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El Rol de los Datos Sísmicos en el Estudio de Remociones en Masa
The role of seismic data on landslide research

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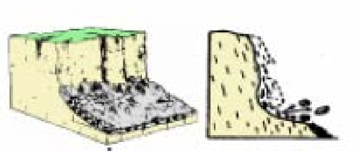
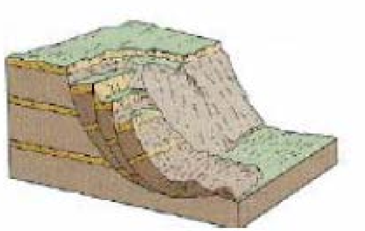
Landslides



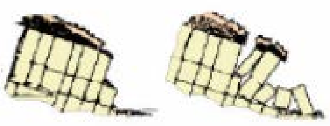
(a)

Caídas (falls)



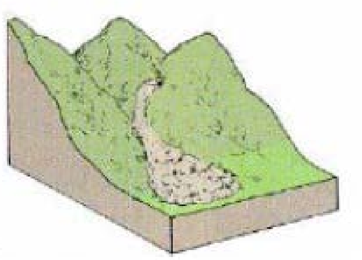
(b)

Deslizamientos (Slides)



(c)

Volcamientos (Topples)



(d)

Flujos y avalanchas (Flows)

(e)

Propagación Lateral (Spreads)

Slides

Deslizamiento de roca en bloque de tipo plano, Cañón de Pacoima, California, terremoto de Northridge, 1994.

Deslizamiento rotacional (slump) de suelo en sector El Manzanito, valle del Maipo, generado por el terremoto de Las Melosas de 1958

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Falls

Caída de bloques en Quebrada Tarapacá, terremoto del 13/06/2005

Rock avalanches

Deslizamiento de rocas que derivó en avalancha en quebrada lateral al fiordo Aysén, sector epicentral en terremoto de 2007.

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Flows and Lateral Spreads

Flujo de detritos en quebrada lateral al Fiordo Aysén, terremoto de 2007

Camino afectado por lateral spread, terremoto de Seattle, 2001

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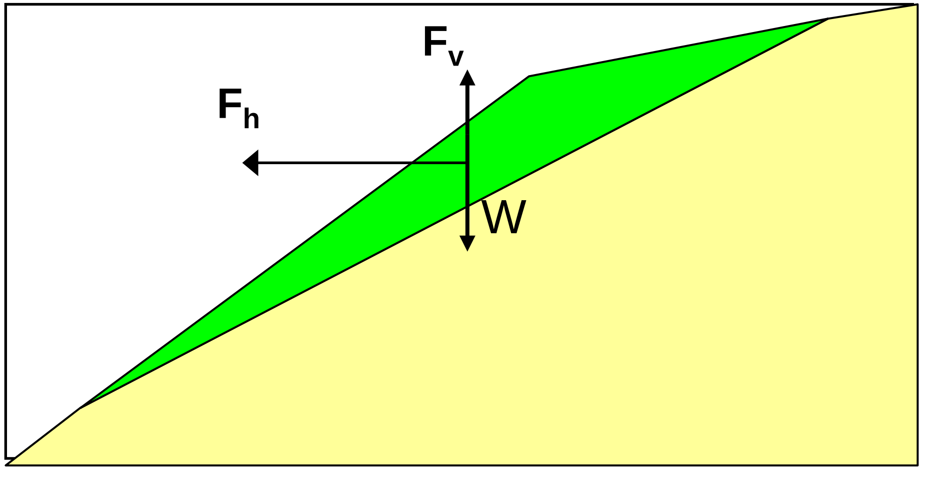
Landslide Research

- Landslide mechanisms
- Failure mechanics
- Stability analyses
- Triggers: Earthquake, rainfall and volcanism
- Hazard analyses
- Geomorphological analyses (age of deposits, erosion rates, relationships with tectonics and climate)

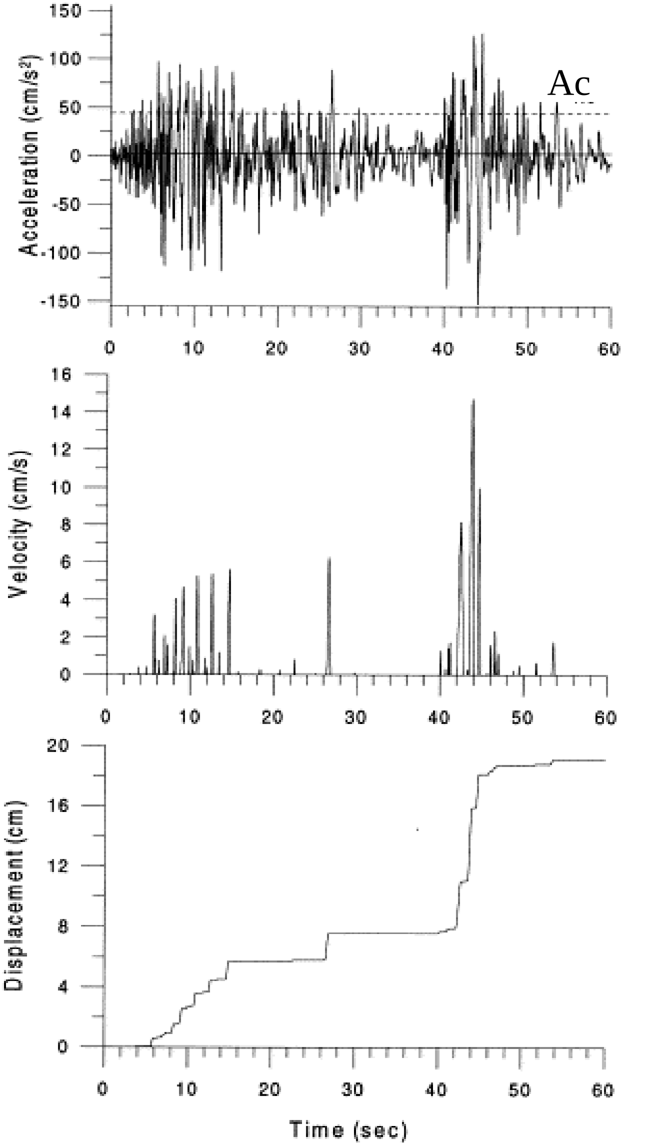
The use of seismic data. Input for:

- Slope stability back-analyses of earthquake-induced landslides
- Slope models, failure mechanics
- Soil (rock) dynamics lab testing
- Landslide Hazard maps
- Detection of remote landslides

Slope stability back (forward)-analyses of earthquake-induced landslides



$$F.S. = \frac{cA + (W(\cos\alpha - k_h \sin\alpha - k_v \cos\alpha) - U)\tan\phi}{W(\sin\alpha + k_h \cos\alpha - k_v \sin\alpha)}$$



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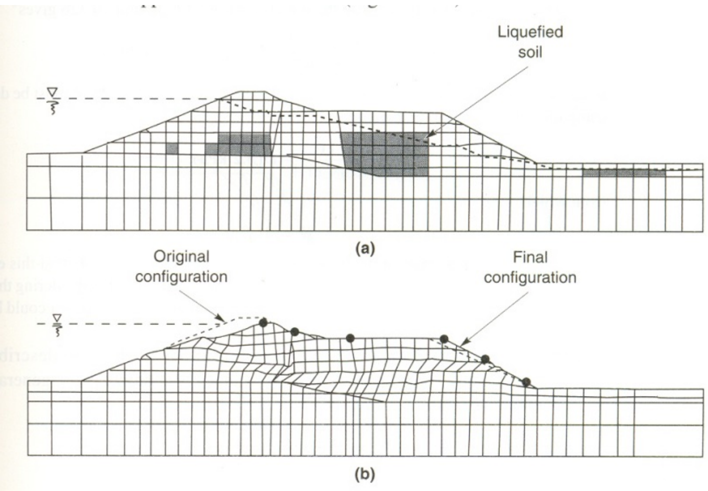
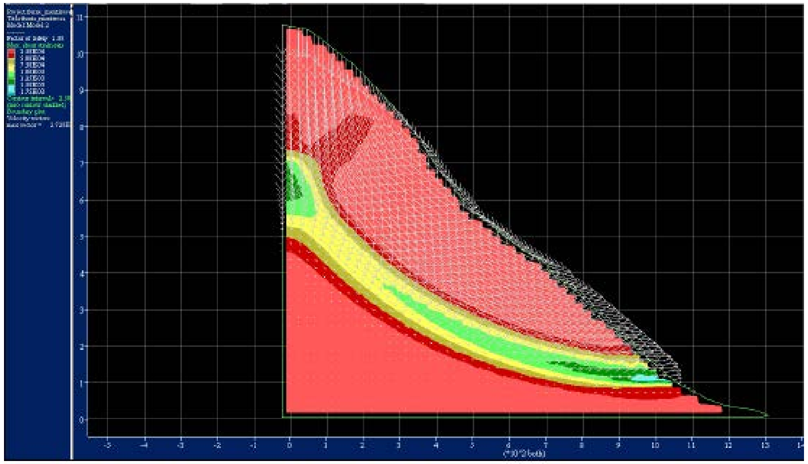
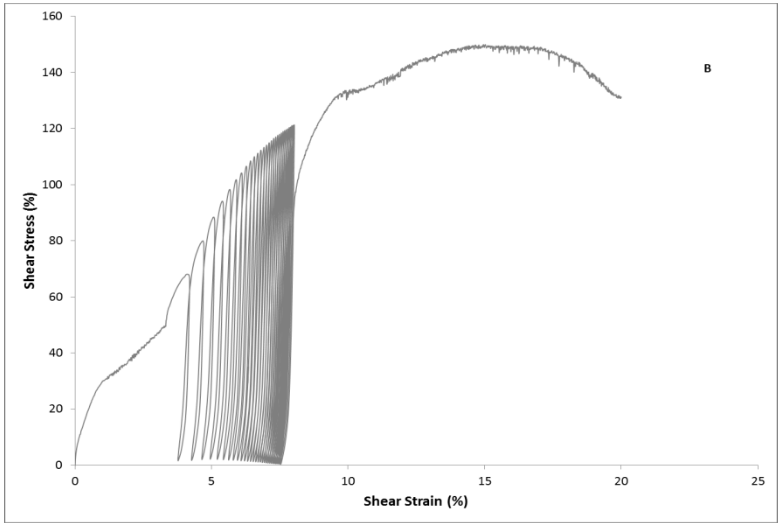
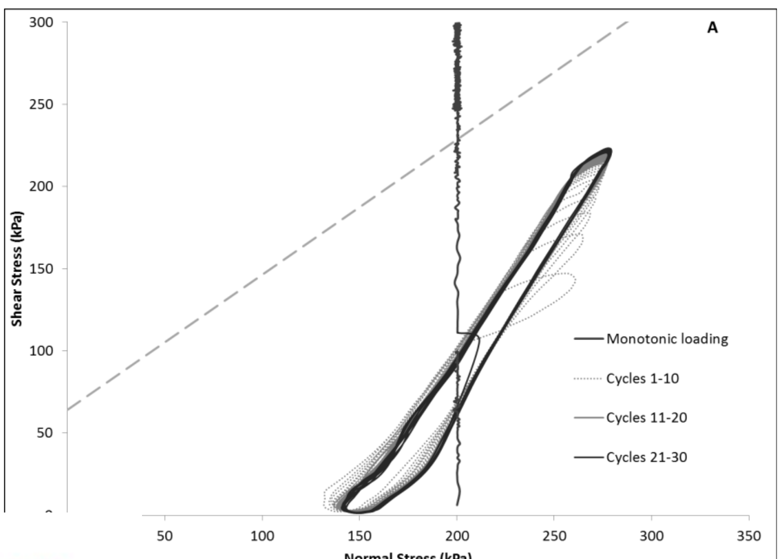
Slope models, failure mechanics

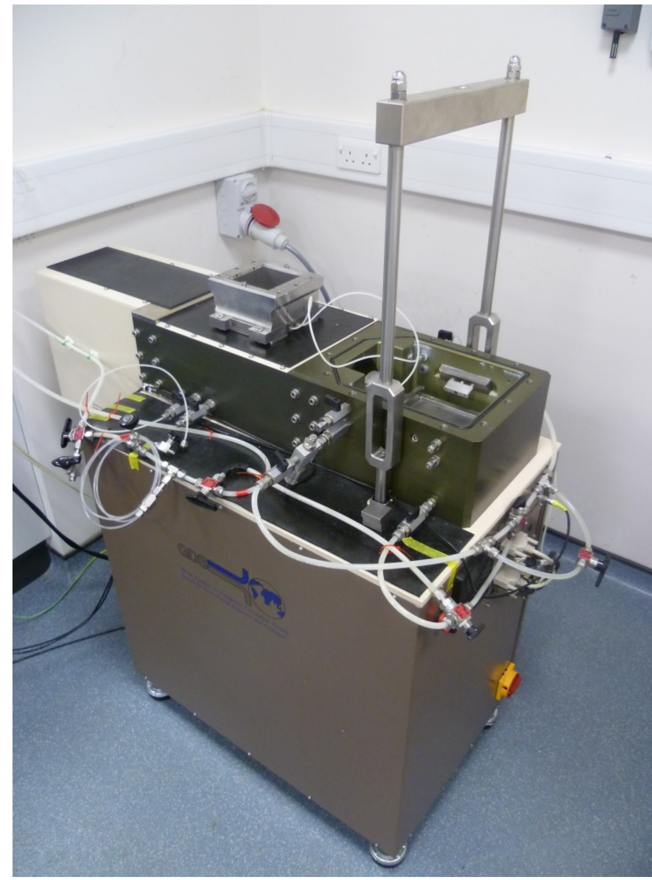




Laboratory Dynamic Tests

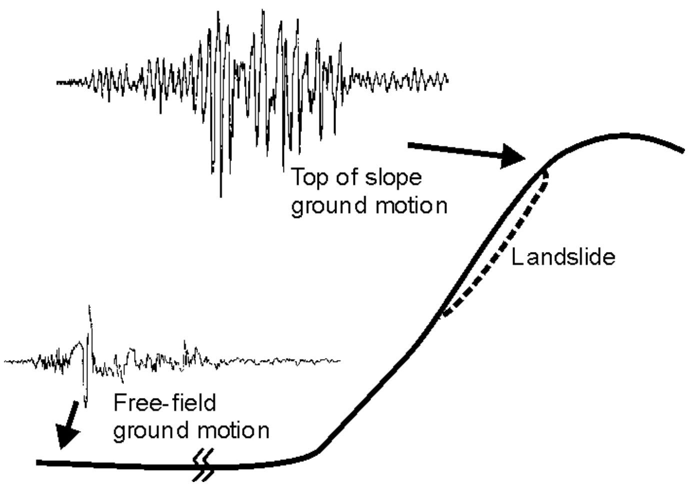






“Good” seismic data for specific site analyses should have:

- Acceleration records (for force analyses used for slope stability)
- Proximity to the landslide area (very local phenomenon)
- Ideally, stations on top of slopes to account for topographic amplification



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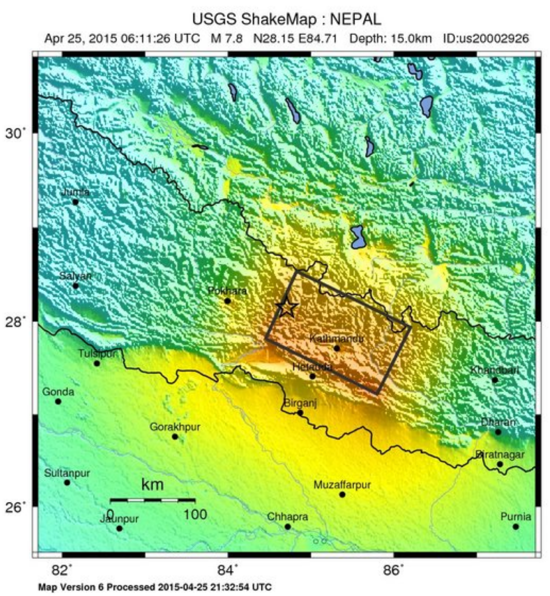
Landslide Hazard Maps

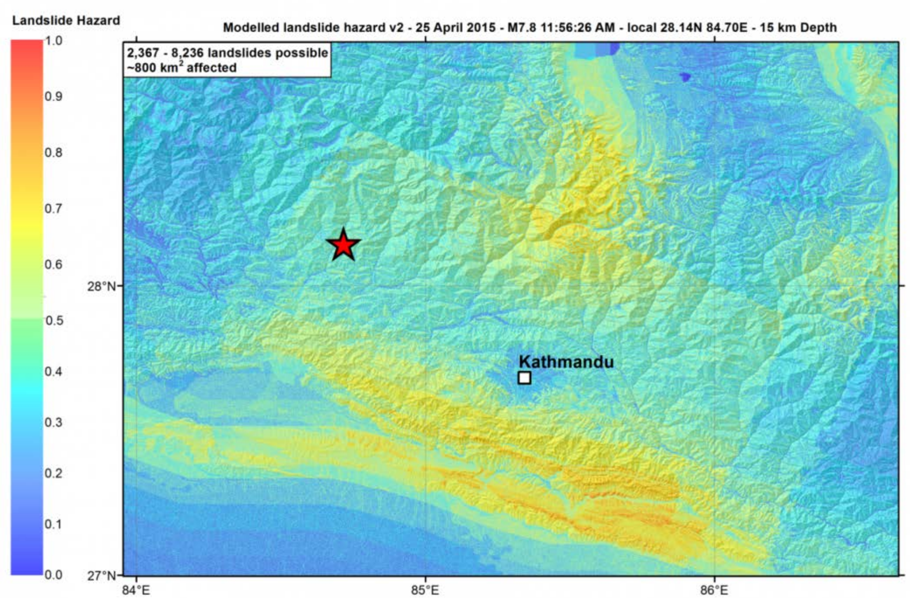
- Based on seismic hazard maps, empirical attenuation relationships or recent shake maps.



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

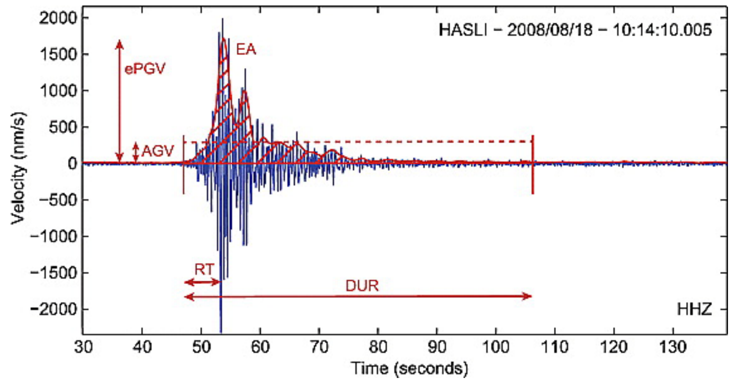
- Preliminary landslide hzard model run just after Neparl earthquake. Input data are USGS Shake Map and topography (slope, location on the hillside and slope aspect).(Tom Robinson, U. Canterbury)

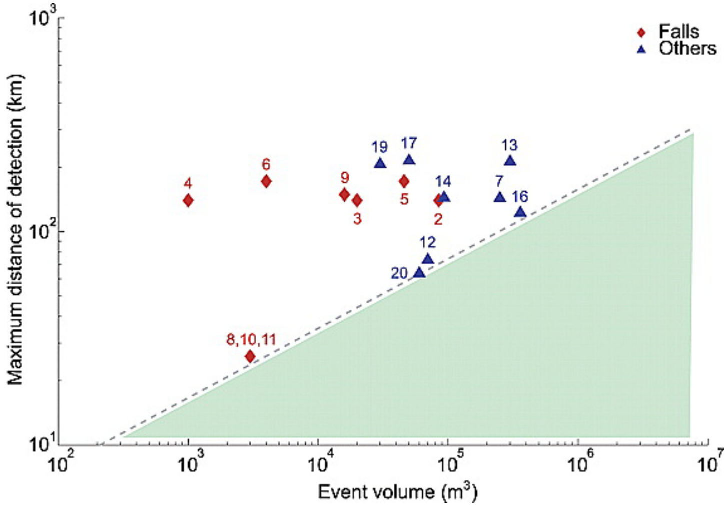


Detection of remote landslides

- Large, fast landslides, especially those formed from rock, are sufficiently energetic that they generate earthquake waves that can be recorded remotely.
- Potential for landslide:
  - Detection
  - Location

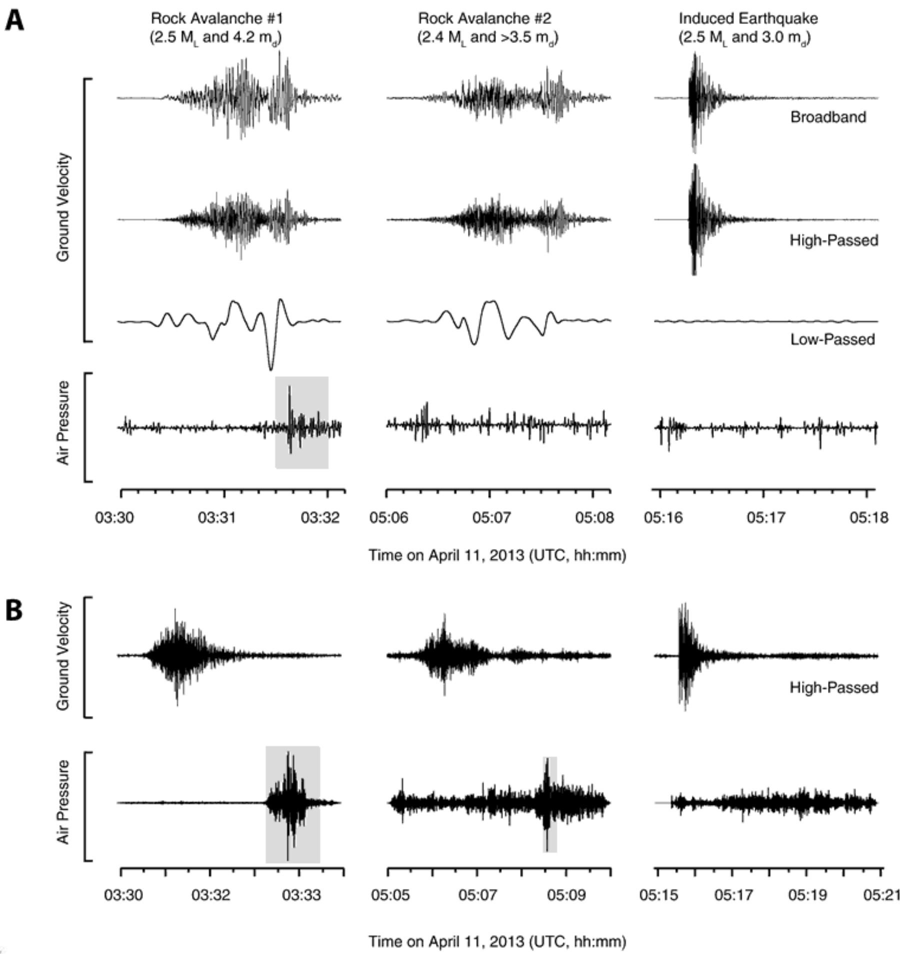
- In addition, processing of the signal allows the speed of movement, and other parameters such as rockslide volume, runout distance, drop height, potential energy to be estimated.





Dammeier et al 2011

Bingham Canyon rock avalanches, 2013, Utah



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Pankow et al 2014

Little boulder deposited by 1987 Parraguirre debris flow, central Chile