



**11th International Bridge and
Structure Management Conference
Mesa – Arizona, USA.**



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**Management System For Natural
Risk Disaster On Infrastructure:
Regional Approach (GRDR)**

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Catolica de Valparaiso, Civil Eng, PhD

27 April 2017



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Latin American disasters

Structural damage in Chile

GRD and GRDR Method: Description and Application

Start up – South Chile

Final comments



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Latin-American Disasters



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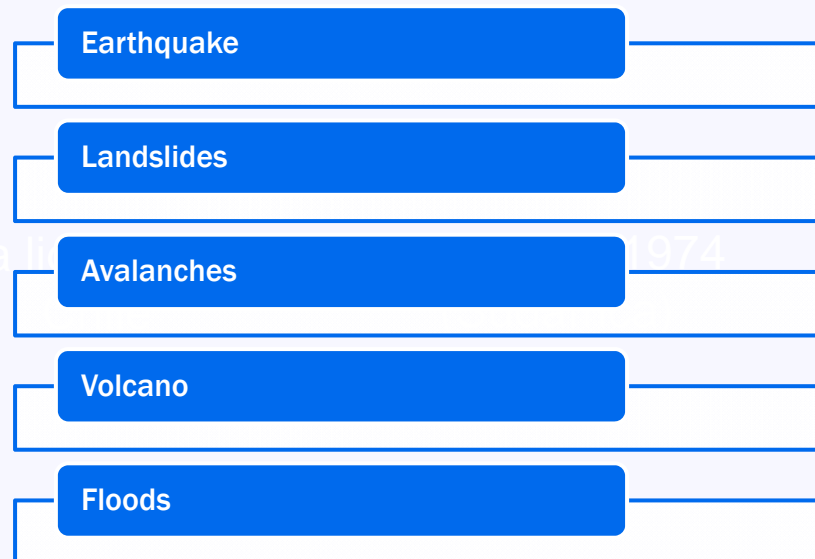
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Backgrounds

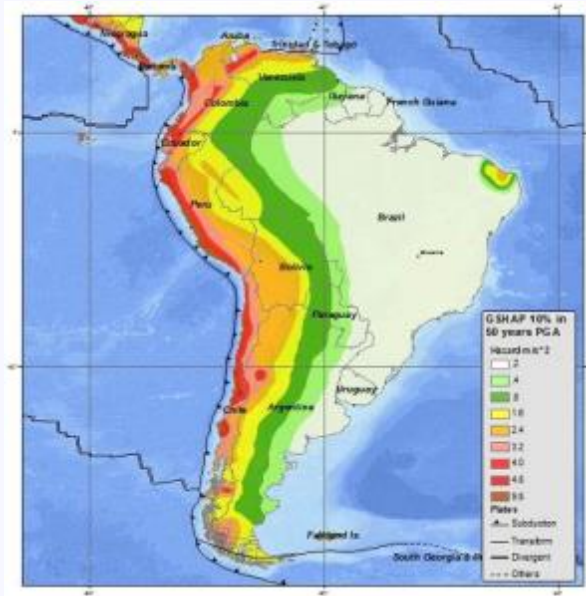
Latin America has been exposed, in recent times, various types of natural disasters including earthquakes, fires, volcanic activity, landslides, mud, among others. This condition requires the development of methods for identification of hazards, simulation / modeling of likely scenarios, impacts on society and control measures and mitigation

Mochino 1978
(Japón)

La li 974



Regional Hazards





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LATAM Disasters

2010 Haiti Earthquake (12 January 2010)

- Epicenter 15 km from Port au Prince, Haiti's capital.
- 7.2 magnitude
- Died 316,000 people.

Tsunami minor

- Deaths: 4 people.

This earthquake was the strongest recorded in the area since 1770. The earthquake occurred in was felt in nearby countries such as Cuba, Jamaica and the Dominican Republic, where it caused fear and **preventive evacuations**.

Chile Earthquake + Tsunami 2010

- February 27, 2010,
- Magnitude 8.8
- Epicenter in the Chilean Sea, opposite the towns of Curanipe
- Died 264 People

It was felt in much of the Southern Cone with varying intensities, (Buenos Aires and São Paulo)



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LATAM Disasters

Guatemala Earthquake

- February 4, 1976
- Magnitude of 7.5 degrees on the Richter scale
- Epicenter 5 kilometers 160 kilometers northeast of the capital Guatemala City
- 23,000 died

In just a few seconds one third of the capital was reduced to debris and thousands of buildings collapsed.

1960 Valdivia Earthquake

- Great Chilean Earthquake
- May 22, 1960
- Epicenter Araucanía Region
- Magnitude 9.5 (10 minutes)

Series of tsunamis

- 2,000 people dead.

Greater magnitude earthquake recorded



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LATAM Disasters

Flood Rio de Janeiro

- Year 2010
- Died 100 person.

Most victims have been buried by landslides in favelas built on hillsides.

Flood Mexico

- October 28 to December 15, 2007
- Mexican states of Tabasco and Chiapas
- Peak floods of rivers

Since the last rescue, and water extraction, delay of one month

Eruption of Nevado del Ruiz volcano

- November 13, 1985
- Department of Tolima, Colombia.

Story of Omaira Sanchez.

Importance of prevention systems, emergency support



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Hazards and Structural Damage in Chile



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Landslide

| | |
|--------------------------|--|
| Country | CHILE |
| Place | Atacama |
| Year | 2015 |
| Causes | Heavy rainfall |
| Main consequences | Infrastructure destruction Deaths Contamination |





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VOLCANOES

| | |
|--------------------------|---|
| Country | CHILE |
| Location | Los Ríos Y Araucanía |
| Year | 2015 |
| Causes | Volcanic eruption |
| Main consequences | Destruction of infrastructure Casualties Contamination |





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Gobierno de Chile | Ministerio de Obras
Públicas



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**COLAPSO PUENTE EN PUNTO LÉN
RUTA 160 KM 32**



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COLAPSO DE PUENTE



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Hazards and Structural Damage in Chile
Last three month!!!



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| | |
|--------------------------|--|
| Country | CHILE |
| Location | Quellon - Chiloé |
| Year | 25 December 2016 |
| Causes | Eartquake 7,6 Mw |
| Main consequences | Road and Bridge Collapse Social and economic issues |





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| | |
|--------------------------|---|
| Country | CHILE |
| Location | Petrohue – Route Ch 225 |
| Year | 7 January 2017 |
| Causes | Rain fall Landslids |
| Main consequences | Road Collapse Isolation of 100 persons |





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| | |
|--------------------------|--|
| Country | CHILE |
| Location | Central of Chile 800 km |
| Year | December 2016 |
| Causes | Forest Fires |
| Main consequences | Destruction of infrastructure (Santa Olga town) 7154 Casualties 596.185 HA Native Forest burnt 11 death |





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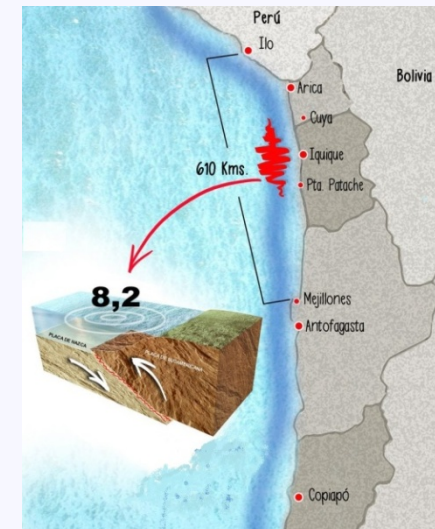
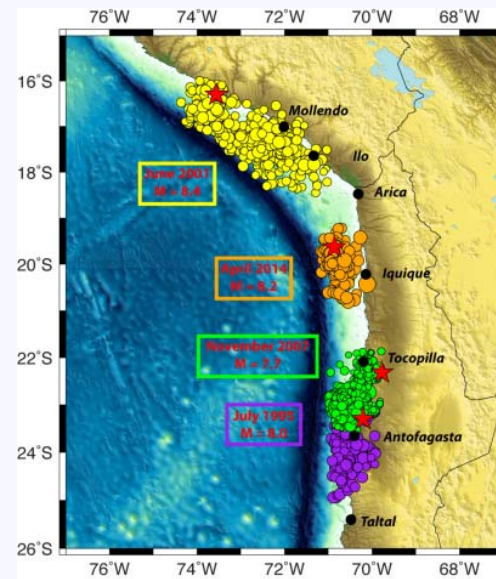
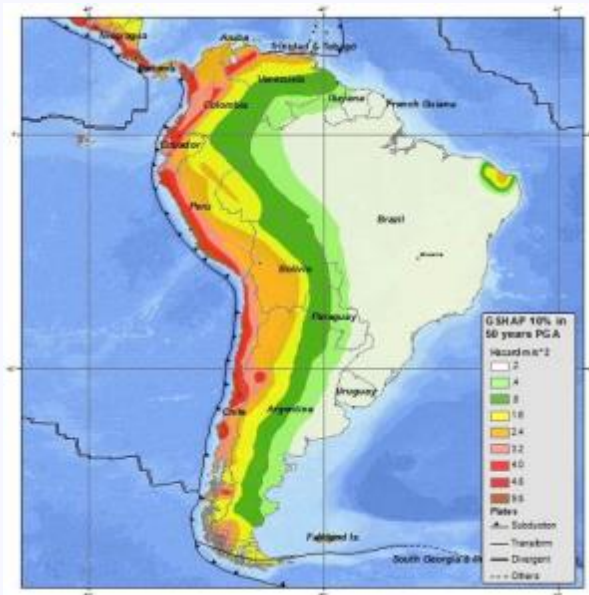


Todo noticia todo deporte
@Hector98866352



Nacional: Desde el espacio la NASA envía imagen del incendio de valparaiso..@TVN @ucv_tv @24HorasTVN @Mega

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Risk Management in LATAM and the Caribbean

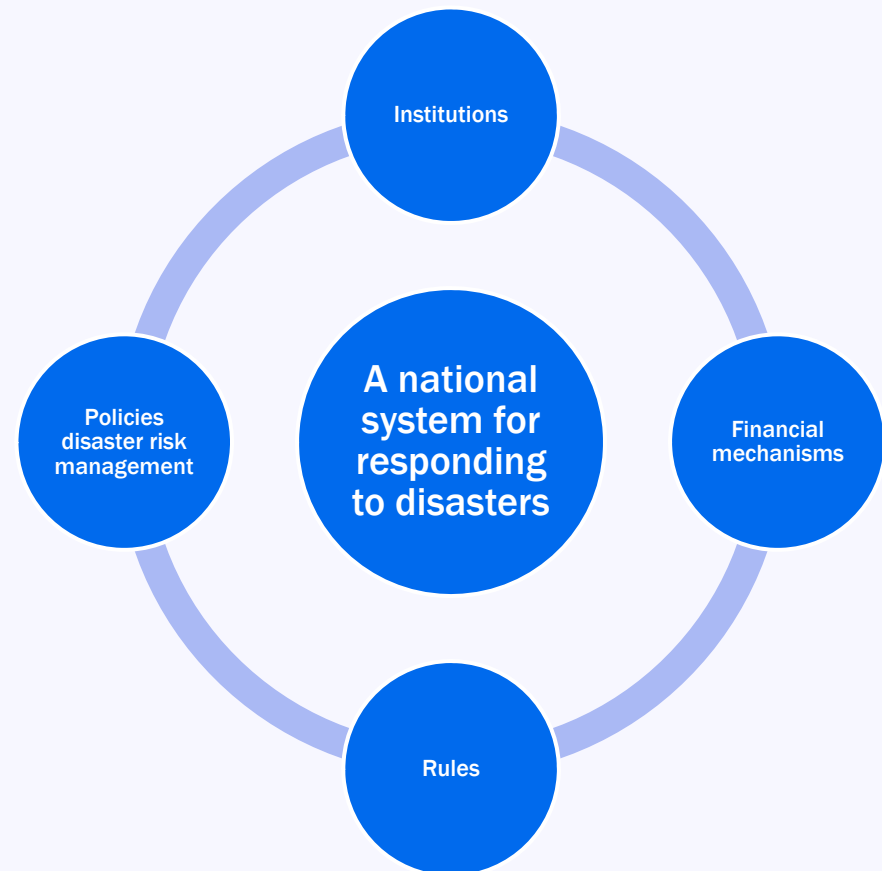
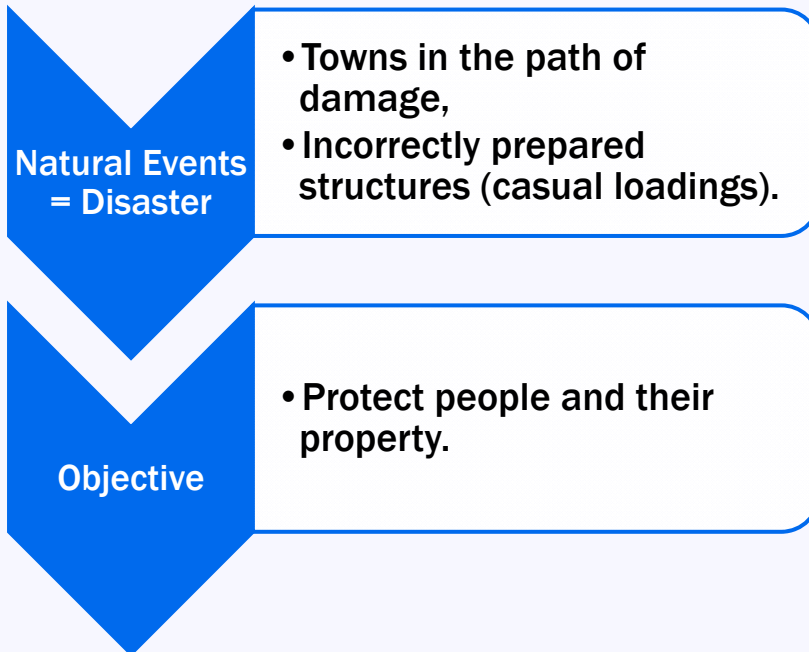


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LATAM System





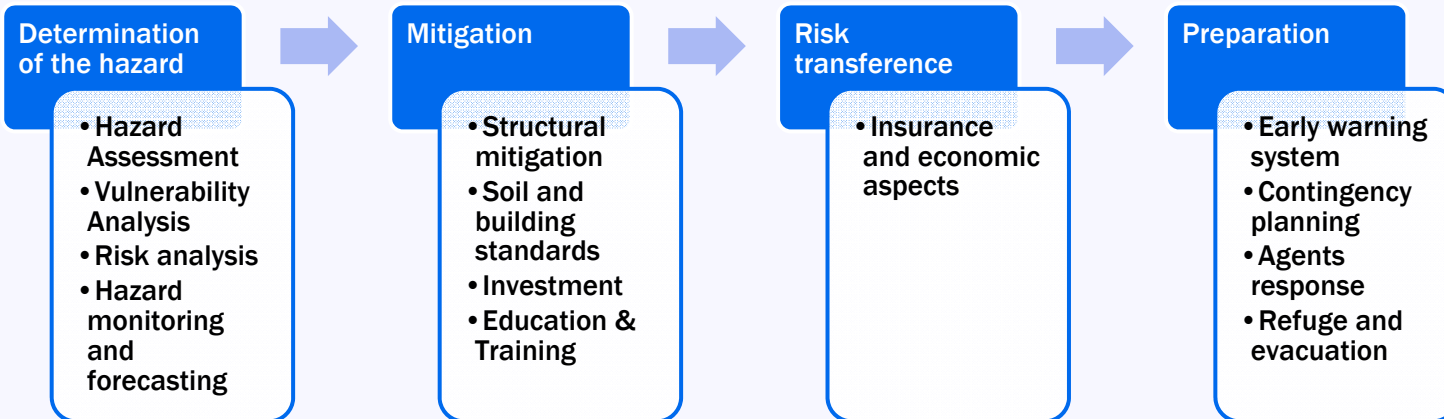
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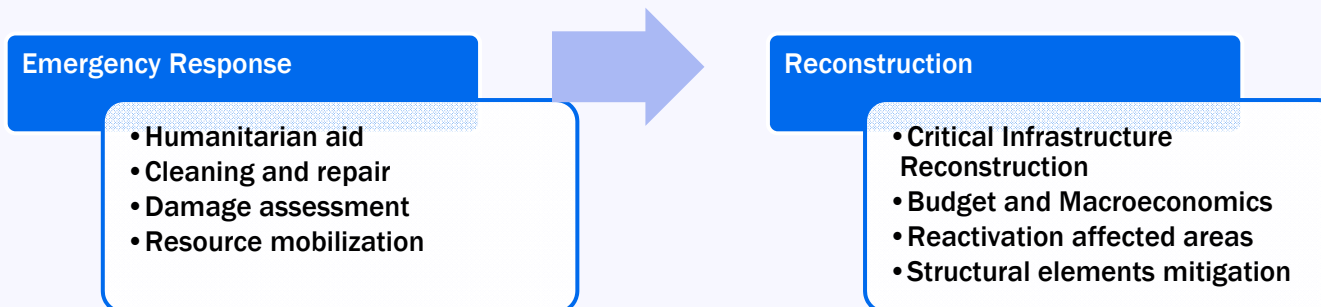
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Pre-Disaster

Integral Disaster Risk Management



Post-Disaster





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Disaster management systems in Latin America and the Caribbean

Government agencies to respond to emergencies

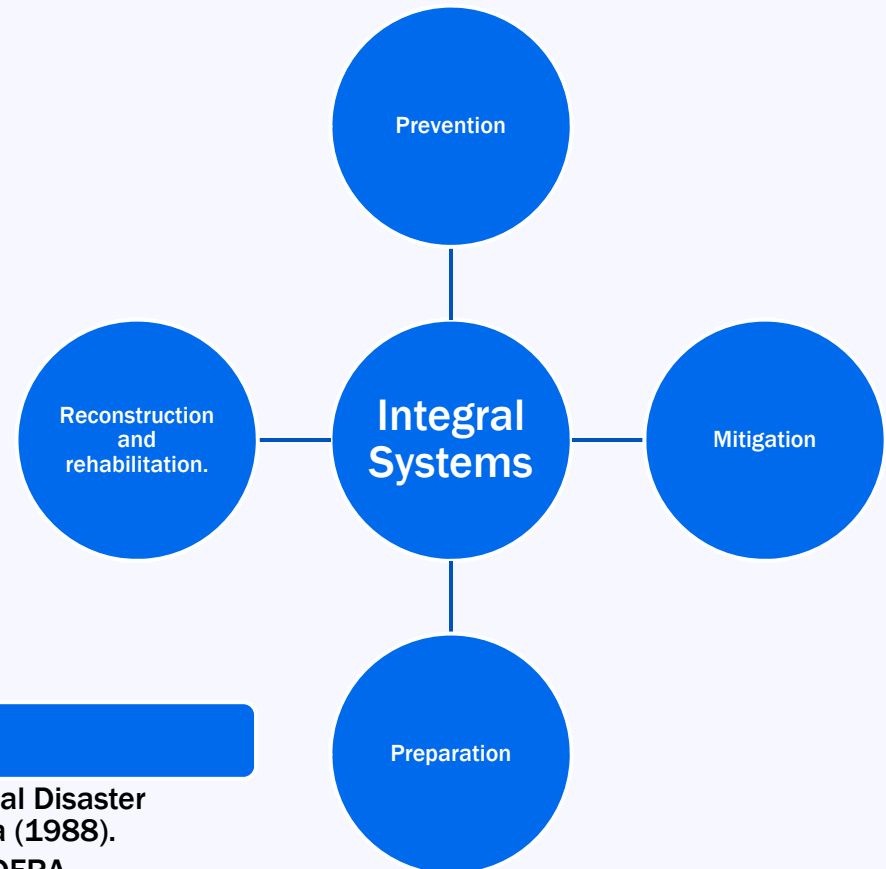
- Argentina
- Brasil
- Chile
- Colombia
- República Dominicana
- El Salvador
- Nicaragua
- Guatemala
- Honduras
- México

Civil Defense

- Ecuador
- Perú
- Venezuela

Entities

- Coordination Center for Natural Disaster Prevention in Central America (1988).
- English-speaker Caribbean CDERA
- South America: Andean Development Corporation





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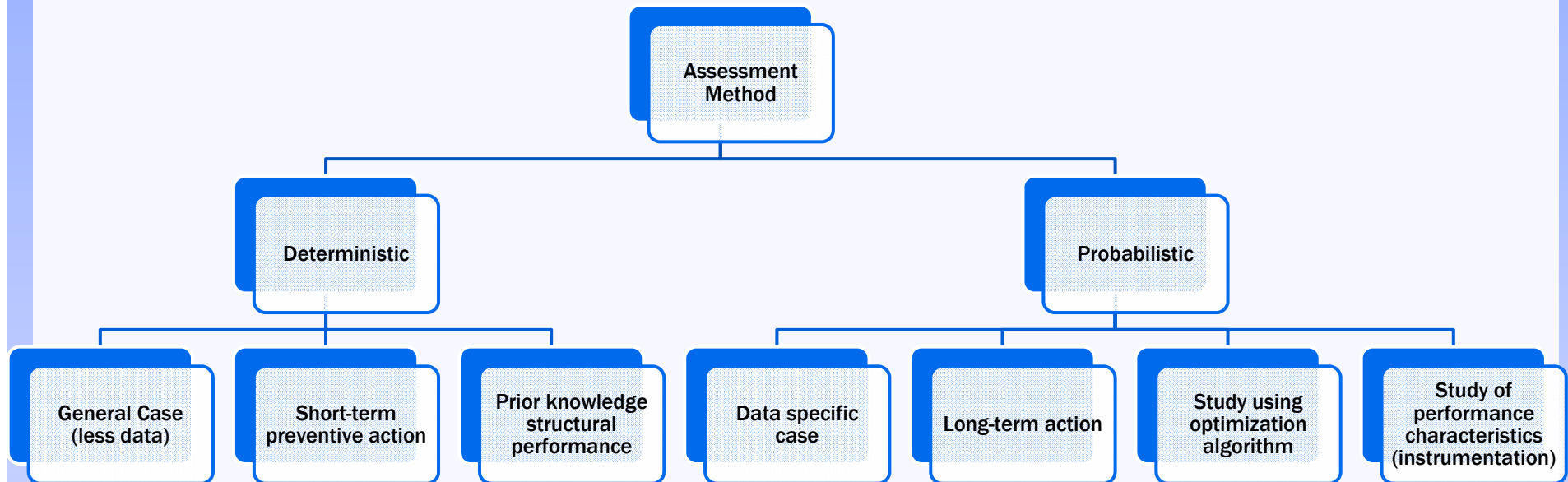
GRD and GRDR Methods: Description and Application



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The Probabilistic Risk Assessment (CAPRA) Program

RiskAssessment
Flood
Hurricane
Landslide

Seismic
Tsunami
Volcano
Vulnerability



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The structures have been subjected to different types of operational and accidental loads.

With climate change these structures have been subjected to hazards which were not anticipated in its design.

The deterministic method is intended to predict the damage of a structure under different types of hazards and prevent future damage.

The deterministic method is updated by inspections using local technical groups = Alerts.



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COSIPLAN IIRSA Method. Management of Risk Hazard on Infrastructure (G.R.D)

There are problems with the management of infrastructure at Central Level



- Higher Cost
- Less knowledge and understanding of the needs of citizens
- Few knowledge of structures at each sector



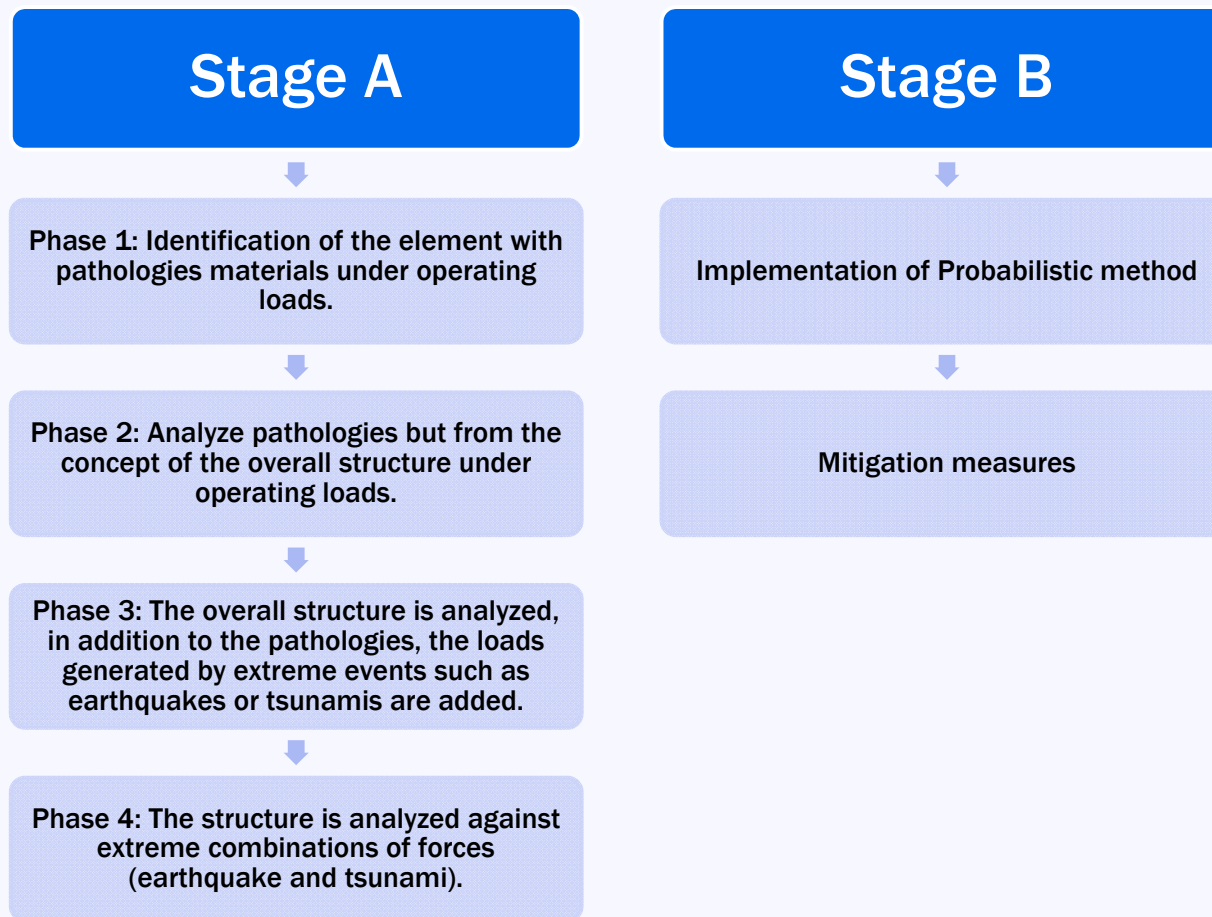
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- The application of this method includes 2 stages and 4 phases:





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Chilean Proposal for Risk Management on infrastructure. Regional actions (G.R.D.R in Spanish)

Non Central Methodology

Manager and inspection risk
team of Central Level

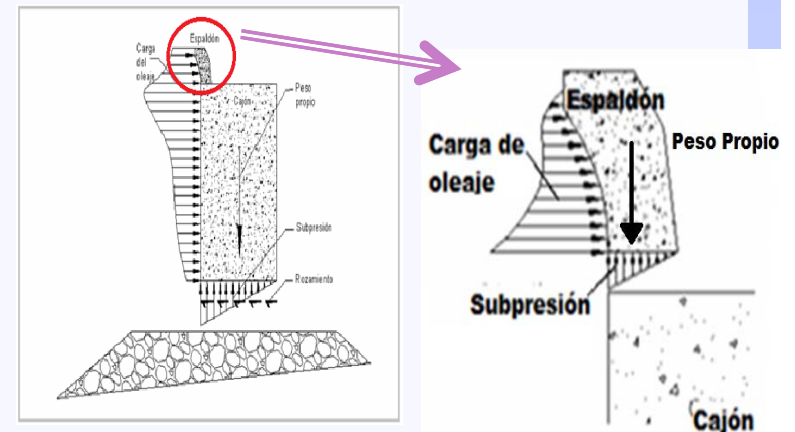
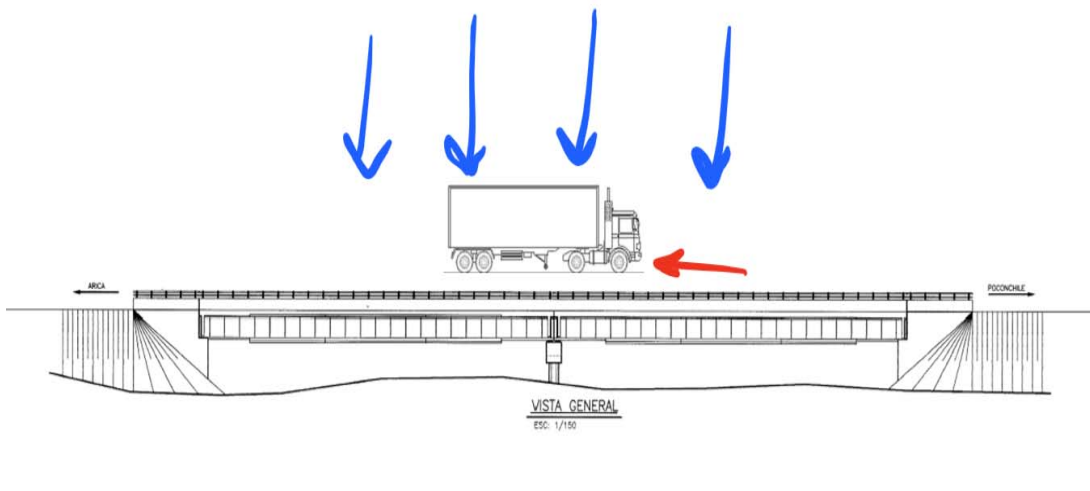
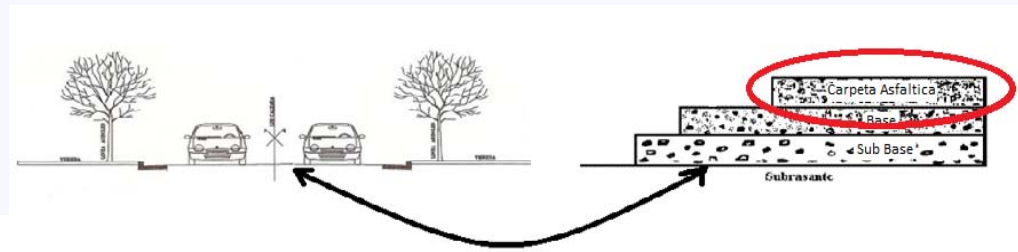
Transfer knowledge to
regional teams



Infrastructure management at
Regional Level, until certain value of
vulnerability of each structures

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- Phase 1 – Element Pathologies – Services Loads.
- Damage index - Material.



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| Elemento Estructural | Riesgo | Fase I | |
|------------------------------|--------------------------------------|--------------|-------|
| | Patología | Calificación | Nivel |
| Carpeta asfáltica | Fisuras y Grietas por fatigamiento | Menor | 1 |
| | Fisuras y grietas en bloque | Menor | 1 |
| | Grietas de borde | Menor | 1 |
| | Fisuras y Grietas Longitudinales | Menor | 1 |
| | Fisuras y Grietas Transversales | Menor | 1 |
| | Fisuras y Grietas Reflejadas | Menor | 1 |
| | Parches Deteriorados | Menor | 1 |
| | Baches en Carpetas Asfálticas | Menor | 1 |
| | Baches en Tratamientos Superficiales | Menor | 1 |
| | Ahuellamiento | Menor | 1 |
| | Deformación Transversal | Menor | 1 |
| | Exudaciones | Menor | 1 |
| | Desgaste | Menor | 1 |
| | Perdida de Áridos | Menor | 1 |
| | Ondulaciones | Menor | 1 |
| Estatus General del Elemento | | | 1 |

Carpeta Asfáltica



Es la base mas economica y que se ocupa en las carreteras en Chile por su trabajabilidad y por la facilidad para crear la mezcla. Es la base superior de toda la carretera, donde tiene contacto directo los vehiculos cuando circulan.

[Volver](#)

| Posibles Daños | Descripción | Causas | Medición |
|-----------------------------|---|---|---------------------------------------|
| Fisuras y grietas en bloque | Agrietamiento que divide el pavimento en trozos rectangulares | Mezcla asfáltica muy rígida. Espesor del pavimento inadecuado para el nivel de solicitaciones. | Establecer cantidad de m ² |

| Fisuras y Grietas en Bloque | Medición de falla | |
|-----------------------------|-------------------|--|
| <p>PLANTA</p> | 1 | No se observa daño Se observan distitas fisuras menores sin interconectarse entre si |
| | 2 | Ancho de fisuras < 3 mm o grietas selladas en buenas condiciones y de ancho que no se puede determinar |
| | 3 | 3 mm < ancho grietas < 20 mm, o grietas de ancho medio > 20 mm, rodeadas de un agrietamiento de severidad baja Ancho de grietas > 20 mm o grietas de un ancho medio > 20 mm, rodeadas de un agrietamiento de alta severidad |



[Volver](#)

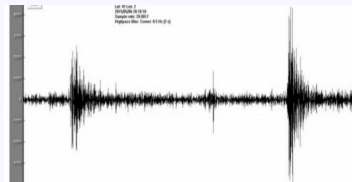
| Ubicación de la falla | Zona |
|-----------------------|---|
| No aplica 1 | No existe daño |
| Ubicación 2 | Se observa en el centro de la carretera |
| Ubicación 3 | Se observa en los bordes de carretera |

Niveles de evaluación con que se rellena la ficha de inspeccion

| | Valor |
|----------|-------|
| Menor | 1 |
| Moderada | 2 |
| Mayor | 3 |

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■ Phase 3



Terremoto (A)

Incendio (E)

Estructura

Tsunami (D)



Alud (B)

Inundacion (C)





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GRDR Method: Start up – South of Chile



Master Degree Program of Construction
and Management

Student: Rafael Romo Contreras
Date: October 2016

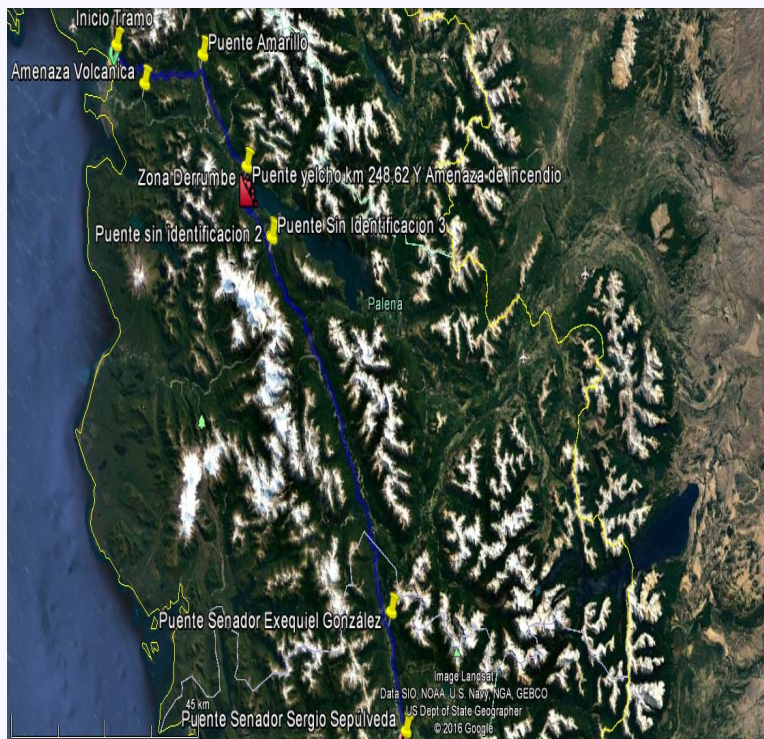


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“Start up Program - Route 7”





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| | |
|--------------------------|--|
| Country | CHILE |
| Location | Chaiten – Access to Patagonia |
| Year | May 2008 |
| Causes | Volcano |
| Main consequences | Road and bridge collapse Destroy of Chaiten city 4000 Casualties Disrupt water and electrical service |

Chaiten City



Chaiten Volcano





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Inspections:

- (2) Suspension Bridge
- (1) Cable stay Bridge
- (5) Traditional Bridge
- (200 km) Roads
- Landslide areas





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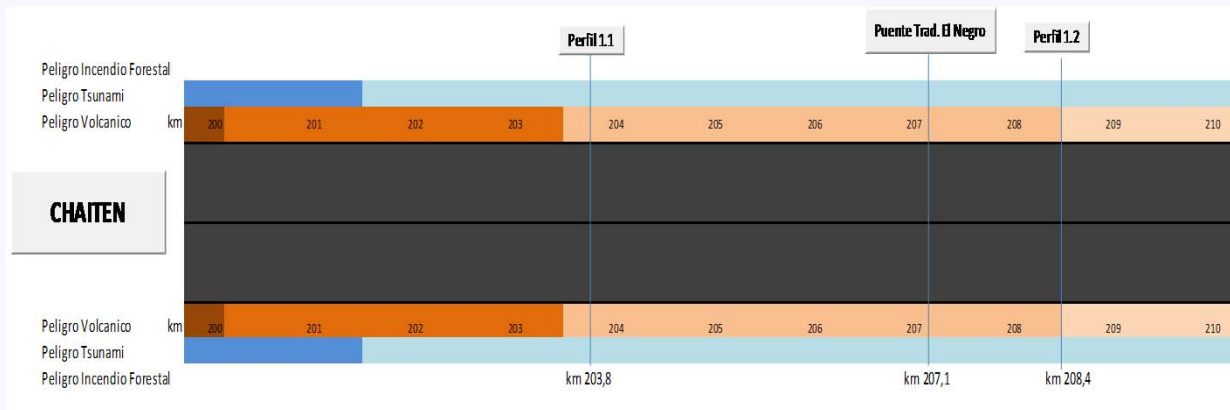


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Structure Planning Inspection:

In office analysis:

- Contact and information of regional emergency entities and navy-police to provide support during inspection
- Gathering information of structures (previous inspections and drawings)
- Analyze the weather and potential hazards
- Prepare inspection sheets (phase 1,2 and 3)



Monography

Simbología

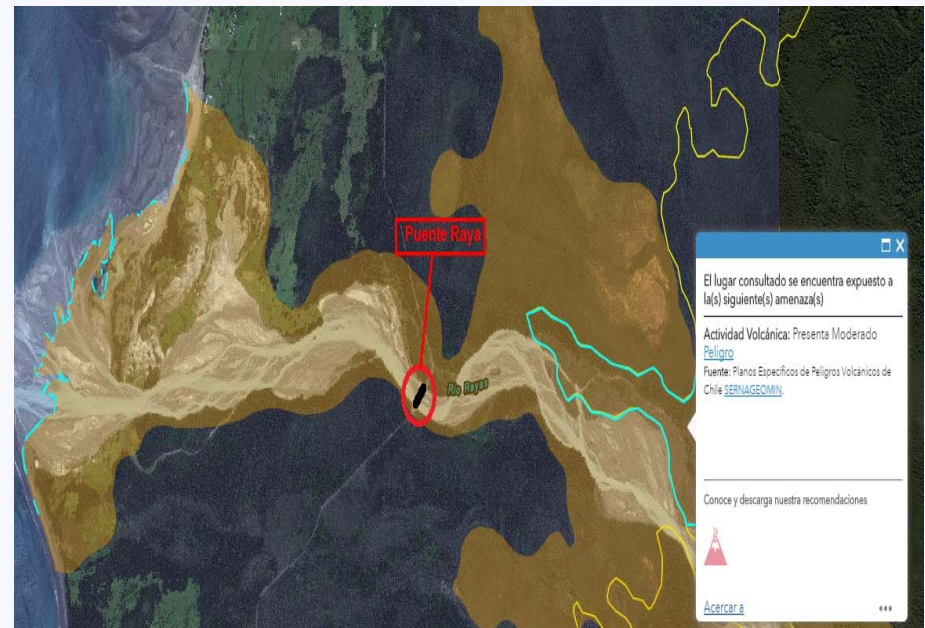
- Zona Volcanica Presenta Alto Peligro
- Zona Volcanica Presenta Moderado Peligro
- Zona Volcanica Presenta Bajo Peligro
- Zona Volcanica "Área susceptible de ser afectada por Peligros Volcánicos"
- Tsunami: Se encuentra en Área de Evacuación
- Tsunami: Se encuentra bajo Cota 30
- Incendio Forestal: Densidad Baja
- Camino Asfáltico
- Camino de Ripio

Infraestructura: Define the inspection considering hazard level

“Volcano Hazards”

Bridge: Raya

Typology: Traditional



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Protocol of Inspection

- Team: 7 Professional + 1 Technical
- Monography review
- Maintenance and GRDR sheets
- Micro and Macro Inspection





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Technical Inspection

Carol Urzúa Bridge



Raya Bridge





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Technical Inspection

Yelcho Bridge



El Amarillo Bridge





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Technical Inspection

Michimahuida Bridge



Exequiel González Bridge





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Non Considered Hazard on Bridge area. Fires Future implementation

Wood Fire – Under the Bridge





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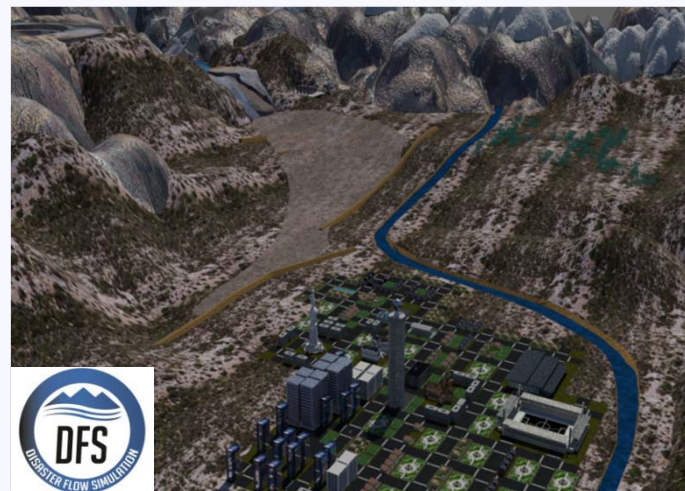
Future research GRDR

Start up: Valparaiso Region (Tsunami, Earthquake, Landslides and Fires)

Update Maintenance Sheet for phase 1 and 2.

Update Hazard Sheet and Catalog of Pathologies of GRDR

To develop optimization algorithm and software solutions



Santiago – CHILE
18 al 20 de Octubre de 2017
October 18 to 20, 2017



SECOND INTERNATIONAL BRIDGES CONGRESS - CHILE 2017, DESIGN, CONSTRUCTION AND MAINTENANCE

Venue

Santiago - Chile

Dates

18 - 20 October 2017

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