMENT (DRM)	F. BARRENECHEA	Dec 05 (Mon)	16:40-17:00	Armatambo Room
OS-4-4	INTERACTIVE WEB-BASED APPLICATION FOR SEISMIC AND FLOOD RISK ASSESSMENT	M. NASTEV	Dec 05 (Mon)	17:20-17:40	Armatambo Room
OS-4-5	CORPORATE SOCIAL RESPONSIBILITY FOR PREVENTION, MITIGATION AND RESILIENCE OF THE REGION INCREASED FROM ANY DISASTER	A. BODENHEM	Dec 05 (Mon)	17:40-18:00	Armatambo Room
OS-4-6	DESING OF A DSS FOR THE MANAGEMENT OF PRE-DISASTER STAGES OF EARTHQUAKES IN BUCARAMANGA	D. MARTINEZ	Dec 05 (Mon)	18:00-18:20	Armatambo Room
OS-4-7	THE SHORTLY-BEFORE SEISMIC ALARMS	R. PULGAR	Dec 05 (Mon)	18:20-18:40	Armatambo Room
OS-4-8	EVALUATION OF THE LOCAL SEISMIC RESPONSE IN THE URBAN CENTRAL AREA OF THE CITY OF HUARAZ	R. REYES	Dec 05 (Mon)	18:40-19:00	Armatambo Room
OS-4-9	DISASTER MANAGEMENT SIMULATION LAB: A TOOL FOR DISASTER PREPARADENESS AND EMERGENCY RESPONSE AT THE CHILEAN NATIONAL EMERGENCY OFFICE	L. ROBLEDO	Dec 06 (Tue)	11:30-11:50	Armatambo Room
OS-4-10	ENERGY APPROACH IN ITALIAN RESILIENT CITIES. CASE STUDY	A. LOPEZ	Dec 06 (Tue)	11:50-12:10	Armatambo Room
OS-4-11	PHYSICAL AND SOCIAL VULNERABILITY BY THE GIANT TSUNAMI OF 1746 IN THE SOUTHERN SECTOR OF CALLAO, PERU	V. CUISANO	Dec 06 (Tue)	12:10-12:30	Armatambo Room
OS-4-12	RISK MANAGEMENT IN TERRITORIAL PLANNING, CASE OF GALERAS VOLCANO, COLOMBIA	O. MESIAS	Dec 06 (Tue)	14:00-14:20	Armatambo Room
OS-4-13	ADAPTATION RESPONSES OF A COASTAL CITY IN BANGLADESH DURING CYCLONE GENERATED STORM SURGE	R. KABIR	Dec 06 (Tue)	14:20-14:40	Armatambo Room
OS-4-14	TSUNAMI INUNDATION MAPS FOR RISK MANAGEMENT AND MITIGATION IN THE PERUVIAN COAST	E. ORTEGA	Dec 06 (Tue)	14:40-15:00	Armatambo Room
OS-4-15	AN INNOVATIVE METHODOLOGY FOR THE SEISMIC RISK MITIGATION ON LARGE TERRITORIAL SCALE	A. ANELLI	Dec 06 (Tue)	15:00-15:20	Armatambo Room
OS-4-16	CAPACITY BUILDING ON DISASTER RISK MANAGEMENT: HANDS-ON EXPERIENCES FROM THE CENTRAL AMERICA PROBABILISTIC RISK ASSESSMENT (CAPRA) PROGRAM	A. ZEBALLOS	Dec 06 (Tue)	15:20-15:40	Armatambo Room
OS-4-17	SEISMIC RESPONSE AND PERFORMANCE UPGRADING OF EXISTING MASONRY BELL TOWERS	G. MILANI	Dec 06 (Tue)	15:40-16:00	Armatambo Room

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-4-18	CASE STUDY: THE STATUS OF SOUTH AFRICAN INFRASTRUCTURE AND THE RESILIENCE OF ESSENTIAL FACILITIES.	T. SHIWILOWILO	Dec 06 (Tue)	14:00-14:20	Manchay Room
OS-4-19	BUILDING RESILIENT CITIES IN SOUTH AFRICA – CASE STUDIES FOR THE DEVELOPING WORLD OF STRATEGIES USED IN DURBAN AND CAPE TOWN	S. JAIN	Dec 06 (Tue)	14:20-14:40	Manchay Room
OS-4-20	ESTIMATION OF THE SEISMIC HAZARD AND THE IMPACTS FOR THE MAIN HUMAN SETTLEMENTS ALONG CONVERGENCE MARGINS PLATES IN SOUTH AMERICA AND CARIBBEAN	M. TRIVIÑO	Dec 06 (Tue)	14:40-15:00	Manchay Room
OS-4-21	SIMULATION MODEL AND PERFORMANCE PLANNING FOR A RECONSTRUCTION PROGRAM INFRASTRUCTURE AND ENVIRONMENT DAMAGED BY NATURAL DISASTERS BY PROCESSING BIG DATA	L. BECERRA	Dec 06 (Tue)	11:50-12:10	Manchay Room
OS-4-22	HUMAN EVACUATION AND SIMULATION VIA AGENT-BASED MODEL. A PERUVIAN CASE	S. GALLO	Dec 06 (Tue)	15:20-15:40	Manchay Room
OS-4-23	RESILIENT COMMUNITY, A PROCESS OF COLLECTIVE CONSTRUCTION	O. CHUQUISENGO	Dec 06 (Tue)	15:40-16:00	Manchay Room
OS-4-24	DISTRICT WISE MULTI-HAZARD ZONING OF BANGLADESH	M. AHMED	Dec 06 (Tue)	11:30-11:50	Manchay Room
OS-4-25	BACKGROUND AND IMPLEMENTATION OF URBAN RESILIENCY PROJECT IN BANGLADESH	M. AHMED	Dec 06 (Tue)	15:00-15:20	Manchay Room
OS-4-26	INCREASING URBAN RESILIENCE THROUGH INTEGRATED MODELING OF IMPACT IN LARGE-SCALE DISASTERS	E. MAS	Dec 06 (Tue)	12:10-12:30	Manchay Room
OS-4-27	SOCIAL ENGINEERING OF POLITICAL AND INSTITUTIONAL MANAGEMENT FOR DISASTER RISK MANAGEMENT AT THE SUB NATIONAL TERRITORY	M. MOLLO	Dec 06 (Tue)	11:30-11:50	Maranga Room
OS-4-28	EQUIPPING A TRAILER VAN VEHICLE TO BE A MOBILE EMERGENCY OPERATIONS CENTER IN A DISASTER SITUATION	G. GOMEZ	Dec 06 (Tue)	11:50-12:10	Maranga Room
OS-4-29	DISASTER RISK MANAGEMENT: CASE OF CALCA, CUSCO, PERU	O. LOZANO	Dec 06 (Tue)	12:10-12:30	Maranga Room
OS-4-30	THE ROLE OF UNIVERSITIES ON DISASTER RISK REDUCTION IN THE COMMUNITY: UPRM CASE STUDY	I. PAGAN	Dec 05 (Mon)	17:40-18:00	Manchay Room
OS-4-31	RISK REDUCTION IN VULNERABLE NEIGHBORHOODS LOCATED ON HILLSIDES OF INDEPENDENCIA DISTRICT, LIMA-PERU	J. SATO	Dec 05 (Mon)	18:00-18:20	Manchay Room
OS-4-32	DETECTION OF COLLAPSED BUILDINGS AND LANDSLIDES DUE TO THE 2016 KUMAMOTO EARTHQUAKE FROM LIDAR DATA	L. MOYA	Dec 05 (Mon)	18:20-18:40	Manchay Room
OS-4-33	PLANNING OF CITIES AFFECTED BY NATURAL PHENOMENA IN ICA REGION - PERU	R. BENDEZU	Dec 05 (Mon)	18:40-19:00	Manchay Room
OS-4-34	EVALUATION OF PARAMETER AVS30 FOR ESTIMATING SEISMIC AMPLIFICATION IN THE CITY OF LIMA, PERU	D. CALDERON	Dec 05 (Mon)	17:20-17:40	Manchay Room
OS-4-35	EL AGUSTINO HILLSIDES: MANAGING DISASTER RISKS	M. AREVALO	Dec 05 (Mon)	17:00-17:20	Armatambo Room

Theme 5: Protection of Essential Facilities

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-5-1	A NEW METHOD FOR VOLCANIC ERUPTION FORECASTING APPLIED WITH SUCCESS ON UBINAS VOLCANO	J. DEL CARPIO	Dec 05 (Mon)	16:00-16:20	Maranga Room
OS-5-2	MCDM METHODS FOR THE IDENTIFICATION OF INTERVENTION STRATEGIES FOR SEISMIC RETROFITTING OF SCHOOL BUILDINGS	A. ANELLI	Dec 05 (Mon)	16:20-16:40	Maranga Room
OS-5-3	DAMPING COEFFICIENT (BD) FOR SEISMICALLY ISOLATED STRUCTURES IN PERU	R. OVIEDO	Dec 05 (Mon)	16:40-17:00	Maranga Room
OS-5-4	PRIORITIZATION METHODOLOGY FOR SEISMIC RISK REDUCTION IN PUBLIC SCHOOLS. STUDY CASE: LIMA, PERU	S. SANTA CRUZ	Dec 05 (Mon)	17:00-17:20	Maranga Room
OS-5-5	PROBABILISTIC SEISMIC RISK ASSESSMENT IN SCHOOLS AND HOSPITALS IN LIMA CITY WITH CAPRA PLATFORM	S. SANTA CRUZ	Dec 05 (Mon)	18:00-18:20	Maranga Room
OS-5-6	CONTRIBUTIONS FOR THE IMPROVEMENT OF HOSPITAL INFRASTRUCTURE BASED ON HOSPITAL SAFETY INDEX: CASE STUDY PERU	D. CUBILLAS	Dec 05 (Mon)	17:40-18:00	Maranga Room
OS-5-7	A MODEL FOR MEASURING VULNERABILITY IN URBAN TRANSPORT NETWORKS IN INTERMEDIATE CITIES: THE CASE OF AYACUCHO	H. AZPUR	Dec 05 (Mon)	17:20-17:40	Maranga Room

Theme 6: Safe Buildings

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-6-1	AN ANALYSIS OF THE DYNAMICS OF SEISMICALLY ISOLATED STRUCTURES TAKING INTO ACCOUNT THE ROTATIONAL COMPONENTS OF SEISMIC EFFECTS	E. SIMBORT	Dec 05 (Mon)	16:00-16:20	Huallamarca Room
OS-6-2	APPLICATION OF SEISMIC ISOLATION IN THE RETROFIT OF HISTORICAL BUILDINGS. PRESERVATION OF CULTURAL HERITAGE IN AREQUIPA-PERU	E. SIMBORT	Dec 05 (Mon)	16:20-16:40	Huallamarca Room
OS-6-3	VISCOUS AND FRICTION DAMPERS FOR THE SEISMIC PROTECTION OF THE TALLEST BUILDING IN JAPAN	J. LOPEZ	Dec 05 (Mon)	16:40-17:00	Huallamarca Room
OS-6-4	SEISMIC EVALUATION OF MASONRY INFILLED PANELS UNDER NEAR-SOURCE PULSE-LIKE GROUND MOTIONS	H. MONIRI	Dec 05 (Mon)	17:00-17:20	Huallamarca Room
OS-5-5	PROBABILISTIC SEISMIC RISK ASSESSMENT IN SCHOOLS AND HOSPITALS IN LIMA CITY WITH CAPRA PLATFORM	S. SANTA CRUZ	Dec 05 (Mon)	18:00-18:20	Maranga Room
OS-5-6	CONTRIBUTIONS FOR THE IMPROVEMENT OF HOSPITAL INFRASTRUCTURE BASED ON HOSPITAL SAFETY INDEX: CASE STUDY PERU	D. CUBILLAS	Dec 05 (Mon)	17:40-18:00	Maranga Room
OS-5-7	A MODEL FOR MEASURING VULNERABILITY IN URBAN TRANSPORT NETWORKS IN INTERMEDIATE CITIES: THE CASE OF AYACUCHO	H. AZPUR	Dec 05 (Mon)	17:20-17:40	Maranga Room

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-6-1	AN ANALYSIS OF THE DYNAMICS OF SEISMICALLY ISOLATED STRUCTURES TAKING INTO ACCOUNT THE ROTATIONAL COMPONENTS OF SEISMIC EFFECTS	E. SIMBORT	Dec 05 (Mon)	16:00-16:20	Huallamarca Room
OS-6-2	APPLICATION OF SEISMIC ISOLATION IN THE RETROFIT OF HISTORICAL BUILDINGS. PRESERVATION OF CULTURAL HERITAGE IN AREQUIPA-PERU	E. SIMBORT	Dec 05 (Mon)	16:20-16:40	Huallamarca Room
OS-6-3	VISCOUS AND FRICTION DAMPERS FOR THE SEISMIC PROTECTION OF THE TALLEST BUILDING IN JAPAN	J. LOPEZ	Dec 05 (Mon)	16:40-17:00	Huallamarca Room
OS-6-4	SEISMIC EVALUATION OF MASONRY INFILLED PANELS UNDER NEAR-SOURCE PULSE-LIKE GROUND MOTIONS	H. MONIRI	Dec 05 (Mon)	17:00-17:20	Huallamarca Room
OS-6-5	PRE-SIZING CRITERIA FOR BUILDINGS WITH SEISMIC ISOLATION SYSTEMS IN PERU	R. SALINAS	Dec 05 (Mon)	17:20-17:40	Huallamarca Room
OS-6-6	SCENARIO OF SEISMIC SOURCE AND SOIL SHAKING FOR THE WESTERN EDGE OF THE CENTRAL REGION OF PERU	H. TAVERA	Dec 06 (Tue)	15:00-15:20	Huallamarca Room
OS-6-7	RAPID SEISMIC RISK ASSESSMENT OF STRUCTURAL COLLAPSE BASED ON OPERATIONAL MODAL ANALYSIS	D. REIS	Dec 05 (Mon)	17:40-18:00	Huallamarca Room
OS-6-8	CONTROL SYSTEM FOR A THREE-DEGREE-OF-FREEDOM SHAKING TABLE DURING SEISMIC SIMULATIONS TESTS	J. VELASQUEZ	Dec 05 (Mon)	18:00-18:20	Huallamarca Room
OS-6-9	SEISMIC ASSESSMENT OF THE COSTA VERDE CLIFFS IN LIMA	A. PRETELL	Dec 05 (Mon)	18:20-18:40	Huallamarca Room
OS-6-10	SEISMIC REHABILITATION WITH DISSIPATORS OF VISCOUS FLUID FOR AN ESSENTIAL BUILDING WITH SEISMIC HIGH VULNERABILITY	J. ANAMPA	Dec 06 (Tue)	11:30-11:50	Huallamarca Room
OS-6-11	ASSESSMENT OF THE LEVEL OF VULNERABILITY OF A STEEL BUILDING DUE TO EXTRAORDINARY EVENTS	R. RIVAS	Dec 06 (Tue)	11:50-12:10	Huallamarca Room
OS-6-12	DEVELOPMENT FRAGILITY CURVES FOR CONFINED MASONRY BUILDINGS OF LIMA CALIBRATED WITH CYCLIC TEST	H. LOVON	Dec 06 (Tue)	12:10-12:30	Huallamarca Room
OS-6-13	MODIFICACIÓN DE LA RESPUESTA SÍSMICA DE UN PUENTE MEDIANTE CONTROL PASIVO	G. PINTO	Dec 06 (Tue)	14:00-14:20	Huallamarca Room
OS-6-14	COMPARATIVE SEISMIC DESIGN BETWEEN A CONVENTIONAL SYSTEM AND A SEISMIC ISOLATION SYSTEM (LRB), FOR AN 8-STORY CLINIC IN TRUJILLO'S CITY	Y. JACOBO	Dec 06 (Tue)	15:00-15:20	Maranga Room
OS-6-15	THE TEMPLE OF MISKA – CUSCO: VERIFICATION OF THE POST-EARTHQUAKE DAMAGE AND A PROPOSAL OF RETROFITTING	R. MAMANI	Dec 06 (Tue)	14:40-15:00	Maranga Room
OS-6-16	SEISMIC AMPLIFICATION BY TWO-DIMENSIONAL DYNAMIC ANALYSIS IN THE ARCHAEOLOGICAL PARK OF SACSAYHUAMAN	J. ALVA	Dec 06 (Tue)	14:20-14:40	Huallamarca Room

ID	TITLE	PRESENTING AUTHOR	DAY	TIME	ROOM
OS-6-17	RETROFITTING OF GOVERNMENT BUILDINGS WITH VISCOUS DAMPING	M. BURGOS	Dec 06 (Tue)	14:40-15:00	Huallamarca Room
OS-6-18	EXPERIMENTAL IN-PLANE CYCLIC RESPONSE OF MASONRY WALLS IN LIMA, PERU	S. PARI	Dec 06 (Tue)	15:20-15:40	Huallamarca Room
OS-6-19	SEISMIC RESPONSE RECORDED BY THE MONITORING NETWORK OF BUILDINGS (REMOED) IN LIMA CITY	M. DIAZ	Dec 06 (Tue)	14:00-14:20	Maranga Room
OS-6-20	BUILDING DAMAGE DUE TO MANABI ECUADOR EARTHQUAKE AND THEIR EXPECTED BEHAVIOR BASED ON SIMPLIFY MODELS	C. ZAVALA	Dec 06 (Tue)	14:20-14:40	Maranga Room
OS-6-21	REAL TIME SEISMIC MONITORING CENTER – CEMOS OF THE JAPAN PERU CENTER FOR EARTHQUAKE ENGINEERING RESEARCH AND DISASTER MITIGATION-CISMID	M. ESTRADA	Dec 06 (Tue)	15:20-15:40	Maranga Room
OS-6-22	ARMY OF PERU AND THEIR PARTICIPATION IN DISASTER RISK MANAGEMENT SUPPORT	R. LAVADO	Dec 05 (Mon)	18:40-19:00	Huallamarca Room
OS-6-23	MILITARY EMERGENCY BRIGADE (BRIME)	R. DEVOTO	Dec 06 (Tue)	15:40-16:00	Huallamarca Room

ORAL SESSION PROGRAM

		SESSION I PARAISO ROOM	SESSION II PURUCHUCO ROOM	SESSION III MANCHAY ROOM
		PROTECTION OF PUBLIC LIFELINE SERVICES	DISASTER RISK AND CLIMATE CHANGE	BUSINESS CONTINUITY PLANNING & PLANNING OF RESILIENT CITIES
		Chairmen: A. DELGADO, J. LOPEZ	Chairmen: T. SANCHO, J. M. KUROIWA	Chairmen: A. KUMAR, A. BERGERON
Mon 5 Dec	16:00-16:20	OS-1-1 ENSURING WATER AND SEWAGE SYSTEM, POST EARTHQUAKE CASE IN LIMA AND CALLAO Author: J. VARGAS (PERU)	OS-2-1 LEVELS OF RISK AND VULNERABILITY ASSOCIATED WITH FLOODS AND CLIMATE CHANGE ADAPTATION IN BINATIONAL BASIN PUYANGO - TUMBES Author: B. GARCIA (PERU)	OS-3-1 SHOPPING MALL DISASTER ACCELERATES RISK QUESTIONNAIRE AND PROFESSIONAL EDUCATION FOR ENGINEERS Author: A. BERGERON (CANADA)
	16:20-16:40	OS-1-2 PROPOSAL FOR NOVEL ELECTRICAL SYSTEMS TO ENSURE THE ELECTRICITY SUPPLY IN HOSPITALS DURING DISASTERS: IN THE CASE OF EARTHQUAKES AND FLOODING Author: J. MIREZ (PERU)	OS-2-2 GROUND-BASED SYNTHETIC APERTURE RADAR (GB-SAR) FOR LANDSLIDE STUDIES AND MONITORING IN PERU Author: J. FLORENTINO (PERU)	OS-3-2 CRISIS MANAGEMENT CONTINGENCY PLAN IN CALLAO – PROPOSAL OF RESPONSE MEASURES THROUGH INTEGER LINEAR PROGRAMMING MODELS FOR THE DISTRIBUTION OF EMERGENCY KITS TO PROVIDE VICTIMS WITH HUMANITARIAN AID Author: X. RODRIGUEZ (PERU)
	16:40-17:00	OS-1-3 BASE ISOLATION AND SUPPLEMENTAL DAMPING SYSTEMS FOR EARTHQUAKE PROTECTION OF RC WATER STORAGE TANKS Author: E. MAMANI (PERU)	OS-2-3 HUAYCO'S EARLY WARNING SYSTEM Author: A. VALDEZ (PERU)	OS-3-3 ENHANCING CAPACITY BUILDING FOR DISASTER MANAGEMENT. Author: A. KUMAR (INDIA)
	17:00-17:20	OS-1-4 ANTENNAS ELEVATION SYSTEM, MOBILE, WITH ENERGY AUTONOMY, THAT ALLOWS THE IMMEDIATE REACTIVATION OF EMERGENCY RADIO–COMMUNICATIONS, IN COMMUNICATIONS COLLAPSE CASES Author: A. BANDA (PERU)	OS-2-4 HOLISTIC MODEL FOR DISASTER RISK ASSESSMENT AS A TOOL FOR CLIMATE CHANGE ADAPTATION Author: M. PEREZ (PERU)	OS-3-4 DEVELOPMENT OF AN INFORMATION SYSTEM FOR DISASTER RISK MANAGEMENT WITH A FOCUS PROCESS Author: R. VILLON (PERU)
	17:20-17:40	OS-1-10 GROUND IMPROVEMENT BY JET GROUTING FOR LIQUEFACTION HAZARD MITIGATION IN BRIDGE OVER QUILCA RIVER, AREQUIPA, PERU Author: S. ORTEGA (PERU)	OS-2-5 DYNAMICS OF ALUVIONAL FLOWS IN THE QUINCEMIL TOWN, SUB-BASIN OF ARAZA RIVER Author: J. CHAHUA (PERU)	OS-4-34 EVALUATION OF PARAMETER AVS30 FOR ESTIMATING SEISMIC AMPLIFICATION IN THE CITY OF LIMA, PERU Author: D. CALDERON (PERU)
	17:40-18:00	OS-1-6 INFRASTRUCTURE MANAGEMENT SYSTEM FOR SEISMIC RISK REDUCTION ON BRIDGES AND VIADUCTS OF LIMA CITY Author: J. OLARTE (PERU)	OS-2-6 FLOOD RISK MANAGEMENT: CURRENT PERSPECTIVE FLOOD RISK MANAGEMENT PLANS IN SPAIN Author: T. SANCHO (SPAIN)	OS-4-30 THE ROLE OF UNIVERSITIES ON DISASTER RISK REDUCTION IN THE COMMUNITY: UPRM CASE STUDY Author: I. PAGAN (PUERTO RICO)
	18:00-18:20	OS-1-7 RISKS IN BRIDGES, VIADUCTS AND TUNNELS BUILT IN ROAD CONCESSIONS IN PERU, URGENT RISK REDUCTION MEASURES Author: J. LOPEZ (USA)	OS-2-7 A FIELD-BASED RELATION TO ESTIMATE RAINFALL EROSIVITY: A CASE STUDY OF RIMAC RIVER BASIN Author: J. FERNANDEZ (PERU)	OS-4-3 RISK REDUCTION IN VULNERABLE NEIGHBOR HOODS LOCATED ON HILLSIDES OF INDEPENDENCIA DISTRICT, LIMA-PERU Author: J. SATO (PERU)
	18:20-18:40	OS-1-8 EARTHQUAKE DAMAGE AND REHABILITATION OF WATER AND SEWER SYSTEMS: EXPERIENCE OF 2007 ICA EARTHQUAKE Author: J. RUCOBA (PERU)	OS-2-8 RISK DISASTER AND CLIMATE CHANGE Author: J. SUAZO (PERU)	OS-4-32 DETECTION OF COLLAPSED BUILDINGS AND LANDSLIDES DUE TO THE 2016 KUMAM OTO EARTHQUAKE FROM LIDAR DATA Author: L. MOYA (JAPAN)
	18:40-19:00	OS-1-9 DISASTER RISK REDUCTION IN HYDROELECTRIC PLANTS Author: R. VILLANUEVA (PERU)	OS-2-9 INTEGRATION OF REMOTE SENSING INFORMATION AND GIS-BASED PLATFORMS TO SUPPORT DISASTER RISK MANAGEMENT Author: B. ADRIANO (JAPAN)	OS-4-33 PLANNING OF CITIES AFFECTED BY NATURAL PH ENOMENA IN ICA REGION - PERU Author: R. BENDEZU (PERU)

SESSION IV ARMATAMBO ROOM	SESSION V MARANGA ROOM	SESSION VI HUALLAMARCA ROOM
PLANNING OF RESILIENT CITIES	PROTECTION OF ESSENTIAL FACILITIES	SAFE BUILDINGS
Chairmen: M. NASTEV, F. BARRENECHEA	Chairmen: F. RIOS, S. SANTA CRUZ	Chairmen: A. PRETELL, H. MONIRI
OS-4-1 SOCIAL RISK REDUCTION ALONG THE PERUVIAN COASTAL CITIES Author: L. RUIZ (PERU)	OS-5-1 A NEW METHOD FOR VOLCANIC ERUPTION FORECASTING APPLIED WITH SUCCESS ON UBINAS VOLCANO Author: J. DEL CARPIO (PERU)	OS-6-1 AN ANALYSIS OF THE DYNAMICS OF SEISMICALLY ISOLATED STRUCTURES TAKING INTO ACCOUNT THE ROTATIONAL COMPONENTS OF SEISMIC EFFECTS Author: E. SIMBORT (PERU)"
OS-4-2 REDUCING THE RISK VOLCANIC OF AREQUIPA CITY Author: L. MACEDO (PERU)	OS-5-2 MCDM METHODS FOR THE IDENTIFICATION OF INTERVENTION STRATEGIES FOR SEISMIC RETROFITTING OF SCHOOL BUILDINGS Author: A. ANELLI (PERU)"	OS-6-2 APPLICATION OF SEISMIC ISOLATION IN THE RETROFIT OF HISTORICAL BUILDINGS. PRESERVATION OF CULTURAL HERITAGE IN AREQUIPA-PERU Author: E. SIMBORT (PERU)"
OS-4-3 STUDY OF A PRIORITY FOR MUNICIPALITIES MAP FOR DISASTER RISK MANAGEMENT (DRM) Author: F. BARRENECHEA (CHILE)	OS-5-3 DAMPING COEFFICIENT (BD) FOR SEISMICALLY ISOLATED STRUCTURES IN PERU Author: R. OVIEDO (PERU)"	OS-6-3 VISCOUS AND FRICTION DAMPERS FOR THE SEISMIC PROTECTION OF THE TALLEST BUILDING IN JAPAN Author: J. LOPEZ (JAPAN)"
OS-4-35 EL AGUSTINO HILLSIDES: MANAGING DISASTER RISKS Author: M. AREVALO (PERU)	OS-5-4 PRIORITIZATION METHODOLOGY FOR SEISMIC RISK REDUCTION IN PUBLIC SCHOOLS. STUDY CASE: LIMA, PERU Author: S. SANTA CRUZ (PERU)"	OS-6-4 SEISMIC EVALUATION OF MASONRY INFILLED PANELS UNDER NEAR-SOURCE PULSE-LIKE GROUND MOTIONS Author: H. MONIRI (SPAIN)"
OS-4-4 INTERACTIVE WEB-BASED APPLICATION FOR SEISMIC AND FLOOD RISK ASSESSMENT Author: M. NASTEV (CANADA)	OS-5-7 A MODEL FOR MEASURING VULNERABILITY IN URBAN TRANSPORT NETWORKS IN INTERMEDIATE CITIES: THE CASE OF AYACUCHO Author: H. AZPUR (PERU)"	OS-6-5 PRE-SIZING CRITERIA FOR BUILDINGS WITH SEISMIC ISOLATION SYSTEMS IN PERU Author: R. SALINAS (PERU)"
OS-4-5 CORPORATE SOCIAL RESPONSIBILITY FOR PREVENTION, MITIGATION AND RESILIENCE OF THE REGION INCREASED FROM ANY DISASTER Author: A. BODENHEM (PERU)	OS-5-6 CONTRIBUTIONS FOR THE IMPROVEMENT OF HOSPITAL INFRASTRUCTURE BASED ON HOSPITAL SAFETY INDEX: CASE STUDY PERU Author: D. CUBILLAS (PERU)"	OS-6-7 RAPID SEISMIC RISK ASSESSMENT OF STRUCTURAL COLLAPSE BASED ON OPERATIONAL MODAL ANALYSIS Author: D. REIS (BRAZIL)"
OS-4-6 DESING OF A DSS FOR THE MANAGEMENT OF PRE-DISASTER STAGES OF EARTHQUAKES IN BUCARAMANGA Author: D. MARTINEZ (COLOMBIA)	OS-5-5 PROBABILISTIC SEISMIC RISK ASSESSMENT IN SCHOOLS AND HOSPITALS IN LIMA CITY WITH CAPRA PLATFORM Author: S. SANTA CRUZ (PERU)"	OS-6-8 CONTROL SYSTEM FOR A THREE-DEGREE-OF-FREEDOM SHAKING TABLE DURING SEISMIC SIMULATIONS TESTS Author: J. VELASQUEZ (PERU)"
OS-4-7 THE SHORTLY-BEFORE SEISMIC ALARMS Author: R. PULGAR (PERU)		OS-6-9 SEISMIC ASSESSMENT OF THE COSTA VERDE CLIFFS IN LIMA Author: A. PRETELL (USA)"
OS-4-8 EVALUATION OF THE LOCAL SEISMIC RESPONSE IN THE URBAN CENTRAL AREA OF THE CITY OF HUARAZ Author: R. REYES (PERU)		OS-6-22 ARMY OF PERU AND THEIR PARTICIPATION IN DISASTER RISK MANAGEMENT SUPPORT Author: R. LAVADO (PERU)"

		SESSION VII PARAISO ROOM	SESSION VIII PURUCHUCO ROOM	SESSION IX MANCHAY ROOM
		PROTECTION OF PUBLIC LIFELINE SERVICES	DISASTER RISK AND CLIMATE CHANGE	BUSINESS CONTINUITY PLANNING & PLANNING OF RESILIENT CITIES
		Chairmen: F. ALFERINK, J. KUROIWA	Chairmen: A. MENON, E. GUADALUPE	Chairmen: M. AHMED, E. MAS
Tue 6 Dec	11:30-11:50	OS-1-12 CONSIDERATIONS ON DESIGN AND CHOISE OF MODERN PIPELINES FOR USE IN EARTHQUAKE PRONE AREAS Author: F. ALFERINK (NETHERLANDS)	OS-2-10 CREEPING DISASTERS DUE TO WATER TABLE RISE IN THE CENTRAL COAST OF PERU Author: J. M. KUROIWA (PERU)	OS-4-24 DISTRICT WISE MULTI-HAZARD ZONING OF BANGLADESH Author: M. AHMED (BANGLADESH)
	11:50-12:10	OS-1-5 PROPOSED DESIGN AND DEVELOPMENT OF A SYSTEM THAT INTEGRATE THE LOCAL RADIO STATIONS FOR EMERGENCIES AND DISASTERS, IN ORDER TO MEET THE ABSENCE OF A CENTRAL COMMUNICATION WITH A SINGLE EMERGENCY NUMBER TYPE 911, IN THE CITY OF LIMA Author: A. BANDA (PERU)	OS-2-11 REPAIR OF FLOOD DAMAGED ROAD INFRASTRUCTURE IN SOUTH AFRICA – A CRITICAL ANALYSIS Author: A. MENON (SOUTH AFRICA)	OS-4-21 SIMULATION MODEL AND PERFORMANCE PLANNING FOR A RECONSTRUCTION PROGRAM INFRASTRUCTURE AND ENVIRONMENT DAMAGED BY NATURAL DISASTERS BY PROCESSING BIG DATA Author: L. BECERRA (PERU)
	12:10-12:30	OS-1-11 DISASTER RISK REDUCTION TO ATTEND TO PERU'S MAXIMUM ELECTRICITY DEMAND IN THE EVENT OF A BREAK IN THE CAMISEA GAS PIPELINE Author: R. SANTILLAN (PERU)	OS-2-12 DIFFERENTIAL BEHAVIOR OF HUAICOS IN CHOSICA IN THE YEARS 1987, 2012 AND 2015, AND GENERAL ASPECTS OF RISK MANAGEMENT Author: E. GUADALUPE (PERU)	OS-4-26 INCREASING URBAN RESILIENCE THROUGH INTEGRATED MODELING OF IMPACT IN LARGE SCALE DISAS TERS Author: E. MAS (JAPAN)

		SESSION XIII PARAISO ROOM	SESSION XIV PURUCHUCO ROOM	SESSION XV MANCHAY ROOM
		DISASTER RISK AND CLIMATE CHANGE	DISASTER RISK AND CLIMATE CHANGE	PLANNING OF RESILIENT CITIES
		Chairmen: C. DE LA FUENTE, J. CABRERA	Chairmen: R. LOPEZ, E. MILLONES	Chairmen: T. TSHIWILOWILO, M. TRIVIÑO
Tue 6 Dec	14:00-14:20	OS-2-19 EVALUATION OF CONTROL WORKS FOR THE DEBRIS FLOW IN THE COLOCAYA GULLY UNDER CLIMATE CHANGE SCENARIOS Author: J. CABRERA (PERU)	OS-2-13 IN THE RIMAC RIVER VALLEY, THE DESERTIFICATION PROCESS CONSTITUTES A THREAT? Author: E. MILLONES (PERU)	OS-4-18 CASE STUDY: THE STATUS OF SOUTH AFRICAN INFRA STRUCTURE AND THE RESILIENCE OF ESSENTIAL FACILI TIES. Author: T. TSHIWILOWILO (SOUTH AFRICA)
	14:20-14:40	OS-2-20 REGIONAL INTEGRAL SOLUTIONS TO REVERSE THE PRESENT CRISIS OF POTABLE WATER Author: C. DE LA FUENTE (USA)	OS-2-14 MODELING FLOOD IN THE MIDDLE ZAMBEZI BASIN USING REMOTE SENSING AND HYDROLOGICAL MODELING TECHNIQUES Author: T. NHARO (ZIMBABWE)	OS-4-19 BUILDING RESILIENT CITIES IN SOUTH AFRICA – CASE STUDIES FOR THE DEVELOPING WORLD OF STRATEGIES USED IN DURBAN AND CAPE TOWN Author: S. JAIN (SOUTH AFRICA)
	15:00-15:20	OS-2-21 GEOHAZARD MAPS OF PROCESS TRIGGERED BY EARTHQUAKES Author: G. DELGADO (PERU)	OS-2-15 ANALYSIS OF THE POTENTIAL OF STRUCTURE-FROM-MOTION TO GENERATE SPATIAL INFORMATION IN DEVELOPING COUNTRIES Author: M. ASTORAYME (PERU)	OS-4-20 ESTIMATION OF THE SEISMIC HAZARD AND THE IM PACTS FOR THE MAIN HUMAN SETTLEMENTS ALONG CONVE RGENCE MARGINS PLATES IN SOUTH AMERICA AND CARIBBEAN Author: M. TRIVIÑO (COLOMBIA)
	14:20-14:40	OS-2-22 ACTIVE FAULT STUDIES FOR EARTHQUAKES DISASTER REDUCTION Author: C. BENAVENTE (PERU)	OS-2-16 DROUGHT FORECASTING WITH ARTIFICIAL NEURAL NETWORKS AND GENETIC ALGORITHMS USING REMOTE SENSING PRECIPITATION Author: I. AYALA (PERU)	OS-4-25 BACKGROUND AND IMPLEMENTATION OF URBAN RESILIENCY PROJECT IN BANGLADESH Author: M. AHMED (BANGLADESH)
	15:00-15:20	OS-2-23 DYNAMIC, EVOLUTION AND MULTI-METHOD MONITORING OF SIGUAS LANDSLIDE, AREQUIPA, PERU Author: P. VALDERRAMA (PERU)	OS-2-17 MCA APPLICATION IN THE PLANNING FOR FLOOD MITIGATION- DOWNSTREAM CHILLON RIVER Author: J. CELMI (PERU)	OS-4-22 HUMAN EVACUATION AND SIMULATION VIA AGENT-BASED MODEL. A PERUVIAN CASE Author: S. GALLO (PERU)
	14:20-14:40	OS-2-24 HEAVY RAINS ON THE WESTERN SLOPE OF THE PERUVIAN ANDES ASSOCIATED WITH SYNOPTIC-SCALE CIRCULATIONS: MARCH 22ND AND 23RD, 2015 Author: A. CHANCAFE (PERU)	OS-2-18 STRUCTURAL VULNERABILITY TO NATURAL HAZARDS IN PUERTO RICO Author: R. LOPEZ (PUERTO RICO)	OS-4-23 RESILIENT COMMUNITY, A PROCESS OF COLLECTIVE CONSTRUCTION Author: O. CHUQUISENGO (PERU)

SESSION X ARMATAMBO ROOM	SESSION XI MARANGA ROOM	SESSION XII HUALLAMARCA ROOM
PLANNING OF RESILIENT CITIES	PROTECTION OF ESSENTIAL FACILITIES	SAFE BUILDINGS
Chairmen: A. LOPEZ, L. ROBLEDO	Chairmen: M. MOLLO, M. ESTRADA	Chairmen: H. SCALETTI, R. RIVAS
OS-4-9 DISASTER MANAGEMENT SIMULATION LAB: A TOOL FOR DISASTER PREPARADENESS AND EMERGENCY RESPONSE AT THE CHILEAN NATIONAL EMERGENCY OFFICE Author: L. ROBLEDO (CHILE)	OS-4-27 SOCIAL ENGINEERING OF POLITICAL AND INSTITUTIONAL MANAGEMENT FOR DISASTER RISK MANAGEMENT AT THE SUB NATIONAL TERRITORY Author: M. MOLLO (PERU)	OS-6-10 SEISMIC REHABILITATION WITH DISSIPATORS OF VISCOUS FLUID FOR AN ESSENTIAL BUILDING WITH SEISMIC HIGH VULNERABILITY Author: J. ANAMPA (PERU)
OS-4-10 ENERGY APPROACH IN ITALIAN RESILIENT CITIES. CASE STUDY Author: A. LOPEZ (ITALY)	OS-4-28 EQUIPPING A TRAILER VAN VEHICLE TO BE A MOBILE EMERGENCY OPERATIONS CENTER IN A DISASTER SITUATION Author: G. GOMEZ (PERU)	OS-6-11 ASSESSMENT OF THE LEVEL OF VULNERABILITY OF A STEEL BUILDING DUE TO EXTRAORDINARY EVENTS Author: R. RIVAS (VENEZUELA)
OS-4-11 PHYSICAL AND SOCIAL VULNERABILITY BY THE GIANT TSUNAMI OF 1746 IN THE SOUTHERN SECTOR OF CALLAO, PERU Author: V. CUISANO (CHILE)	OS-4-29 DISASTER RISK MANAGEMENT: CASE OF CALCA, CUSCO, PERU Author: O. LOZANO (PERU)	OS-6-12 DEVELOPMENT FRAGILITY CURVES FOR CONFINED MASONRY BUILDINGS OF LIMA CALIBRATED WITH CYCLIC TEST Author: H. LOVON (PERU)

SESSION XVI ARMATAMBO ROOM	SESSION XVII MARANGA ROOM	SESSION XVIII HUALLAMARCA ROOM
PLANNING OF RESILIENT CITIES	SAFE BUILDINGS	SAFE BUILDINGS
Chairmen: R. KABIR, G. MILANI	Chairmen: C. ZAVALA, M. DIAZ	Chairmen: H. TAVERA, J. ALVA
OS-4-12 RISK MANAGEMENT IN TERRITORIAL PLANNING, CASE OF GALERAS VOLCANO, COLOMBIA Author: O. MESIAS (VENEZUELA)	OS-6-19 SEISMIC RESPONSE RECORDED BY THE MONITORING NETWORK OF BUILDINGS (REMOED) IN LIMA CITY Author: M. DIAZ (PERU)	OS-6-13 MODIFICACIÓN DE LA RESPUESTA SÍSMICA DE UN PUENTE MEDIANTE CONTROL PASIVO Author: G. PINTO (PERU)
OS-4-13 ADAPTATION RESPONSES OF A COASTAL CITY IN BANGLADESH DURING CYCLONE GENERATED STORM SURGE Author: R. KABIR (BANGLADESH)	OS-6-20 BUILDING DAMAGE DUE TO MANABI ECUADOR EARTHQUAKE AND THEIR EXPECTED BEHAVIOR BASED ON SIMPLIFY MODELS Author: C. ZAVALA (PERU)	OS-6-16 SEISMIC AMPLIFICATION BY TWO-DIMENSIONAL DYNAMIC ANALYSIS IN THE ARCHAEOLOGICAL PARK OF SACSAYHUAMAN Author: J. ALVA (PERU)
OS-4-14 TSUNAMI INUNDATION MAPS FOR RISK MANAGEMENT AND MITIGATION IN THE PERUVIAN COAST Author: E. ORTEGA (PERU)	OS-6-15 THE TEMPLE OF MISKA – CUSCO: VERIFICATION OF THE POST-EARTHQUAKE DAMAGE AND A PROPOSAL OF RETROFITTING Author: R. MAMANI (PERU)	OS-6-17 RETROFITTING OF GOVERNMENT BUILDINGS WITH VISCOUS DAMPING Author: M. BURGOS (PERU)
OS-4-15 AN INNOVATIVE METHODOLOGY FOR THE SEISMIC RISK MITIGATION ON LARGE TERRITORIAL SCALE Author: A. ANELLI (PERU)	OS-6-14 COMPARATIVE SEISMIC DESIGN BETWEEN A CONVENTIONAL SYSTEM AND A SEISMIC ISOLATION SYSTEM (LRB), FOR AN 8-STORY CLINIC IN TRUJILLO'S CITY Author: Y. JACOBO (PERU)	OS-6-6 SCENARIO OF SEISMIC SOURCE AND SOIL SHAKING FOR THE WESTERN EDGE OF THE CENTRAL REGION OF PERU Author: H. TAVERA (PERU)
OS-4-16 CAPACITY BUILDING ON DISASTER RISK MANAGEMENT: HANDS-ON EXPERIENCES FROM THE CENTRAL AMERICA PROBABILISTIC RISK ASSESSMENT (CAPRA) PROGRAM Author: A. ZEBALLOS (USA)	OS-6-21 REAL TIME SEISMIC MONITORING CENTER – CEMOS OF THE JAPAN PERU CENTER FOR EARTHQUAKE ENGINEERING RESEARCH AND DISASTER MITIGATION-CISMID Author: M. ESTRADA (PERU)	OS-6-18 EXPERIMENTAL IN-PLANE CYCLIC RESPONSE OF MASONRY WALLS IN LIMA, PERU Author: S. PARI (PERU)
OS-4-17 SEISMIC RESPONSE AND PERFORMANCE UPGRADING OF EXISTING MASONRY BELL TOWERS Author: G. MILANI (ITALY)		OS-6-23 MILITARY EMERGENCY BRIGADE (BRIME) Author: R. DEVOTO (PERU)

POSTER SESSION LIST

PROTECTION OF PUBLIC LIFELINE SERVICES	
PS-1-1	TECHNO-ECONOMIC ASSESSMENT FOR CO-PRODUCING BIOGAS AND BIO-HYDROGEN FROM CORNSTOVER AS GREEN ENERGY PROVISION Author: M. MANYUCHI (ZIMBABWE)
DISASTER RISK AND CLIMATE CHANGE	
PS-2-1	PLANNING TOWARDS A RESILIENT CITY HOLISTIC APPLIED TO METROPOLITAN TRUJILLO Author: J. BUCHELLI (PERU)
PS-2-2	SEISMIC VULNERABILITY OF HOSPITALS EMBLEMATIC TRUJILLO CITY BEFORE THE SEVERE EARTHQUAKE OCCURRENCE Author: J. BUCHELLI (PERU)
PS-2-3	RISK DISASTER IN SAN MARTIN REGION: GREAT CHALLENGES FOR THE SUSTAINABLE DEVELOPMENT Author: J. MEDINA (PERU)
PS-2-4	CHANNELING AND RIVERSIDE DEFENCES IN THE LACRAMARCA RIVER, SWAMP SECTOR OF VILLA MARIA - SANTA PROVINCE - ANCASH - VULNERANILITY AND RISK REDUCTION Author: M. MERMOZA (PERU)
PS-2-5	MANAGING WILDFIRE RISK ACROSS THE AUSTRALIAN LANDSCAPE USING REMOTE SENSING Author: L. WALLACE (AUSTRALIA)
PS-2-6	EXTREME EVENTS DUE TO GLACIER RETREAT IN THE HUAYTAPALLANA GLACIER, RESEARCH PROGRESS: DAM RUPTURE SCENARIO Author: J. CHAHUA (PERU)
PS-2-7	DEBRIS FLOW MITIGATION WITH FLEXIBLE RING NET BARRIERS – CHOSICA CASE STUDY Author: C. OVIEDO (PERU)
PS-2-8	INTER-SEISMIC COUPLING IN THE CENTRAL REGION OF PERU INFERRED FROM GPS DATA Author: J. VILLEGAS (PERU)
PS-2-9	POPULATION PERCEPTION EVALUATION OF IMPLEMENTATION OF TSUNAMI MITIGATION IN CONSTITUCION, MAULE REGION Author: Y. LUENGO (CHILE)
PS-2-10	SEISMIC PERFORMANCE OF HIGH WATER TANKS WITH FRAME TYPE SUPPORT IN ICA Author: L. NUÑEZ (PERU)
PS-2-11	THE ONTOLOGY OF RISK IN THE EDUCATION SYSTEMS OF CIVIL ENGINEERING IN LATIN AMERICA Author: R. RIVAS (VENEZUELA)
PS-2-12	MONITORING DRONICA FOR EALY WARNING IN AREAS OF HUAYCOS AND OIL SPILLS Author: E. CASTRO (PERU)
PS-2-13	ACTION PLAN FOR EMERGENCIES IN THE OPERATION AND MAINTENANCE OF IRRIGATION PROJECTS Author: S. ASALDE (PERU)
PS-2-14	SOME ASPECTS OF SCIENCE, TECHNOLOGY AND ENGINEERING IN THE ANCIENT PERU, IN THE PROTECTION OF PUBLIC LIFELINE SYSTEMS AND PLANNING OF RESILIENT CITIES Author: L. VELAZCO (PERU)
PS-2-15	CAMBIO CLIMÁTICO E IMPLICANCIAS EN EL MOVIMIENTO EN MASA EN LA ZONA NOR-ESTE DE LA CIUDAD DE ABANCAY 2013-2016 Author: L. GUANUCHI (PERU)
PS-2-16	STUDY OF VIBRATIONS IN BUILDINGS ADJACENT TO THE QUARRY ATOCONGO – POPULATED AREA VIRGEN DE LOURDES- VILLA MARIA DEL TRIUNFO - LIMA Author: V. PEÑA (PERU)
PLANNING OF RESILIENT CITIES	
PS-4-1	RESILIENT URBAN COMMUNITIES, A PROPOSAL FOR THE METROPOLITAN AREA IN VERACRUZ, MEXICO Author: L. SANDOVAL (MEXICO)
PS-4-2	TERRITORIAL SUSTAINABLE MANAGEMENT OF PERU 2050 Author: M. MORALES (PERU)
PS-4-3	LUDIC EDUCATIONAL ACTIVITIES THAT TEACH ABOUT THE FLOODING DISASTERS RISK IN MONTERÍA, CORDOBA, COLOMBIA. Author: C. HERRERA (PERU)
PS-4-4	PROPOSAL TO IMPLEMENT NATURAL WATER RESERVES TO BE STOCKED IN TIMES OF FLOODING AND ARE USEFUL IN TIMES OF DROUGHT IN CÓRDOBA, COLOMBIA Author: L. DIAZ (COLOMBIA)
PS-4-5	DETERMINATION OF HAZARD FLOOD MAPS USING THE 2D KANAKO MODEL Author: F. ESCUSA (PERU)
PS-4-6	DIGITAL DESIGN AND FABRICATION OF TEMPORARY AND EMERGENCY SHELTER, OF RAPID AND EQUITABLE DISTRIBUTION AFTER NATURAL SEISMIC CATASTROPHE Author: J. BARRANTES (PERU)

PS-4-7	PROGRESS IN DISASTER RISK REDUCTION IN AREQUIPA CONO NORTE, SOUTHERN PERU Author: H. NUÑEZ (PERU)
PS-4-8	NUMERICAL SIMULATION OF DEPOSITS FLOWS AND REDUCTION OF DISASTER RISK BY HYDRAULIC INFRASTRUCTURE IN THE RiMAC RIVER -CHOSICA AREA Author: C. HUAREZ (PERU)
PS-4-9	CHANGING PROPERTIES OF DAILY PRECIPITATION CONCENTRATION IN THE MANTARO RIVER BASIN- CENTRAL ANDES OF PERU Author: R. ZUBIETA (PERU)
PS-4-10	NONLINEAR ANALYSIS OF CONCRETE HEXAGONAL FREE FORM SHELL STRUCTURES Author: M. CAYCEDO (BRAZIL)
PS-4-11	ENTITLING OF BRACES AS STRUCTURAL ELEMENT OF BUILDINGS Author: L. NITUNGA (KENYA)
PS-4-12	FORM UPAO 2014: FOR EVALUATION OF THE SEISMIC VULNERABILITY IN REINFORCED CONCRETE BUILDINGS, EXPERIENCES IN PERU AND ECUADOR AFTER EARTQHAUKE OF APRIL 16 OF 2016 Author: L. QUIROZ (PERU)
PROTECTION OF ESSENTIAL FACILITIES	
PS-5-1	STUDY OF TRAINING OFFER AND LABOR DEMAND FOR OPERATIONAL, TECHNICAL AND PROFESSIONAL STAFF IN DISASTER RISK MANAGEMENT AND CLIMATE CHANGE Author: V. ALVARADO (PERU)
PS-5-2	INFLUENCE OF MATERIAL TYPE IN DYNAMIC BEHAVIOR OF SOIL DAMS Author: J. CELMI (PERU)
SAFE BUILDINGS	
PS-6-1	EVALUATION OF THE CHANGE OF IRRIGATION SYSTEM AS A MEASURE OF MITIGATION OF THE EFFECTS OF CLIMATE CHANGE ON THE OCCURRENCE OF AGRICULTURAL DROUGHT IN SOUTHERN PERU Author: J. CABRERA (PERU)
PS-6-2	COMPUTATIONAL MECHANICS APPLIED TO THE SIMULATION OF RESILIENT CITIES COMPLEX NETWORKS BASED ON THE SCALE ALLOMETRIC, SUSTAINABILITY AND RISK REDUCTION Author: C. CASTRO (PERU)
PS-6-3	COMPARATIVE STUDY OF URBAN SEARCH AND RESCUE NATIONAL ACCREDITATION PROCESS IN THE AMERICAS' REGION Author: J. TERRONES (PERU)
PS-6-4	SEVERE SEISMIC DAMAGES DUE TO CONSTRUCTIVE DEFICIENCIES Author: E. ZARATE (PERU)
PS-6-5	CONTRIBUTIONS OF THE PIURA RISK MANAGEMENT GROUP (GGR) IN THE DISASTER RISK REDUCTION IN PERU Author: J. CONTRERAS (PERU)
PS-6-6	HAZARDS, VULNERABILITY AND RISK MAPS, LAND USE PLAN DISASTER, PROJECT AND MITIGATION MEASURES OF THE COSTA VERDE Author: C. VENTURA (PERU)

MEMO

ORAL SESSION ABSTRACTS

OS-1-1: **ENSURING WATER AND SEWAGE SYSTEM, POST-EARTHQUAKE CASE IN LIMA AND CALLAO**

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Abstract

Disasters frequency and severity caused by natural hazards has increased in the last 20 years, among other reasons they are attributable to climate change, increased economic, social and urban vulnerability. In particular, Earthquakes from 1582 to 2007 in Peru, had registered 47 major earthquakes (6,0 to 8,0 MM magnitude), which 70 % ones occurred along Lima and Ica regions (Silgado, 1978; Bernal and Tavera, 2002; INDECI, 2004; USGS, 2014).

According to SUNASS (2013), SEDAPAL (Lima and Callao Potable Water and Sewage Service), company in charge to supply water and lead sewage systems to Lima and Callao, the potable water coverage is 91,0%, in the case of drainage system is 84,4%. The PNUMA (United Nations Environment Programme, 2005) reports that 70 % of the primary network pipes and 29% of the secondary ones are older than 30 years old. On the other hands, SEDAPAL (2014) states that potential earthquakes exposure are: (i) by 24,4 % to primary network pipelines, (ii) by 54,5 % to secondary network pipelines and (iii) by 9,6% to potable water treatment plants.

After an earthquake, water supply service can contaminate or temporarily cut off, current SEDAPAL service is nearly 20,0 m3/s. This research tackles about strategies to use temporarily alternative suppliers such as networking water trucks, water wells, alternative large-scale treatment units, mobile short and medium-scale treatment units, home purification techniques among other ones. Complementary other issue relates such as developing sanitary, hygiene, healthy and quality practices to be applied by people casualties are proposes.

Results shown current supply water service cannot be substituted by current alternative suppliers. It proposes short, medium and long term strategies such as developing suppliers, optimize and modernize current water service supply, etc. Ensuring this supply service is vital to support emergency and recovering activities to beaten communities.

Keywords: water and sewages systems, earthquake, supply service.

OS-1-2: **PROPOSAL FOR NOVEL ELECTRICAL SYSTEMS TO ENSURE THE ELECTRICITY SUPPLY IN HOSPITALS DURING DISASTERS: IN THE CASE OF EARTHQUAKES AND FLOODING**

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Abstract

Here we propose new configurations of electrical systems, which can be implemented in existing or new hospitals and also be used in hospital extension areas or open areas that would be used as field hospitals to attend to the population. The proposed electrical systems are based on the use of both conventional sources (for example, generator sets that are already widely used in hospitals) and non-conventional sources, such as renewable technologies: photovoltaic solar energy, fuel cells and/or others that could easily be connected and disconnected to/from the electricity system reliably and simply, with few instructions required, since it is proposed to distribute the electricity in continuous current. Continuous current distribution has the advantage of making better use of the sectional/area conductor; the difference in potential is the only requisite for power transmission, so this means that a DC bus can be implemented to meet the needs of the moment, without worrying about synchronization among sources of power; besides which, in the event of short circuit, it is easier to control than alternate current systems. These new topologies of hospital electricity systems have been conceived to provide high flexibility, scalability, redundancy, and adaptation to a post-disaster scenario. The disaster scenario addressed is that of an earthquake, where hospital infrastructure may be partially or completely destroyed. The article shows and analyzes information referring to former and present hospital electricity system designs, and includes suggestions for the implementation of safe hospitals, based on which, electricity schemes are presented with an explanation of their improvement over the present designs. The new designs presented have been divided into different cases to enhance the explanation, and also because they can be implemented based on the particular complexity and need of each hospital or healthcare facility and local or national situation. We hope that the article will be a contribution to the design of electricity systems in hospitals, because it is important to ensure the quantity and quality of the electricity supply under normal working conditions in the hospital, and this will become one of the basic factors for hospital services to be able to continue during and following a disaster, with the greatest possible autonomy: so much depends on the lighting, the biomedical equipment, machinery and equipment that have to process and keep available the materials, instruments and supplies that the health personnel require to attend to the patients.

Keywords: electrical system, low tension, continuous current, renewable energy, reliability.

OS-1-3: **BASE ISOLATION AND SUPPLEMENTAL DAMPING SYSTEMS FOR EARTHQUAKE PROTECTION OF RC WATER STORAGE TANKS**

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Abstract

Circular cylindrical reinforced concrete (RC) storage tanks play a fundamental role in the water supply system. They are usually used to store water. Hence, damage to water storage tanks may cause serious direct and indirect impacts. In highly seismic countries such as Peru, it is very important for these structures to remain operative after a severe seismic event. This paper shows the effectiveness of passive hybrid control system (base isolation and supplemental damping systems) for the earthquake protection of circular cylindrical RC water storage tanks under bi-directional horizontal earthquake ground motions. A viscous fluid damper (VFD) was used as a passive supplemental energy dissipation device in association with friction pendulum system (FPS) to form a passive hybrid control system. For the seismic analysis, tanks were considered to have a linear elastic behavior, the tank-water interaction was represented by an equivalent mechanical model, and the inelastic non-linear behavior of the isolation system was represented by a bi-axial hysteretic restoring force model. For this investigation, the following parameters of FPS base-isolated RC water storage tanks were considered: the water-height/tank-inner-radius ratio (H/R), the tank-wall-thickness/tank-inner-radius ratio (e/R), the target vibration period of the isolation system (Tb), and the friction coefficient of the isolation system (μb). The effects of non-linear viscous damping of the VFD on the seismic response of FPS base-isolated RC water storage tanks were investigated by taking different values of velocity exponent of the damper (λd). Further, the effects of a variation in damping ratio of the damper (ξd) on the seismic response of FPS base-isolated RC water storage tanks were also investigated. Twenty-one pairs of selected and scaled ground motions were used in time-history analysis. The effects of study parameters on seismic response of FPS base-isolated RC water storage tanks with and without supplemental damping system for a spectrum compatible ground motions corresponding to the design earthquake for the most severe earthquake zone according to a proposal for Peruvian standards for earthquake-resistant design were studied. The seismic responses of the tanks with passive hybrid system was compared with the corresponding seismic responses of the tanks with FPS isolation system, as well as with the tanks with base-fixed. The results of the investigation show that the addition of supplemental damping in the form of a viscous fluid damper significantly reduces the earthquake response of FPS base-isolated RC water storage tanks. The non-linear viscous damping was found to be more effective in controlling the lateral displacement of the tank's base relative to the ground.

Keywords: friction pendulum system, viscous fluid damper, RC water storage tanks, time-history analysis.

OS-1-4: ANTENNAS ELEVATION SYSTEM, MOBILE, WITH ENERGY AUTONOMY, THAT ALLOWS THE IMMEDIATE REACTIVATION OF EMERGENCY RADIO–COMMUNICATIONS, IN COMMUNICATIONS COLLAPSE CASES

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Abstract

This article proposes a low-cost, low-tech portable antenna lift system that will automatically restore the UHF / VHF radiofrequency signal from collapsed antenna towers due to a disaster. This system will allow the immediate reactivation of the link between emergency radio stations affected by the collapse of their communications due to loss of signal from its antenna. Communications situations collapses in disasters, like the earthquake in Pisco-Peru, 2007, 2004 Sumatra tsunami, Hurricane Katrina, etc., were analyzed, concluding that the authorities are unable to organize an effective response during the first 72 hours in the aftermath of the impact. This is due to the lack of timely and accurate information about what happened, limiting organize their human and material resources to provide relief operations for victims and survivors. The response of the emergency services and first responders is critical during the first few hours, which are crucial from the point of view of victims survival. The data were limited or no information received and transmitted in this period, is mainly due to the collapse of different communications systems and physical inability to restore them immediately. The most important thing is to recover the elements and collapsed structures, towers and antennas as wireless mechanisms of signal transmitter / receiver to reset broadcasting signal. It has been determined that metal towers, where antennas are installed, are usually installed in tall buildings using towers up to 50 meters without significant loss of signal. But this characteristic makes them extremely sensitive to collapse during events that cause disasters.

The proposed system can raise the antennas at heights in excess of 18-story buildings, allowing the exchange of radio frequency signals directly and without interference. For this, we have considered the development of different elements, such as balloons, drones, advertising balloons, etc., adjusting them properly conditioned elements and technology to: instant deployment, reset communications signal and other aspects of disaster response support. It can easily be installed in areas close to Radio Communications Centrals and is automatically activated after the collapse of the antenna or tower. The system is aimed at collapse of communications generated by disasters, but also can be used in other cases as maintenance, test signals, etc., which need raise an antenna to establish the link from a particular location. So the same procedure can be used for temporary signal replacement of relay stations towers, cellular towers, microwave towers, etc. Being a lightweight, portable and easily transportable system allows installation and operation anywhere inaccessible.

Keywords: disaster communications breakdown, antennas installation, antenna towers replacement.

OS-1-6: INFRASTRUCTURE MANAGEMENT SYSTEM FOR SEISMIC RISK REDUCTION ON BRIDGES AND VIADUCTS OF LIMA CITY

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Abstract

The purpose of this research is to draw up an infrastructure management system for seismic risk reduction on bridges and elevated viaducts in the city of Lima. To this end, the seismic hazard and categorization are studied where the bridges are located, the bridges are georeferenced according to their soil type, a methodology will be proposed to estimate structural vulnerability with qualitative-quantitative methods, and a proposal will be made for a simplified performance-based model. Lastly, the seismic risk is estimated at the first level of evaluation by means of technical-visual inspections of 62 bridges and viaducts in the city of Lima and Callao.

The results, presented in a geographic information system (GIS), show the structural safety levels of each of the bridges evaluated. The conclusion is that 29.1% of the evaluated bridges are in an Adequate or Good condition; 24.2% of the evaluated bridges are in a Fair condition; and 46.7% of the bridges are in a Poor or Critical condition.

The present research has identified the problems found in each element of the bridges, so the possibility now exists to create solutions for these problems. The solutions need to focus on the bridges classified as being in a Poor, Very Poor, or Critical condition is this study. In the case of the bridges classified as Very Poor and Critical, the immediate intervention of the competent authorities is recommended in order that work may begin on repairs and renovation.

Keywords: risk and disaster prevention, information technology and infrastructure management systems.

OS-1-7: **RISKS IN BRIDGES, VIADUCTS AND TUNNELS BUILT IN ROAD CONCESSIONS IN PERU: URGENT RISK REDUCTION MEASURES**

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Abstract

Over the past few years, Peru has been carrying out a costly road concession program where the concession holder has been responsible for the design and construction of the works and, in several cases, the supervision is also paid for by the same concession holder.

Project execution with the design-construction system has had good results in countries such as the United States, but it has been a different story in Peru. In Peru, when this system has been used for bridges, the constructions have turned out to be less safe, and highly vulnerable to the effects of severe natural phenomena such as El Niño or large magnitude earthquakes.

As an example of this, we have the case of the large number of bridges that collapsed in northern Peru as a result of the El Niño in 1983 and 1998. In such cases, the calls to bid were for a lump sum using the design-construction system, with the result that in most cases the bridges were built with insufficient lengths and foundation types. This is why they collapsed in the unusually high volumes of water during the El Niño phenomenon.

The situation has recently become worse with the road concessions, which, in most cases, when construction works are being designed, priority is given to the concession holder's earnings rather than to the safety and durability of the construction works. This situation has become even more critical when projects are designed by foreigners who lack the knowledge or experience in highly seismic areas and do not have the legal permits to exercise the profession in Peru. In the case of the bridges, viaducts, and tunnels currently under construction in Lima, the situation is critical: appropriate design regulations are not being used, different design criteria and regulations are applied in a single project, and – besides being irrational, this is dangerous for the population. For example, for the viaducts and tunnels, different regulations have been combined: Peruvian regulation E030 on earthquake-resistant building design, with the design procedures of the Eurocodes and Spanish regulations.

In the case of Lima's Metro Line 2, the Peruvian Association of Engineers (CIP) has given a statement pointing out deficiencies in the earthquake-resistant design and the danger for the population; nevertheless, the Minister of Transport and representatives of the Ministry of Housing of the last government have expressed their disagreement with CIP's statement, and the irregularity continues to exist.

In view of this situation, in this paper we present the structural capacity evaluation for specific road projects under way in Lima and the national highway system, and we point out the deficiencies and make recommendations for urgent actions that need to be taken for risk reduction.

OS-1-8: **EARTHQUAKE DAMAGE AND REHABILITATION OF WATER AND SEWER SYSTEMS: EXPERIENCE OF 2007 ICA EARTHQUAKE**

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Abstract

The 2007 Peru-Ica Region earthquake, Mw 8.0, affected a great part of Ica Region, Peru. The damages due to the earthquake on different components of water and sewer system at Ica, Pisco and Chincha cities were studied.

The damage information observed in the water and sewer systems in recent earthquakes such as 2009 New Zealand, 2010 Chile, 2011 Tohoku-Japan and 2016 Ecuador were also studied.

SEDAPAL is the Water and Sewer Company at Lima Metropolitan area. SEDAPAL provides the services for more than 9 million persons that live in this city. After the occurrence of 2007 Ica earthquake, SEDAPAL sent technical personnel, tools, equipment and materials to support and rehabilitate the water and sewer systems at Pisco, Chincha and Ica cities among others. The severe damages at Pisco city are explained. The water and sewer system was out of order and damaged due to soil characteristic such as saturated sand which caused high seismic intensities and partial soil liquefaction in some places.

This paper describes SEDAPAL experience in the rehabilitation of the water and sewer system damaged by the earthquake Ica 2007, in addition to other experiences, the existing legal framework in the country and the Disaster Risk Management Fund of the regulatory office. It served to apply it in the development of Disaster Risk Management Plan due to earthquakes and tsunamis whose review can contribute as a model in the preparation for other cities, reducing the vulnerability of the water and sewer system.

Keywords: water, sewer, Ica, Peru, disaster risk management.

OS-1-9: **DISASTER RISK REDUCTION IN HYDROELECTRIC PLANTS**

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Abstract

We know that Peru has great hydroelectric potential of about 60,000 MW of which we are only using about 7 to 8 %; as demand steadily increases and if the national economy is reactivated, there will be significant growth in electricity consumption.

New power plants will have to be implemented to meet this situation.

In fact, preference should be given to the clean and renewable energy such as hydroelectric plants, but always with the support of natural gas thermal plants and smaller-scale sources of non-conventional renewable energies, as the Hydraulic have the serious drawback of the irregularity of hydrological cycles so we should be prepared for possible droughts.

Just to belittle these drawbacks of drought, should regularize the regime of rivers by implementing cascading dams throughout its course, to collect the rainwater for one or two years; this implementation also serve to control the overflowing rivers and the collapse of its slopes by heavy rainfall that occur every year causing serious material damage and sometimes loss of humans and animals.
You can also regulate the channels, making transfers of areas with reverse hydrological regimes, implementing the system of complementarity.

An important part is the dams and headrace galleries that should have a permanent monitoring system to prevent failures in their facilities and serious consequences for nearby populations.
Another high risk are Hydro Electric Central penstock, since broken for any reason, either by natural phenomena or vandalism, flood the Power Plant and all locations that are close to it.

Similarly, in the Power Plant, all major components as raw machines, alternators, transformers and switching elements, must have their protection systems well tight and calibrated to perform satisfactorily against any type of failure, either electric, mechanical or abnormal natural force (earthquakes) to avoid higher amount disasters and accidents.

In this work, all these situations are detailed and solutions are proposed to prevent the occurrence of disasters.

Keywords: tunnel, penstock, dams, turbine, alternator.

OS-1-10: GROUND IMPROVEMENT BY JET GROUTING FOR LIQUEFACTION HAZARD MITIGATION IN BRIDGE OVER QUILCA RIVER, AREQUIPA, PERU

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Abstract

Peru is located on the South American coast of the Pacific Ocean, one of the most active seismic regions on Earth. Among the many geological hazards present in this area, the phenomenon of liquefaction should be emphasized. Through this process, certain saturated soils affected by seismic events develop high interstitial pressures in a short period of time, resulting in a reduction of the effective stress that can lead to the loss of its bearing capacity.

From a geological point of view, the most liquefaction-prone locations are, among others, coastal areas, port zones and river banks, which are generally characterized by high population density and concentration of infrastructures. These events can trigger disasters of great impact for civil society, such as cuts of energy supply, potable water, sewerage, telecommunications or transport routes, causing significant economic and human losses that hinder the development of the country.
The assessment of liquefaction potential is both determinant and challenging, due to the complexity of the physical phenomenon and the seriousness of the associated damages. To mitigate this risk and guarantee the stability of works, soil improvement techniques are increasingly frequent. However, although their effectiveness seems to be supported by practice, there are many unresolved questions regarding the design and effect of these treatments.

In this context, Bridge over Quilca River may be considered an excellent example of application of soil improvement techniques to mitigate liquefaction risk, due to the soil conditions and the effective acceleration at the site.

The foundation of this bridge consisted of drilled shafts of diameter 1500 mm and length between 36 and 38 m, confined between Jet Grouting columns 20 m deep. This way, a double objective was pursued: to reduce the potential of liquefaction around each foundation and to guarantee an adequate bearing capacity against vertical and horizontal stresses.

The state of the art in techniques of soil improvement is reviewed in this article, justifying the advantages of the proposed solution over other alternatives with analytical and numerical models. The configuration of this foundation is of great theoretical and practical interest in a field of continuous development and evolution, not only in Peru, where these are relatively recent techniques, but also worldwide.

Keywords: liquefaction, ground improvement, jet grouting.

OS-1-11: **DISASTER RISK REDUCTION TO ATTEND TO PERU'S MAXIMUM ELECTRICITY DEMAND IN THE EVENT OF A BREAK IN THE CAMISEA GAS PIPELINE**

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Abstract

According to information provided by the COES, the Maximum Demand of Peru's electricity system in 2015 was 6244.3 MW (on the day of the maximum demand, 50.7% of generation was seen to be based on Hydroelectrics, and 43.9% based on Thermoelectrics). The South Zone was that which grew the most in 2015 because of the entry of the Las Bambas mining project, and the extension of Cerro Verde Mining Company.

However, making a cut as of July 15, 2016, we find – again from information provided by the COES –, that the maximum demand was 6262.89 MW, with 54.43% supplied by thermoelectric plants (based on natural gas), and 40.75% supplied by hydroelectric plants.

This analysis leads us to infer that in the event of a seismic or geotechnical disaster involving the pipeline that brings the natural gas from the Las Malvinas field to Chilca, we would have a serious problem regarding the supply of electric power. For such a circumstance, in which we could well find ourselves, we need to think of alternative sources of generation of electric power: approximately 3409 MW would need to be covered. We propose several alternative solutions to this serious problem.

1st option: Construct a security gas pipeline from the point of connection (PC) located in the existing transportation system as far as the locality of Urcos (Cusco); and construct the Southern Gas Pipeline, going from Urcos to the southern coast of Peru (Mollendo and Ilo), which would enable us to generate 1400 MW; the rest of the power would be supplied by the hydroelectric power plants now under construction.

2nd option: Meet the demand for natural gas on the part of thermoelectric power plants by using the export pipeline of PERU LNG S.R.L.

3° option: Supply the thermoelectric plants with natural gas by constructing two (2) regasification terminals, one in the north and the other in the south, so that they can supply northern and southern Peru with natural gas; either the gas from Camisea (in a normal situation), or imported gas, in the event of a possible break in the gas pipeline coming from Camisea. In this paper, an analysis is made of the electricity demand in the north and the south of the country, as well as the demand that is met by thermoelectric power plants. An analysis is also made of the construction of the energy security pipelines and of the Southern Gas Pipeline, its feasibility and implications.

In addition, an analysis is made of the feasibility of constructing the two Regasification Terminals, both in the north and in the south of Peru, analyzing their highly favorable contribution to the massification of natural gas in Peru and to energy security in the event of a break in the gas pipeline coming from Camisea. All these situations are analyzed in this paper, and alternative solutions are proposed to deal with the types of disasters mentioned.

OS-1-12: **CONSIDERATIONS ON DESIGN AND CHOICE OF MODERN PIPELINES FOR USE IN EARTHQUAKE PRONE AREAS**

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Abstract

Pipelines for distribution of gas, water and for the collection of sewage are considered as part of the lifelines of the society. When buried in settlement prone areas or earthquake prone areas, they are loaded by prescribed displacements. In case of settlement prone areas, like in countries located river delta areas, like The Netherlands, the deformations are slow but considerable. In earth quake prone areas the deformation are also considerable but they are happening in a much shorter period of time. In both cases however, the performance of the pipeline is very much related to the ability of the pipeline to follow the soil movements. That ability can be created by flexible joints and/or by using flexible and ductile pipeline materials. The excellent performance of the Dutch water network in settlement prone areas will be shown for reference purposes. Results of failure statistics and the tendencies they show will be discussed. Also it will be illustrated that there is a difference when considering pipes transporting compressible versus non-compressible media. A bending model will be used to illustrate the relative importance of the pipeline characteristics, such as pipe diameter, type of jointing, Overall Design Coefficient, flexibility and ductility of the pipe system. The results will give further guidance in designing pipeline systems as well as the type of systems preferably to be used in earthquake prone areas. Important in establishing pipeline systems are the risks associated in not obtaining the right jointing properties. Also the possibility of verifying if the joints have the properties as expected will be illustrated. The relative usefulness of site pressure testing will be illustrated as well. Next to pressure applications, a few guiding notes will be presented for waste water collection systems. Conclusions will be drawn and a table shown, showing a rating of the relevant parameters for the most common systems.

Keywords: earthquake, flexibility, ductility, pipeline deformation, water mains, pipeline jointing.

OS-2-1: **LEVELS OF RISK AND VULNERABILITY ASSOCIATED WITH FLOODS AND CLIMATE CHANGE ADAPTATION IN BINATIONAL BASIN PUYANGO-TUMBES**

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Abstract

Basin Binational Transboundary Puyango - Tumbes, covering territories of northern Peru and southern Ecuador, is the center of the impacts El Niño, specifically the Tumbes Region, presents critical conditions of vulnerability that permanently expose its people and production systems to natural events.

The research was conducted with the aim of reducing vulnerabilities and prevent disaster risks; it was identified and defined the study area, determining the possible risk scenarios (rain, storms and floods).

To do so, risk index was applied by flooding, this model allowed from a holistic perspective assess the level of risk of flooding in the Tumbes region and marginal urban localities.

It was established the relative size of threat (T), being of size 3 (high), establishing that it is representative flooding also ability to damage (D) of threat in locations of Aguas Verdes (Zarumilla) and Barrio San Jose (Tumbes), since the peri- urban flooding in this area cause a strong impact, determining a matrix of significance for threats, being very significant selection criteria.

Levels of risk and vulnerability, were determined by the model of risk indices, being the highest (0,58), corresponding to stratum 1 (Sector San Jose, Bellavista, Aguas Verdes) and the low (0,35) , layer 2 corresponding to (center of the city of Tumbes, top).

With regard to the consequences, economic losses, operational involvement (collapse of water and sewage system), environmental pollution (presence of sewage, propelling epidemics) was determined.

It was determined that the driving factors that increase the risk level are climate, the geographical location of the study area, the proximity to the equator and the mangrove area, the depth of groundwater level and soil salinization.

At the urban level, vulnerability as intrinsic factor of the risk was associated with not only exposure of the material context and / or physical susceptibility of the elements exposed to be affected, but also weaknesses, social fragility and lack of capacity community response study areas.

Keywords: threat, vulnerability, climate change, flood risk index.

OS-2-2: **GROUND-BASED SYNTHETIC APERTURE RADAR (GB-SAR) FOR LANDSLIDE STUDIES AND MONITORING IN PERUPRONE AREAS**

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Abstract

The peruvian territory has a varied topography, steep regions around mountainous areas near populated zones. Because of this, people might be exposed to hazardous geological conditions such as landslides. Therefore, monitoring this phenomenon is almost a mandatory task in order to give people assessment and to reduce risk to the minimum. So far, these studies have been done with geotechnical engineering and geological traditional instruments like inclinometers, GPS, and others, with no remote sensing capabilities. A Ground-Based Synthetic Aperture Radar (GB-SAR) system using interferometry methods is a useful tool for mapping and monitoring displacements on mountain slopes in a remote way. The GB-SAR instruments allow us to study large areas (of a few km2) from long distances (remotely) with high accuracy. Given these advantages and in order to collaborate with the Solid Earth research department of the Instituto Geofísico del Perú (IGP), a GB-SAR system is under development at the Jicamarca Radio Observatory (JRO). The JRO GB-SAR is a portable and robust instrument which can provide broadband measurements in the Ku-band with a synthetic antenna with an aperture of up to 1.5 m. The aim of this work is to present the electrical and mechanical characteristics of the system, as well as, the algorithms used for the formation of the radar images. Field campaigns on mountainous areas and steep hillsides (potential landslides zones) will be carried out to test the system measurement capabilities.

Keywords: landslides, GB-SAR, interferometry, risk, remote.

OS-2-3: **HUAYCO'S EARLY WARNING SYSTEM**

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Abstract

Every year, Peru is badly affected by the occurrence of many natural disasters. Among the ones that affect us more frequently, the huaycos are the ones that cause more damages. The huaycos are flash flood containing various solid and liquid materials caused by heavy rains that occur mainly in the Andean regions and part of the Jungle.

Disasters occur with certain recurrence and with differences on intensity, number of deaths, victims and destruction every year and during summer season. The intensity of the huaycos has been growing in recent years as a consequence of changes in the global climate as well as being strongly linked to El Niño. It is for this reason that it is necessary to take an alert attitude and act quickly preventing and mitigating possible future disasters.

The present project, huayco's early warning system, contemplates various technical aspects of instruments and sensors that integrated into an electronic system allows us to obtain information about a huayco occurrence so that the authorities and the community can take contingency actions. It uses different kinds of sensors such as ultrasonic sensors (for altitude measurement), accelerometers for vibration sensing and an IP camera. These sensors are attached to an embedded system which manages the data acquisition from the sensors and according to the sensed values it determines the occurrence of a huayco and communicates the event through the network to a web interface. It also uses solar panels to obtain the required energy for the operation of the system. The status of the system can be monitored via web in real time. The alerts generated by this system followed by the quick action of authorities and the community in general might avoid the occurrence of human loses due to a huayco event.

Keywords: an early warning system for huaycos, remote monitoring, embedded systems.

OS-2-4: **HOLISTIC MODEL FOR DISASTER RISK ASSESSMENT AS A TOOL FOR CLIMATE CHANGE ADAPTATION**

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Abstract

The purpose of this article is to present a consistent and coherent conceptual model, risk assessment Disaster (ERD), from a holistic approach, critical analysis and synergy of criteria and concepts of environment, combined with approaches and evolution concepts of risk, threat and vulnerability, is part of the overall objective of sustained thesis (2009) by the author, developed since 2002. The procedures followed for construction of model ERD are based on the general equation of the Global Environment (AG) which is equal to: Natural Environment (AN) x Social Environment (AS) x Built Environment (AC), proposed by the author, linked to the universal equation community risk (risk = threat x vulnerability) White (1975): “the risk to suffer disasters depends not only on the magnitude of the threat as such but the vulnerability of society exposed to the threat”. As achieved results proposes a broad new way of conceptualizing the “environment” as “global environment”, becoming the theoretical scaffolding upon him the conceptual model of holistic and sustainable risk management and disaster (Ghs-RD) was built, and ERD model. It is concluded that the risk itself is the fundamental problem and the disaster is a problem arising and that part of the difficulties for effective management has been the lack of a holistic and comprehensive approach to risk to facilitate their estimation and intervention from a perspective multidisciplinary. In order to demonstrate the correct use and versatility of the model it was implemented in Andean communities of Huaraz under the APELL, Program Awareness and Preparedness for Emergencies at Local Level, UNEP APELL Program Awareness and Preparedness for Emergencies at Local Level, UNEP APELL, program. It may be replicable in rural or urban environments of Peru and used as a tool for adaptation to climate change.

Keywords: risk assessment, prevention, threat, vulnerability.

OS-2-6: **FLOOD RISK MANAGEMENT: CURRENT PERSPECTIVE FLOOD RISK MANAGEMENT PLANS IN SPAIN**

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Abstract

Flood Risk Management has evolved significantly in Europe and in Spain, in a satisfactory way, in recent decades. It describes the current perspective on this issue, consistent with the EU directive on floods and with international trends, collecting the contributions made by the Committees of SPANCOLD (SPANISH COMMITTEE ON LARGE DAMS) and the CICCP (SPANISH CIVIL ENGINEERS INSTITUTION) and the main conclusions of the latest Conference on “Flood in Spain”, with the participation of the more relevant social and professional participants.

Details about Flood Risk Management in Spain are included, highlighting: the analysis of the problem; the progress on this issue through the recent Flood Risk Management Plans in Spain from the process of implementing the European Directive; and improvement proposals for flood management as R & D development.

Keywords: floods, European directive, risk management, current perspective.

OS-2-7: **A FIELD-BASED RELATION TO ESTIMATE RAINFALL EROSIVITY: A CASE STUDY OF RIMAC RIVER BASIN**

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Abstract

Water erosion is a significant problem worldwide, particularly in developing countries such as Peru, whose economy depends heavily on the extractive industry and where the availability of updated information is scarce. This region exhibits a soil erosion spatial variability due to particular topographic and climate conditions induced by the tropical Andes and during El Niño Southern Oscillation events. Rainfall erosivity factor is shown as the most representative indicator to determine a potential risk of water erosion. Countless relations have been developed to estimate rainfall erosivity values in limited data context. However, these relations tend to overestimate the R factors and don't represent their spatial variability due to the presence of mountains and high local rainfall intensities. Nowadays, Peru doesn't have a field-based relation to estimate rainfall erosivity (R-factor) according to the climatic and topographic conditions typical of the area. On the other hand, some projections based on global models have indicated that Peru will face variations in rainfall patterns due to the process of global warming. According to the UN Post-2015 Development Agenda entitled "Transforming Our World: the 2030 Agenda for Sustainable Development", governments such as Peru have adopted new global sustainable development goals. This document sets through goal 15 toward 2030 to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. In that context, this study aims to define a field-based relation to estimate R factor in Peru whose case study is the Rimac River basin. This research is structured into three main stages. Firstly, the background and justification of the study are presented which includes a hydrological, geological and land use characterization of the Rimac River basin. Secondly, the methodology to estimate the R-factor in the Revised Universal Soil Loss Equation (RUSLE) by Wischmeier & Smith (1978) and Renard et al. (1997) approaches. This method indicates that R factor is calculated by a long-term average of the annual sum of the product of a storm's kinetic energy (E) and its maximum 30-min intensity (I30), known as the EI30. For that, we use pluviographic records availability from public agencies in Peru. Finally, a rainfall erosivity map is generated by linear interpolation of the R values calculated in the Rimac River basin. This map provides an important tool for land use planning in Rimac River basin and for areas with similar geographical characteristics in Peru.

Keywords: water erosion, erosivity, precipitation.

OS-2-8: **RISK OF DISASTERS AND CLIMATE CHANGE**

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Abstract

Water is a vital element, but its shortages or extreme abundance in short or medium periods of time, can create destruction of infrastructure created by man and represents a risk for the sustainability of life.

In Peru, these problems are frequent, with different characteristics and impact on its three natural regions: Coast, Mountains and Amazon plain.

In all natural regions, disaster of different characteristics are a result of what locally can be called “The Hand of God” or failure of the designs or under estimation of the intensity of the phenomena, which can be a result of the lack of historical information about extreme events, deficient geological studies or other limitations, related to the works or the project location.

The paper presents natural disasters registered in the three regions and the proposals to initiate activities that will have the goal of mitigating the damage that could be generated and recommendations to increase quality water availability for the country’s development.

Keywords: COPEGP

OS-2-9: **INTEGRATION OF REMOTE SENSING INFORMATION AND GIS-BASED PLATFORMS TO SUPPORT DISASTER RISK MANAGEMENT**

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Abstract

Natural disasters such as tsunamis, typhoons, and earthquakes, have produced considerable damage to infrastructures causing major human and economic losses. For instance, in the case of the 2011 Tohoku Tsunami, according to the Fire and Disaster Management Agency, Japan, 127,291 houses were completely destroyed and 18,958 people were killed. Furthermore, in the case of the 2013 Super Typhoon Haiyan, as November 2014, 550,928 were totally destroyed and 6,293 individuals were reported dead (National Disaster Risk Reduction and Management Council, The Philippines). In the last year, in the case of the 2015 Nepal Earthquake, as May 2015, a total of 202,157 houses were totally destroyed and 8,020 individuals were killed, 16,033 injured and 373 missing (National Emergency Center 2015, Nepal Government).

The continuous occurrence of disasters has leaded to an increased public awareness of the impact that this catastrophic events. In this context, we developed a set of GIS-based toolbox to detect damage areas based on differences between pre- and post-event satellite images of moderate-resolution. This method was tested using imagery dataset from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensor taken following the 2013 Super Typhoon Haiyan in the Philippines. Further, we employ a change detection analysis to conduct an early damage mapping of the affected areas. In addition, we introduce and advance methodology to extract destroyed buildings using high-resolution pre- and postevent Synthetic Aperture Radar (SAR) intensity images. This method was tested using a dataset from the COSMO-SkyMed sensor and the building damage observed in Tacloban city in the Philippines. This methodology relayed on a change detection analysis of building footprint signatures detected on SAR images. Moreover, a new function of building damage ratio was developed for mapping destroyed buildings. The proposed methodology successfully detected with an overall accuracy of 82% destroyed building with footprint size greater than 50 m2. Finally, the damage function developed in the present study characterized the damage after the typhoon that hit Tacloban city, the Philippines. Therefore, they are expected to serve as a tool for damage estimation of future events.

Keywords: satellite images, synthetic aperture radar data, building damage assessment.

OS-2-10: **CREEPING DISASTERS DUE TO WATER TABLE RISE IN THE CENTRAL COAST OF PERU**

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Abstract

Disasters caused by emerging underground water constitute slow onset occurrences that make take years, even decades to develop. In the United Kingdom the main cause of flooding by water table rise is mostly caused by very unusual heavy rainfall episodes percolating through rock fissures whereas in the Eastern United States flooding has occurred due to a relatively rapid rise in the water table when pumping stopped in some urban areas.

Peru's Central and Southern Coast is a narrow, hyperarid area whose annual rainfall is below 10mm. Therefore, irrigation is needed to guarantee successful crops. In addition, due to the arid nature of this area, chicken farms and other businesses have been established along the Central Coast, particularly in the Lima Provinces Region.

It has been observed during recent years that heavy irrigation in the upper section of some basins has led to growth of coastal wetlands that, in some cases, have even been declared protected sites. Although this may be good news for the environment, as these sites have become new resting sites for migratory species, a number of businesses may be affected by the growth of the wetlands. Other problems, such as liquefaction during an earthquake, may cause extensive damage due to the rise of the water table and the sandy nature of the soil. Agricultural lands located near the shoreline have also been affected as salinization has already been reported in sites South of Lima, such as the Cañete Valley.

Urban expansion has led to occupation near protected sites. In 1997, SEDAPAL, Metropolitan Lima's water supply company, ceased the exploitation of wells in the Chorrillos district near Pantanos de Villa, a RAMSAR site. Water table slowly rose until it started causing flooding of Huertos de Villa, a housing development. Humidity caused damage to the houses and unhealthy living conditions. A similar case occurred in El Pinar development, North of Lima, were houses located near the Chillon River were flooded when pumping stopped. These problems have not been permanently solved as of today.

This paper reports cases of disasters and potential hazards that have occurred or may occur due to the slow rise of the water table whose origin is, at least to a certain extent, anthropogenic. Expected sea level rise, due to climate change, will most certainly contribute to the exacerbation of these problems near the shoreline of the Peruvian Coast and preventive measures should be taken in the next years.

Keywords: creeping disasters, water table rise, flooding, salinization.

OS-2-11: **REPAIR OF FLOOD DAMAGED ROAD INFRASTRUCTURE IN SOUTH AFRICA – A CRITICAL ANALYSIS**

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Abstract

In the last decade, there have been several occurrences of floods in various parts of South Africa, which lead to severe damage of road infrastructure. The most notable floods that caused major damage to road infrastructure were in the years 2009, 2011, 2012, 2014 and 2016. The floods washed away numerous bridges, culverts and even long stretches of road. Communities were cut off from schools, hospitals and neighboring towns. Road authorities had to respond quickly to reinstate access to these communities and to fix the damaged infrastructure. Given the urgency, often road authorities had to find a quick fix to the problem and they may not had the luxury to find the most viable and long-term solution. This raises several questions and concerns. Some of them include - do the authorities opt for a quick fix rather than a sustainable long-term solution? Are the flood damaged projects affected by standard procurement and supply chain process? Are there sufficient checks in place to ensure quality of workmanship? In short, have the funds been spent fruitfully?

This paper aims to critically evaluate the process of repairing flood damaged road infrastructure, in South Africa. In the 2015/16 financial year, through the Provincial Road Maintenance Grant, National Treasury allocated USD 34 million to five provinces (states). The grant conditions specifically stated that the funds were for the repair and rehabilitation of road infrastructure which have been damaged by floods. This paper seeks to highlight the differences, experiences and lessons leant.

The paper starts out with a literature review of the various local and international best practices, guidelines, policies and standards. Subsequently, this study dwells into the details of all the flood damaged projects which were funded in the 2015/16 financial year. It compares the projects from the design phase to the final close out report. In addition industry experts, officials from the various departments such as roads, disaster management, treasury and procurement were interviewed. Based on the comparison of the projects and the interviews, this paper draws in on the various challenges on the projects.

One of the key findings of the study was that the grant conditions were too restrictive in terms of timeline and the type of repair. It did not allow sufficient room for the road authorities to provide for an effective solution. The study also found that the procurement process for flood damaged projects was different from that of a conventional infrastructure project. However, this meant that small, upcoming contractors with insufficient skills were used on the projects, which lead to poor workmanship. The study makes recommendations to improve service delivery, while ensuring value for money.

Keywords: floods, climate change, roads, infrastructure, transportation, South Africa, resilient.

OS-2-12: **DIFFERENTIAL BEHAVIOR OF HUAYCOS IN CHOSICA IN THE YEARS 1987, 2012 AND 2015 AND GENERAL ASPECTS OF RISK MANAGEMENT**

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Abstract

The huaycos (debris flows) in Chosica, occurred between 1987, 2012 and 2015 have their differences in their behavior, since they are linked to their geology and external aspects such as meteorological conditions, especially rainfall; also to physical vulnerability, economic, social, technical, educational and others of the population that ultimately lead to loss of human lives and infrastructure.

The main ravines are Pedregal, Quirio, Carossio, Mariscal Castilla, Rayos de Sol (Corrales), Santo Domingo, La Cantuta, Virgen del Rosario, La Ronda and La Libertad. Each stream has an individual behavior, due to the geological characteristics, being the most important the geomorphology, slope of the ravine, size of the ravine, shape and amplitude of the receiving basin, channel and conoide of ejection, various intrusive rocks of the Coastal Batolito, fracture sets (discontinuities), accompanied by their orientation, spacing and persistence; that together with the weathering of the place will generate different sizes and forms of the debris to be transported by the huayco according to the precipitation and each micro basin river will have different potential of buildings destruction, being the main mechanisms lateral erosion, front and bottom, mainly in the riverbed and burial in the conoide of ejection.

Precipitation can be differentiated, for example, in 1987 the microbasins located on the right bank, Pedregal and Quirio, received the highest precipitation and therefore increased destruction. Similarly in 2012, the Mariscal Castillla, Virgen del Rosario, Santo Domingo ravines located on the left bank, and in the year 2015 the ravines of the right bank Carossio and Corrales (Rayito de Sol) were the most affected. Another factor to take into account is the quality and quantity of prevention works. After 1987, chiseling works were carried out, dissipators of huayco energy and widening of the channel in the Pedregal and Quirio ravines, which worked well in 2012, being weakened and partly destroyed in 2015.

In terms of risk management, it will detail the part of the risk analysis, which is the study of threats and vulnerabilities and is the key factor to develop the subsequent areas and components of risk management, such as the reduction of risks that It involves knowing the prevention and mitigation, and the management of adverse events that involves the preparation, alert and response to the huaycos; this last one is an important factor for the preservation of the life of the settler in Chosica. It is also key educational management, should train the teachers of Chosica about huaycos. It is also key educational management, should train the teachers of Chosica on huaycos, to have future generations resilient and knowledgeable of these natural events and live with the huaycos that will last geologically for thousands of years.

Keywords: huaycos in Chosica, vulnerability, risk management.

OS-2-14: **MODELING FLOODS IN THE MIDDLE ZAMBEZI BASIN USING REMOTE SENSING AND HYDROLOGICAL MODELING TECHNIQUES**

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Abstract

Mbire District, in the Middle Zambezi Basin, experiences floods annually. The study aimed at applying remote sensing and hydrodynamic modeling tools to map, and understand flood processes in order to improve flood management in the district. In determining the spatial and temporal variation of flood inundation in the district, NDVI MODIS images for the period 2005-2006, 2008-2009, 2013-2014 and 2014-2015 were processed in ILWIS GIS environment. The above period was classified by the Civil Protection Unit and ZINWA as flood years. Validation of the MODIS derived flood areas was done using 68 GCPs collected using participatory GIS mapping methods. A binary logistic regression model through the SPSS software was used to determine the spatial variation of flood hazard as a function of environmental factors. The results were confirmed using hydrologic modeling techniques, where the HEC-HMS model helped to quantify the peak flow and runoff contributed by the three sub-basins in the Mbire District (Angwa, Musengezi and Lower Manyame). The HEC-RAS model was used to map inundated areas for the Lower Manyame Basin for the flood return periods, 10, 25, 50 and 100 years. Flood mapping using MODIS images showed that the maximum areas flooded is 1 934 km2 on 16 January 2006, and 1 895 km2 on 8 January 2015. A good agreement of (R2=0.86) between GCPs and MODIS derived flooded area for 8 January 2015 was recorded. Environmental factors that significantly explained flooding are distance from water bodies ($p<0.05$). Simulations through the HEC-HMS model indicated an average yearly observed flow rates of 15.6 * 107 m3 16.2 * 107 m3, and 25.7 * 107 m3 for Lower Manyame (Mapomha), Musengezi (C109) and Angwa (Angwa) basins respectively. These flows were against an average discharge of 19.7 * 107 m3 /yr., 18.3 * 107 m3/yr. and 25.4 * 107 m3/yr. for Lower Manyame, Musengezi, and Angwa respectively. Model performance was evaluated and the efficiency for Musengezi showed a RMSE of 5.25 %, RBIAS of 0.04 % for Angwa the RMSE was 3.94 % and RBIAS of -0.003 % and Manyame gave a RMSE of 5.25 % and RBIAS of 0.07 %. The HEC-RAS simulated inundated areas are 56.3 km2, 57.3 km2, 58.4 km2, 58.7 km2, 59.1 km2 for the 2008-9 season, 10 year, 25 year, 50 year and 100 year return floods respectively and these are in and around Chikafa, Hunyani and Mushumbi Pools areas. The study concludes that Mbire District is vulnerable to floods hence the need for a flood protection measure framework that provides practical and feasible solutions, basic constructional guidelines for the protection of settlements and agricultural lands as well as a near real-time monitoring framework provided by this study.

Keywords: binary logistic regression, flood routing, NDVI, return period, MODIS.

OS-2-15: **ANALYSIS OF THE POTENTIAL OF STRUCTURE-FROM-MOTION TO GENERATE SPATIAL INFORMATION IN DEVELOPING COUNTRIES**

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Abstract

Developing countries often show limitations in the existence and/or availability of data representing fluvial morphodynamics. This contrasts with the need to have fluvial geomorphological data available for risk management in the event of flooding and debris flows. In this context, the Structure-from-Motion (SfM) technique –¬¬which automates classical photogrammetry processes for the generation of digital elevation models (DEMs), is less costly, and presents similar precisions to those recorded by sophisticated equipment (e.g. LIDAR and Laser Scanning)—has the potential to reverse these limitations. Moreover, the development of unmanned aerial vehicles (Drones) makes it possible today to record extensive areas with great precision and quality and, together with sophisticated computers, they make the use of this technique feasible.

This study applies SfM to generate a DEM on a stretch of the Rímac River (1.1 km), which flows through Lima (population ~ 9 million), the capital of Peru. To this end, field work and desk work were both done; the field work was divided into three stages, namely: 1) Measuring elevations of the bottom of the river bed recorded in 40 sections along the Rímac River axis. 2) Building concrete topographic control points (CP) along the sides of the river axis: five CP every 200 m. 3) Obtaining aerial photographs by using a UAV (Unmanned Aerial Vehicle). Based on the information gathered, the aerial pictures were aligned and the SfM algorithm was applied for the generation of the dense point cloud (DPC). The DPC, which contains spatial information as well as information of values of the RGB (Red, Green and Blue) color model, was calibrated from the topographic CP, and errors of less than 0.29 m were found in the DEM. Additionally, following the Optical Bathymetric Mapping criterion, an empirical linear model was formulated to reproduce the shape of the river bed. For this purpose, the spatial DPC information of the river bed (elevations and RGB model values) was used, as well as the field measurements of the bed elevation. Once the DPC had been corrected for the river bottom, the DPC of non-flooded areas was included to generate the final DEM of 0.5 m of resolution based on a process of interpolation. Judging from the results, SfM does have the potential to generate DEM required in hydraulic models.

OS-2-16: **DROUGHT FORECASTING WITH ARTIFICIAL NEURAL NETWORKS AND GENETIC ALGORITHMS USING REMOTE SENSING PRECIPITATION**

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Abstract

The aim of this research, is to determine the performance of regional agricultural drought prediction applied in the Mantaro-Peru basin, using artificial intelligence techniques such as Artificial Neural Networks (RNA) and Genetic Algorithms (GAs). For the prediction, the RNA-NARX model has been implemented in the Matlab programming language, taking into account the external inputs to the Global Climate Indexes (ICG) such as MEI, PDO and NIÑO1 + 2, which present greater correlations with the representative index of droughts in the Mantaro-Peru basin. The GAs have optimized the statistical parameters of the Gamma distribution for the estimation of the Standardized Precipitation Index (SPI), using the SPIGA package, (own authorship), written in the R language. Alternatively, have been considered the Precipitation Index Standardized Evapotranspiration (SPEI) and the Vegetation Condition Index (VCI). The latter has been proposed as the standard index to determine the best representative index of drought, by its direct nature of the normalized vegetation conditions.

The instruments used were the programming languages R (statistical results), Python (packages for the calculation of droughts) and Matlab (implementation of the RNA-NARX model). The software used, QGIS for the presentation of maps, ICI-RAFT - REFRAN-CV for the regional analysis of frequencies.

The study area, corresponds to the Mantaro basin distributed in 1145 cells of 25 km2, denominated synthetic stations and is located in the hydrographical region of the Amazon river. 10 homogeneous regions have been determined using the Self Organizing Map (SOM-RNA) classification techniques and the Regional Analysis of Frequencies L-Moments, defining the arid region according to the aridity index and the representative drought index with its respective (SPEI 6 months) that responds to the growth and development of vegetation in the basin with Pearson correlation equal to 0.58.
The Meteorological data such as rainfall and monthly temperatures correspond to PISCO (Peruvian Interpolated data of the SENAMHI's Climatological and hydrological Observations) data prepared by SENAMHI-Peru, with spatial resolution of 0.05°. For the construction of the RNA-NARX prediction model, 2 groups have been determined, the first for the construction of the model with 80% of the register, corresponding to the periods of 1981-2009 and for the validation of the model and the hypothesis with the Remaining 20% for the period 2009-2015. The statistical results (Pearson) of the model were 0.916, 0.915 and 0.902 in the training, validation and test stages, respectively.

OS-2-17: **MCA APPLICATION IN THE PLANNING FOR FLOOD MITIGATION – DOWNSTREAM CHILLON RIVER**

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Abstract

Flood disasters are situations that occur as a consequence of the occurrence of natural, technical or caused by man phenomenon (in this case flooding), when population has vulnerable conditions then, human losses, health losses, destruction of collective properties and severe damages to the environment are caused. Those are consequences of unsustainable development, since disaster risk management is not considered in the planning of the development process. Likewise, conflicts in decision-making process have led crisis generalized in society. The purpose of this paper is to apply the Multi-criteria Analysis (MCA), as a decision-making tool, to select the best strategic solution alternative to reduce flooding risks in downstream Chillón River floodplain, during the Planning Process of Disaster Risk Management (pre-disaster phase); for which three stages have been defined: Stage I: Identification of problem: "Considerable impact in urban areas located in the lower Chillón River floodplain, due to the high vulnerability degree facing the flooding probability". The goal is to "Mitigate Damages". For this purpose, all available information about the lower Chillón River (Pte. Chillón – mouth), have been collected, such as topography, hydraulic characteristics, social, cultural and economic aspects, as well as the environmental condition of the site.

Stage II: Elaboration of hazard map of lower Chillón river for a return period Tr = 100 years, vulnerability map considering floodplain and urban zones located around the river; and overlapping both maps previous, the flooding risk maps of the lower Chillón River is elaborated. HecRAS and ArcGIS software were used to elaborate these maps; The maps include part of the districts Los Olivos, Puente Piedra, San Martin de Porres, Ventanilla and Callao, where it was found that Ventanilla: A.H. Alfredo Villac; San Martin de Porres: San Diego; Los Olivos: La Floresta de pro, part of Urb. Pro; Puente Piedra: Nueva Esperanza, Lo. Chillón, A.H. Fortaleza Kuelap, Coop. La Enselada, Asc. Los Sauces., are the areas with higher risk. In those places, flooding can reach up to more than 4,0 m. Subsequently, the Decision Context is elaborated with all stakeholder, and 4 alternatives are proposed: A: To attenuate upstream flow and increase agricultural activity on floodplain; B: Implement an Early Warning System to detect flooding and training population for monitoring; C: To reinforce the riverfront defenses or dike systems and getting the achievement the goal by population; And D: To establish a system of urban norms focusing to reduce flooding damages. The final objective is to select the best solution alternative to mitigate flooding in the lower Chillón River.

Stage III: Application of MCA to evaluate the solution alternatives proposed and projected on the initial stage, comparing qualitative and quantitative results of the risk reduction achieved by each proposal. Scoring is recorded in the scorecard, it is an evaluation scheme of alternatives based on objectives and evaluation criteria such as: flood areas, physical damage to the population, water level, number of population affected, capacity to respond, etc. Finally, through the MCA technique, a Solution Matrix has been generated, selecting as the best strategic solution alternative the "Construction and / or reinforcement with a dike system".

Keywords: disaster, flood, risk, planning, multi-criteria analysis.

OS-2-18: **STRUCTURAL VULNERABILITY TO NATURAL HAZARDS IN PUERTO RICO**

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Abstract

Extreme natural events can constitute catastrophic hazards and are some of the major risks that cause significant damages to the built and natural infrastructure around the World. Puerto Rico, as an example of a Caribbean Island, is exposed to catastrophic natural hazards. The Island is highly exposed to hurricanes which cause extreme winds and torrential rainfall, coastal storm surge, riverine floods, landslides, and other hurricane related risks. There is also a high risk of occurrence of catastrophic earthquakes and possibilities of tsunamis, soil instabilities, and built infrastructure failures (e.g., dams' failure). The exposure to a highly dynamic climate brings weather extremes and changes causing torrential rainfall, catastrophic droughts, and many other stresses to the environment. It is a local and universal priority to address the exposure to natural hazards, reduce the risk and vulnerability of infrastructure, and increase the resiliency of built structural systems exposed to natural hazards.

The exposure to these multihazard risks requires to address the associated risks and vulnerability of the Island's built infrastructure. Among many studies at UPRM, the level of risk and vulnerability of buildings due to extreme winds, earthquakes, and floods have been addressed. The studies focused on providing structured methodologies and system to help in the determination of the expected damage caused by natural events in typical settings useful to end users like the insurance companies, consultants, and educators in Puerto Rico. Methodologies were developed to identify, simulate, model, evaluate, and measure the level of resiliency and modes of failure of buildings due to extreme natural forces.

Various specific projects have focused on seismic risk and soil types, earthquake resistance of buildings; damage caused by strong winds; experimental studies of seismic vulnerability of reinforced concrete residences; structural damage caused by flooding including the effects of hydrostatic, hydrodynamic, ocean wave, storm surge, tsunami, debris impact, scour and erosion, and floatation forces; incorporation of results into probable maximum loss calculation; and benefits of applying elastic theory for structural design, among others.

A relevant advancement in the understanding of the level of risk and structural vulnerabilities were obtained by means of new robust methodologies. Outcomes from these studies are presented by means of new methodologies, maps, and a structured software tool namely INSOL and they were made available for structural analysis and design by various end users. The Civil Engineering curriculum was highly impacted in depth and breadth for managing and reducing disaster risks. A significant academic and professional impact has been achieved on the faculty and students who participated in these projects.

Keywords: natural multihazard, risks, vulnerability, resiliency, structures.

OS-2-19: **EVALUATION OF CONTROL WORKS FOR THE DEBRIS FLOW IN THE COLOCAYA GULLY UNDER CLIMATE CHANGE SCENARIOS**

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Abstract

The Andean region of Peru is characterized by a semi-arid climate and the presence of a large number of ephemeral gullies that are dry most of the year round and become activated only in the rainy season. This type of gully typically has steep slopes and contains great volumes of alluvial material; it tends to produce mud-and-debris flows that include blocks several meters in diameter. The effects of this kind of phenomenon range from houses being destroyed, crops affected, and even rivers becoming dammed with the subsequent bursting of banks, which can cause flooding.

Bearing in mind the possible effects of climate change that suggest an increase in rainfall in the wet season, one can imagine an increase in the production of sediments and in the volumes carried along by the mud-and-debris flows in these gullies, with the consequent increase in risk to the neighboring population.

In this document we analyze the case of Colocaya Gully, a tributary of Ilabaya River, in southern Peru. The huaycos, a Peruvian term used to refer to debris flows, generated in this gully regularly produce the damming of this river, with the consequent rising of the water level in the river and flooding of the village located upstream from the confluence of the two river beds. In 2009 there was a proposal to construct a sediment retention pond, 6 m deep, as a control measure to prevent the occurrence of the above phenomenon; however, the present climate changes make it necessary to evaluate the performance of this structure under the new scenario.

For this purpose, a two-dimensional model of the debris flow was constructed, based on the model proposed by O´Brien & Julien (1988). This model includes three terms: viscosity, critical yield stress, and a turbulent-dispersive parameter. The model was calibrated in accordance with the estimated sediment volumes and design precipitations considered in the study made for the pond for construction purposes.

To evaluate the effects of climate change, the projections included in the Fifth Report of the IPCC were used, based on the results of the Coupled Model Intercomparison Project Phase 5 (CMIP5). The projected precipitations were used to estimate the new volume of sediments and the performance of the structure.

The results will serve as reference for the authorities and decision makers as they plan to prevent future disasters.

Keywords: debris flow, climate change, CMIP5, numerical models.

OS-2-20: **REGIONAL INTEGRAL SOLUTIONS TO REVERSE THE PRESENT CRISIS OF POTABLE WATER**

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Abstract

During the last decade and even before, the changes in climatic effects at the global level have created a spectrum of crisis and constant disarray in many places of the world; specially for those countries whose major water dependency comes from glaciers and from underground water, better known as aquifers.

The reality of Peru, to be much more precise on its southern regions or provinces, known as Ica, Arequipa. Moquegua and Tacna; the suffering and anguish for the lack of the precious resource it's having a major tall. The crisis is acute and the outcry is felt across the regions due to the hydric shortages. It is understandable the overall complaint from the population as well as the industrial and mining sectors. It is certain also these regions are practically fully dependent of ground water. The main issue to be presented it's a matter of water mass balance. In one of the main aquifers hydrogeological calculations have been performed throwing an estimated annual demand of 125 million of cubic meters (MCM), likewise the natural restoration is assessed in the order of 55 MCM; therefore a deficit of 70 MCM is existing and present nowadays. Observing the deficit, the population expect the worst to come due to the existing weather patterns and climatic change. The irreversibility of the echo-system threats with a permanent drought and many other disasters to come.

One of the major solutions to be proposed, it's to reinject storm water that normally is lost from precipitation to the Southern Andes and the sub-tropical levels called jungle eye brow, under the technology of deep injection wells, this action would increase the hydric restoration to the aquifer making it self-sustainable indefinitely and for the use of all those whose survival depends overall. The engineering to be proposed has been proven successfully in Southern California at the North of Los Angeles County. The measured and proven increases of water reinjection to the existing aquifer will provide a major benefit, since this big metropolis is dependent of the Colorado River and water from other major sources.

The assertive planning along with engineering of innovation have given the best results and the hope to secure the resource to its population and more importantly to many industries depending deeply of that.

Therefore, this technology is proposed as an integral solution on the Southern Regions of Peru.

OS-2-21: **GEOHAZARD MAPS OF PROCESS TRIGGERED BY EARTHQUAKES**

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Abstract

Earthquakes are phenomena that occur by reactivation of active geological faults, where the stored energy is released in the form of seismic waves, which results in deformations and cracks in ground that are trigger by co-seismic and post-seismic phenomena as landslides, soil liquefaction, volcanic activity, tsunamis, among others; those not only generate significant changes in the landscape, but also economic losses and human fatalities. Some examples of Phenomena triggered by earthquake like those caused by the earthquake in Italy (2016), Nepal (2015), Lushan (2013), Kashmir (2005), among others.

For this reason, seeing that seismic hazard assessment on by reactivation of a geological fault is not enough, it seeks to evaluate the potential negative impact of co-seismic and post-seismic events, or alternatively determine the probability of occurrence of such phenomena against the reactivation of a geological fault with its maximum magnitude likely.

Starting on Morphotectonic, Neotectonic and Palaeoseismological Analysis, which allow to characterizing the seismogenic potential of tectonic structures, it is elaborated seismic acceleration maps (seismic hazard), deducted from the maximum magnitude that could generate an active fault; followed generate susceptibility analysis of different geological processes. Following this, from the interaction between susceptibility maps and seismic acceleration map to get the hazard maps by processes triggered by the reactivation of a fault, that is our objective.

These maps are an important tool for Territorial Planning to decision making in prevention plans and risk management.

Keywords: earthquake, active fault, seismic hazard.

OS-2-22: **ACTIVE FAULT STUDIES FOR EARTHQUAKES DISASTER REDUCTION**

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Abstract

Earthquakes has demonstrated to be geological processes with negative impact in the social and economy growing up of a country. The earthquakes with superficial hypocenter (<20 km) and associated to geological fault reactivations such as Alaska (2002), Japan (1995), Nepal (2015) and Italy (2016) among others, which left large losses and GDP (Gross Domestic Product) lowers. For example, cost of Chile's disaster was USD $30,000 million, USD $14,000 million in Haiti for reconstruction, less than the figure of other disasters, but it is almost twice as that country produces in a year.

Peru is not free of earthquakes by geological faults, with the most remembered such as Ancash (1946), Cusco (1950), Huancayo (1969) and Arequipa (1990, 2013), among others. By this on the last decades has been making an effort to identify potential seismogenic faults with nationwide. Recent works carried out in the INGEMMET shows updates on active geological faults' maps, with more than 150 structures in southern Peru. According to Proinversion, precisely in this area of the country, there are large investment projects to be realized between 2016-2018 (e. g. oil pipeline in southern Peru, mining, energy, transport and others), bordering the sum of US $ 30,000 million.

From this arises the importance of studies that INGEMMET has been doing about the characterization of active geological faults, that has based on various research techniques to identify earthquakes that have taken place in the past (hundreds of thousands of years ago), by determining its maximum possible magnitudes and recurrence; to generate geologic hazard scenarios, based on numerical models (e.g. earthquake-Paruro, Cusco 2014). This information that INGEMMET has generated, it must be taken into account in the territory planning and its contribution to the improvement of the technical standard E.30 of earthquake resistant designs.

Finally, as a comment, infrastructure projects success in many cases depends from management and forecasting information related to geological hazards (eg earthquakes, avalanches, landslides, mudflows, etc.), such as occurred in Japan where mega-group Kashiwazaki-Kariwa reactors collapsed by effects of an earthquake in 2007 knocking out power to 15 million families; while in Alaska, an 7.9 earthquake produced by Denali fault, did not affect the operation of an oil pipeline, because the construction of this work was foreseeing the existence of a geological fault and knowing their seismogenic potential.

Keywords: earthquakes, active fault, earthquakes engineering, seismic hazard.

OS-2-23: **DYNAMIC, EVOLUTION AND MULTI-METHOD MONITORING OF SIGUAS LANDSLIDE, AREQUIPA, PERU**

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Abstract

Siguas landslide is located in Arequipa region, is a mass movement triggered by a continue advance of anthropic hydric saturation since 2005, that involves important national infrastructure and farmland´s hectares of El Pedregal, one of the main agricultural and livestock production zone in the southern region of Peru.

Lithologically landslide´s area is formed by conglomerates and volcanic sequences of the Moquegua Formation (Eoceno-oligoceno) with alluvial Pleistocene and quaternaries deposits as part of Moquegua basin´s fill. These sequences are common in the grade of porosity and unconsolidated of the material.

A detailed research of satellite images and aerial photographs show the dynamic of deformation and displacement of Siguas landslide, with a high elevation of his movement rate since 2007 to nowadays, all the years his scarp becomes more extensive, actually it has a semi-circular geometry of 1.4 kilometers length that causes the destruction of more farmland. Falling blocks on the scarp is a permanent condition.

The mass slipped has a dynamic behavior with granular segregation structures formed by compressive stresses, stretching efforts and more that 5 meter of blocks displacement, such behavior generates the continue lock of the valley causing a natural damming of the Siguas river, affecting areas on the valleys toe, the first lock of the valley was the last months of 2014. The habitants of the area unload the lake removing the mass of the movement using heavy machinery.

Faced with the need of monitoring the multistages of Siguas landslide data acquisition was established. The first stage consisted in the collection of historical aerial photographs pre-sliding and acquisition of satellite images to understand the temporal evolution in the past years. The second stage involved the construction of milestones on the scarp and body of the landslide that serves as control points for obtaining accuracy information by GPS-RTK surveying. The third stage was the construction of fixed monitoring base stations for the installation of laser scanner high millimetric structures precision (LiDAR) on the landslide´s body. Actually the LiDAR is the one of most modern monitoring equipment with the best results. Underlining that data acquisition milestones and stations is a permanent and constant activity.

OS-2-24: **HEAVY RAINS ON THE WESTERN SLOPE OF THE PERUVIAN ANDES ASSOCIATED WITH SYNOPTIC-SCALE CIRCULATIONS: MARCH 22ND AND 23RD, 2015**

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Abstract

This paper describes the causes of the event occurred on March 22nd and 23rd 2015 in Lurigancho Chosica, Lima, Peru. A development of heavy precipitation analysis was conducted on the western slope of the Peruvian Andes. It was found to be associated with a Cut-Off Low. Which is one of the synoptic scale atmospheric systems that, uniting all the required meteorological conditions could generate torrential rain, which was developed to the southeast of the Eastern Pacific. As a matter of fact, this system was originated by the propagation of waves from a tropical cyclone in the Western Pacific off the coast of Australia, advecting cyclonic vorticity in high levels, intensifying and moving a ridge from west to east directed by Rossby waves.

During these days, Peru's central highlands registered anomalous precipitation data for the season. On Monday 23rd at approximately 15:30 these conditions led to the activation of the Santo Domingo, Quirio, Carossio, Libertad, San Antonio Corrales and Pedregal tributaries (INDECI, 2015) which caused landslides, floods, and the overflowing of the Rimac river affecting housing, roads and even including wounded and casualties among local population. Using tools for analysis such as the model Global Forecast System (GFS), satellite imagery, weather data and also a software (GrADS) which allows to display the behavior of the meteorological variables involved, a complete analysis of this event will be performed.

This research was conducted in order to know the mesoscale, synoptic and global scale systems, associated with precipitation of this mountainous region that resulted in landslides and flood, as well as to make this paper a tool, used in risk management and mitigation measures for the decision making in favor of this vulnerable area, which was declared in emergency.

Keywords: Cut-Off low, rigde, vorticity, synoptic scale.

OS-3-1: **SHOPPING MALL DISASTER ACCELERATES RISK QUESTIONNAIRE AND PROFESSIONAL EDUCATION FOR ENGINEERS**

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Abstract

The Algo Centre Mall in Ontario, Canada, underwent a partial structural failure in 2012, when a segment of the rooftop parking deck collapsed into the building, crashing through to the ground floor below. More than 20 people received non-life-threatening injuries and two people died in the collapse.

As the regulator of professional engineering in the province, Professional Engineers Ontario (PEO) was granted standing in the first phase of the ensuing public Inquiry. PEO was provided a formal opportunity to recommend changes in relation to professional engineers and engineering, in areas relevant to the events leading up to the tragedy. The Inquiry Commissioner endorsed almost all of the 11 recommendations PEO made in its submission to the commission. Implementing these recommendations, in addition to the others made by the Commissioner that apply to our profession, will strengthen engineering practice in Ontario and help to prevent similar tragedies from occurring. Among the recommendations in the report one was of significance: “Recommendation 1.24: The Professional Engineers of Ontario (PEO) should establish a system of mandatory continuing professional education for its members as soon as possible…”

PEO regulates 80,000 licensed engineers and despite its status as the largest engineering regulatory body in Canada, PEO remains one of the few provincial engineering regulators in Canada that lacks a mandatory Continuing Professional Education (CPE) regulation. PEO is implementing this CPE policy in recognition of the fact that PEO should be proactive in regulating the profession. A proactive stance focuses on preventing faulty engineering practice rather than relying on a system for punishing licence holders for practice failures that could possibly have caused harm.

As Chair of the new PEO Continuing Professional Practice Task Force, we developed the framework for a proposed CPE program that focuses on i) maintaining provision of competent engineering services ii) ensures CPE requirements will be based on the risk that the work of the individual licence holder presents to the public and the profession iii) encourages licence holders and their employers to adopt risk mitigation measures within the work environment, iv) improves on existing programs in Canada.

Beginning in January 2017 the Task Force proposes that all PEO licence holders will be required to complete an on-line annual report as part of their licence renewal process. Completion of the Engineering Practice Risk Review will be included as part of the member profile update. The Engineering Practice Risk Review requires licence holders to respond to questions that ascertain the risk associated with their practice and the related best practices and risk mitigation measures employed. Completion of this form will generate the individual CPE targets. Under these conditions, CPE targets for a practitioner would be commensurate with the actions taken by the practitioner or firm while still achieving PEO’s goal of reducing the overall risk associated with the member’s engineering practice. The system will allow for members to report their annual CPE activities. This information will be publicly available, if the licence holder chooses, in the holder’s profile. This collection of data regarding current CPE activities will be useful during consideration of next steps.

Keywords: structural, risk, education, licensing.

OS-3-2: CRISIS MANAGEMENT CONTINGENCY PLAN IN CALLAO – PROPOSAL OF RESPONSE MEASURES THROUGH INTEGER LINEAR PROGRAMMING MODELS FOR THE DISTRIBUTION OF EMERGENCY KITS TO PROVIDE VICTIMS WITH HUMANITARIAN AID

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Abstract

Between January and September of 2014, there were 178 earthquakes registered in Peru, 9% of which occurred in the city of Lima, where 28.4% of the Peruvian population lives. The last strong earthquake that affected the country occurred on August 15th, 2007 and revealed the inefficiency of the distribution system managed by the National Institute of Statistics and Computing, to supply people greatly affected by the earthquake with emergency kits.

The purpose of this study is to identify the variables that determine the number of fatalities due to an earthquake occurring in the Metropolitan Area of Lima and Callao, and to design an appropriate routing system to distribute the emergency kits needed to assist the victims.

The number of fatalities was estimated using a multivariable econometric model adapted to our Peruvian socioeconomic reality that considered variables regarding the tectonic event in question, and characteristics of the affected areas. In addition, in combination with INDECI (Instituto Nacional de Defensa Civil) and the regional government of Callao, we used integer linear programming models and existing diagnosis identified by the national entites to propose a BCP and contingency plan to determine the exact routes and quantities, the vehicles should transport towards the refugee areas with the humanitarian aid kits. In this investigation and feasible proposal, we used Vehicle Routing with Time Windows a it is proved to be an adequate model to apply in this scenario, since it calculates the number of vehicles and the routes needed to promptly assist all victims with humanitarian aid. The proposed model improves the response capacity of the entities involved in the Peruvian crisis management system as it has been done based in real facts. The objective of this study, is due to the fact that it has been proven to be effective and feasible in the region of Callao, it can be re applied for Lima and then Peru.

Keywords: earthquakes, humanitarian aid, integer linear programming, vehicle routing with time windows, multivariable econometric model.

OS-3-4: DEVELOPMENT OF AN INFORMATION SYSTEM FOR DISASTER RISK MANAGEMENT WITH A FOCUS PROCESS

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Abstract

Law 29664 of 2011 creates the National System of Risk Management Disaster (SINAGERD) in Peru, as a synergistic, interinstitutional, decentralized, transversal, participatory system in order to identify and reduce hazards, minimize risks, avoid generating new risks and promote preparedness and response to disasters, by establishing principles, policy guidelines, components, processes and tools.

To do this we need to develop information systems that support the processes of SINAGERD which are: risk assessment, risk prevention, risk reduction, reconstruction, preparedness, response and rehabilitation.

In Peru it has been developed IS that comprises alpha numeric data, records, spatial data and various information systems that support the processes of risk management regulated in the Law of SINAGERD. Nonetheless, nowadays, it is not enough to have a SI with high quality standards. It is also needed to review the processes that will support the systems, redesign processes by eliminating repetitive unnecessary activities that do not contribute to generate value to the process and then we turn to radically reduce the time indicators, cost, quality and service. It is only after an information system that supports the new process is created.

As established in Article 53° of Supreme Decree No. 048-2011-PCM, approving the law of SINAGERD, INDECI manages the National Information Preparedness, Response and Rehabilitation System. That is why the General Office of Information Technology and Communication (OGTIC) has identified an opportunity in the institution to develop a project that involves review and process approach in order to develop an information systems that provides management support emergency response, damage assessment, needs analysis, driving actions, coordination for immediate actions and delivery of care, shelter and food to the affected population.

This information system will allow to articulate the Emergency Operations Centers and facilitate the flow of information for decision-oriented processes of Reactive Management (Preparedness, Response and Rehabilitation) so that it provides comprehensive support, in line to the current requirements for interoperability with other components of SINAGERD for efficient and effective performance of Disaster Risk Management.

Process management is essential for transforming organizations to ensure the successful development of information systems that will incorporate new paradigms in order to obtain fundamental improvements in the way work processes INDECI and thus be more competitive and permanently protect the lives of all citizens.

Keyword: INDECI (National Institute of Civil Defense), IS (Information System), process.

OS-4-1: **SOCIAL RISK REDUCTION ALONG THE PERUVIAN COASTAL CITIES**

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Abstract

Disasters have caused losses and damages to humans, economy and society around the world (Doocy, S. et al, 2013). Disaster risk is essentially a social process that occurs in a geographical area in a given time, and depending on the population density, socioeconomic, cultural and educational level of a particular social group, the type of construction, services (water, sewage and electricity) and purchasing. And it tests the degree of environmental sustainability and structural vulnerability of buildings (UNDP, 2004).

In Peru, people from rural areas who are forced to settle in insecure and vulnerable sectors of the city; middle-income population occupying low average homes located in areas of danger (Riofrio, G., 2003) they do not possess adequate mitigation and protection systems.

Coastal cities are constantly creating new vulnerabilities and test their existing risk management. The areas defined as suitable for urban use is not in a suitable soil, try to solve the problem of housing for low-income families (Comerio, M., 2013). And worst, it is the maintenance of public sector buildings, such as hospitals.

One of the important aspects in reducing risk is to maintain and integrate culture (knowledge, beliefs, values and norms), since this culture can increase the vulnerability of communities to disasters (Kulatunga, U., 2009)

It is required effective management of Peruvian communities, community awareness, and preparedness can play a major role in disaster risk reduction. Use of the strengths of them can be better used to organize and act promptly and effectively during disastrous situations, such as earthquakes.
The victims and material damage from earthquakes in the Peruvian coast, grade 7 to grade 9, despite being recurring instead, be accompanied by tidal waves have caused thousands of deaths and missing according to data from 1958 to 2013 (Seiner, L., 2009; Bernal and Tavera, 2002; INDECI, 2004). And it was required the integration of resilience of affected communities to natural disasters and their consequences.

This paper evaluates local knowledge with scientific knowledge effectively to improve the response of the diversity of social actors in the daily construction of risk in cities, based on lessons learned from disasters in this area, besides the concept of land use planning considering microzonation places to populate or repopulate.

Keywords: disaster risk, coastal city, vulnerability of buildings, earthquakes, microzonation.econometric model.

OS-4-2: **REDUCING THE VOLCANIC RISK OF AREQUIPA CITY, PERU**

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Abstract

Misti volcano is one of the seven active volcanoes of Peru. It is located in the Plio – Quaternary volcanic chain in southern Peru. Misti volcano belongs to the Central Andean volcanic zone (CVZ). This volcano is located only 17 km from the center of Arequipa city, and more than one million people live just at less than 10 km from the crater.

Misti volcano has shown several eruption events: explosive eruptions (plinians, subplinians, freato – magmatics, vulcanians), effusive eruptions, dome rising and collapse , and of flank´s instability phenomena that have generated at least two debris avalanches (Thouret et al., 2001). This volcano have presented Plinian eruptions with more than 20 km-high eruptive columns with as it occurred 2 thousand years ago (Mariño 2008), but also it use to present moderate vulcanian eruptions as the eruptions that occurred between the years 1140 and 1470 (Macedo, 1994). Currently, Misti volcano presents sporadic fumarolic activity that is monitored by the INGEMMET Volcano Observatory.

Vulnerability in Arequipa city is increasing every day because of the city growth toward the volcano flanks, an area that is considered very dangerous. Major risk is noted in Alto Selva Alegre, Miraflores, Mariano Melgar and Paucarpata districts and furthermore, in ravines that drain the volcano flanks like San Lázaro, Pastores, Huarangal, Agua Salada and El Chiral where houses have been built within the talwegs.

For those reasons, in 2007 INGEMMET elaborated the hazard map from Misti volcano this map shows three volcanic dangerous zones: high (red color), low (yellow color) and moderate (orange color) in addition INGEMMET gives talks and workshops and explains in simple ways about main types of hazards and actions that people should to take in case of volcanic eruption.

Currently INGEMMET has a new version of the hazard volcanic map from Misti volcano, this is a new format more friendly to the society and also this version considered suggestions about How to do before, during and after of a possible eruption. This new version indicates evacuation routes and also shows expansion limits towards Misti volcano this expansion limits was approve recently in the Metropolitan development plan of Arequipa (municipal ordenance N° 961 - 2015) by the Arequipa's provincial government and this ordenance will be valid until 2025.

Maps will be print in A3 format by municipalities and they will be distributes by SEAL and SEDAPAR in order to the information is known and benefit everyone and in this way avoid a big disaster.

Keywords: volcanic hazards, hazard maps, volcano risk management.

OS-4-3: **STUDY OF A PRIORITY FOR MUNICIPALITIES MAP FOR DISASTER RISK MANAGEMENT (DRM)**

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Abstract

Faced with a disaster, local governments are the first to respond to the aid of their community. However, these do not always have adequate resources to develop efforts aimed at prevention and response to disastrous events.

According to recent studies by international agencies like the United Nations, Chile spends 1.2% of GDP (3,000 million dollars) in response actions, rehabilitation and reconstruction due to the risks that the country faces. In some countries in the region, the economic loss reaches an average of between 250,000 million and 300,000 million dollars a year (Global Assessment Report, 2015).

Having multi-hazard maps to guide the actions of local governments becomes a necessity when planning. This piece of work identified 25 priority municipalities for Disaster Risk Management (DRM) – out of 346 in the country – mapping, through a Geographic Information System, the physical, social and economic conditions of each area along with the study of the most frequent hazards that have caused impact on the population, whether extensive or intensive risks (frontal systems, earthquakes, forest fires, volcanic eruptions, etc.). This prioritization would guide and focus the resource planning of public services in the field of disaster risk reduction, in order to build resilience in communities.

The period of data analyzed included information from 2004 to 2015 for each of the variables. The establishment of priority municipalities was performed by a multi-criteria evaluation through the AHP / ANP method, assigning to each variable relative and absolute values, where the former follow the hierarchy of indicators within each variable and the latter determine the weight of the variable in the prioritization.

Since the resources of local governments are mostly scarce, this innovative study establishes priority maps for DRM, which means a real contribution to planning. The development of instruments for land use planning at the municipal level in Chile does not yet consider the DRM as a valid tool to achieve sustainable development.

In this way, priority municipalities for the DRM must incorporate in their instruments of land use the disaster risk factor as a variable to consider when planning, guiding the development process according to risk, which implies the intervention of physical, social, cultural, economic, institutional and environmental variables of the municipalities. By doing so, current risks are reduced and new hazards and vulnerability conditions for the communities and goods are not generated.

Risk management as a notion and concept should be considered as a significant facet of the development processes and planning and not as an external compensator of inevitable stressful situations and crises.

Keywords: disaster risk, risk map, response, risk management, prevention.

OS-4-4: INTERACTIVE WEB-BASED APPLICATION FOR SEISMIC AND FLOOD RISK ASSESSMENT

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Abstract

In Canada, disastrous severe weather and geological hazards take place every single year and often cause considerable damage and economic losses. To meet the pressing need of Canadian municipalities and other levels of governments to perform multiple-hazard risk assessment, the federal government has partnered with provincial and territorial departments, municipalities and academia with the objective to develop standardized methods and tools for risk assessment and to promote their widespread usage. This paper reports on the ongoing activities on the development of natural hazard risk assessment tools for use by the public safety community. The focus was put on an interactive web-based application freely accessible via internet, with no need for any commercial software or advanced GIS or engineering knowledge.

The web-application in a prototype version is designed to allow non-expert users to run otherwise complex risk scenarios at a 'press of a button'. The analysis runs through a simple selection process based on intuitive step-by-step prompts which begin with establishing location and hazard type, before requiring user input details of the event to simulate. It combines seismic and flood hazard information, inventory of assets at risk and vulnerability models to compute the potential negative impacts. The hazard scenarios are modelled as probabilistic events with a given return period, as recorded historic events, and as deterministic what-if scenarios developed interactively by the user. The inventory dataset consists of information on the building occupancy, structural type and economic value. A standard and relatively coarse inventory of the exposed buildings is provided to users as a first-hand option. Users will be provided with the option to modify the embedded database and/or to build their own local inventories. The vulnerability modelling is based on the concept of damage curve as a direct function of the hazard intensity at a given location, shaking intensity in case of earthquakes and depth of water for inundations. An example describing seismic risk assessment at an urban scale for the city of Montreal is given at the end.

The web application is envisaged as a hub for earthquake and flood hazard and risk assessment in Canada with the possibility to increase the range of natural hazards in future maintaining the same modular framework. It is expected to bridge the current communication barriers between the Canadian risk experts and decision makers within the public safety community. The combination of the ready-to-use information and the user-friendly visual web-environment will further promote the use of knowledge on potential negative consequences from natural hazards in the preparation of appropriate long term mitigation plans, emergency action plans and for operational training.

Keywords: earthquakes, floods, risk analysis, economic loss, social loss.

OS-4-5: **CORPORATE SOCIAL RESPONSIBILITY FOR PREVENTION, MITIGATION AND RESILIENCE OF THE REGION INCREASED FROM ANY DISASTER**

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Abstract

Corporate Social Responsibility is the ethical commitment that companies assume for internal and external welfare of the surrounding area; under this commitment, companies avoid or mitigate any negative impacts that may arise on individuals and the physical and geographical environment in which they operate.

A company recognized in this aspect carries with it to raise the prestige of workers in the family, neighborhood and community where you live field; and therefore calls contain labor increased demand for applicants.

In this context What would be the social result of having companies where all employees are trained in the prevention and mitigation?, What would be the level of acceptance and prestige of a neighbor who works at the company, knowing that front a disaster is prepared and willing to work with the community where you live?, how people receive the news about the company developing its operations in its jurisdiction, shall develop training in prevention and disaster risk mitigation?.

In the Peruvian State and according to the regulations, there are Civil Defense Committees, composed of commission's executive at three levels of government, of which its meetings are chaired by the regional governor or mayor respectively with community participation in condition volunteer.

The greatest risk in the Tacna region is the presence of a strong telluric event which experts say would exceed 9 degrees on the Richter scale, the same that would bring destruction, suffering and death.

The question is: What is the contribution of organized business sector if he had a share in these committees?, What would the state pay towards these companies working responsibly to their workers and the community ?, How would participate the entity private in various activities and drills?

Following an analysis of the above aspects, it has come to the following conclusions:
Faced with a disaster are three times of action: the first determined by prevention, the second related at the time of the disaster, and the third with aspects of resilience, understanding this concept as the ability to overcome a disturbing act.

As part of this process, the sum of joint, orderly and planned actions between public and private entity would lead him to obtain a higher degree of resilience of the region, not only by an earthquake of great magnitude if not for any other disaster.

Keywords: BODENHEIM.

OS-4-6: **DESIGN OF A DSS FOR THE MANAGEMENT OF PRE-DISASTER STAGES OF EARTHQUAKES IN BUCARAMANGA**

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Abstract

Throughout history humanity has been exposed to catastrophic and unexpected events both natural and anthropogenic, which have claimed a large amount of human lives and material damage quantified in thousands of dollars. In order to mitigate the impact of these economic and human losses, the scientific community has developed information systems to support activities related to disaster management including the decision support systems (DSS). The most important activities to be carried out in the stages of disaster preparedness and mitigation are the following: shelter selection, evacuation routes planning and humanitarian aid distribution. These activities are usually addressed by the field of operations research through combinatorial optimization to solve facility location problems, vehicle routing problems, and their combinations.

However, there is a significant problem on the development of decision-making tools within disaster management which lies in the high uncertainty associated with the consequences of the occurrence of a possible catastrophic disaster. To address these issues, the DSS applications for disaster management (DSS-DM) have used different approaches including artificial intelligence (AI), expert systems (ES) and machine learning (ML). In addition, some DSS-DM use geographic information systems (GIS) technologies that allow visualization features and relevant information management to the decision-making process.

Bucaramanga is a Colombian city with a high seismic activity because it is located on a geological fault system. In addition, the need for economic housing forces its inhabitants to build on areas of seismic amplification (hillsides and crowns of slopes) without meeting the minimum requirements to ensure earthquake resistant structures. These current conditions can cause considerable material and human losses in the case of a seismic event. Therefore, an adequate planning of logistical activities in an earthquake disaster is required. Once a major seismic event occurred, it is difficult to obtain quickly reliable information due to problems in the communication networks, so an approach to planning scenarios prior to the catastrophic event is recommended. Accordingly, this paper presents the design of a DSS-DM that allows the decision-making related to the earthquake preparation and mitigation activities in Bucaramanga, generating disaster scenarios based on historical data and geo-referenced information by means of models of machine learning.

Keywords: decision support system, disaster management, machine learning, VRP, FLP, LRP.

OS-4-8: **EVALUATION OF THE LOCAL SEISMIC RESPONSE IN THE URBAN CENTRAL AREA OF THE CITY OF HUARAZ**

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Abstract

In the present research of the quantitative type, the evaluation of the local seismic response has been carried out in the central urban zone of the city of Huaraz, where there is the presence of soft soils. The investigation is proposed because these special soils present unfavorable conditions for the foundation of the buildings, as well as they produce a seismic amplification by effect of site, in addition that the place studies in a zone of high seismicity.

A quantitative prediction of earthquake movement leading to the assessment of the local seismic response is a key element in assessing and mitigating seismic disasters. The examination of destructive earthquakes in the world in recent times revealed a close relationship between the distribution of damages and the near-surface impedance contrasts. The geological-geotechnical and soil rigidity effects can significantly affect the frequency-amplitude content and the duration of movement at a site relative to that of the underlying rock; these alterations, known as local effects, indicate the need to identify and assess them in the estimation of local seismic hazard. The precise evaluation of the seismic hazard at the urban level requires the carrying out of detailed studies that take into account the influence of the effect of the soil, so it is fundamental to determine for each site the seismic response of the soil.

The local seismic response has been evaluated using the constitutive model of equivalent linear analysis, where the rigidity and damping characteristics of the soil are initially considered linear and then adjusted iterating until they are compatible with the deformation levels induced by the design earthquake in the Land (earthquake of 31-05-1970). The analysis was carried out for a geological-geotechnical model obtained in the study; And with the calibration, data processing and analysis of the model has been achieved through a one-dimensional (1D) analysis using ProShake software and a 2D analysis using Quake/W software, which models the terrain stratigraphic profile using the method of the finite elements. From the results of the analysis of the local seismic response, it is obtained that the soft soils produce very high seismic amplification, comparing the spectrum of the design quake obtained with what proposes the norm E.030-2016; for which it is recommended for a safe design of earthquake resistant buildings in soft soils, parameters and factors obtained considering site effects must be used. The buildings currently built in the urban central zone of the city of Huaraz would have catastrophic damage in the face of a severe earthquake due to the high seismic amplification of this area.

Keywords: local seismic response, soft soils, linear equivalent analysis, seismic amplification.

OS-4-9: DISASTER MANAGEMENT SIMULATION LAB: A TOOL FOR DISASTER PREPAREDNESS AND EMERGENCY RESPONSE AT THE CHILEAN NATIONAL EMERGENCY OFFICE

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Abstract

The Chilean National Research Center for Integrated Natural Disaster Management (CIGIDEN) was created in 2011 as a FONDAP Project (15110017) from the Chilean Science and Technology National Commission (CONICYT). This project comes from the need and required response to well-known natural disasters that have strike our country in the past. This Research Center flourished as a scientific reference and active support to help emergency management organizations and practitioners. As a way to receive the scientific contributions from the diverse Center´s research lines, the Disaster Management Simulation Lab (DMSLab) was created later on. Its goal: to provide transfer and research capabilities from the 6 research lines by offering scientific integration and additionally Emergency-Based Decision-Making Training and Optimization through Simulation. The DMSLab, as a Simulation-Based Multidisciplinary Risk Analysis Platform began its development by focusing on Decision-Making Emergency-Based Training with the capability to adapt its initial configuration to the organization´s own structure and providing scientific background to initial generating conditions and triggering events. This Simulation-Based Training Tool has three main components: Message Generation, Cartographic Visualization and Dynamic Simulation. Among these components, we have to highlight the use of state of the art geographic information system-based natural hazard development, and a complex network oriented evaluation methodology and application in order to retrieve all scientific and useful information needed to execute an emergency exercise with a subsequent performance appraisal. This training tool is intended to measure the decision-making process and protocols. For this, roles (live and virtual) must be defined, protocols (KPIs) must be analyzed, a script for event generation must be proposed and executed, and a training structure must be established. All these components will then be part of the overall training system design in order to provide a realistic ad-hoc exercise. As possible outcomes, we can mention: Interoperability Capacity, Team Work Dynamics, Flaws in Implementation, KPI's Fulfillment, Stress and Disruptive Event Measurements, and Special Needs.As possible areas of applicability as well, me can mention Early Warning Systems, Logistics, Evacuation, and Training, among others.

We selected for our first Use Case Scenario the National Emergency Office (ONEMI) Early Warning Center (CAT). Why this? because ONEMI, as the official Emergency Management Office of the Chilean Government, plays the most important role in every emergency or disaster that have or may occur in Chile. The CAT, as the neuralgic component of ONEMI, will then articulate all information and further response to all members of the Civil Protection System. We have to consider also that this Use Case Scenario is the technical response to the February 27th 2010, 8.8 Mw Earthquake and subsequent Tsunami that stroke 6 regions of Chile, around 700 km in distance, and affected 2 million people, with over 500 people being killed and 370.houses destroyed. In this event, ONEMI and the CAT played a vital role in the disaster and evacuation management. With the implementation of a first stage simulation-based decision making emergency exercise we pretend to improve the early response and disaster management performance within the CAT.

Keywords: emergency, disaster, simulation, training.

OS-4-10: **ENERGY APPROACH IN ITALIAN RESILIENT CITIES. CASE STUDY**

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Abstract

Following The United Nations Framework Convention on Climate Change of 1992, governments have mainly focused on actions to reduce greenhouse gas emissions. But in recent years there is still the widespread awareness that the effects of climate change are in place and are likely to increase in the future. It is therefore necessary to strengthen the initiatives for adaptation at national, regional and local level to cope with extreme events that more and more frequently hit our planet.
Resilience is a concept that, in engineering of materials, indicates the ability of a material to resist dynamic stresses without breaking. In recent years it has spread rapidly in many different disciplines, from ecosystems to social systems. The resilience of a city is the ability to withstand the dynamic stresses which arise in the form of natural disasters and climate change.

A resilient city uses innovative systems in the processes of governance, the strengthening of the connections between social, eco systemic / environmental and economic. It is a flexible city, which responds with quick reactions, competent and able to diversify the answers, efficient, interconnected and independent at the same time, adaptable.

Resilient Cities must become skilled in producing economic, social, innovative and environmental answers; should “resist the pressure of history.” No longer just talking about urban regeneration, a term that refers to urban design that, in the case of resilient cities must provide a complete multi-disciplinary integration and multi framework which guarantees a serious spatial planning and a ban on further land consumption.

A city able to build strategic positive visions, to create more opportunities thanks to the innovation and the pursuit of continuous improvement of itself.

A Resilient City needs collaboration and sharing expertise, innovation and funding, many long neglected structural works and innovative ICT technologies for a climate smart urban life.

Resilient cities need to be built to address both climate change and the effects of climate change with a common technology infrastructure for the production of local and renewable energy (solar thermal and photovoltaic integrated not only in buildings but as part of public space). The scenario that emerges is that of a more beautiful city, safer and livable, more humane. A city with its own efficiency and energy self-sufficiency, water and food, a city with green spaces capable of cooling and combatting the heat island effect, but also capable of acting as a connecting element for the community. The same organizational and management models of the city can in fact be re-thought, thanks to new network technologies, based on a less hierarchical model: imagining a collaborative management of the territory and its resources, starting with self-management of the landscape by local communities.
Cases of Italian Cities Resilient as best practice at European level.

Keywords: resilient, cities, renewable energy, management, communities, best practice.

OS-4-11: PHYSICAL AND SOCIAL VULNERABILITY BY THE GIANT TSUNAMI OF 1746 IN THE SOUTHERN SECTOR OF CALLAO, PERU

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Abstract

The central coast of Peru is the area that presents the greatest records of tsunami earthquakes in the country. Therefore, the conurbation of Callao and Lima has historically been exposed to the danger of tsunami inundation. On October 28, 1746 (270 years ago), a giant tsunami was recorded on this area, which it was generated by an earthquake between 8.5 and 9.0 Mw, and Callao was the most impacted by this event. This research analyses the physical and socio-economic dimensions of tsunami vulnerability in the southern sector of Callao. Physical vulnerability was obtained by applying the Papathoma Tsunami Vulnerability Assessment - PTVA, and socio-economic vulnerability was measured through data recorded by the 2007 Census. The product of this analysis was systematized in the Zoning map of tsunami vulnerability in the southern sector of Callao Region (Peru), Furthermore, the most critical areas and levels of vulnerability was identified. The results established that 63% of the total area has high vulnerability, mainly due to the variables used as materiality and water intrusion in buildings, by the physical dimension; and population overcrowding and low incomes, by the socio-economic. In addition, it is concluded that the area with high level of vulnerability is characterized by residential use, with 32 buildings and 3965 people affected. Finally, recommendations for the management of the affected areas are proposed.

Keywords: tsunami, physical vulnerability, social vulnerability, Callao.

OS-4-12: **RISK MANAGEMENT IN TERRITORIAL PLANNING, CASE OF GALERAS VOLCANO, COLOMBIA**

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Abstract

This research is proposed as a doctoral thesis on urbanism at the Universidad Central de Venezuela. It considers the latent problem originated by the reactivation of the Galeras Volcano, which is located in Los Andes mountain range at the South of Colombia, and its interaction with the city of San Juan de Pasto, located at its foothills. The thesis addresses concepts of the Complex Systems Theory, striving to achieve a clear view of the generalities of the variables that intervene in the management of the volcanic risk that endangers more than 500 thousand inhabitants of the city. The thesis departs from a qualitative research and deepens into particularities in order to be able to understand how they can modify its entirety, providing solutions for a land planning towards more resilient cities.

In the case of Galeras Volcano, we want to analyse how much we have progressed in terms of the inclusion of the management of the volcanic risk in a territorial planning, which are the contributions and which are the deficiencies, both on the implementation of plans and its practical application. Through the application of the methodology used to study environmental issues. A comprehensive assessment (EI, in Spanish) intends to understand the position of each one of the different players and their proposals and actions against volcanic risk, in order to minimize it.

Using the progress made so far as a starting point, and considering the research visit held at the Universidad Nacional Autónoma de México (UNAM), we proposed a matrix that incorporates political, administrative, socio cultural, physical and natural components and each one of the most important variables that intervene in the risk management and their inclusion on land planning, where we can understand the set of interrelationships, the role of each player, the need of including associated disciplines both to social sciences and land sciences, and how the whole chain can be reactivated in a negative or positive way. This matrix is explained from the application of different examples of specific experiences on risk management for Galeras Volcano, as a starting point to create proposals striving for the resilience of Pasto and the influence area of the volcanic threat. In the former matrix we tried to understand the role of each one of the professionals of the different disciplines, which are added, to understand the interaction of the social being with the territory he/she inhabits and how the social perception of the risk is construed.

Keywords: risk management, risk perception, land planning, resilient city.

OS-4-13: **ADAPTATION RESPONSES OF A COASTAL CITY IN BANGLADESH DURING CYCLONE GENERATED STORM SURGE**

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Abstract

A coastal city is a desirable location for business, exportation and upgraded quality of life. Chittagong is a coastal city of Bangladesh which not only accumulates individual buildings and structures, but also holds critical infrastructure like roadways, households, settlement area and water system.

Bangladesh coast is a breeding ground for tropical cyclones. When cyclones make land-fall, the wind, surge height and excessive rain cause severe damage and destruction of environment resulting both injuries and fatalities to people. 1991 cyclone, a category 4 type cyclone hit the Chittagong coast and caused severe damage in both exposed and inland urban coastal city. So, to overcome the risks and vulnerabilities by figuring out the urban adaptation responses for cyclonic hazard is the burning issue now-a-days. The adverse impact of vulnerability with low and inadequate adaptive measures makes the urban coastal city, Chittagong at high risk from cyclones. This study will focus on risk and vulnerability assessment with adaptation responses for the Chittagong urban city due to 1991 cyclone. Result of this type of approach can lead to changes in the direction of research and development for future urban planning.

Keywords: coastal city, tropical cyclone, adaptation responses, urban vulnerability, high risk, planning.

OS-4-14: **TSUNAMI INUNDATION MAPS FOR RISK MANAGEMENT AND MITIGATION IN THE PERUVIAN COAST**

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Abstract

The CNAT-DHN is in charge of making, updating and publishes periodically Tsunami Inundation Maps TIM) for main coastal cities and ports along the Peruvian coast. The first maps were developed using tsunami refractions curves technique that estimates tsunami arrival time and tsunami height along the coastline. In 1998 and 2008 through TIME (Tsunami Inundation Modelling for Exchange) project computational efforts allowed to improve these maps by numerical simulation using the Tohoku University Numerical Analysis Model for Near-field tsunamis No.2 (TUNAMI-N2) code based on shallow water theory and Cartesian coordinate system and developed by the Disaster Control Research Center, Tohoku University, Japan. Prior to the 23 June 2001 event, there had been only two tsunami documented in the past 25 years, both in 1996. The Chimbote tsunami accelerated the tsunami hazards maps efforts of the DHN, and evacuation maps were completed in 2001 for 20 coastal areas. The firsts TIM for La Punta, Callao in 1997 elaborates with cooperation of National University of Engineering (CISMID-UNI). According to historical testimony in 1746, the capital city of Lima was completely destroyed by ground shaking and subsequent tsunami flood killed 4800 of 5000 inhabitants in La Punta, Callao (Dorbath et al., 1990; Jiménez et al., 2013). The update TIM for la Punta, Callao has been published in 2014 with support of JICA project. The numerical simulation was conducted for two scenarios: 8.5 Mw (pink color) and 9.0 Mw (worst-case) in red color. These maps contain topographical information of some of Peru's coastal areas that illustrate how far inland tsunami waves could penetrate during major earthquakes. Up to present DHN has elaborated more than 100 tsunami inundation maps published free on web site. Detailed maps of potential tsunami inundation areas are important for the delineation of evacuation routes and long-term planning in vulnerable coastal communities and also are very useful tools for regional and local government in Peruvian coast.

Keywords: tsunami inundation maps, risk management, evacuation, disaster.

OS-4-15: AN INNOVATIVE METHODOLOGY FOR THE SEISMIC RISK MITIGATION ON LARGE TERRITORIAL SCALE

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Abstract

Seismic risk reduction of student populations in highly seismic areas is crucial. A considerable intervention on urban scale in the system of public schools is a challenge to governments due to limited economic availability and the remarkable amount of school buildings extremely vulnerable. A prioritization strategy of intervention is required.

Decision makers need modern and efficient methods that allow a multidisciplinary approach. Several studies have proposed prioritization ranking but it is necessary to go beyond the simple reduction of vulnerability aspects and provide rational and valid operational tools on the technical-scientific level.

In this paper, we propose to define a prioritization methodology for seismic risk reduction in public schools. The case of schools in the city of Lima has been analyzed. Data of the previous studies have been used, elaborated and integrated in order to provide the proposed methodology.

Through the concept of resilient city, we have defined qualitative and quantitative evaluation criteria. They consider the factors that determine the seismic risk of the buildings (i.e. hazard, vulnerability and exposure), how to manage and recover the emergency as well as integration and social cohesion aspects. The criteria have been analyzed separately also using Geographic Information Systems (GIS) in order to identify the spatial and territorial relationships of the public schools with their surroundings. Subsequently, they have been directly integrated using appropriate Multi-Criteria Decision-Making (MCDM) methods. For each criterion has been assigned a weight, and through their assignment, numerous political scenarios have been considered. These scenarios want to simulate some likely behaviors of the decision maker in order to consider the possible uncertainties involved in planning.

The proposed work could represent a real seismic risk mitigation policy on a large territorial scale. In fact, through the MCDM methods and using the concept of city resilience, it could provide a simplified and multi-disciplinary approach, with solid technical and scientific bases and a holistic view of the problem.

Keywords: city resilience, school buildings, prioritization methodology, GIS, MCDM methods.

OS-4-16: CAPACITY BUILDING ON DISASTER RISK MANAGEMENT: HANDS-ON EXPERIENCES FROM THE CENTRAL AMERICA PROBABILISTIC RISK ASSESSMENT (CAPRA) PROGRAMCOAST

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Abstract

The World Bank Probabilistic Risk Assessment (CAPRA) Program was initially launched in Central America as a partnership with the Center for Coordination of National Disaster Prevention in Central America (CEPREDENAC), the United Nations International Strategy for Disaster Reduction (UN-ISDR) and the Inter-American Development Bank. The objective of CAPRA is to support countries in increasing the understanding of disaster risk in order to develop and mainstream disaster risk information into development programs and policies. In 2010, the CAPRA software suite was presented. CAPRA is a modular and free tool which integrates software to calculate probabilistic hazard models, build asset exposure databases and evaluate physical vulnerability. The main software is a risk calculation engine which includes a mapping tool. CAPRA allows to evaluate risk in terms of physical damage – buildings and infrastructure– and estimates risk in terms of financial losses. The main risk metrics used in CAPRA are the Annual Average Loss (AAL) and the Probable Maximum Loss (PML). The focus in the past 6 years has been to enhance the institutional and technical capacity of governments and technical agencies to quantify and use disaster risk information as part of their priorities.

The World Bank B CAPRA Program has provided tools, capacity building, knowledge products, and advisory services, through Technical Assistant Projects (TAPs) to countries all over Latin-America. These TAPs has been focused in creating and strengthening the technical and institutional capacity for risk quantification, critical in order to manage effectively risk.

A TAP is a country-driven initiative in which the World Bank role is to strengthen institutional and technical capacity on probabilistic risk assessment through hands-on practical training and complementary advisory services.This paper will present the CAPRA TAPs on Seismic Risk Assessment developed since 2013 in 1. Panama City (Panama), 2. Managua (Nicaragua), 3. San Marcos and San Pedro Sacatepéquez (Guatemala), 4. Santa Tecla (El Salvador), and 5. Arraiján (Panama). The first four studies focused on the analysis and evaluation of building assets related to Housing, Health and Education sectors. The last one mentioned, assessed the Water and Sanitation Infrastructure.

A CAPRA TAP for seismic risk assessments includes four general activities: (i)Identification of threats and historical review, collecting existing information about seismological geological and geotechnical information and identification of seismic hazard parameters; (ii)Inventory and categorization of exposed buildings and definition of vulnerability functions; (iii)Evaluation of disaster risk by seismic events; and (iv)Development of hazard and risk maps and examples of applications of risk management.

A rigorous review of the results is undertaken in partnership with the local teams. The TAP finalize discussing the results and analyzing the opportunity to develop specific applications aimed to improve current disaster risk reduction practices and policies.

Keywords: probabilistic assessment, seismic risk assessment, hazard models, hazard maps.

OS-4-17: **ASEISMIC RESPONSE AND PERFORMANCE UPGRADING OF EXISTING MASONRY BELL TOWERS**

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Abstract

The paper presents numerical investigation on seismic vulnerability of masonry bell towers and propose different upgrading systems. Masonry bell towers, part of cultural and historical heritage, are very widespread in Italy and is fact that to their conservation is given a special attention last years. Some FE analyses results from two existing masonry bell towers located in Emilia Romagna region, recently (2012) struck by a seismic sequence of a moderate intensity, are reported. As a consequence of the low-quality of masonry material, they are exposed to a high risk against lateral loads. Their vulnerability is therefore subject to the combination of mechanical material properties, interaction soil structure, geometrical irregularities, seismic active zones and even to their inclination in some cases. The cases studied are selected intentionally to represent a panoramic view of all mentioned parameters.

The towers have been subjected to different analyses: simplified analysis, linear dynamic analysis, static nonlinear analysis and nonlinear dynamic analysis, in order to have the full response of the structures, in reliable terms. The adopted analysis parameters are in accordance with the Italian Code recommendations for seismicity of the region, masonry mechanical properties and the semplified analysis of the towers. The results shows a conformity between different analyses and highlight the vulnerability of the structures under seismic actions. Dynamic nonlinear analysis are conducted repeatedly by scaling the peak ground acceleration of the used acelerogram to achieve a performance-capacity relationship.

Three different upgrading techniques are than proposed and analyzed in the same conditions as the existing towers. The first, consist on local interventions by improving mechanical properties of the masonry material by injecting refined mortar. The second technique presents steel frame/truss structure placed in the inner part of the tower, used as backrest to increment the rigidity and the capacity of the tower. The last one uses the FRP composites for upgrading in and out of plane capacity of the masonry walls. The numerical analyses results are than compared in terms of performance improvement and implementation facilities.

Interventions to similar structures are very important and requires detailed investigations in order to achieve the proper solution. The experience has shown that the interventions imposed well, are those which cure the problem but conserve the heritage. It is highly recomended that bell towers should be retrofitted in order to mitigate the seismic risk and injected mortar is found a reasonable solution compared to the others proposed, for the specific seismic intensity.

Keywords: masonry towers, seismic vulnerability, retrofitting, FRP composites, steel frame.

OS-4-18: **CASE STUDY: THE STATUS OF SOUTH AFRICAN INFRASTRUCTURE AND THE RESILIENCE OF ESSENTIAL FACILITIES**

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Abstract

Resilience is the property of a structure, development or city to return into a state of functionality after it has faced a natural and/or man-made disaster. The Oxford Dictionary aptly describes resilience as "the capacity to recover quickly from difficulties and toughness".

This paper seeks to study the capacity of cities and infrastructure in the developing world; looking into detail at South Africa, to withstand natural and man-made disasters and suggest ways in which developing countries can assure the rapid recovery of essential facilities in the event of such disasters. Disasters in the South African context are catastrophic events caused by either a natural event such as drought, flooding and more recently tornados; or man-made event such as veld fires (aggravated fires on elevated open grassland in Southern Africa), and violent protests. All these disastrous elements adversely affect the States infrastructure and in the case of essential/primary infrastructure such as hospitals, should the infrastructure not be designed and maintained to be resilient, the impact of these events could have life threatening consequences.

In 2006, the South African Institute of Civil Engineering released South Africa's first Infrastructure Report Card (IRC) detailing the state of the Nations Built Environment from Roads, Airports, and harbours to Hospitals, Electricity Distribution and Water & Sanitation. The panel investigating the state of the infrastructure gave an overall rating of D+, siting a lack of skills and funding to assist the nation maintain its infrastructure. The overall rating improved after the 2011 IRC was released to a grade of C-. The higher grade was due to the FIFA World Cup that was hosted in South Africa in 2010 which resulted in billions of Rands being invested into public infrastructure. It was reported in the IRC 2011, that although the grade had increased, the infrastructure at a municipal level was still deteriorating and the resilience of the old and new infrastructure was "questionable" without a commitment to maintenance.

Recently, South Africa has been hit with drought, flooding in certain areas and recently in July, a tornado struck a township in Gauteng, Midrand and caused irrevocable damage to informal settlements and shopping centres. Major damage to secondary infrastructure was also seen to have been caused by the #FeesMustFall protests that caused damage in the Millions of Rands to infrastructure at public Universities. It lies with the State to ensure that departments and programs are created to react to disasters and that the facilities that bear the brunt of these events have been well maintained and have skilled individuals managing them. In this way, after disaster has struck, a speedy, well documented plan can be put into motion to mitigate the effects.

Keywords: probabilistic assessment, seismic risk assessment, hazard models, hazard maps.

OS-4-19: **BUILDING RESILIENT CITIES IN SOUTH AFRICA – CASE STUDIES FOR THE DEVELOPING WORLD OF STRATEGIES USED IN DURBAN AND CAPE TOWN**

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Abstract

Urban areas are centers of business, development and livelihood – a driving force in each nation and magnets to increasingly dwindling rural populations. The importance of long term sustainable planning of cities is becoming evident not just for economic reasons of the nation but to ensure a holistic approach to the livelihood of the millions of people who live in and contribute to the city. Apart from the apparent needs for sustainability resilience of cities is equally important. Resilience is defined as the capacity to recover quickly from difficulties. No matter how methodically a city is planned, unforeseen circumstances will occur which affect the operation of the city and endanger the safety of the inhabitants, the most predominant of these circumstances being natural disasters. Organisations such as the United Nations Office for Disaster Risk Reduction, ICLEI – Local Governments for Sustainability, Resilientcity.org and most notably 100 Resilient Cities collaborate with cities to ensure awareness is raised, better methods are found and the goal for resilient cities is reached This paper will briefly describe the recognition of resilience in the context of the two chosen cities.

This paper will generally talk to cities in the developing world and specifically study Durban and Cape Town in South Africa as case studies of resilient cities in the developing world. Durban was one of the first cities on the global 100 Resilient Cities list. It has numerous urban strategies such as integrating natural environments into infrastructure systems eg. for flood attenuation and in depth coastal strategies to combat rising sea levels. Innovative technologies such as water re-use are being pioneered in this fast growing city to ensure water supply and optimized usage of existing water. In coordination with specialized research units, such as Climate Systems Analysis Group in Cape Town, extensive research, analysis and modeling has allowed the city to develop predicated effects of climate change to allow decision making in crucial areas. Durban is remarkable in its urban objectives as it prioritizes social resilience and socio-economic factors, addressing issues such as education, employment and social cohesion. The city's municipal programme has piloted "Climate Smart Communities" projects which build the city's resilience from the individual up. Not to be overlooked is the perseverance of the city's leadership to steer the city in this pioneering direction.

Cape Town has also recently been added to the final 100 Resilient Cities list, also awarding it further funds and skills to allow it to achieve its resilience goals. Cape Town is an environmentally conscious city with governmental and non-governmental organisations improving the city's green engineering, sustainability and conservation. Its natural environment zones make it more resilient to natural phenomena by acting as buffers or absorbents in some cases. Cape Town is prone to flooding especially in informal settlement areas, a problem which has to be solved by intensive collaboration between communities, government and relevant non-governmental organisations before the engineering begins. To deal with coastal risks, Cape Town developed and implements a thorough Coastal Management Strategy which includes intelligent zoning and spatial development, clear building policy as well as integrated management and stakeholder engagement. Cape Town's continuous efforts to reduce the city's carbon footprint, at government level and privately, further ensures that climate change is slowed down and stopped before it brings about more natural disasters.

After literary studies, this paper will interview relevant officials to gain further insight into the strategies of these two cities. The interviews will include information on the planning processes, stakeholders involved, hindrances in the processes, dealing with policy and future plans for the cities. The paper summarises recommendations in the form of an infographic.

KEY WORDS: resilient cities, South Africa, natural disasters, community Liaison.

OS-4-20: ESTIMATION OF THE SEISMIC HAZARD AND THE IMPACTS FOR THE MAIN HUMAN SETTLEMENTS ALONG CONVERGENCE MARGINS PLATES IN SOUTH AMERICA AND CARIBBEAN

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Abstract

Latin American territory has registered along history at least 77000 lost of lifes, more of 15 million of affected people and 37 billion of dollars in economic losses due to disaster happened as part of seismic hazard (Swis Re and GEM, 2014). In this sense, natural phenomena, which can generate physical damage, human lost and lost of capital as well as the vulnerability of people located on human settlements in hazard zones. (CEPAL, 2014). In addition to change life conditions of communities as well as the economic activity of the countries in Latinoamerican.

Subduction surface in South America and the Caribbean represent a complex process of driving and resisting forces as part of region geodynamics, where dynamics is promoted from ridge push through potential energy toward trenches (Faccena, 2014). Energy produced is associated with the main source for building of mountain ranges, volcanic expressions and large earthquakes on the past few centuries, as detailed several authors although previous rupture descriptions and historical explanations of several of these events occurred before of 1900s related to subduction processes (Bilek, 2009; Stein and Wysession, 2013).

Determination of along-strike dip and along-dip variations have been a relevant target through different analysis for correlating them with orientation of tension axis, seismicity rate, volcanism, depth of seismicity, magnitude earthquakes, thermal structure, etc. (Gutcher et al., 2000; Chen et al., 2001; Bilek, 2009; Shellart & Rawlinson, 2013). Records of GPS measurements and Seismotectonic Deformation (STD) estimations show that movement of the slivers parallel to the subduction trench are controlled by the angle of convergence and are associated with the features of the Andes Range and seismic/ aseismic zones (Holt et al., 1991; Corredor, 2003; Teza et al., 2008; Vergolle et al., 2010; Nocquet et al., 2014), also previous works which have used empirical approaches between magnitude and frequency of seismicity based on the Gutenberg-Richter (GR) law (Gutenberg & Richter, 1944).

Nowadays and based on a larger seismic hazard due to overpopulated cities along this geotectonic feature, it is necessary to identify better subduction zone segments potentiality dominated by relatively long recurrence times and related to giant earthquakes (Müller and Landgrebe, 2012). In this work, we will present the main results obtained from an analysis done along Caribbean and South American margin plates, in order to improve the knowledge of seismic sources along subduction zones. We will support this segmentation on subduction angles, tectonic moment rates from GPS measurements, Seismic Moment Rates and mapping of the b-values and we estimate a map of seismic hazard as contribution to the assessment of seismic risk for the region and a future program about Disaster Risk Reduction by seismic events.

Keywords: subduction, strain, seismotectonic, seismic hazard, disaster risk reduction.

OS-4-21: **SIMULATION MODEL AND PERFORMANCE PLANNING FOR A RECONSTRUCTION PROGRAM INFRASTRUCTURE AND ENVIRONMENT DAMAGED BY NATURAL DISASTERS BY PROCESSING BIG DATA**

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Abstract

As result of the natural disasters that have taken place in our country, one of the first measures taken is the gathering of information about the damaged infrastructure and environment. Said information always results in a reduced number of variables used to take immediate and timely decisions aimed at a fast reconstruction that ensures the recuperation of the habitable and productive capacity of the affected area. However, because of the reduced number of variables on which these decisions are based, recovery becomes slow and financial funds destined to this goal are wasted, in addition to the corruption that erupts within the management of these funds due to the information chaos (non-structured and disorganized information).

Based on the combination of integrated mechanisms of a territorial urban planning and the reconstruction management of a previous experience in the region of Arequipa, Peru (earthquake and tsunami in June 2001), this paper intends to make a technical proposal that shows what happened and what was done, achieving a superposition of financial and physical acts that led to the recovery of the region after a moderate natural disaster. This has allowed us to raise a technical financial proposal derived from models simulated in a big data center. This proposal includes suggestions on how to act during the disaster and the physical financial reconstruction of the affected area, seeking a fast and sustainable recovery that is physically and financially optimally managed.

Finally, this paper seeks to, based on the explained model, replicate and generate previously simulated different reconstruction processes scenarios that feed on real-time and existing information.

Likewise, this method pretends, in the future, by applying Artificial Intelligence, to generate mathematical models with self-learning capabilities that will allow us to reach simulation processes that will be useful to researchers, citizens, authorities or entities involved in obtaining results that can provide guidelines for the creation of state policies aimed at confronting the permanent occurrence of natural disasters (lower the country's vulnerability to these natural phenomena), and to improve or enhance the participation and/or coordination between all private and public entities (local, regional, national and international) involved in the reconstruction processes.

Keywords: reconstruction, big data, planning, damaged infrastructure and environment.

OS-4-22: **HUMAN EVACUATION AND SIMULATION VIA AGENT-BASED MODEL. A PERUVIAN CASE**

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Abstract

Tsunamis are one of the most destructive natural phenomenons in the world, affecting coastal countries around the world, especially the ones located in the Pacific Ocean. For instance, in 2001, an 8.4 Mw earthquake measuring hit the West Coast of Ocoña, Arequipa – Peru, triggering a large tsunami that inundated coastal areas and affecting thousands of people. Also, in Concepcion-Chile, in 2010, a strong tsunami with more than eight meters height destroyed several towns devastated by the quake impact. In both cases, there were no early warnings and community preparedness on rapid evacuation to higher ground.

Besides, Agent-Based Modeling (ABM) is increasingly becoming a tool for analyzing and modeling transitions in socio-technical systems. For instance, there are evacuation models related to the event of a fire in a bi-directional road tunnel and buildings, traffic evacuation, earthquake and hurricane. This is due to ABM´s capacity to capture the effects of the interactions between heterogeneous agents that aggregate macro scale behaviors or trends emerge in order to explore emergent macro phenomena such as social or collective behaviors.

In this study, the province of Mancora (a coastal area in Peru) is taken as a case study site; and ABM is used to investigate evacuation behaviors, and their impacts, of residents in Mancora, as well as their interactions during a tsunami hazard.

In the model, pedestrians and cars are considered like agents who make a multi-criteria decision to be safe from tsunami. Then, three evacuation scenarios -including horizontal, vertical and horizontal and vertical- are simulated in NetLogo platform and Geographic Information Systems (GIS) data sets are used as spatial inputs. In addition, this research aims to elaborate on how evacuation shelters (i.e. horizontal and vertical shelters) can be enhanced by analyzing key factors derived of the decision-making behavior from the evacuees through of the Capacity Demand Index (CDI) during the shelter demand analysis.

Results show that evacuation time of agents affects the spatial distribution on safety structures during the complex process of tsunami evacuation; and vertical evacuation shelters are preferred by agents due to its closeness, thus being an effective strategy of evacuation feasibility.

Keywords: agent-based model, tsunami evacuation, decision-making, life safety.

OS-4-23: **RESILIENT COMMUNITY, A PROCESS OF COLLECTIVE CONSTRUCTION**

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Abstract

Experience developed in the community of Marquecca, Chuquibambilla district, Grau province, Apurímac region, Peru, located between 3,500 and 4,650 MASL, relocated from a floodable area to a safe area in an upper part, through a community planning process; zone exposed to frost, cold waves, strong winds and heavy rains.

The rains hit the baseboards, walls due to bad construction practices, openings in walls that cause cooling in houses and respiratory diseases in children and elderly. Inadequate use of water poured into the public road causing puddles and breeding of flies and mosquitoes.

The houses have multipurpose rooms, where productive practices are carried out, food storage, raising small animals which causes skin diseases and diarrhea, stoves that generate toxic smoke that pollute the environments and cause respiratory diseases.

Community with organizational conflicts, weakened by the lack of leadership of the authorities. Families with gender problem. Loss of local practices and knowledge.
The "Resilient Community" is a group of people and families, capable of adapting and responding to the adversities generated by climate events that affect the community; reassessing ancestral, organizational and technological knowledge and practices that jointly propose apply risk reduction actions and adaptation strategies to climate change, for the protection of their livelihoods.
A resilient community must:

• Recognize the risks of disasters and understand the dynamics of the territory, the causes that generate them, and the strategies to overcome the disasters. • Planning development through effective actions, technologies and knowledge, implemented with development stakeholders, security, responsibility that protects the livelihood of families. • Sharing scientific, technical, and local knowledge to formulate and apply strategies and technologies to respond to disasters. • Strengthen the organization as the engine for the effective functioning of the community, generating bonds of solidarity, support, equity for adequate reduction of disaster risks. • Developing local technologies through the transfer of local knowledge to generate mechanisms and strategies for disaster response and livelihood protection. • Coordinate and articulate with development processes, generating alliances with public and private institutions to achieve an effective impact of work. • Properly manage livelihoods to reduce causes of risk that affect the community, through land management, water management, rescue of local practices and technologies. • Assign budget and resources for risk reduction actions, to achieve the objectives of the action plan. • Establish mechanisms for monitoring and control, which will allow measuring the progress of plans and activities. • Engage all stakeholders, so that resilience is strengthened as a transversal process in order to create a real and true prevention culture.

This experience includes households with their own components, such as: • Food storage system (putucllus-take). • Improved stove, adapted to the family need and local culture. • Hot water, generated by the stove with a system connected to it and a water pipe. • Domestic water treatment, with filtration systems to use the water in the family garden. • Family garden for planting vegetables and medicinal plants. • Insulation of housing to protect against cold.

OS-4-24: **DISTRICT WISE MULTI-HAZARD ZONING OF BANGLADESH**

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Abstract

Bangladesh is stated as one of the most natural disaster prone countries in the world. Among different disasters in Bangladesh, tornado, flood, earthquake, and cyclone are major hazards according to the historical occurrences and their potential damages. For proper disaster management, recognition of the existence of the hazards and identification of the vulnerable areas are first important tasks. Thus, the prime objective of this study was to prepare a district wise multi-hazard zoning map of Bangladesh. For the purpose, firstly a complete district wise database of four disasters in Bangladesh was prepared. Comparing scenarios of these hazards in Bangladesh and their corresponding scales all over the world, suitable intensity scales and their corresponding damage risk levels were proposed. For calculation of district wise individual hazard scores, hazard factors and weighting factors for particular hazards were defined based on the organized district wise historical disaster database of Bangladesh through consultation with experts from relative fields. After that district wise individual and multi- hazard scores were calculated. Then the districts of Bangladesh were subdivided into three zones based on calculated multi-hazard scores. Finally, district wise multi-hazard zoning map of Bangladesh was prepared. The research findings are crucial and important for policy makers for decision making regarding disaster management strategies, i.e. planning for disaster prevention, mitigation, and preparedness actions.

Keywords: intensity scale, damage risk levels, multi-hazard, multi-hazard mapping, Bangladesh.

OS-4-25: **BACKGROUND AND IMPLEMENTATION OF URBAN RESILIENCY PROJECT IN BANGLADESH**

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Abstract

Bangladesh is the most disaster prone country in the world, and is highly exposed to a variety of hazards such as floods, cyclones and earthquakes. The Government of Bangladesh (GoB) has instituted disaster risk reduction policies and invested in infrastructure along coastal areas to mitigate the risk from floods and cyclones, primarily after the catastrophic cyclones of 1970 and 1991. Over the years, the GoB has demonstrated that investments in flood management and cyclone preparedness saves lives, reduces economic losses, and protects development gains. As a result, the Government's actions are often cited in the argument for proactively investing in Disaster Risk Management (DRM) globally. Despite these tangible gains, the vulnerability of Bangladesh's urban areas is not as well understood – or addressed – in the country's policy framework. With 7 million people living in the jurisdictional boundaries of Dhaka City Corporation, and 15 million in the wider Dhaka metropolitan area, the greater Dhaka area is particularly at risk. Land use planning regulation, and public service delivery in the urban areas of Bangladesh has failed to keep up with the pace of growth. The current regulatory environment is somewhat opaque and the enforcement mechanisms for urban development control do not address structural safety, creating an environment that lacks practical enforcement capability and accountability. In this context, physical and social vulnerabilities keep increasing and any hazards such as floods, building collapses, or earthquakes present a formidable threat to life and prosperity. Recent events serve as grim indicators of the extreme vulnerability of the built environment in Dhaka. The collapse of the Rana Plaza building in Savar on April 24, 2013 resulted in the death of 1,127 people and was the latest and most deadly in a series of structural failures in the city. The tragedy in Savar has prompted the GoB to consider how to reduce disaster risks in urban areas and simultaneously increase its capacity to respond more effectively to emergencies including disaster events. The Rajdhani Unnayan Kartripakkha (RAJUK) – or Capital Development Authority of GoB – was established in 1987 under the Ministry of Housing and Public Works (MoHPW). Its mandate is to lead planning and development in Dhaka City and peripheral areas, in coordination with city corporations, pourushavas and union parishads. RAJUK's jurisdiction extends beyond the administrative boundaries of the Dhaka City corporations to adjoining secondary cities. Amongst its responsibilities, the Building Construction Rules (2008) provide authority to RAJUK to enforce the national building code in addition to the Construction Rules themselves. Under this broad mandate, RAJUK plays an important role in steering the development of Dhaka and overseeing the implementation of construction codes and standards.

To better understand the physical risk, as well as the institutional and legal structures in place to manage the risk, the GoB has been working with the World Bank since 2012 in preparation for the proposed Urban Resiliency Project (URP). This collaboration has been supported by the Global Facility for Disaster Reduction and Recovery (GFDRR) to address seismic risk and the structural vulnerability of urban buildings and infrastructure. This support convenes government officials across ministries and agencies to: i) reach consensus on the level of seismic risk in Dhaka and hazards in other parts of Bangladesh; ii) increase the understanding of legal and institutional arrangements and "on-the-ground" practices related to urban DRM; iii) define parameters to make development plans and land use processes risk sensitive; and iv) establish a data sharing platform. This paper will discuss the above issues and the implementation mechanism of Urban Resiliency Project in Bangladesh from RAJUK's point of view.

Keywords: urban resiliency, earthquake, building code enforcement, RAJUK, Bangladesh.

OS-4-26: **INCREASING URBAN RESILIENCE THROUGH INTEGRATED MODELING OF IMPACT IN LARGE-SCALE DISASTERS**

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Abstract

The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), that was adopted at the Third World Conference on Disaster Risk Reduction on March 2015, has noted that "it is urgent and critical to anticipate, plan for and reduce disaster risk to effectively protect people and socioeconomic assets, amongst others, to strengthen community resilience". Thus, to contribute to urban resilience through harnessing recent advances in geo-simulation modeling and web-based dynamic visualization for communicating results. We pool the combined expertise of two research groups in Japan and Israel in order to develop a Dynamic Integrated Model for Disaster Management and Socio-Economic Analysis (DIM2SEA) within a new starting project. In here, we will combine dynamic simulations with the generation of synthetic big data such that every individual agent in the model has a socio-economic profile and an accurate spatial distribution. The generation of this detailed micro data from aggregate statistical allows for the socio-economic analysis of populations at risk, social vulnerability and distributional effects of disasters at varying spatial and temporal scales. In the temporal dimension, the model can simulate both, the short run effects of a catastrophic event, such as disruption of city life, infrastructure collapse, evacuation and rehousing along with the longer term changes to land use, and urban morphology. The model can identify whether short run shocks have long term impacts and whether the urban system over time 'settles down' to a new equilibrium in the aftermath of a disaster and whether or not this equilibrium is stable. This feature is critical in post-disaster recovery scenarios in order to "Build Back Better" and, therefore, increase urban resilience. The project consists on four major stages: (1) Household distribution and socioeconomic profiling, in this stage, census tract data is downscale through algorithms develop by the project into household and indiviudal level of representation; (2) Analysis and simulation of short term, disaster supportology and long-term models, in this stage, earthquake and tsunami damage assessment for buildings and human is estimated based on fragility curves and evacuation simulation; (3) Synthetic big data generation and analysis, in this stage, temporal and dimensional outcomes of simulation are stored into a synthetic database for analysis of emergent behavior and dynamic behavior of the system; (4) Web-based visualization for decision support, in this stage, the scenario is shown and the tools for assessing the impact are build into a web platform to ease the usability of this tool. Finally, the aim of this presentation is to introduce the objectives, plan and expected outcomes of this new project while sharing our recent research activities on simulation, agent-based modeling and socio economic analysis for earthquake and tsunami disasters.

Keywords: urban resilience, disaster modeling.

OS-4-27: **SOCIAL ENGINEERING OF POLITICAL AND INSTITUTIONAL MANAGEMENT FOR DISASTER RISK MANAGEMENT AT THE SUB NATIONAL TERRITORY**

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Abstract

This research was designed to determine the factors that are important to include in what might be called "social engineering of political and institutional management for Risk Management of Disasters". The territories that were included in this research, Ayacucho, Huancavelica, Junín, Ica and Apurimac, face complex scenarios due to their geographic location and geodynamic features, which establish a high level of exposure to recurring natural disasters such as El Niño, landslides, heavy rain, earthquakes and frost. This study took as reference variables related to essential aspects of "Making Cities Resilient" and the National Plan for Disaster Risk Management in Peru 2014-2021. This research used five instruments to collect information from primary and secondary sources, which have been processed quantitatively and qualitatively in five regional governments, five provincial municipalities and five public universities. The findings show that the key players do not know not only the risk involved, but also the influence of the characteristics of extensive risk in rural areas and urban margins; due to the vulnerability of these communities caused by the processes of disorderly urban development and poverty conditions. There is not effectively intervention in prevention and risk reduction. Thus, more than 60% of the exposed population is not part of the priorities because the risk has not been precisely identified and is not distributed evenly in the territory of the regions included in this research.

This study suggests that without the general or extensive knowledge of risk over territories and resources, any process of territorial and institutional planning is not possible to develop resilience conditions. The models of decentralized management of regional governments and provincial municipalities fail to articulate coherence between the management of administrative systems and program management transversely in the different lines of action of governance and fail to incorporate the private sector and the population effectively because political will and technical capacity is not achieved programmatic continuity in management processes. Knowledge and information for risk management will fail to be even a catalyst and determining element, if effective advocacy and positioning of the knowledge-generating institutions and technicians of government agencies is not exercised. Therefore it should be in value processes and mechanisms to ensure capacity building.

Keywords: social engineering, disaster risk management, political advocacy, capacity, planning and management.

OS-4-28: EQUIPPING A TRAILER VAN VEHICLE TO BE A MOBILE EMERGENCY OPERATIONS CENTER IN A DISASTER SITUATION

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Abstract

This paper presents a prototype Mobile Command and Control Post for Emergencies and Disasters, which was designed and implemented with the help of staff from the Technical Productive Education Center of the Army in the city of Ilo, recycling and reusing a Trailer-Van, and other Army equipment and material no longer in use, to adapt to this new function. This equipment is able to be used as a Mobile Emergency Operations Center in coordination with the National Disaster Risk Management System to provide support in emergency and/or disaster situations that may occur in any part of the country, and especially in areas that are difficult to reach, which serves as a reinforcement to increase the resilience of the affected localities. With high mobility and capacity for moving in all kinds of terrain (4x4 or 6x6 depending on the tractor), it meets the need for sending an Advance Command Post as soon as possible to an area affected by a disaster, without using the normal roads, which could be affected by the same event (bridges and highways collapsed), leaving several aid vehicles stranded, while only certain all-terrain trucks and ambulances can get there. This Mobile Command and Control Post is a trailer with a metal cabin, on a chassis with pneumatic tires, and a fording capability of more than 120 cm. Equipped with radio and different systems of telecommunications, including: VSAT satellite system, Wiracocha system, VHF and HF systems, video surveillance system, and satellite TV, it has accessories such as a generator set, which gives it autonomy in its electricity requirements, and it can have solar panels installed on the roof. Lower energy consumers for interior and external lighting, battery chargers for portable radios, and others can use the power-generating system of the tractor vehicle itself. It has towers for the installation of different antennas, satellite dishes, TV screen, and multimedia projector. These features allow: all-terrain access, recovery of communications in the affected area for the Command and Control of the support elements bringing aid to the affected population; and it enables the authorities responsible for dealing with the disaster to have, in real time, Information for Damage Evaluation and Analysis of Needs, to be transmitted to the different government agencies, including Early Response Units, Hospitals, etc., and information for decision making in all the emergency and disaster operations. When the communications systems is included in the Mobile Emergency Operations Center, as a Command Post, the planning and communications can be started simultaneously in less than five (05) minutes after displacement to the affected area, and it can be maintained in continuous operation 7 x 24 in a self-sufficient and autonomous way. It is hoped that this prototype will serve as a contribution to Risk and Disaster Reduction Engineering in the design, prevention, and implementation of practical, economic technological solutions, which will be available in all the countries.

Keywords: mobile emergency operations center, mobile incident command post, mobile command post, restoring communications in disasters.

OS-4-29: **DISASTER RISK MANAGEMENT: CASE OF CALCA, CUSCO, PERU**

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Abstract

The purpose of this paper is to show that disaster risk management (DRM) is not only a social process, but that the basis of that management is at the local level.

The district of Calca, is located in the province of Calca, Sacred Valley of the Incas, Cusco Region. It is a rural district with 18,500 inhabitants; 50% of its population lives in the capital city. It is located on the riverbanks of the Vilcanota River and is crossed by the Cochoq River.

Between 2007 and 2008 a local risk management experience was developed with the participation of the Provincial Municipality of Calca, the urban population and rural communities, the public and private entities of the district, international cooperation and the advice of the non-governmental organization, PREDES.

A very important sensitization process was carried out in order to know the risks of disasters through participatory processes, elaborating specific studies, with the purpose of formulating technical instruments for the DRM that were of local government management, but also to generate awareness in the population and public and private entities about the need to be organized, to establish levels of coordination to reduce existing risks, to prevent the generation of new risks and to be prepared to respond to a disaster.

When the population of the neighborhood of Piste, critical sector to floods, were elaborating their Community Plan in a participatory form, they realized that they themselves were responsible to their flooded houses for having built at the edge of the river. It is so that a group of them decided to cede 2 meters of their land in order to build a river defense and leave a path for maintenance. It was financed by the Municipality, the international cooperation and with the labor of the population.
An early warning system was established, where the Municipality communicated with the rural community of Pampacocha, the Health Center in the city and local radio.

The Municipality programmed projects to reduce and prevent risks, based on the DRM plans that were developed and were disseminated among the population.

The contribution to disaster risk reduction was incorporated as one of the criteria for prioritizing projects in the participatory budget, and 3 projects were approved to be implemented in the following year.

It was a process of awareness and training, where the beneficiaries were officials of the municipality and local public entities, but also children, youth and population in general, who participated in activities that raised their awareness of disaster risk.

In conclusion, in order to obtain results in DRM, all local actors should be involved: public, private and community, with technical instruments, maintaining sensitivity on risk, taking prevention and risk reduction measures in concert, and being prepared to face disasters.

Keywords: risk, disasters, participation, disaster risk management, technical instruments, dissemination.

OS-4-30: THE ROLE OF UNIVERSITIES ON DISASTER RISK REDUCTION IN THE COMMUNITY: UPRM CASE STUDY

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Abstract

Institutions of higher education are responsible to educate and form the new generation of professionals, citizens, and human beings for the benefit of their countries and the rest of the World. Public universities are founded with a mission of being leaders in teaching, research, and service with a relevant impact on the local and global communities. Universities are required to focus their educational agenda in impacting the sustainable future economic development, environmental quality, health, homeland security, and many other national priorities to warranty the social wellbeing of their citizens. These goals are achieved through appropriate formal and informal education through curricula, research initiatives, institutional services, and alternative learning initiatives.

Puerto Rico is a tropical Island located in the Caribbean. It is exposed to natural and technological hazards which under extreme states may turn into catastrophic events. The effects of natural events like earthquakes, tropical and extratropical storms and hurricanes, climate dynamics and change, ocean dynamics, soil instabilities, and many other natural phenomena produce extreme rainfall, water surges, winds, erosion, structural instabilities, landslides, social chaos, ecological changes, and infrastructure deterioration, among others. Being an Island also brings the burden of accessibility, mobility, and sustainability. The UPRM, a federal Land Grant, Sea Grant and Space Grant institution, is the main public engineering and technological institution in Puerto Rico with over 100 year of existence and contribution to the public interest. Its prominent College of Engineering working as a team with the College of Agriculture Science, the College of Business Administration, and the College of Art and Science have been responsible to form a main portion of the local and international work force providing professionals and leaders who are and have been responsible to handle the risk to reduce natural and technological hazards that cause major disasters. Its accessibility to a highly diverse network in Latin America, the Caribbean, Central and South America, and North America enriches the inclusion of a diverse student and faculty community.

The University works closely with local, state, federal and international government agencies, research and education sponsoring institutions, consortium of universities, professional and social organizations, and the general public to advance knowledge, learning, and service activities for the benefit of reducing disasters risk and improving the resiliency of communities exposed to natural and technological hazards. Research work has impacted the curriculum, the administrative infrastructure, and the presence and visibility of the university in the disaster management business, either public of private. This paper addresses multiple UPRM initiatives that have contributed to a more resilient and better prepared community to manage and resist disaster risks in the Island. It also addresses various initiatives that involve not only the university community but also the external community as a whole to help be better prepared to understand and minimize damages due to natural and technological hazards. The institution still has to overcome significant challenges to become a leader and an essential player in the whole community approach to minimize the risk the community faces due to various hazards. In conclusion, the University must be a key role player in the community preparedness for being disaster resilient.

Keywords: education, university, disaster, multihazard, risk reduction, resiliency.

OS-4-31: **RISK REDUCTION IN VULNERABLE NEIGHBORHOODS LOCATED ON HILLSIDES OF INDEPENDENCIA DISTRICT, LIMA-PERU**

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Abstract

This paper highlights the enormous challenge of earthquake risk reduction of hillside dwellers, taking as an example neighborhoods intervened since January 2015 (Villa El Ángel, El Volante II, El Volante III and Santa Cruz) by the program named "Risk Reduction in Vulnerable Areas of Independencia district, Lima Province" as a joint work between an NGO, local government and foreign cooperation (OFDA/USAID).

The vulnerability conditions in these neighborhoods are similar to those of more than one million inhabitants in the Peruvian capital, as a result of hillside squatting without adequate planning, fragility of informally built buildings, poverty situation and lack of preparation to respond adequately to a disaster, such as the scientifically predicted highly destructive earthquake off the central coast of Peru.

In these neighborhoods, there are 530 dwellings located on hillsides (more than 2,500 people) whose occupants became aware of their risk exposure, complemented with emergency preparedness recommendations, such as the elaboration of a family plan, basic first aid and emergency water, sanitation and hygiene.

In the participatory diagnosis process, we found that a increasing risk is the presence of mafias promoting squatter settlements in increasingly higher slopes in already occupied hillsides. Two implemented pilot afforestation interventions are the basis for a municipal program that will allow risk reduction through urban control by creating a physical limit to stalking squat attempts, soil stabilization and protection against falling rocks, in addition to environmental improvement.

If we succeed in avoiding risk increase with adequate prevention and planning, we will have a better chance to focus on risks reduction with neighborhood approach on existing vulnerable areas, such as housing reinforcement and urban land use with a disaster risk management approach.

This initiative involved the local government, first strengthening its capabilities and then developing the management instruments required by the Sinagerd Law (Law No. 29664) and allocating human resources and necessary coordination for workplan´s agreed actions by the Working Group on Disaster Risk Management.

Among encountered problems, we have the frequent rotation and lack of availability of municipal officials, low budget allocated to risk management, bureaucracy and continuous squat attempts that hamper potential afforestation areas, even in adjacent spaces to those already forested.

Engineering alone, despite its great breakthroughs, is not enough to reduce the present urban risk and should be rather a multidisciplinary effort, promoting awareness and capacity building for vulnerable population, authorities and local officials, the exercise of effective urban control, and State, international cooperation and private sector support.

Keywords: urban risk, risk reduction, housing vulnerability, community approach, disasters, participation, disaster risk management, awareness, hillsides, afforestation.

OS-4-32: DETECTION OF COLLAPSED BUILDINGS AND LANDSLIDES DUE TO THE 2016 KUMAMOTO EARTHQUAKE FROM LIDAR DATA

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Abstract

On April 14, 2016 at 21:26 an Mw 6.5 earthquake occurred in Kumamoto prefecture, Japan. Soon after, about 28 hours later, another earthquake of Mw 7.1 occurred. Thus, the first event was designated as the foreshock and the second one as the mainshock. Both epicenters were located close to rural areas, such as Mashiki town, Kashima town, Mifune town and Nishihara village. Therefore, the earthquake produced extensive damage to the infrastructure and human losses. In this paper, building collapsed and landslide produced during the mainshock are detected from a pair of digital surface models (DSM), before and after the mainshock, obtained from airborne Lidar data. Based on the difference of the building height between the pre-event DSM and post-event DSM, the collapsed buildings and undamaged buildings are recognized. Our results point out that Lidar technology is an important tool in disaster management.

Keywords: Lidar, the 2016 Kumamoto earthquake, building damage, landslides.

OS-4-33: **PLANNING OF CITIES AFFECTED BY NATURAL PHENOMENA IN ICA REGION - PERU**

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Abstract

Urban growth is the world phenomenon with the greatest impact on humanity, as the last century our planet has become predominantly urban. In this context, cities face the increasingly large and urgent challenges of society, including unemployment, climate change and vulnerability to natural and man-made disasters. In the vast majority of developing countries we find unplanned urban growth, which leads to inefficient, hostile and risky cities. The lack of participatory planning in cities is evidenced by the occurrence of an intense natural or anthropogenic phenomenon, which drastically paralyzes its functioning. In that sense, urbanization, far from being a process of development and improvement of living conditions, has become one of the main causes of risk.

Peru, a mega diverse country, is also an area of intense natural phenomena due to its geomorphological and climatic characteristics, including its location on the Pacific fire belt and El Niño phenomenon. It makes this place a recurrent scenario of earthquakes, tsunamis, huaycos, floods and droughts. The cities of Ica and Pisco as well as the entire Ica region have suffered due to the lack of adequate planning, becoming vulnerable cities as they are constantly exposed to risk.

As a background: After the floods of Ica caused by El Niño phenomenon in 1998, UNDP in coordination with the Peruvian State, through CEREN, then INDECI and the San Luis Gonzaga University of Ica, developed a sustainable city model, which means a safe, ordered, healthy, attractive, efficient and environmental and cultural habitat respectful city. For this 1st stage Sustainable Cities Program it was clear that the priority was the safety of the cities. Then, when in 2007 the earthquake with epicenter in Pisco affected the same region, it was verified that in spite of the disaster risk management studies done and approved for each city, the action plan wasn't implemented by neither local State administrative authorities nor municipalities. It leaved us very significant lessons regarding city planning, which is now focused on community risk reduction, self-organization capacity increasing and adaptation to unforeseen changes.

From this period onwards, transcendental changes and country agreements have taken place at local and global level. Now Disaster Risk Management and Adaptation to Climate Change are mandatory State Policies that must call to dialogue all the actors: local authorities, academia, enterprise, civil society, state, cooperation, among others, in order to comply with the agreements adopted in the Sendai Framework for Action to achieve resilient cities.

Keywords: local actors, risk, training, resilience.

OS-4-34: EVALUATION OF PARAMETER AVS30 FOR ESTIMATING SEISMIC AMPLIFICATION IN THE CITY OF LIMA, PERU

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Abstract

The city of Lima is on the Peruvian coast, which forms part of the Pacific Ring of Fire, characterized by showing high seismic activity. The seismic history of the city dates back to ancient times, and numerous destructive earthquakes have been reported from Colonial times to the present.

Different studies have shown that the seismic resistance of soils can be estimated on the basis of the dynamic parameters of the strata that make up the soil profile. One of these parameters is the Shear Wave Velocity (Vs), which depends on the rigidity of the soil and is usually found by geophysical explorations.

In recent years, a significant number of microzonation studies have taken into account the value of AVs30 (average shear wave velocity of the first 30 m) as a means of estimating amplification or performing soil classification. The AVs30 value has been adopted by the International Building Code as a parameter for classifying rigidity of the soil. However, some authors have criticized the use of the AVs30 and have proposed the use of 10 m instead of 30 m in cases where the layer of soft soil is thin in the area.

In this study, the average shear wave velocity is evaluated at different depths to find the depth at which there is the best correlation with the amplification. In addition, the amplification will be found based on the function of transfer of seismic profiles found in the field with MASW tests and from microtremor arrangements.

Keywords: shear wave velocity, MASW tests, seismic amplification, AVs30.

OS-5-1: **A NEW METHOD FOR VOLCANIC ERUPTION FORECASTING APPLIED WITH SUCCESS ON UBINAS VOLCANO**

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Abstract

Between February 2006 and August 2009, the Observatorio Vulcanológico del Sur (OVS) belonging to the Geophysical Institute of Peru (OVS-IGP) recorded the seismic signals of the first eruption of the Ubinas volcano occurred in 37 years. Upon studying such records, it was possible to identify seismic signals closely associated with rapid magma rise and imminent explosions. With this experience, four years later, when a new eruptive process began, the specialists of the OVS-IGP were prepared to make forecasting of its explosions. This work explains the method found whose high effectiveness has been demonstrated during the 2013-2015 eruption which presented three periods of intense activity separated by lapses of relative calm: (1) Period 1, from 6/3/2013 to 29/10/2013, highlighting the occurrence of 9 explosions in seven days. (2) Period 2, from 01/01/2014 to 23/11/2014, where it occurred the greater activity of the entire eruptive process. (3) Period 3, from the 7/12/2014 to the 7/11/2015 where the rise of magma remained a moderate explosive activity. The analysis of seismic signals shows that in each period a sequence of particular type of earthquakes (ie a "seismic pattern") occurring at the beginning, during and after the rapid rise of magma to the surface, which culminates with explosions. In parallel, this seismic pattern has been contrasted with satellite thermal image data from the crater, obtained by the MIROVA system of the University of Turin (Italy). We found a direct association between the advent of seismic events of a particular type called "HIBRID earthquakes" and the arrival of magma to the surface evidenced by the satellite thermal image, which meant a very high probability of explosion.

The seismic pattern that accompanies the activity of the volcano towards its final explosive activity corresponds to: (1) "Tornillo" earthquakes and "Volcano-Tectonic" earthquakes occur. The tornillos are associated with circulation of fluids (water, steam, gases and magma) into cavities inside the volcano. The "Volcano-Tectonic" earthquakes are associated with rock fracture due to immense pressures. (2) "Tremors" occur. They are related to perturbation of the hydrothermal system by proximity of the ascending magma body. (3) "Hybrid" earthquakes occur. They are directly associated with the ascent of magma in its last kilometers before reaching and / or reaching the surface. A few moments later the MIROVA images detect the hot body. (4) Finally, "Explosions" occur. At that time, the seal or plug is destroyed in the most superficial zone of the volcanic conduit. (5) "Spasmodic tremors" immediately occur. They are associated with the expulsion of large volumes of ash and gases into the atmosphere, which is visible for many kilometers around the crater. The finding of this seismic pattern during the eruption of the volcano Ubinas has allowed to predict the behavior of the volcano as well as to give the warning of imminence of explosion to the authorities of the SINAGERD local and national. This is an example of the great importance of science to protect lives that may be in imminent danger.

Finally, recently in October 2016, the Self Potential (SP) geoelectric method was successfully applied to identify the disturbances that magma causes to the hydrothermal system just before an imminent explosion. All this new scientific knowledge gained has further increased the prognostic capacity of the OVS.

Keywords: eruption forecast, volcanic earthquake, volcanic explosion, eruption warning, life protection.

OS-5-2: **MCDM METHODS FOR THE IDENTIFICATION OF INTERVENTION STRATEGIES FOR SEISMIC RETROFITTING OF SCHOOL BUILDINGS**

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Abstract

Resilience of a city depends strongly on both the continual operation of the strategic buildings and the damage level of the structures. Unfortunately in many cities of the world these aspects represent weak points and limited resources reduce the possibilities to address the problem. Therefore in these cases, it is necessary to propose optimal and massive interventions avoiding waste.

Prioritizations and selection of best retrofitting alternatives on a large territorial scale must consider technical, economic and social criteria. The choice of criteria is one of the key issues especially for strategic buildings, such as schools and hospitals, which generally have a highly vulnerability and further problems related to the choice and the implementation of the retrofitting intervention. In this context, the Multi-Criteria Decision-Making (MCDM) methods can be used to provide a valuable support to deal with the intricate problem of identifying the solution of optimal intervention.

In this paper we focus on definition of the optimal retrofitting alternative. Our study case is a school building designed and constructed in the '80s, according to the old Italian seismic code. A wide experimental in situ and laboratory campaign has been done in order to know and understand its main elements.

Different retrofitting alternatives have been considered and two MCDM methods have been applied and compared in order to select the optimal solution. According to the current use of the buildings, the problem of disruption of occupancy has been a fundamental topic and particular attention has been devoted to the safety conditions and operational step in construction site. The possibility of a next strength upgrade for incremental retrofitting has also been assessed. These and other aspects have been pondered in order to promote procedures able to define optimal intervention strategies that can be easily extended in every city, so as to reduce the seismic risk of schools and increase the resilience of cities.

Keywords: city resilience, school buildings, retrofitting strategies selection, MCDM methods.

OS-5-3: **DAMPING COEFFICIENT (BD) FOR SEISMICALLY ISOLATED STRUCTURES IN PERU**

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Abstract

Technical Standard E.030 “Earthquake-resistant design” of the National Building Regulations, approved by Supreme Decree N°003-2016-Vivienda on January 24, 2016 indicates that: “It is permitted to use seismic isolation or energy dissipation systems in building, providing that the provisions of Peruvian Standard E030 are complied with, with regard to the minimum shear force at the base and maximum permissible floor structure distortion; and insofar as are applicable the requirements of the American Standard: “Minimum Design Loads for Building and Other Structures”, ASCE/SEI 7-10, Structural Engineering Institute of the American Society of Civil Engineers, Reston, Virginia, USA, 2010.”

Technical Standard E.030 says that: “New buildings of A1 category shall have seismic isolation at the base.” However, in Peru there is no design procedure for buildings with seismic isolation, so the damping coefficient will be proposed based on the effective damping of the isolation system for the design of seismically isolated structures in Peru.

To determine the damping coefficient (BD), the following will be done: A: An assemblage of accelerograms of Peruvian earthquakes will be selected and their acceleration response spectrum for 5%, 10%, 15%, 20%, and 30% will be found, to subsequently find their ratio with respect to the spectrum of 5% of damping. B: Results of isolated buildings are compared with the values of the proposed factors and those of the ASCE7-10 Standard.

Finally, a comparison will be made of the damping coefficient of the seismic records considered with those obtained from the effective damping and the spectrum of Peruvian Standard E030-2016.

Keywords: damping, isolated, seismically, structures, coefficient.

OS-5-4: **PRIORITIZATION METHODOLOGY FOR SEISMIC RISK REDUCTION IN PUBLIC SCHOOLS. STUDY CASE: LIMA, PERU**

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Abstract

School buildings in highly seismic areas are under permanent hazard. This situation is extremely critical for student population who attend public schools with high vulnerability factors such as insecure infrastructure, poor community preparedness and deficient conditions due to social exclusion. Risk reduction becomes a challenge to the government because of the great amount of population at risk and the lack of capacity of the authorities to attend them all simultaneously.

Academia and international agencies have been working to develop risk reduction strategies for schools, e.g. retrofitting infrastructure, preparedness and planning. Although it involves different areas of knowledge, few opportunities have been created for interdisciplinary and participatory work in order to create a comprehensive and holistic vision of the problem.

In this paper, a prioritization methodology based on indicators or rankings is presented. The methodology takes into account factors related to weaknesses or capabilities in all stages of risk occurrence: classroom, school, environment, and city.

Physical factors are expressed by means of two indicators of seismic risk: loss scenarios and average annual loss. Social factors are taken into account from experts opinions, and are combined by MCDA method. Thus, schools are classified into different levels of priority according to their physical and social capabilities.

The proposed methodology is applied to the case of public schools in Lima, Peru. The consequences of applying three risk reduction strategies (two government proposals and the methodology proposed in this paper) in different seismic scenarios are compared. The comparison is done in different areas: economic losses due to structural damage, operation of schools, accessibility, areas suitable for emergency care, etc. Risk maps representing the different areas are obtained. The positive and negative consequences of each methodology are assessed. After comparison, the methodology proposed is validated by the positive differences shown on maps with respect to those implemented by the government.

Keywords: mitigation, public infrastructure, decision making, risk assessment.

OS-5-5: **PROBABILISTIC SEISMIC RISK ASSESSMENT IN SCHOOLS AND HOSPITALS IN LIMA CITY WITH CAPRA PLATFORM**

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Abstract

The large-scale seismic events in Peru throughout history caused extensive damage and loss of life. The state of critical infrastructure is crucial in reducing the physical vulnerability of the city, and appropriating a response to emergency attention. Lima, the capital city, has the largest number of schools and hospitals affected by earthquakes and by the poor maintenance of public infrastructure. The Pontifical Catholic University of Peru (PUCP) and the World Bank implemented CAPRA (Comprehensive Approach for Probabilistic Risk Assessment) in September 2011, under the Technical Assistance Project (TAP) for probabilistic seismic risk assessment of Lima's hospitals and schools. This strategic partnership strengthens institutional capacity development on model generation hazards and disaster risk management, as well as its integration into public policies and social development programs.

This research's objective is to quantify the risk from the probabilistic assessment of its components: hazard, vulnerability and exposure, in terms of probable economic losses regarding infrastructure damage. The methodology proposed by CAPRA program is based on information obtained about the architectural and structural characteristics, in order to study their possible behavior in normal and crisis period. It considers five steps: collection, review and processing of information on seismic hazard; definition of vulnerability information from previous studies and visits; georeferenced database generation; seismic risk calculation regarding the estimated values Average Annual Loss (AAL) and Probable Maximum Loss (PML) and database consolidation and final report on the study results.

The results confirm the physical vulnerability of analyzed facilities. For instance, after an 8.2 magnitude earthquake with an epicenter on the coast of Lima, educational and hospital infrastructure would be inoperative by 92% and 83%, respectively. In that context, schools AAL (US$ 17 million) represents 3.3 % of its replacement value, while hospitals AAL (US$ 11.6 million) represents 2%. This amount, known as the technical premium, is the base for the annual insurance premium regarding earthquake protection, which is high and uncompetitive compared with the values of the insurance sector market.

The study seeks to define criteria and recommendations on issues of risk transfer, planning for emergency response and funding for post-disaster reconstruction. In addition, this study could be used for the development of seismic risk mitigation plans of essential urban infrastructure.

Keywords: risk assessment, economic losses, public infrastructure.

OS-5-6: **CONTRIBUTIONS FOR IMPROVING HOSPITAL INFRASTRUCTURE BASED ON THE HOSPITAL SAFETY INDEX: CASE STUDY PERU**

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Abstract

The Hospital Safety Index (HSI) is a study that forms part of the Safe Hospitals policy, where a general analysis is made of the vulnerability of health-care facilities during a disaster, touching on three aspects: Structural, Non-structural, and Organizational-Functional. Using evaluation guidelines recommended by the WHO/PAHO, we obtain a numerical value that indicates the likelihood of a health-care facility to be able to continue working during a disaster. However, it has criteria and considerations that are too general and need to be improved, changed, or made more precise in their purposes, which are described and analyzed; and the same is true of the national procedures currently in force, with regard to their implementation within Peru's Health System. In this article, contributions are made to the criteria of architectural design and evaluation, and regarding a detailed intervention plan for improving the hospital infrastructure and the workability of a hospital during and after a disaster. The type of disaster focused on is an earthquake.

Keywords: HSI, hospital infrastructure, vulnerability, safe hospital, WHO/PAHO.

OS-5-7: **A MODEL FOR MEASURING VULNERABILITY IN URBAN TRANSPORT NETWORKS IN INTERMEDIATE CITIES: THE CASE OF AYACUCHO**

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Abstract

The evaluation of vulnerability in cities can be very broad. One of the main approaches can deal with the lifelines that enable a city to keep its basic systems working; if these lifelines are interrupted by some natural or man-made phenomenon, they can reduce the response functions of the emergency systems. If we understand that the transport system is one of the city's lifelines, we can systematically analyze what the surrounding hazards or threats are. And we also need to analyze the degree of response on the part of the transportation infrastructure. The combination of the two answers can help us determine how prepared these systems can be to different kinds of threats, and to maintain a minimum degree of displacements.

Nowadays, most cities have integrated lifeline systems; the interruption of transportation lines affects, and is interdependent with, the other lifelines, such as energy, telecommunications, and smart systems. Ayacucho is an intermediate city (some 170 thousand inhabitants); its historic city center is one of the most attractive to tourists in Peru, with its narrow streets dating back to Colonial times, which now carry different means of transportation that they had not originally been designed for.

The analysis in this research work, performed with topological networks, enables us to identify the most vulnerable stretches, using the values of Accessibility of Urban Transport Systems; and these stretches could become more vulnerable in the event of an occurrence of an extraordinary nature, in terms of climate, earthquake, or man-made disaster (fires or other extraordinary activities). The model is presented to quantify the Vulnerability Index of one link or a set of links of an urban Transport System in a specific scenario, as a consequence of interruptions in each link, in order to analyze the impacts on traveling times or the unsatisfied travel demand; during the course of the study, a Delaunay Triangulation Algorithm was used to discretize the city perimeter, where the polygon will be obtained of the belonging areas of the bus stops. The study determines the most vulnerable links and their resilience; these results are of vital importance in the strategic planning of the city and for proposing improvements in an urban transport system.

Keywords: vulnerability, transport systems, intermediate cities, resilience, urban lifelines.

OS-6-1: AN ANALYSIS OF THE DYNAMICS OF SEISMICALLY ISOLATED STRUCTURES TAKING INTO ACCOUNT THE ROTATIONAL COMPONENTS OF SEISMIC EFFECTS

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Abstract

The analysis of seismic isolation systems (SIS) is generally performed under kinematic excitations defined by horizontal ground motions. The influence of vertical and rotational components of earthquake excitation on the response of SIS is practically not investigated. However, these excitations significantly affect the oscillation behavior of the idealized system: Protected Superstructure (PS)-SIS and may reduce the effectiveness of SI devices.

The influence of the rotational excitations can be clearly seen on the example of the pendulum type SIS. The ground rotation and thus the base rotation of the structure leads to an asynchronous motion of different pendulum devices and to their different longitudinal deformation. Thereby, the tension and compression forces of the devices are different. This leads to the twisting (torsion), rocking and vertical displacement of the seismically isolated structure. Similar considerations can be made with regard to seismic isolation based on the application of rubber bearings. This paper investigates the influence of the above-mentioned effects.

A mathematical model that allows investigating the influence of not only horizontal but also vertical and rotational components of earthquake excitation on the response of SIS is analyzed. This mathematical model consists of several groups of equations. The first group of equations describes the relationship between the PS generalized coordinates and the displacements of the PS attachment points to pendulum devices or SI bearings.

Wherein, PS (superstructure) is assumed to be an absolutely rigid body, i.e. its dynamics is described by six coordinates. The second group of equations describes the relationship between the devices internal forces (or bearings internal forces) and the PS attachment points displacements.
The third group of equations describes the dynamics of the PS under the above-mentioned forces and external kinematic effects. For the pendulum type SIS in the absence of rotational excitations and absolutely rigid devices these equations permanently transform into the famous equations of oscillations of the physical pendulum.

The paper presents results of numerical analysis. This analysis is based on the variation of the elastic and inertial parameters of the mathematical model, as well as on the external effects.
The analysis purpose – Determine the degree of influence of rotational ground motions on the SIS efficiency.

Keywords: seismic isolation, rotational components of seismic effects, influence of rotational ground motions.

OS-6-2: **APPLICATION OF SEISMIC ISOLATION IN THE RETROFIT OF HISTORICAL BUILDINGS. PRESERVATION OF CULTURAL HERITAGE IN AREQUIPA-PERU**

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Abstract

This paper presents a research on the retrofit by means of seismic isolation of Old Chapel of Virgin of Chapi Sanctuary, situated in Arequipa, seriously damaged by June 23, 2001 Atico Earthquake (Mw8.4).

Based on the obtained results we can conclude the seismic isolation is the most suitable solution for the seismic retrofit of the structure, because it allows to obtain a good structural behavior without compromising the architectural characteristic of the superstructure.

A new isolation method is then proposed for the seismic retrofit of historical buildings. We need to remark that traditional techniques, based on the increasing of strength and ductility, are not suitable for the seismic rehabilitation of cultural heritage buildings. Besides, historical buildings often present weak points, such as an irregular form both in plan and in elevation and shallow foundations.
Furthermore, under earthquakes of high intensity, traditional structures can just guarantee against the collapse, but cannot avoid heavy damages both to structural and non-structural elements. As a result, for cultural heritage buildings, a suitable equilibrium between the two opposite requirements is usually accepted, i.e. a partial seismic improvement is obtained preserving their original monumental characteristics, identity and historical value. It is worth noting that, due to the historical importance and to the daily presence of tourists, the seismic rehabilitation of historical buildings is quite delicate, aiming at the protection of both human life and cultural heritage.

In this way the proposed technique is based on the realization of an isolated platform under the building foundation without any intervention on the building. Moreover, this method can be used for both single buildings and set of buildings, typical of Peruvian historical centers.

Thereby, base isolation could be a suitable solution for the rehabilitation of historical structures. It aims to reduce seismic actions, thus avoiding significant damages to the structure and its contents even under strong earthquakes, and presents very low interference with the structure itself.

Keywords: seismic isolation, historical buildings, cultural heritage.

OS-6-3: **VISCOUS AND FRICTION DAMPERS FOR THE SEISMIC PROTECTION OF THE TALLEST BUILDING IN JAPAN**

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Abstract

Seismic protection of buildings in Japan, perhaps the world's most earthquake-prone country, is a significant engineering challenge. To ensure structural stability and safety against the extreme seismic forces induced by the destructive earthquakes that hit the country, high technology, innovative solutions, and very strict design requirements are necessary. When planning and designing the Abeno Harukas terminal building in Osaka, a 300-m high building which is the tallest building in Japan, these standards were set even higher. In order to meet these demanding requirements, it was necessary to design a highly efficient structure with high energy dissipation capacity. Therefore, it was crucial that the energy dissipation devices to be installed in the structure were able to provide a stable and high damping, to effectively reduce swaying and dissipate seismic energy. This paper presents a general description of the high-rise building and its structure, and pays special attention to the characteristics and performance of the dampers installed in the structure, i.e. viscous and friction dampers. Viscous dampers are piston-type devices that dissipate seismic energy into heat by the flow of a fluid through an orifice during seismic excitations. On the other hand, friction damper devices consist of several steel plates rotating against each other, where the developed friction allows for energy dissipation. The damping force of the viscous damper is velocity-dependent, while for the friction damper case it is displacement-dependent. Due to this fact, when combined in the same structure, they provide a more constant damping to effectively reduce vibrations while increasing the building redundancy. The current paper provides the description and results of the experimental tests carried out in both types of dampers, in order to ensure that the strict project requirements and specifications were met or exceeded. The obtained experimental results, along with the conclusions of the numerical analysis of the building structure, highlight the suitability of these devices to effectively control the seismic response of the tallest building in Japan against extreme earthquakes.

Keywords: seismic protection, high-rise building, damper.

OS-6-4: **SEISMIC EVALUATION OF MASONRY INFILLED PANELS UNDER NEAR-SOURCE PULSE-LIKE GROUND MOTIONS**

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Abstract

A structure's appropriate seismic performance needs available strength and deformation capacities of the components to be more than the earthquake imposed necessities on the structure. Due to structural behaviour during an earthquake, performance evaluation should be carried out by nonlinear time history analysis procedure and according to selected ground shakings.

Masonry infill walls are mainly used to increase initial stiffness and strength of reinforced concrete (RC) frame buildings. It is mainly considered as a non-structural element. Using Incremental Nonlinear Dynamic Analysis (IDA) method, the effects of illustrious characteristics of masonry infills on the reinforced concrete (RC) frames performance, is investigated. Two in plan symmetric reinforced concrete frames, one 6-story and one 10-story (as mid-rise buildings), are modeled to evaluate the reinforced concrete frame building with brick infill panels. The masonry-infilled panels are modeled by means of equivalent diagonal strut elements, which can only carry compressive loads, characterized by an idealized degrading hysteretic behavior. IDA analysis is to be carried out on the models such as bare frame and strut frame, which is performed by the use of computer software, OpenSees, from which different parameters are computed. Twenty bidirectional ground motions used to simulate the earthquake. The models designed for two different scenarios depending on the distance to the fault, (i.e. 10 near-fields and 10 far-fields ground motion) and applied along the structural axes of the buildings. For each individual pair of accelerograms corresponding to the same ground motion (near and far fault) the values of period of models are calculated. The results show that infill panels increase the stiffness of the structure and decrease the periods of the models. In also found that, masonry infills, provides a consequential contribution to decrease the dissipation energy demands in elements and significantly reduce the maximum displacements of frame, if present in all stories.

Keywords: near-field earthquake, masonry-infilled panels, dissipation energy demands, maximum displacements, seismic vulnerability.

OS-6-5: **PRE-SIZING CRITERIA FOR BUILDINGS WITH SEISMIC ISOLATION SYSTEMS IN PERU**

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Abstract

Since the early years of the 1980s to the present, a significant amount of research, technological development and practical applications have been done in the field of seismic isolation of buildings. Although there is significant background about it, there are not provisions at level of regulation of earthquake resistant design in Peru. However, there is now a requirement for the use of certain seismic protection systems for essential structures in health facilities. In the case of analysis and design of buildings with these systems, the Peruvian earthquake-resistant standard adopted as the main reference the ASCE/SEI 7-10 code.

In this paper, some criteria are presented to estimate quickly relevant parameters of the structural response of buildings with seismic isolation. The answer is calculated based on simple models whose parameters are considered representative of the building, using dynamic analysis with accelerograms based on the seismicity of the country. Suitable properties for isolation systems are estimated in order to optimize the structural behavior of the isolated buildings under seismic excitations.

Based on the dynamic analysis indicated, criteria for the analysis and design of buildings with seismic isolation, based on control of accelerations and displacements, are developed. The acceleration is an important variable of the structural response; its limitation is an appropriate way to control the potential damage of non-structural components in the building. The displacement control limits the drifts for both structure and isolators.

Finally, a case study is shown, consisting of a building with an isolation system based on reinforced elastomeric isolators with lead core, whose characteristics are pre-sized with the above criteria. Then the building is evaluated by time-history analysis with accelerograms representative of seismicity on firm ground, obtaining satisfactory results, consistent with the objectives of earthquake resistant building design.

Keywords: seismic protection systems, base isolation, earthquake resistant design criteria, essential buildings.

OS-6-6: **SCENARIO OF SEISMIC SOURCE AND SOIL SHAKING FOR THE WESTERN EDGE OF THE CENTRAL REGION OF PERU**

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Abstract

The last earthquake occurred in Japan (2011), demonstrated the difficulty of assessing seismic risk based solely on historical and instrumental seismicity information. To improve the risk assessment of major earthquakes, a methodology is proposed for the western edge of the central region of Peru to estimate the sliding distribution of the future large earthquake based on an interseismic coupling distribution model, as well as historical earthquakes. The sliding model obtained from geodetic data defines the large scale characteristics of the asperities associated with the great earthquake, being appropriate for the simulation of long period waves. In order to simulate strong motion of soil, heterogeneities are added on a small scale in order to simulate high frequencies. To achieve this purpose, the broadband source model is constructed by summing the short period slippage obtained from a Von Karman power spectral density function and the slip model inferred from geodetic data. Using these slips models and assuming several locations of hypocenter, we calculate the values of acceleration of the soil in Lima. These values are added to the effects of site obtained from microtremores measurements and geotechnical data. The values of acceleration obtained for Lima are greater than 0.6g, reaching in coastal zones values of 0.9g.

Keywords: asperities, ground motion, large earthquake, Peru.

OS-6-7: **RAPID SEISMIC RISK ASSESSMENT OF STRUCTURAL COLLAPSE BASED ON OPERATIONAL MODAL ANALYSIS**

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Abstract

Recent catastrophic seismic events, especially in Latin America, have shown the need to provide a rapid seismic risk assessment in order to prioritize retrofitting or evacuation of existing reinforced concrete buildings before an aftershock hits the same region; note that most buildings designed and erected before the 80's in Latin America followed designing rules which were in its first stages of development and it may not conform with the most recent findings and acceptable structural safety levels. Although, statistical tools and structural health monitoring techniques are becoming more accessible, it still demands a high investment on data acquisition equipment, sophisticated numerical analysis, and well trained specialists to perform a proper risk analysis on seismic affected structures. This paper aims to present a simplified method, based only on the natural frequency of a structure, to verify the susceptibility of a reinforced concrete building to second-order effects. The method can be used given the results of a simple operational modal analysis. The formulation behind the method presented in this paper is based on the D'Alembert's principle, Rayleigh's method, and the use of generalized coordinates to represent the dynamic behavior of flexible structures. The simplified identification factor proposed herein and named represents, in short, the ratio between second-order and first-order overturning moments for the most loaded columns of the structure. Therefore, can provide a reliable factor to assist in a risk decision-making process to prioritize retrofitting or evacuation of existing reinforced concrete buildings and defining safe aftershock sheltering zones.

Keywords: modal analysis, rapid assessment, concrete buildings.

OS-6-8: **CONTROL SYSTEM FOR A THREE-DEGREE-OF-FREEDOM SHAKING TABLE DURING SEISMIC SIMULATIONS TESTS**

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Abstract

Earthquakes occurred in South America have shown that buildings are highly vulnerable against severe movements and that our design codes must keep on developing. The recent earthquakes occurred in Peru (2007), Chile (2010) and Ecuador (2016) have caused hundreds of deaths.

In order to mitigate this seismic risk, seismic simulations tests have been performed on shaking tables. These platforms allow us to simulate the movement generated by the earthquakes. In particular, electrohydraulic tables allow us to simulate strong motion earthquakes because they are composed by a hydraulic system that can generate large forces in the platform by means of a combination of servovalves and actuators. The seismic simulation tests on shaking tables allow a better understanding of the response of structural systems of concrete, steel and masonry. When the test structure is very massive there is a very pronounced interaction between the table and the test structure. This interaction is even more complicated if the test structure suffers damage or behaves in the nonlinear range.

In this paper, the interaction between the shaking table and the test structure is analyzed. First, analytical models based of viscoelastic mechanical systems are built for one and two degrees of freedom. With the mathematical tool of the frequency domain analysis, transfer functions are computed and it is shown that uniaxial shaking tables distort the seismic signal for very massive test structures. Closed-loop control systems constitute a very powerful tool to reduce the interaction by means of automatic feedback systems. These control systems reduce the interaction through compensation components that adjust in real-time forces, velocities and displacements.

Based on the analysis of uniaxial shaking tables, a mathematical model is proposed for an electrohydraulic shaking table with 3 degrees of freedom: horizontal, vertical and rotational movements. This model takes into account the interaction of the test structure. To improve the performance on the control system several correction techniques are discussed in terms of force compensation, stabilization of pressure difference, velocity and acceleration compensation. Therefore, it is possible to represent the movement of the ground during a strong earthquake with 3 degrees of freedom. Finally, the proposed control system might be used in the laboratory of structures with shaking tables that allow movement in multiple degrees of freedom and hence allow to study the seismic response of structures subjected to complex motions of the ground.

Keywords: shaking table, control system, multidirectional table, laboratory of structures, seismic simulation.

OS-6-9: **SEISMIC ASSESSMENT OF THE COSTA VERDE CLIFFS IN LIMA**

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Abstract

This article focuses on the assessment of the Costa Verde cliffs under seismic conditions. The Costa Verde cliffs are located in the coastal areas of San Miguel district, in Lima city (Peru), and their stability is a controversy issue that causes concern in the citizens. Additionally, recent studies suggest Lima as a potential scenario for a large earthquake event, after more than 40 years of seismic silence, which increases the importance to study the Costa Verde cliffs.

Seismic stability of the cliffs were performed on three representative sections. Cliffs consist of interlayered soils deposits of gravelly, sandy and clayey-silty soils (immature sedimentary rocks), which thicknesses were determined from field observations of the cliff slopes. Shear strength properties of these materials were based upon field and laboratory testing including large and standard direct shear tests.

For dynamic characterization, shear wave velocity profiles were obtained from geophysical testing (i.e., MASW) compiled during several studies on similar soil deposits in the San Miguel district. Shear modulus reduction and damping curves are selected from technical literature. Four ground motion records were developed using the spectral matching technique corresponding to specific seismic hazard levels for the area of study.

Soil material properties were calibrated based on current conditions under static loads and previous seismic events occurred in Lima, i.e. the 1966 and 1974 Lima earthquakes. Static stability was performed using the limit equilibrium theory and Spencer method to determined critical slip surfaces (surfaces with the lowest factor of safety).

Permanent seismic displacements were estimated for two different seismic hazard levels and the safety distance above the cliffs. Moreover, the seismic event period of return that will cause critical displacements of the Costa Verde cliffs was determined.

The assessment of these cliffs is an interesting issue and will contribute to the development of a proper prevention planning in this area of the city, which represent and important issue for neighboring dwellers and the hundreds of people who everyday access to the city through the road located right at the toe of the cliffs.

Keywords: dynamic analysis, seismic displacements, spectral matching, Costa Verde cliffs, Lima city.

OS-6-10: **SEISMIC REHABILITATION WITH DISSIPATORS OF VISCOUS FLUID FOR AN ESSENTIAL BUILDING WITH SEISMIC HIGH VULNERABILITY**

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Abstract

In the Peru the dissipators of energy of viscous fluid have applied themselves largely in the stage of conception of the buildings and exist few applications and studies of the seismic behavior of existent buildings incorporated with dissipators of energy, for intentions of seismic rehabilitation. The aforementioned studies are still scarcer when it has to do with edifications with seismic high vulnerability and irregularities in plant and elevation. For it, the objective of present it investigation is to determine in what once the dissipation of energy with dissipators of Fluent Viscoso was measured you influence the seismic answer, taking like unit of study by the structural system porches of the building of classrooms of Metallurgic Ingeniería's School of the Universidad Nacional Jorge Basadre Grohmann, of three levels, of essential category, with seismic high vulnerability and irregularities in plant and elevation.

Firstly a qualitative and quantitative evaluation came true (seismic spectral analysis) to the I edify, getting the diagnosis of the evaluation. Next the grade of seismic vulnerability of the building was determined, applying a methodology proposed in this work. Rehabilitación's methodology Seismic applied has a base firstly in determining these two aspects. Torsional found that the existent building presents a seismic high vulnerability in front of a severe seism, irregularity and irregularity carries E.030 to extremes of rigidity, according to the standard. Next established objectives and rehabilitative, well-founded strategies in the FEMA 356. The objective of rehabilitation matched that the structure have a light damage in front of a severe seism, for it defined, according to Estimación's Methodology of losses for risks (HAZUS, 2010), 0.5 %'s distortion of objective mezzanine itself.

The rehabilitative strategies applied to the structure and the dynamic analysis came true Time Historia to the structure, incorporating the viscous dissipators. Right after repeated repetitions, you got the best possible proposal considering requests from certainty, functionality, costs, availability of materials, between other ones. The metallic struts contributed the necessary rigidity to the structure since the viscous dissipators do not obey this show. The proposal of finaY-YI rehabilitation consisted of dissipators and metallic struts in the long sense of the building of metallic struts and in the short sense (X-X).

In Y-Y the distortion of mezzanine proved to be minor to I confer an objective aspect to it (0.5 %), one will logically have a light damage right after a severe seism. In X-X, the distortion of mezzanine also is minor to the allowed for the NTE E.030. The resistances required in the structural elements are minor to their existent resistance, according to the NTE E.060. The principal obtained conclusion is the great feasibility to rehabilitate buildings, shaped for porches, that they have seismic high vulnerability and extreme irregularity of rigidity, using the dissipation of energy and providing rigidity with metallic struts. The aforementioned combination improves the seismic performance of the structure and it is not enough intrusive, because you minimize the structural interventions in the same. The proposed rehabilitation can come true even with partial use of the building and the direct cost are economically competitive.

Keywords: dissipation of energy, irregularities, seismic rehabilitation, seismic answer, seismic vulnerability.

OS-6-11: **ASSESSMENT OF THE LEVEL OF VULNERABILITY OF A STEEL BUILDING DUE TO EXTRAORDINARY EVENTS**

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Abstract

In this study, an analysis was made of the risks associated with extraordinary events in a low-cost residential building constructed in the city of Caracas, since the structure shows characteristics that suggest that it could have inadequate behavior when facing loads of this kind.

Two types of extraordinary events were included in this study in parallel: explosions and fires. To simulate the structure's behavior in such events, a methodology was used that made it possible to approximate the consequences in a simple way.

Using ETABS 2015structural analysis software, and taking into account the Values of Demand/ Capacity, we were able to characterize the load redistribution routes when the failures caused by the extraordinary loads were simulated. The point of this was to determine whether the failures led to the total or partial Progressive Collapse of the building.

In the light of the results obtained, it was seen that the behavior of the building in such events would be critical, since in most cases the failures due to explosions or fires spread to the whole structure, causing progressive collapse. Only the events simulated on the higher levels were shown not to generate additional failures, and these were classified as local failures.

It is of the utmost importance to adapt structures to cope with this type of events, because they represent a high risk and are not usually taken into account in the design. Regulations in different parts of the world address these considerations in different ways, but most of them coincide in that, in order to deal with progressive collapse, it is necessary to provide the structures with redundancy in alternative load routes, continuity and interconnection in the system, and, generally speaking, make robust buildings.

The existence of special considerations for determining whether or not a building is excluded from being at risk of progressive collapse by the General Service Administration of the United States (GSA), has conditioned predictive studies of eventual levels of risk to which certain strategic or tactical structures could be exposed.

In addition, in Standard ASCE 7-10, in the chapter on "Minimum design loads for buildings and other structures," direct reference is made to the structural integrity linked with the progressive collapse of the building.

Keywords: extraordinary events, progressive collapse, vulnerability, residual structure, redundancy, alternative routes, resilience, robustness.

OS-6-12: **DEVELOPMENT FRAGILITY CURVES FOR CONFINED MASONRY BUILDINGS OF LIMA CALIBRATED WITH CYCLIC TEST**

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Abstract

Due to the demographic growth of Lima, a large amount of confined masonry buildings has been constructed. Majority of them lack of technical council. On the other hand Lima is located in the subduction zone between the Nazca and the South American plates. Hence an earthquake of medium or high intensity may produce important losses. Assessment of earthquake-induced losses is an important start point for the preparation of contingency plans and risk mitigation plans. Fragility curves calculation is important for the losses estimation due to using fragility curves is possible to determine the probability of limit damage state for a given intensity measure level. In statistical terms fragility curves represent the average performance of the overall stock of buildings.

In this work, a set of fragility curves for 1-story and 2-story confined masonry buildings is calculated by the comparison between the displacement capacity and the displacement demand. A database of 120 confined masonry buildings was created based on information gathered in previous studies carried out at PUCP. Important seismic parameters were fitted to probability density functions.

The probabilistic framework of SP-BELA method is extended for its application to confined masonry buildings in order to calculate capacity curves that represent the behavior of the stock of buildings. In this point experimental data is included in order to get more realistic results. These data comes from monotonic cyclic test load performed in confined masonry walls at PUCP's structures laboratory. Simplified capacity curves for confined masonry are obtained by Montecarlo simulation based on the probability density functions previously defined and the extended methodology proposed improved with the experimental data. Then, equivalent single degree of freedom systems are obtained for each building. Also limit damage states are defined in the capacity curves.

The next step is the definition of de seismic demand. Although it can be defined by a uniform seismic hazard spectrum, in this study the seismic demand is define by a set of ground motion records. Due to the fact that when using uniform seismic hazard spectrum results conservative for the loss assessment. Additionally by using ground motion records, the variability of record to record can be partially included. These records correspond to subduction earthquakes extracted from PEER database.

Using Newmark algorithm the maximum displacement demand is obtained for each building at each damage state. By de comparison with the displacement capacity a probability damage matrix is assembled. The best intensity motion level in seudo acceleration is obtained by calculating the correlation coefficient for a log-normal cumulative function. Finally the fragility curves are plotted along the intensity motion level which show the best fit. It is expected that fragility curves are useful to understand the seismic risk of the stock buildings of confined masonry of Lima, and promote actions to improve their seismic behavior.

Keywords: fragility, confined masonry, Lima, cyclic test.

OS-6-13: **MODIFICATION OF THE SEISMIC RESPONSE OF A BRIDGE BY PASSIVE CONTROL**

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Abstract

Over the past few years, engineers have started giving greater impulse to bridges designed with isolated deck/column connection, and at present there are hundreds of bridges in different parts of the world designed with this philosophy; this is mainly due to the fact that the bridges built to this design have shown good correlation between analytical prediction and seismic performance in recent earthquakes.

In traditional bridge designs, we engineers rely on the structure's inherent capacity of ductility due to good detailing to prevent catastrophic failures in the event that an earthquake greater than the design earthquake should occur; moreover, the design philosophy in which the modification of the seismic response is done by passive control can produce more reliable results thanks to the passive energy dissipation devices, whose function is to absorb a portion of the input power, thereby reducing damage.

We are aware, however, of the barriers and constraints in the implementation of these new design trends, due to the lack of technical regulations for the design of this type of structure; added to this, we have the lack of relationship of engineers of the practice with this approach in earthquake-resistant bridge design.

Mainly for this last point, and because of the need to have new, more reliable design techniques, we present this document in which the bases will be developed for guidelines to designing earthquake-resistant bridges, applying the use of passive control, that is, bridges with isolated deck/column connection; in addition, we will show the results of a comparison we will make with the traditional design philosophy.

Keywords: bridges, earthquake engineering, seismic isolation, passive control.

OS-6-14: **COMPARATIVE SEISMIC DESIGN BETWEEN A CONVENTIONAL SYSTEM AND A SEISMIC ISOLATION SYSTEM (LRB), FOR AN 8-STORY CLINIC IN TRUJILLO'S CITY**

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Abstract

Peruvian territory presents a high seismicity originated by a subduction of the Nazca and South American Plates, which forms part of the so-called "Circum-Pacific belt", a highly seismic and volcanic zone, in which most of the Earthquakes occurring in the world. On January 24th, 2016, the technical standard E.030-2016 came into effect, and one of the changes with respect to the previous standard is the inclusion of the "Seismic protection systems, specific to the case of Health establishments", which refers us to a foreign standard approved, in this case ASCE/SEI 7 in its last edition, as long as there is no Peruvian technical standard of its own.

Taking into account these two conditions it was decided to make a comparative analysis between the seismic designs of a conventional structure (Concrete Shear Walls) and a Concrete Moment Frames protected by Base-Isolation Systems (LRB). For the Shear Wall system, first a structuring was done from the architectural plans and a pre-dimensioning of the elements, then the mathematical modeling was performed in the software Etabs v15 (taking into account factors such as, rigid diaphragms, beam-column joint modeling, mass source and others). In order to perform the seismic design, the results obtained from the dynamic analysis (response-spectrum procedure) have been verified with the minimum requirements by the standard E.030-2016 (Drift/h).

In order to use a Base-Isolation System, the following comment was taken into account: "Isolators have little tensile strength", so it was decided to remove the concrete shear walls and replace them with columns, because the concrete shear walls produce a great moments which could lead the isolator failure and thus to collapse of the overall structure, resulting in a concrete moment frames protected by Base-Isolation Systems (LRB).

First the modeling of the fixed structure was carried out, united in its base with beams and slabs, to obtain the reactions (loads that will receive each isolator). The bilinear model was used to obtain the characteristics of the isolator (isolator diameter, lead core diameter, height) and its physical properties such as vertical stiffness, horizontal stiffness, elastic stiffness, post-yield stiffness, yield force and others.

In order to include the seismic isolators effects in the mathematical modeling performed in Etabs, the "Links" element was used. In order to perform the seismic design, the results obtain form the dynamic analysis (response-spectrum procedure) DBE, MCE are smaller than the total displacements (DTD, DTM), we also check the super-structure, the "Drift/h" has to be smaller according to the standard E.030-2016. The final design of Base-Isolation Systems was performed with a Response-History Procedure, using accelerogram record scaled to a target spectrum.

Keywords: base-isolation systems, seismic isolators, comparative seismic design.

OS-6-15: **THE TEMPLE OF MISKA – CUSCO: VERIFICATION OF THE POST-EARTHQUAKE DAMAGE AND A PROPOSAL OF RETROFITTING**

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Abstract

Rehabilitation and preservation of heritage buildings is a task that requires great care, therefore it must be carried out by a multidisciplinary team. This paper is focused on the structural engineering component (often absent) in this kind of projects in Cusco-Peru.

The temple of Miska was built out of adobe and stone masonry in the seventeenth century and in 2006 was declared as a heritage site of Peru. Over time the effects of the lack of maintenance, precipitations, moisture and earthquakes have affected the structural elements of this temple. Therefore the Ministry of Culture decided to carry out some jobs such as rehabilitation and preservation. Shortly after the works were completed a 5.1ML-earthquake struck Miska town in September twenty seventh of 2014. The epicenter was about 5km from Miska causing enormous damage to all of the earthen buildings and also to the temple, which has just been restored.

For the purpose of the structural analysis was necessary to know the mechanical properties of the adobe and stone masonry; besides these tests, the seismic demand was important as well. The seismic acceleration records of the earthquake have been obtained from the Peruvian Geophysical Institute, Ruben Boroschek Company and the Peruvian Association of Professional Engineers. Because the seismic stations were located so far from the epicenter, attenuation laws were applied to calculate the probable acceleration in Miska town.

A structural analysis was developed using thousands of finite shell elements and techniques that consider the process of cracking and decreasing of material strength against different magnitude accelerations of earthquakes, e.g., very frequent, frequent, occasional and rare. The purpose of the structural analysis was to verify what the FEM-program shows with the post-earthquake damage in the temple. Subsequently using the same methodology a proposal of retrofitting was performed in order to give ductility (through grid on walls) and rigidity (through adobe masonry buttresses) to the structure, improving eventually the structural performance of the building on two levels.

Keywords: earthquake, performance, ductility, rigidity and retrofitting.

OS-6-16: **SEISMIC AMPLIFICATION BY TWO-DIMENSIONAL DYNAMIC ANALYSIS IN THE ARCHAEOLOGICAL PARK OF SACSAYHUAMAN**

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Abstract

The research has been developed in the Archaeological Park of Sacsayhuamán considered as Cultural Heritage of Peru, which is located in the Department of Cusco. In 2009 there were notable damages in the walls of the third terrace in the central part, some walls collapsed.

This research presents the evaluation of the dynamic response of soils within the Archaeological Park of Sacsayhuamán - Cusco, using two - dimensional models and the finite element method technique. This analysis allows to define the seismic behavior in terms of the seismic amplification product of the existing stratigraphy and topography.

The objective is to analyze the seismic amplification in the terrain surface of the different sections proposed in the project; for this purpose, two representative sections of the stratigraphic profile and the geometric conditions were selected. Non-destructive techniques were used as geophysical tests using the Multichannel Analysis Surface Waves - MASW, Seismic Refraction, Microtremor Array Measurements - MAM, as well as the Nakamura technique for fundamental period studies. Tests were also conducted with Georadar - GPR.

The two-dimensional analysis was performed using the Quake / W program of Geo-Slope International, and the accelerographic log of the earthquake occurred in Cusco on September 27, 2014, to generate a synthetic accelerogram, adjusted to a uniform hazard spectrum calculated from a study of Seismic Hazard given us an maximum acceleration in rock of 0.25g, corresponding to a return period of 475 years. According to the Geological - Geotechnical and Geophysical characteristics, in each section a soil stratum (clay with gravel) was defined with periods that are within the range of 0.35sec to 0.57sec; Under this is found massive rock (Limestones and Diorites). Based on the velocity of propagation of shear waves (Vs) and the Unit Weight, the Maximum Shear Module (Gmax) values were obtained for each stratum. The analysis was carried out using the two-dimensional Equivalent Linear Method (Seed and Idriss, 1969), using the factors of Reduction of the Shear Module for soil and rock, finding amplifications that are within the range of 1.1 to 1.6.

Also, the spectral ratio of Fourier spectrum amplitude of the surface register and the rock record were determined to obtain the fundamental period of soil vibration, and finally this was compared to the period of vibration that was obtained by Microtremor measurements. Finally the corresponding spectral accelerations (with a damping ratio of 5%) were obtained.

Keywords: Seismic Amplification, Spectral ratio, Geophysical Tests

OS-6-17: **RETROFITTING OF GOVERNMENT BUILDINGS USING VISCOUS DAMPERS**

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Abstract

In the last decade, due to the importance of government buildings, the government of some Latin American countries, such as Peru and El Salvador, has aimed to safeguard the old buildings whose performance level is inadequate to support the earthquake level indicated by current seismic code of each country. The reinforcement proposed for the buildings studied in this paper considers seismic energy dissipation systems such as fluid viscous dampers, which have gained greater popularity in recent years for the reinforcement of existing buildings. The buildings studied correspond to the following government entities: Ministry of Economy and Finance and National Superintendence of Customs and Tax Administration (SUNAT) - Miraflores, in Peru; and the building of The Legislative Assembly, in El Salvador.

The proposed reinforcement for the building of the Ministry of Economy and Finance considers the viscous fluid dampers in Chevron layout in the two orthogonal directions, and the reinforcement of some columns and beams. The proposed reinforcement for the building of National Superintendence of Customs and Tax Administration (SUNAT) considers the viscous fluid dampers in Diagonal layout in the two orthogonal directions, and the reinforcement of some columns and beams. The proposed reinforcement for the building of the Legislative Assembly El Salvador considers fluid viscous dampers in Upper Toggle layout in the transverse direction and Chevron layout in the longitudinal direction, without reinforcing columns and beams. In this way, the initial request was satisfied, not interrupt the activities into the building.

The buildings were analyzed for each layout of fluid viscous dampers taking into account the studies realized by different researchers about the supplemental damping ratio. Three pairs of acceleration time histories for each country were scaled in such a way that the average acceleration spectrum is compatible with the design spectrum of each country. The reinforcement with viscous fluid dampers allows reaching better level of performance: lower displacements and lower interstory drifts. Also, it allows obtaining greater additional viscous damping, which diminishes the seismic force, and less damper forces. Therefore, reinforce old buildings with fluid viscous dampers is a very good alternative reinforcement: the structural damage is reduced significantly, the reinforcement works are done in less time, and the activities into the building are not interrupted.

The results have shown that the efficiency achieved for each layout of the viscous fluid dampers is different. The reinforcement with the Upper Toggle layout achieves the best results; however, its installation is not easily accessible because Taylor Device has the patent. The Diagonal and Chevron layout reduce the drift but not as the layouts Upper Toggle but are the most commonly used, which provide greater comfort in your installation.

Keywords: viscous dampers, dampers non-linear properties, supplementary viscous damping.

OS-6-18: **EXPERIMENTAL IN-PLANE CYCLIC RESPONSE OF MASONRY WALLS IN LIMA, PERU**

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Abstract

The majority of casualties that happens during an earthquake is due to the failure and collapse of masonry buildings, especially those built without any engineering criteria and placed in crowded areas. Self-built dwellings show bad structural behavior due to their inherent poor structural configuration, low quality of materials used, inadequate workmanship, and others. In order to mitigate the seismic risk of these buildings is important to understand and to measure their structural capacity and to know how many of them will exceed a given performance limit state for a given ground motion.

In the last decades, Lima's population has shown an exponential growth without much urban planning (almost 8.5 million people). Lima has a horizontal expansion with a proliferation of low-rise buildings (up to 2-3 floors), mostly built with fired clay masonry. Around 52% of Peruvian dwellings are built with a confined masonry system, and 60% of those are self-constructed. It is therefore highly likely that in case of an earthquake many of them will collapse.

The objective of this work, which is part of a major project, is to identify the structural capacity (through capacity curves) of confined masonry walls representative of informal settlements in Lima. Those walls differ from unreinforced masonry walls due to the presence of reinforced concrete elements built around the wall. Six full-scale walls (one level) will be built and subjected to horizontal cyclic loads at the structural laboratory of the Pontificia Universidad Católica del Perú (PUCP). The cyclic tests will be performed under the FEMA 461 requirements. From the 6 walls, 3 will be tested without vertical load while the others 3 will be tested considering typical vertical loading of a 3 floor dwelling. Furthermore, some control test as compression in piles and diagonal compression on wallets will be performed.

Issues discussed here are ductility, displacement capacity, experimental failure mechanisms and the results are presented in terms of hysteretic force-displacement curves. It is expected that the calculated capacity curves will be useful for further studies to evaluate fragility curves for informal masonry constructions in Lima, and to calibrate numerical models.

Keywords: masonry walls, informal construction, failure mechanisms, experimental test, in-plane cyclic response.

OS-6-19: **SEISMIC RESPONSE RECORDED BY THE MONITORING NETWORK OF BUILDINGS (REMOED) IN LIMA CITY**

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Abstract

The first Monitoring Network of Buildings in Peru has been implemented under the Japan-Peru SATREPS Project subscribed between Chiba University (Japan) and the National University of Engineering (UNI), which was supported by JST and JICA. Three buildings has been implemented from 2011 to 2012, namely Block A of the Edgardo Rebagliati Martins Hospital (HERMBA), The Main Building of the National University of Engineering (PABUNI) and Block G of the Faculty of Civil Engineering of the National University of Engineering (FICUNI). Thus, The Monitoring Network of Buildings (REMOED) started to record quakes since 2011. In the last years, Peruvian Ministry of Economy and Finance supported the acquirement of more sensors to increase this network, which were included in the National Budget PP-068. In that sense, three more buildings has been implemented in 2016, namely, the School of Engineers of Peru located in Tarapoto (CIPTAR), the City Hall of Lamas (MLAMAS) and the Center for Investigation and Information of the Faculty of Civil Engineering (CIIFIC) of UNI. It is important to mention that the CIIFIC is a four-story isolated structure, the first isolated building in its type, designed and constructed by Peruvian engineers from UNI.

Each building has a set of sensors (4 to 5). The sensor is a low cost accelerometer based on the Giant Magnetoresistance. These buildings have different characteristics, such as age, ground mechanic properties, structural systems, and structural status. Since the installation of sensors, several quakes have been recorded, all of them are quakes of low intensity. Nowadays, REMOED is recoding vibration of six buildings on real-time with purpose of analyzing their response and their dynamics characteristics during these quakes. Moreover, the building status can immediately be determined after some quake by damage detection from the measurement of vibrations. Therefore, owners including Government can use the information to support their decisions on Evacuation order within minutes after the mainshock, Retrofitting and Renovation.

Keywords: health monitoring, seismic response, damage evaluation.

OS-6-20: **BUILDING DAMAGE DUE TO MANABI ECUADOR EARTHQUAKE AND THEIR EXPECTED BEHAVIOR BASED ON SIMPLIFY MODELS**

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Abstract

On April 27th 2016, CISMID-FIC-UNI dispatch a research survey mission to the coastal area of Ecuador zone that was affected by an earthquake of Magnitude 7.8 Mw. (IG-Ecuador) that occurs at 18:58 hrs local time on Saturday 16th 2016. The earthquake affect coastal cities in Ecuador specially Mantas, Portoviejo, Bahía and Pedernales among other locations. The earthquake also affect some zones relatively far from the epicenter like Guayaquil city. The hypocenter of the quake was located in front of the coastal city of Pedernales (Manabí), at 20 km depth. The origin of the quake was the displacement of the two tectonic plates: Nazca plate (ocean plate) that enter in a subduction mechanism down the South American plate (continental plate). The research survey mission produce a preliminary report where the interpretation of the seismic behavior that produce damage over the building structures is presented. For this reason earthquake signals provided by Ecuadorian Researchers has been process to find demand spectra for the high acceleration on two stations: AGYE and AMIL

Based on the parameter interpretation of the Ecuadorian Seismic Standard and the seismic capacity ranges proposed by ATC-40 for framed buildings with partition walls and adoption of experimental data from confined masonry, an exercise of the seismic capacity and behavior of these structural buildings was developed. A comparison of the diagnosis earthquake response and the observed behavior during the quake, will produce the need of propose interstory drift limit using the Peruvian Standard NTE-E-030, and comparing with the Ecuadorian Standard.

The results shown that damage was produce on the buildings due to the control of deformation is not representing the structural system.

Keywords: confined masonry, framed system, seismic capacity, experimental test, earthquake response.

OS-6-21: REAL TIME SEISMIC MONITORING CENTER – CEMOS OF THE JAPAN PERU CENTER FOR EARTHQUAKE ENGINEERING RESEARCH AND DISASTER MITIGATION-CISMID

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Abstract

The city of Lima, as capital city of Peru, concentrates almost 30% of the total population of the country and in relation to the total production represents 49% of the total gross domestic product (INEI, 2016) so planning the operation continuity of different economic activities and services is a very important factor for the economic and social development in the country. One of the primary scientific activities for this planning is the constant monitoring of the territory and structures before, during and after a seismic event. Is in this sense that the Japan Peru Center for Earthquake Engineering Research and Disaster Mitigation-CISMID of the Faculty of Civil Engineering of the National University of Engineering has recently implemented the Real Time Seismic Monitoring Center, which is unique in the country since it has three monitoring networks: a) REDACIS, which is the Strong Ground Motion Accelerograph Monitoring Network with 54 accelerometers distributed in Metropolitan Lima and Callao, b) REMOED, which is the network for Structural Building Health Monitoring, this network shows in real time the seismic response of a building so that it can assess, to some extent, the level of damage in the building occurred after an earthquake, c) REMCOT, which is the monitoring network of movement of the Earth crust, this network will include very high-precision permanent GPS stations so it can monitor the activity of Nasca plate thrust toward the South American plate.

These three networks may give detailed information of the seismic activity in Metropolitan Lima and later extend it to inside of the country. This article shows in detail each of these networks and a brief summary of the data that currently are getting.

Keywords: accelerometers, health structure monitoring, evaluation, GPS, ground motion.

OS-6-22: **ARMY OF PERU AND THEIR PARTICIPATION IN DISASTER RISK MANAGEMENT SUPPORT**

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Abstract

The Caral Culture (5000 BC), the cradle of civilization in America and the third oldest in the world, gave birth to the various cultures and pre-Inca and Inca empires. These settlers had to face the rugged nature and morphology of our territory, participating actively in the creation of structures that are vestiges that until today glimpse to the humanity and the technology.

These constructions were made with sense of protection and prevention with low gravity centers, wide bases, solid, stones with three minimum contacts, walls with seismic angles of inclination.

Since the creation of the Peruvian Army, it has participated permanently in support to the population affected by disasters in coordination with the public entities, examples: earthquakes arisen in Arica in the year 1868 when it still belonged to Peru, in Lima and Callao in 1940 , In Yungay 1970 where he supported 60 paratroopers, field hospital and transport of humanitarian aid, in Lima and Callao 1974, in the earthquake in Nazca 1996 and in pisco in 2007, we also participated in support to the disasters produced by the Phenomenon the child occurred in 1983, 1997, 2015 and 2016.

We support the south of the mountains with personnel, vehicles and means for the cold and frost that occur in the middle of the year, as well as volcanic events.

Support was given to other countries, such as the one offered to the Republic of Ecuador by the earthquake of April 16, 2016 with three (03) helicopters, thirteen (13) mechanical equipment and one dron with their respective operators; We carried out works of removal of rubble and of rehabilitation, platforms were constructed for the installation of temporary shelters in zone zero of the city of Manta.

At present, the Army of Peru has been organized at the national level in 23 Commands of Immediate Action for Disasters (COAID), the same ones that have in their organization an aircraft company, a communications company, a rapid intervention company for disasters (CIRD) Which in turn is made up of a safety section, a debris removal section, a search and rescue section and a wound evacuation section, a Mechanical Engineering Equipment (CEMI) company and a conforming service company For health and vehicles for cargo transportation and personnel.

Likewise, the Peruvian Army has been training permanently through agreements and coordination with public and private entities such as the National Institute of Civil Defense (INDECI), National Center for Estimating, Prevention and Reduction of Disaster Risk (CENEPRED), College Doctor of Peru, College of Engineers of Peru, ONGD SAR Peru, the General Corps of Volunteer Firemen of Peru (CGBVP) and the support of other countries.

The Peruvian Army is deployed throughout the national territory, organized to intervene as a first response institution, we act quickly to the disasters in favor of the population and in permanent coordination with the local authorities.

Keywords: army, first response.

OS-6-23: **MILITARY EMERGENCY BRIGADE (BRIME)**

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Abstract

Current legislation provides for the participation of the Army of Peru in the National System of Disaster Risk Management as: First Response Entity.

The Peruvian Army has formulated, through the Directorate of Support to National Development (DIRADNE) a Public Investment Project (PIP) For the special equipment and training of the BRIME. The PIP was carried out by a team of senior officers and the contribution of specialists from various disciplines at international level, Experts from INSARAG and others.

The BRIME, as conceived in this PIP, as the region's best and greatest strength in response to disasters, counting on diverse types of vehicles, special search and rescue equipment, integral communication system and some improvements in infrastructure, using state-of-the-art technology, to become a reference throughout Latin America.

The PIP consists of the following components: equipment, training / training and infrastructure.
The training of the BRIME USAR units will be carried out by INSARAG certified experts, Peru being a member of this international institution that rules the guidelines and standards that must follow these units, whether civil or military.

The contents of the PIP have been coordinated with INDECI and have contemplated the strategies of SINAGERD. The tasks of BRIME are focused on the rescue of human lives, but include engineering work to allow accessibility to affected areas, Restoration of communication routes, basic health services, will provide support to the affected population with drinking water supply, food and support in the installation of temporary shelters, restoration of basic public services, It will also intervene In situations of technological risks and environmental pollution (NBQR material).

International studies indicate indicate that the human lives affected are salvageable in the course of the first 72 hours of the disaster. To ensure accessibility to emergency areas, the PIP contemplates, as an essential point, the acquisition of armored vehicles with traction to caterpillar for the different tasks of engineering and tactical transport.

The Army members would do their work in response to Emergencies, under a rigid chain of command whose purpose is to reduce uncertainty Ensure that established procedures are followed. (As stated by the ILO "Public Emergency Services - FFAA and PNP- they must deal with exceptional situations that occur in society and pose a threat to life).

Perú is a country that is constantly threatened by natural disasters, by its geographical location (Pacific Ring of Fire). Likewise, an INDECI study with the IDB indicates that a major earthquake, followed by tsunami in Lima and Callao (worse scenario) zone in high risk for being in zone of seismic lagoon, would amount to US $ 43,000,000,000.00. This figure implies approximately the annual budget of the state. BRIME would help with the prevention and sensitization tasks to mitigate this damage considerably. While human lives are invaluable, the timely restoration of basic services would reduce the damage considerably, which far exceeds investment.

Keywords: search and rescue, first response entity, Brime.

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