

EARLY WARNING SYSTEMS FOR DEBRIS FLOWS MONITORING IN CHILE

Jaime Cuevas, Dr. Rémi Valois, Dr. Cristián Orrego, Comp. Sc. Eng. José Ruttllant, Dr.

What are debris flows?

- A debris flow consists of particulate material transported and deposited transiently or permanently by a streamflow.
- They can occur suddenly and cause floodings.
- They can be made up of gravel, sand, silt or clay (10-20% fine material)

What do we know about debris flows in Chile?





Historical background

Región de Urica Iarinacota Región de Tavapacio 3quique	Place	Year	Casualties
Región de (Intofagasta	Antofagasta	1991	92
Resin de Alacoma	Atacama	2015	31
Stochén de Caquimbo	Road to Farellones	2009	2
Región de Valpaxaiso	Maipo Canyon	2016	4
Santiago Jummur Region & Libertador Bonavido O Hilgins Jular Región del Maule	Macul Ravine	1993	26

Causes of debris flows in Chile







Lahars



Villarrica volcano

Rain

Zero degree isotherm height in mountain precipitation



- Mid-latitude frontal disturbances from the Pacific Ocean, mostly in austral winter
- Austral summer rains in the Andean Highlands fed from Amazon Basin moisture.



El Niño-Southern Oscillation events

Climate change



Triggering factors for debris flows caused by rain

- Precipitation rate (daily/hourly)
- Accumulated rainfall in the previous 25 days
- Altitude of the 0 °C isotherm

Contributing factors for debris flows

Scarce vegetational cover



Soils with scarce organic matter producing a low capacity of infiltration



Soil texture

Clayish soils infiltrate water at a lower rate than sandy soils





MOUNTAINOUS GEOMORPHOLOGY

Hydrological behaviour of debris flows

Hydrograph-hyetograph relationships for a southern Chilean watershed





Chilean experience

En febrero instalarán 14 nuevas estaciones de monitoreo meteorológico en la Región de Antofagasta

09.01.2016 La iniciativa tiene una inversión superior a los \$500 millones entregados por el Fondo Nacional de Desarrollo Regional (FNDR), considera la colocación de seis estaciones en las diferentes quebradas de Antofagasta; una en la Quebrada de Barriles de Tocopilla; una en la quebrada de Taltal y el resto en la Provincia del Loa.



In February 2016, 14 new stations for meteorological monitoring will be installed in the Antofagasta Region

soyantofagasta.cl

Meteorological sensor anticipates debris flows



Es el primero de 25 que se instalarán en la precordillera santiaguina Sensor meteorológico anticipa aluviones

CAMILA FIGUEROA

Pronosticar fenómenos climáticos y prevenir emergencias en el sector precordillerano de Peñalolén ya no será problema para los expertos. ¿Cómo? Gracias a la inauguración este sábado del primero de los 25 sensores que monitorearán el clima en las zonas altas de Santiago. Esta nueva estación se instaló en el techo del edificio de posgrado de la U. Adolfo Ibáñez: fue financiada por la multinacional estadounidense IBM (dueña de la empresa espe-

cializada en climatología The Weather Company) y será monitoreada por el Centro Nacional de Investigación para la Gestión Integrada de Desastres Naturales (Cigiden) Rodrigo Cienfuegos, académico del Departamento de Ingeniería Hidráulica y Ambiental de la PUC y director del Cigiden, afirmó que este equipamiento ayudará a la predicción de fenómenos anormales -cada vez más usuales- al optimizar las mediciones específicas en los sectores altos de la capital. "La idea es observar el comporta-

miento de la isoterma cero (altura donde se instala la temperatura grado cero), que es justamente la clave para anticipar la ocurrencia de los aluviones. Cuando hay temperaturas altas, tiende a haber mayores precipitaciones en la zona cordillerana: eso genera desprendimiento de material y aluviones". explicó.

Estos sensores, dijo, son relativamente baratos y livianos; por esto mismo, pueden distribuirse fácilmente en toda la zona precordillerana.

Las Últimas Noticias newspaper Sunday, April 9 2017 19

	Library	Calendar	Employment	Contact Us 🛛 🎽 👖
PIMA COUNTY	-	-		Q
Recreation Health Development Business	Community	l En	vironment	Government
Pima County » Government » Regional Flood Control District » Services » Precipitation and S Precipitation and Streamflow Data	Streamflow Data	* * * * * * * * * *	* *	

Automated Local Evaluation in Real Time (ALERT)

The District operates and maintains a network of real-time sensors used to collect hydrometeorological data. This network provides information to county personnel and other agencies about precipitation, stormwater runoff, and weather conditions affecting our regional watersheds.

Using radio telemetry, sensors report data in the National Weather Service Automated Local Evaluation in Real Time (ALERT) format. This type of network is commonly referred to as an ALERT system.

ALERT system sensors are event driven and transmit data in real-time to base station computers at the District's office and the Tucson National Weather Service office. Event driven real-time transmission, means that transmission of data occurs immediately as data is collected at field sites.

Data collected by the ALERT system is used by the National Weather Service to assist in issuing flood watches and warnings and to ground-truth radar determined rainfall estimates.



ALERT data is important to the District in providing for public safety. Data is collected primarily to detect situations that can lead to flooding. Data is also useful in

reconstructing storm events and thus is of interest to a wide range of public and private users.

Currently, the ALERT system includes 93 precipitation, 36 stream, and 4 weather station sites located in Pima and adjacent counties.

VIEW ALERT SENSOR DATA @. Data is provided for current and recent historical periods.

The links below provide additional information about the District's ALERT sensor network and the data collected.









	Finger	Rock V	Vash river (IL	2393)	
Hourly Data Values		Raw Data Values			
05/21/2016 0700 0600 0500 0400 0300 0200	0.50 0.49 0.49 0.49 0.49 0.49 0.49	Î	06/21/2016 06:42:52 06/20/2016 18:44:56 06/20/2016 18:44:56 06/19/2016 18:49:02 06/19/2016 18:49:02 06/18/2016 18:53:09 06/18/2016 06:55:12	0.50 0.49 0.50 0.51 0.51 0.50 0.51	ê
0100 06/20/2016 2400	0.49 0.49	*	06/17/2016 18:57:15 06/17/2016 06:59:19 06/16/2016 19:01:22	0.50	









GENERAL OBJECTIVE

• To warn the population about debris flows in order to rush off and safeguard their belongings

PURPOSE

To avoid the loss of human lives and material belongings in debris flow catastrophes

• METHODOLOGY

In every monitoring point, we will install:



Rain gauge



Ultrasonic device to measure stream stage

Data transmission platform

unto Invitación Conme 🗴 M Recibidos (474) - jxcuevas 🗴 💽 60 Hits of the 60s (Not 💷 🗙 🕥 Red de estaciones meteor 🗴



www.ceazamet.cl

Places of installation





Discharge (I/s)

COMBINED MODEL

Rainfall event





- In Chile, debris flows primarily require high rainfall intensities (high hourly rainfall rates).
- There is a lag time between the origin of debris flows and when they reach populated zones





Joint Projects in S&T&I on Natural Disasters Management

Research on Early Monitoring and Warning Pattern of Flash Flood/Debris Flow and Its Applications

Dawei Zhang, Dongya Sun, et al.



• MANY THANKS!