# CARTOGRAFÍA GEOTÉCNICA

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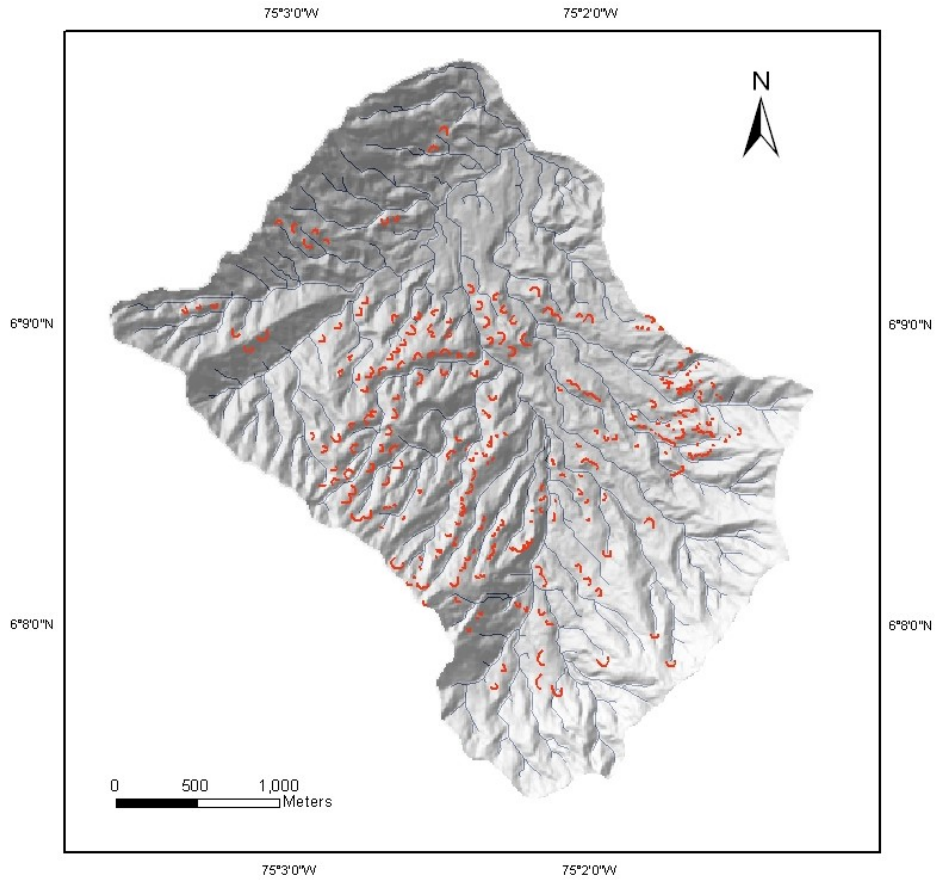
# Inventario de MenM

Colección de las características de los deslizamientos en una cierta área y tiempo, preferiblemente en formato digital con información espacial relacionada con la localización (puntos o polígonos) combinada con información de atributos. Estos atributos deben idealmente contener información sobre:

- el tipo de deslizamiento,
- actividad actual,
- tamaño y/o volumen,
- fecha de ocurrencia o edad relativa,
- causas.




Fuente: AGS (2007), Corominas et al. (2014)

# Por qué son importantes?

- Los inventarios de deslizamientos son la base para evaluar la susceptibilidad, amenaza y riesgo por deslizamientos.
- Son esenciales para los modelos de susceptibilidad que predicen los deslizamientos basados en las condiciones pasadas: Necesitamos saber dónde ocurren y cuántos.
- Esas condiciones son utilizadas para predecir los deslizamientos futuros: Necesitamos saber los factores causantes.
- Estas condiciones difieren para diferentes tipos de movimientos: Necesitamos saber qué pasó.
- La información temporal es esencial para estimar la frecuencia de los deslizamientos: Necesitamos saber cuándo pasaron.
- Los inventarios de deslizamientos son usados para validar los resultados de la zonificación.

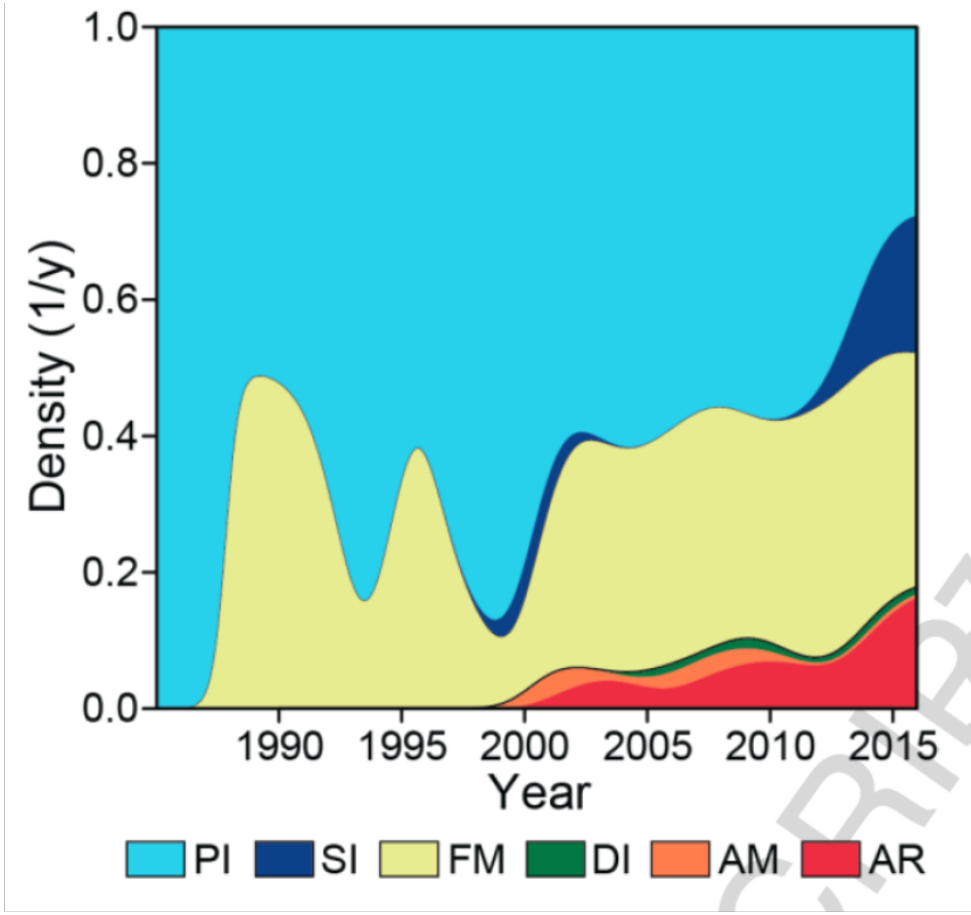
Fuente: van Westen en ACP-EU Natural Disaster Risk Program

# Técnicas de levantamiento

- Análisis de archivos información histórica (Reichenbach et al., 1988; Salvati et al., 2003).
- Fotointerpretación de fotografías aéreas (Guzzetti & Cardinali, 1989, 1990; Galli et al., 2008; Santagelo et al., 2010, 2013).
- Análisis visual de imágenes LIDAR (Ardizzone et a., 2007; van den Eeckhaut et al., 2007; Haneberg et al., 2009; Guzzetti et al., 2012; Razak et al., 2011, 2013).
- Procesamiento de imágenes LIDAR (Martha et al., 2010; Lu et al., 2011, van der Eeckhaut et al., 2012).
- Procesamiento de imágenes de satélite (Mondini & Chang, 2014; Yang & Chen, 2010; Rosin & Hervas, 2005).
- Levantamiento de campo.

Fuente: van Westen en Landslide types and causes; Santagelo et al. (2015)

# Técnicas de levantamiento




Legend: PI, visual interpretation of aerial photographs; SI, visual interpretation of satellite images; FM, field mapping; DI, visual interpretation of DEM derivatives; AM, automatic or semi-automatic mapping using remote sensing imagery; AR, analysis of archive and historical sources.

Fuente: Reichenbach et al. (2018)

# Técnicas de levantamiento

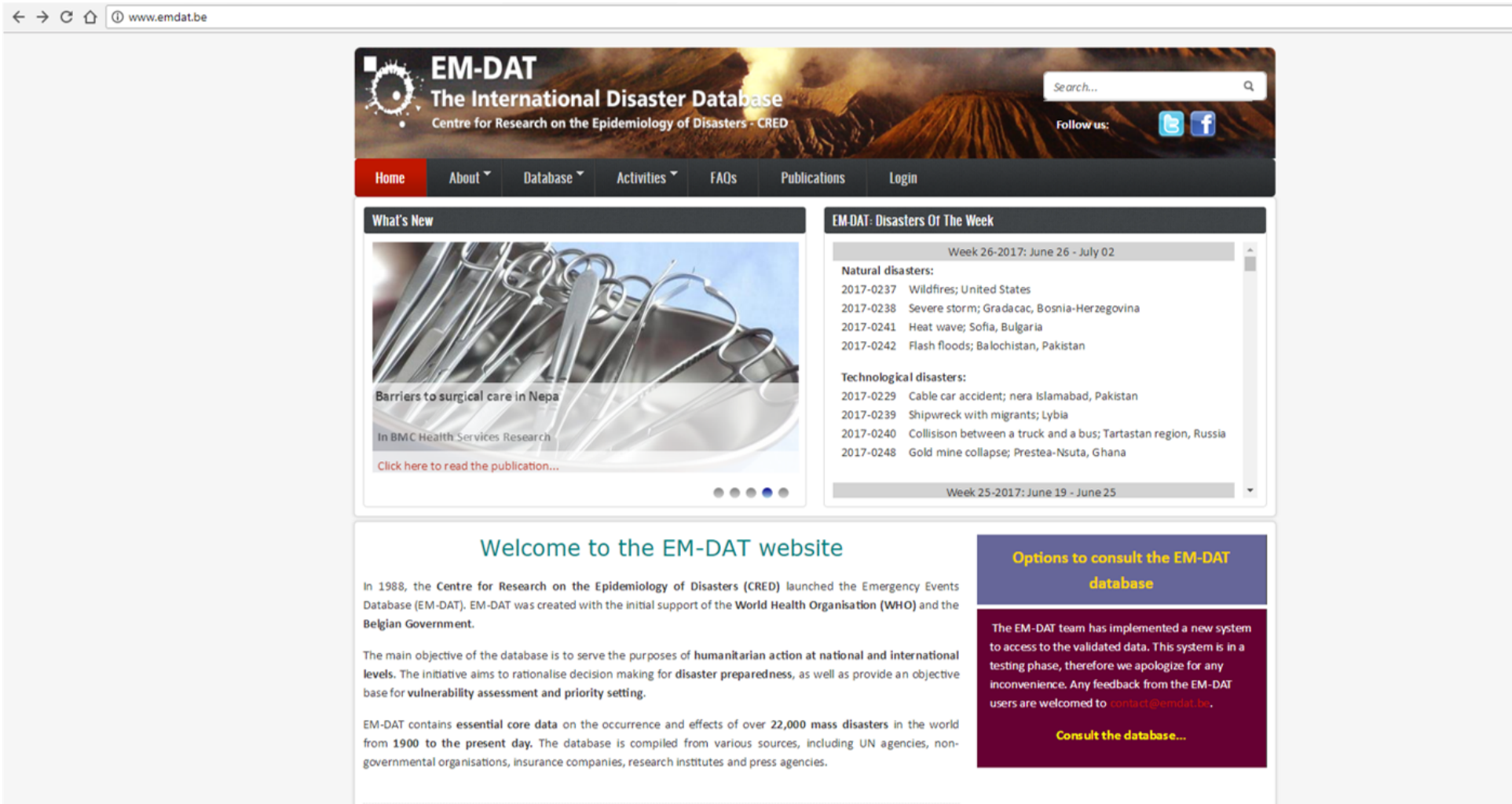
| Group | Technique | Description | Scale | | |
|---|---|---|---|---|---|
| | | | N | L | S |
| **Image interpretation** | Stereo aerial photographs | Analog format or digital image interpretation with single or multi-temporal data set | **M** | **M** | **M** |
| | High Resolution satellite images | With monoscopic or stereoscopic images, and single or multi-temporal data set | **H** | **H** | **H** |
| | LiDAR shaded relief maps | Single or multi-temporal data set from bare earth model. | **H** | **H** | **H** |
| **(Semi) automated classification based on spectral characteristics** | Aerial photographs | Image ratioing, thresholding | **M** | **M** | **M** |
| | Medium resolution multi spectral images | Single data images, with pixel based image classification or image segmentation | **H** | **H** | **H** |
| | | Multiple date images, with pixel based image classification or image segmentation | **M** | **M** | **M** |
| **(Semi) automated classification based on altitude characteristics** | InSAR | Terrestrial Radar Interferometry | **M** | **M** | **M** |
| | | Permanent scatterers for pointwise displacement data | **L** | **L** | **L** |
| | LiDAR | Overlaying of LiDAR DEMs from different periods | **L** | **L** | **L** |
| | Photogrammetry | Overlaying of DEMs from airphotos or high resolution satellite images for different periods | **L** | **L** | **L** |
| **Field investigation methods** | Field mapping | Conventional method | **H** | **H** | **H** |
| | | Using Mobile GIS and GPS for attribute data collection | **H** | **H** | **H** |
| | Interviews | Using questionnaires, workshops etc. | **H** | **H** | **H** |
| **Archive studies** | Newspaper archives | Historic study of newspaper, books and other archives | **M** | **M** | **M** |
| | Road maintenance organizations | Relate maintenance information along roads caused by landslides | **H** | **H** | **H** |
| | Fire brigade/police | Extracting landslide occurrence from logbooks on accidents | **H** | **H** | **H** |

(N=National, L=Local and S=Site specific.

(H= highly applicable, M= moderately applicable, and L= Less applicable)

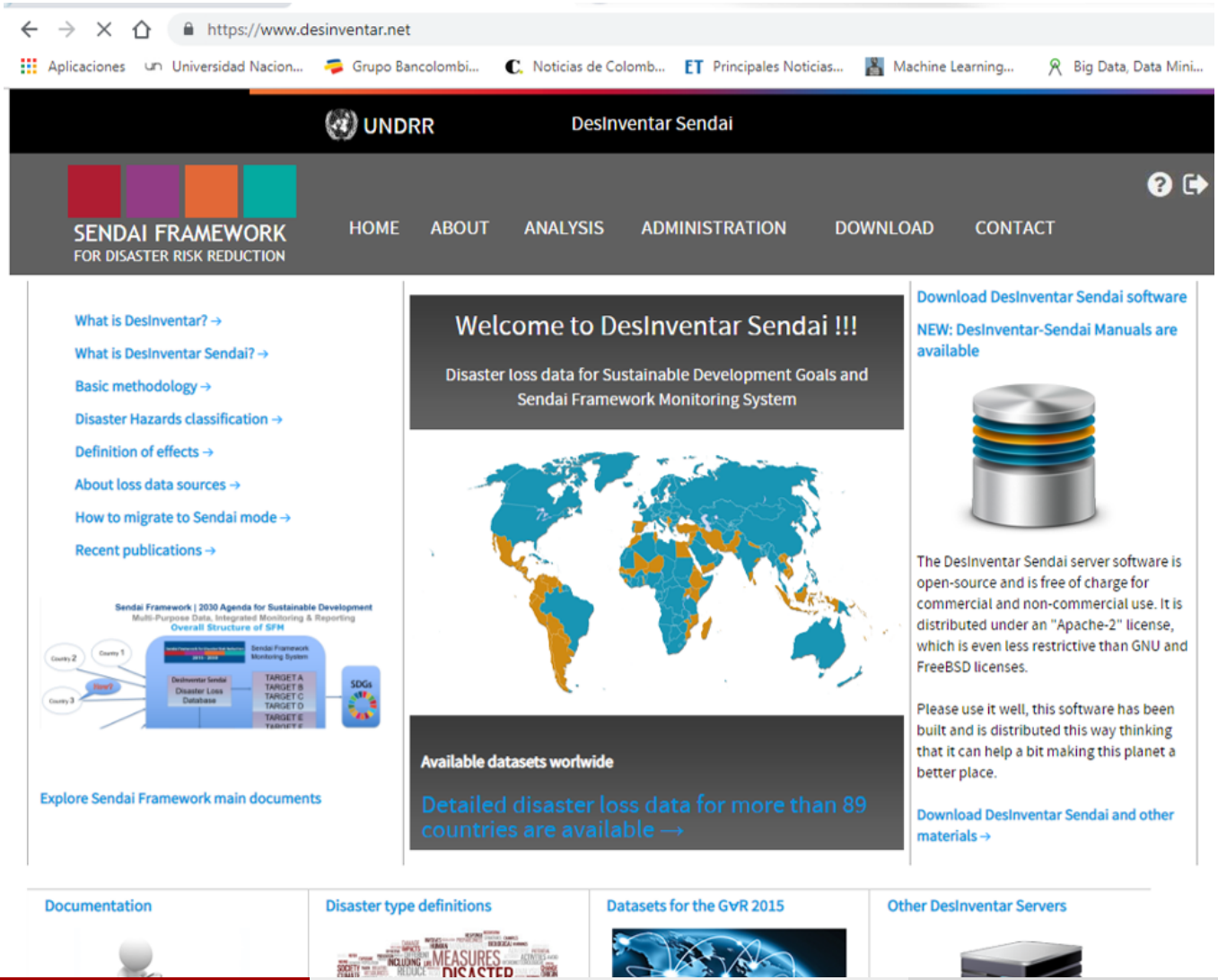
# Inventario histórico

`http://www.emdat.be/`



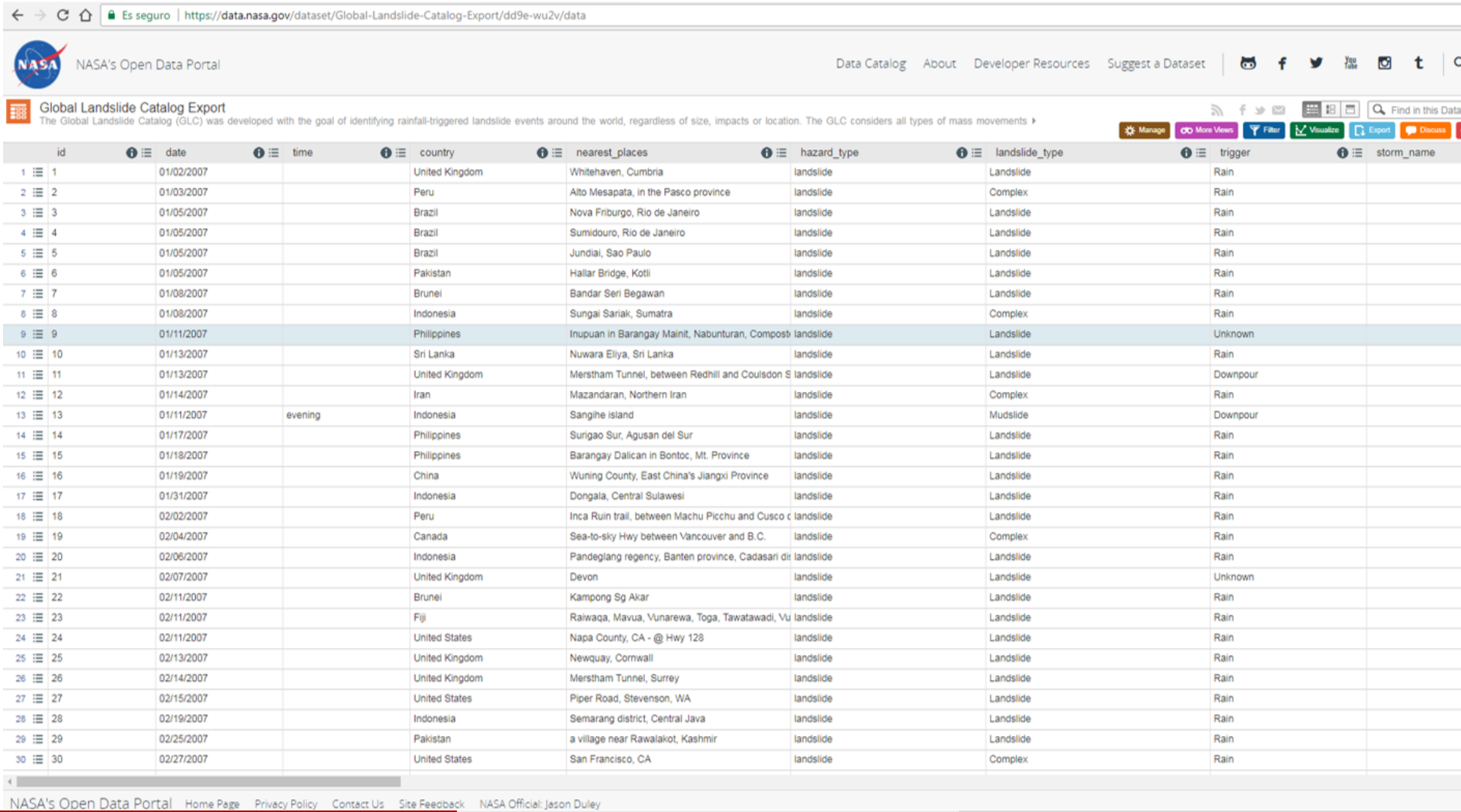
# Inventario histórico

`http://desinventar.net`



# Inventario histórico

`https://data.nasa.gov/dataset/Global-Landslide-Catalog-Export/dd9e-wu2v`



Es seguro | https://data.nasa.gov/dataset/Global-Landslide-Catalog-Export/dd9e-wu2v/data

NASA's Open Data Portal

Data Catalog About Developer Resources Suggest a Dataset

**Global Landslide Catalog Export**

The Global Landslide Catalog (GLC) was developed with the goal of identifying rainfall-triggered landslide events around the world, regardless of size, impacts or location. The GLC considers all types of mass movements

Manage More Views Filter Visualize Export Discuss

| | id | date | time | country | nearest_places | hazard_type | landslide_type | trigger | storm_name |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 01/02/2007 | | United Kingdom | Whitehaven, Cumbria | landslide | Landslide | Rain | |
| 2 | 2 | 01/03/2007 | | Peru | Alto Mesapata, in the Pasco province | landslide | Complex | Rain | |
| 3 | 3 | 01/05/2007 | | Brazil | Nova Friburgo, Rio de Janeiro | landslide | Landslide | Rain | |
| 4 | 4 | 01/05/2007 | | Brazil | Sumidouro, Rio de Janeiro | landslide | Landslide | Rain | |
| 5 | 5 | 01/05/2007 | | Brazil | Jundiai, Sao Paulo | landslide | Landslide | Rain | |
| 6 | 6 | 01/05/2007 | | Pakistan | Hallar Bridge, Kotli | landslide | Landslide | Rain | |
| 7 | 7 | 01/08/2007 | | Brunei | Bandar Seri Begawan | landslide | Landslide | Rain | |
| 8 | 8 | 01/08/2007 | | Indonesia | Sungai Sariak, Sumatra | landslide | Complex | Rain | |
| 9 | 9 | 01/11/2007 | | Philippines | Inupuan in Barangay Mainit, Nabunturan, Compost | landslide | Landslide | Unknown | |
| 10 | 10 | 01/13/2007 | | Sri Lanka | Nuwara Eliya, Sri Lanka | landslide | Landslide | Rain | |
| 11 | 11 | 01/13/2007 | | United Kingdom | Merstham Tunnel, between Redhill and Coulsdon S | landslide | Landslide | Downpour | |
| 12 | 12 | 01/14/2007 | | Iran | Mazandaran, Northern Iran | landslide | Complex | Rain | |
| 13 | 13 | 01/11/2007 | evening | Indonesia | Sangihe island | landslide | Mudslide | Downpour | |
| 14 | 14 | 01/17/2007 | | Philippines | Surigao Sur, Agusan del Sur | landslide | Landslide | Rain | |
| 15 | 15 | 01/18/2007 | | Philippines | Barangay Dalican in Bontoc, Mt. Province | landslide | Landslide | Rain | |
| 16 | 16 | 01/19/2007 | | China | Wuning County, East China's Jiangxi Province | landslide | Landslide | Rain | |
| 17 | 17 | 01/31/2007 | | Indonesia | Dongala, Central Sulawesi | landslide | Landslide | Rain | |
| 18 | 18 | 02/02/2007 | | Peru | Inca Ruin trail, between Machu Picchu and Cusco c | landslide | Landslide | Rain | |
| 19 | 19 | 02/04/2007 | | Canada | Sea-to-sky Hwy between Vancouver and B.C. | landslide | Complex | Rain | |
| 20 | 20 | 02/06/2007 | | Indonesia | Pandeglang regency, Banten province, Cadasari di | landslide | Landslide | Rain | |
| 21 | 21 | 02/07/2007 | | United Kingdom | Devon | landslide | Landslide | Unknown | |
| 22 | 22 | 02/11/2007 | | Brunei | Kampong Sg Akar | landslide | Landslide | Rain | |
| 23 | 23 | 02/11/2007 | | Fiji | Raiwaqa, Mavua, Vunarewa, Toga, Tawatawadi, Vu | landslide | Landslide | Rain | |
| 24 | 24 | 02/11/2007 | | United States | Napa County, CA - @ Hwy 128 | landslide | Landslide | Rain | |
| 25 | 25 | 02/13/2007 | | United Kingdom | Newquay, Cornwall | landslide | Landslide | Rain | |
| 26 | 26 | 02/14/2007 | | United Kingdom | Merstham Tunnel, Surrey | landslide | Landslide | Rain | |
| 27 | 27 | 02/15/2007 | | United States | Piper Road, Stevenson, WA | landslide | Landslide | Rain | |
| 28 | 28 | 02/19/2007 | | Indonesia | Semarang district, Central Java | landslide | Landslide | Rain | |
| 29 | 29 | 02/25/2007 | | Pakistan | a village near Rawalakot, Kashmir | landslide | Landslide | Rain | |
| 30 | 30 | 02/27/2007 | | United States | San Francisco, CA | landslide | Complex | Rain | |

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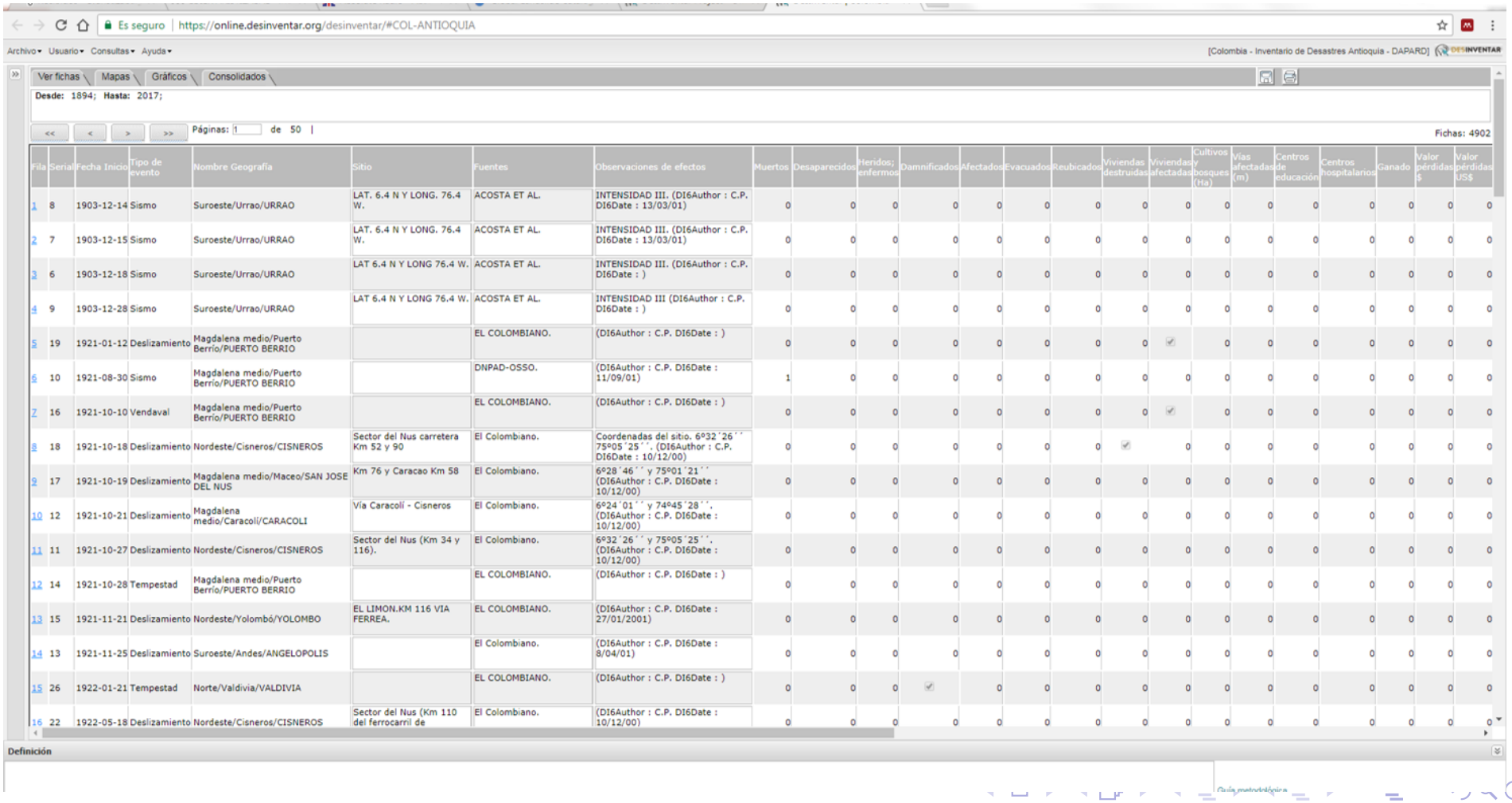
# Inventario histórico

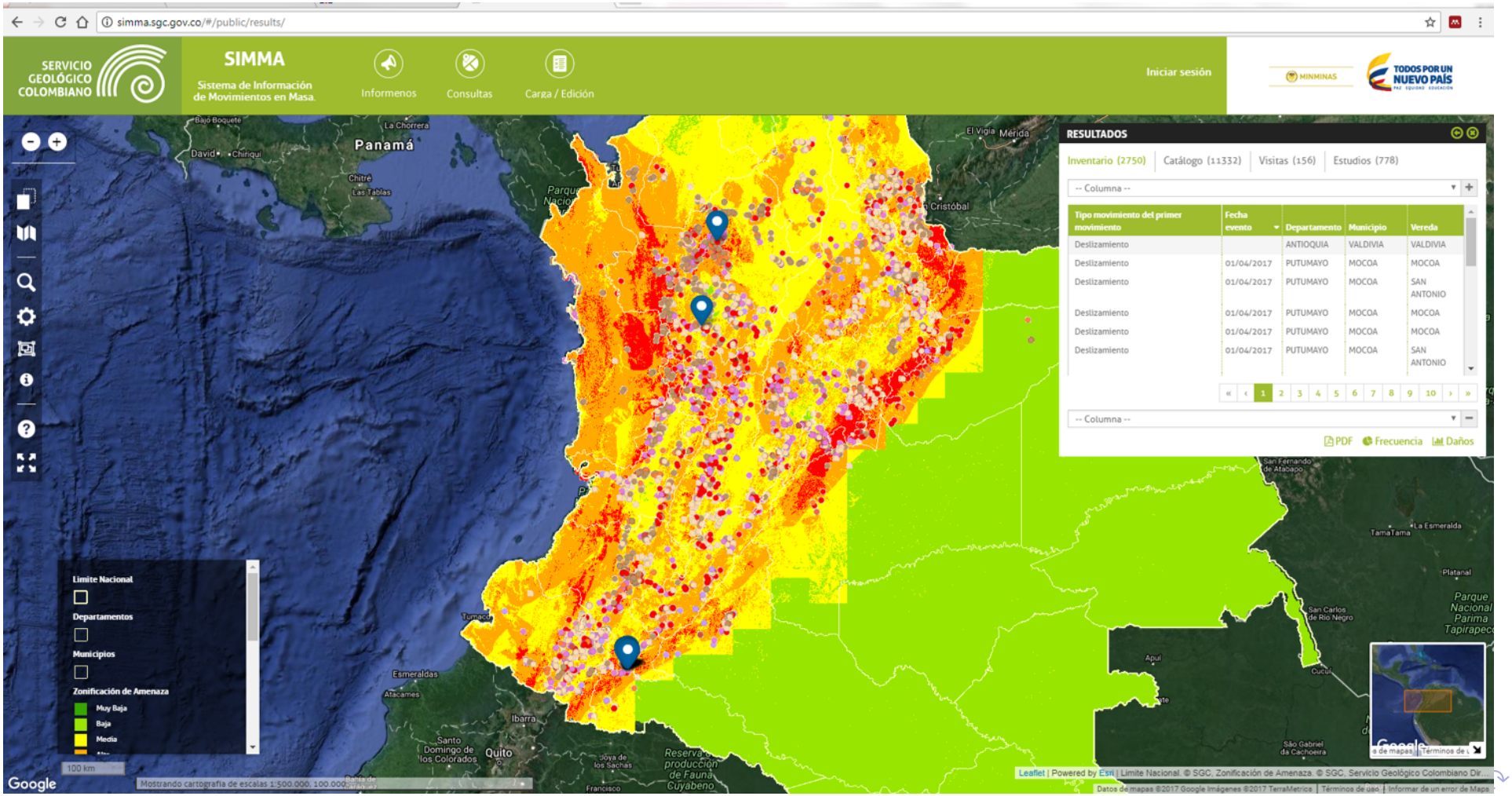
`https://desinventar.org`




| Fila | Serial | Fecha Inicio | Tipo de evento | Nombre Geografía | Sitio | Fuentes | Observaciones de efectos | Muertos | Desaparecidos | Heridos; enfermos | Damnificados | Afectados | Evacuados | Reubicados | Viviendas destruidas | Viviendas afectadas | Cultivos y bosques (Ha) | Vías afectadas (m) | Centros de educación | Centros hospitalarios | Ganado | Valor pérdidas $ | Valor pérdidas US$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 1903-12-14 | Sismo | Suroeste/Urrao/URRAO | LAT. 6.4 N Y LONG. 76.4 W. | ACOSTA ET AL. | INTENSIDAD III. (DI6Author : C.P. DI6Date : 13/03/01) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 7 | 1903-12-15 | Sismo | Suroeste/Urrao/URRAO | LAT. 6.4 N Y LONG. 76.4 W. | ACOSTA ET AL. | INTENSIDAD III. (DI6Author : C.P. DI6Date : 13/03/01) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 6 | 1903-12-18 | Sismo | Suroeste/Urrao/URRAO | LAT 6.4 N Y LONG 76.4 W. | ACOSTA ET AL. | INTENSIDAD III. (DI6Author : C.P. DI6Date : ) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 9 | 1903-12-28 | Sismo | Suroeste/Urrao/URRAO | LAT 6.4 N Y LONG 76.4 W. | ACOSTA ET AL. | INTENSIDAD III (DI6Author : C.P. DI6Date : ) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 19 | 1921-01-12 | Deslizamiento | Magdalena medio/Puerto Berrío/PUERTO BERRIO | | EL COLOMBIANO. | (DI6Author : C.P. DI6Date : ) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 10 | 1921-08-30 | Sismo | Magdalena medio/Puerto Berrío/PUERTO BERRIO | | DNPAD-OSSO. | (DI6Author : C.P. DI6Date : 11/09/01) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 16 | 1921-10-10 | Vendaval | Magdalena medio/Puerto Berrío/PUERTO BERRIO | | EL COLOMBIANO. | (DI6Author : C.P. DI6Date : ) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 18 | 1921-10-18 | Deslizamiento | Nordeste/Cisneros/CISNEROS | Sector del Nus carretera Km 52 y 90 | El Colombiano. | Coordenadas del sitio. 6º32´26´´ 75º05´25´´. (DI6Author : C.P. DI6Date : 10/12/00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 17 | 1921-10-19 | Deslizamiento | Magdalena medio/Maceo/SAN JOSE DEL NUS | Km 76 y Caracao Km 58 | El Colombiano. | 6º28´46´´ y 75º01´21´´ (DI6Author : C.P. DI6Date : 10/12/00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 12 | 1921-10-21 | Deslizamiento | Magdalena medio/Caracolí/CARACOLI | Vía Caracolí - Cisneros | El Colombiano. | 6º24´01´´ y 74º45´28´´. (DI6Author : C.P. DI6Date : 10/12/00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 11 | 1921-10-27 | Deslizamiento | Nordeste/Cisneros/CISNEROS | Sector del Nus (Km 34 y 116). | El Colombiano. | 6º32´26´´ y 75º05´25´´. (DI6Author : C.P. DI6Date : 10/12/00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 14 | 1921-10-28 | Tempestad | Magdalena medio/Puerto Berrío/PUERTO BERRIO | | EL COLOMBIANO. | (DI6Author : C.P. DI6Date : ) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 15 | 1921-11-21 | Deslizamiento | Nordeste/Yolombó/YOLOMBO | EL LIMON.KM 116 VIA FERREA. | EL COLOMBIANO. | (DI6Author : C.P. DI6Date : 27/01/2001) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 13 | 1921-11-25 | Deslizamiento | Suroeste/Andes/ANGELOPOLIS | | El Colombiano. | (DI6Author : C.P. DI6Date : 8/04/01) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 26 | 1922-01-21 | Tempestad | Norte/Valdivia/VALDIVIA | | EL COLOMBIANO. | (DI6Author : C.P. DI6Date : ) | 0 | 0 | 0 | ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 22 | 1922-05-18 | Deslizamiento | Nordeste/Cisneros/CISNEROS | Sector del Nus (Km 110 del ferrocarril de | El Colombiano. | (DI6Author : C.P. DI6Date : 10/12/00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Inventario histórico

`http://simma.sgc.gov.co`



# Inventario histórico

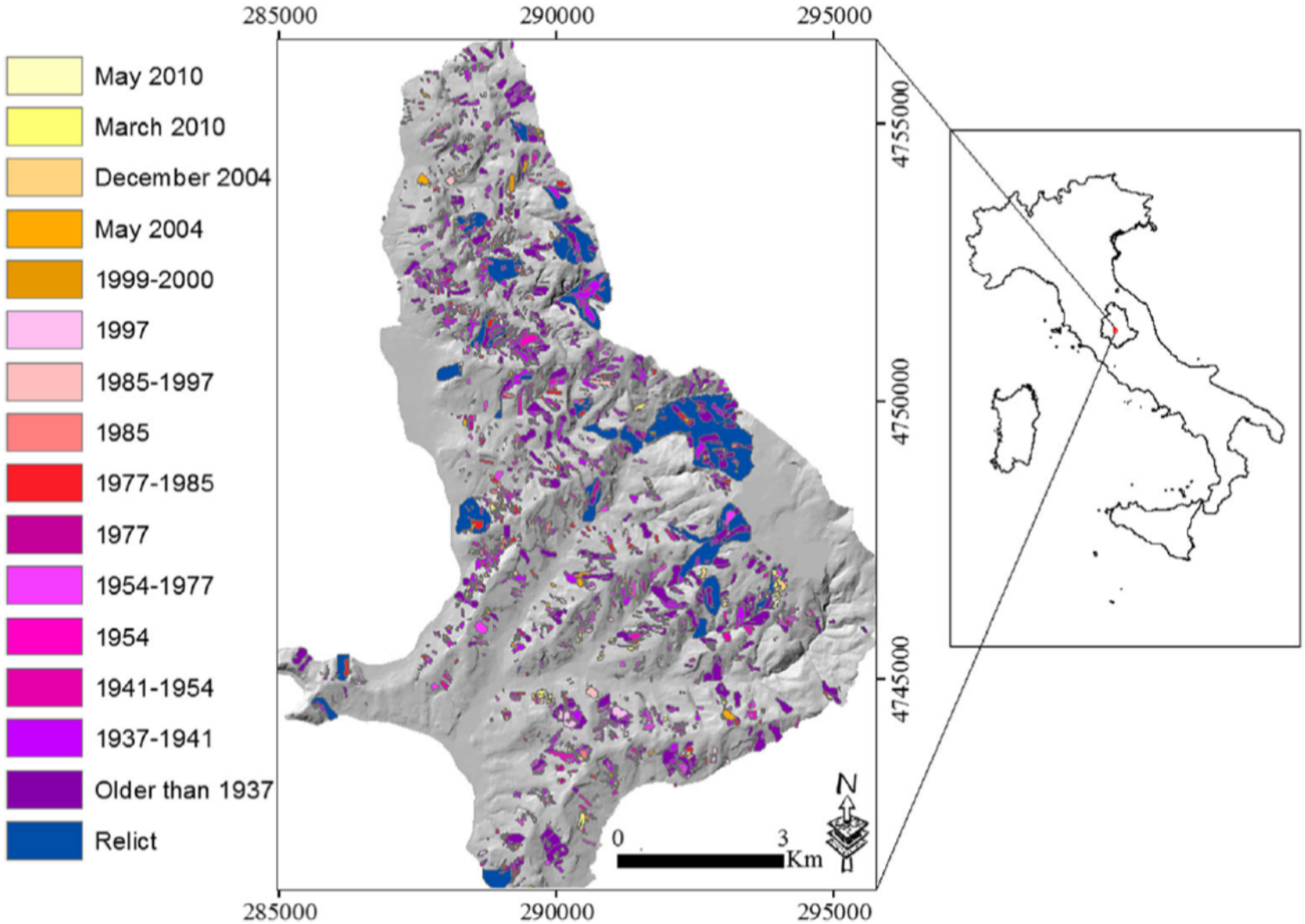
**Inventario de deslizamientos multi-temporal**: son comúnmente utilizados en modelos de susceptibilidad y amenaza. Entre mas largo el periodo que cubre, mayor significancia temporal del inventario.

**Inventario de un solo periodo**: corresponden a inventarios de deslizamientos de un cierto periodo de tiempo a partir de fotos aéreas o imágenes de satélite. No son validos para calibrar un modelo de susceptibilidad.

**Inventario de deslizamientos de un evento**: inventarios de deslizamientos que ocurren como resultado de un evento detonante particular (lluvia, sismo). Son adecuados para análisis de susceptibilidad basados. Su elaboración puede ser mas sencilla, especialmente con imágenes de alta resolución espacial y temporal fácilmente obtenibles en la actualidad.

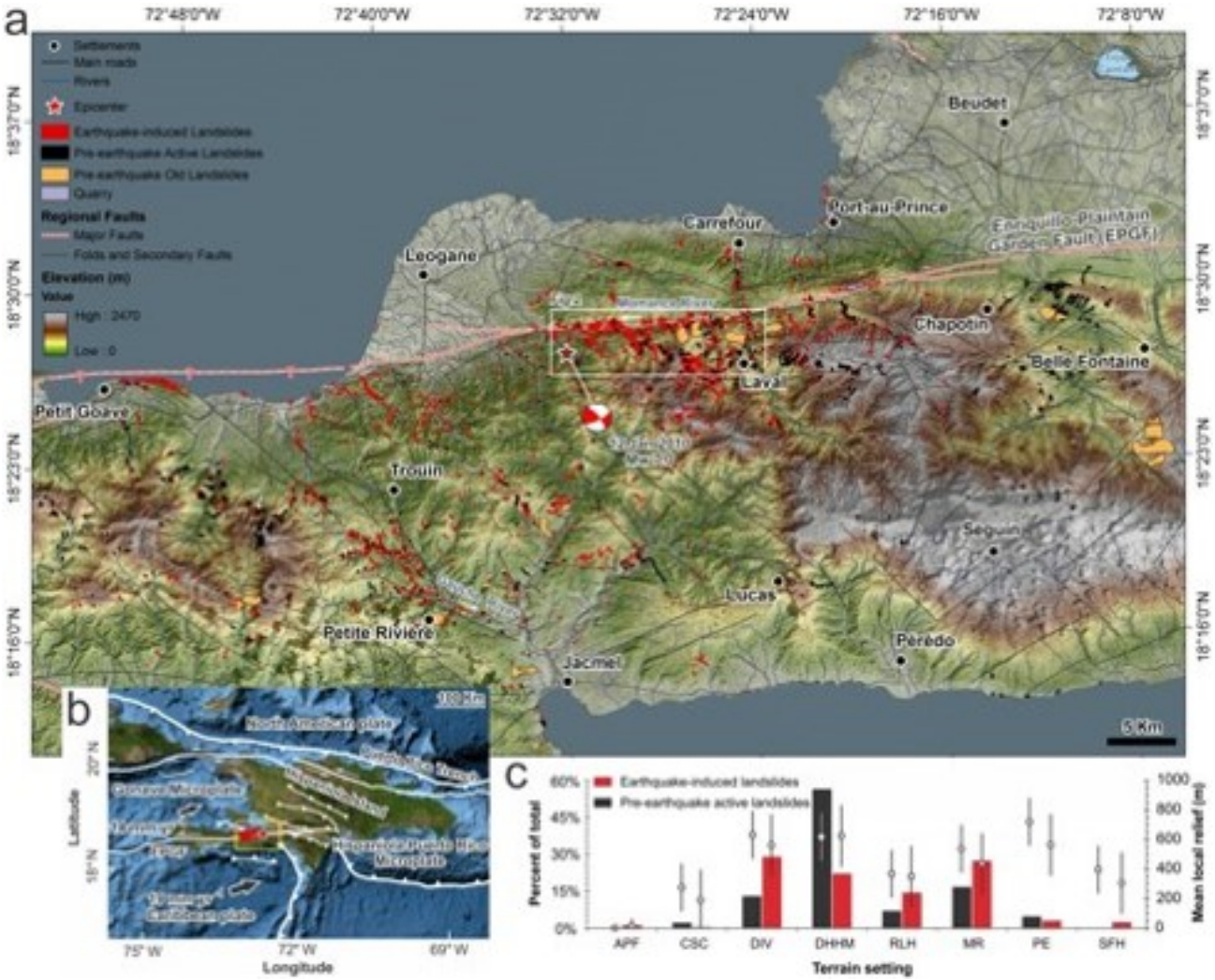
Fuente: Lee (2014) SLdR

# Inventario multitemporal



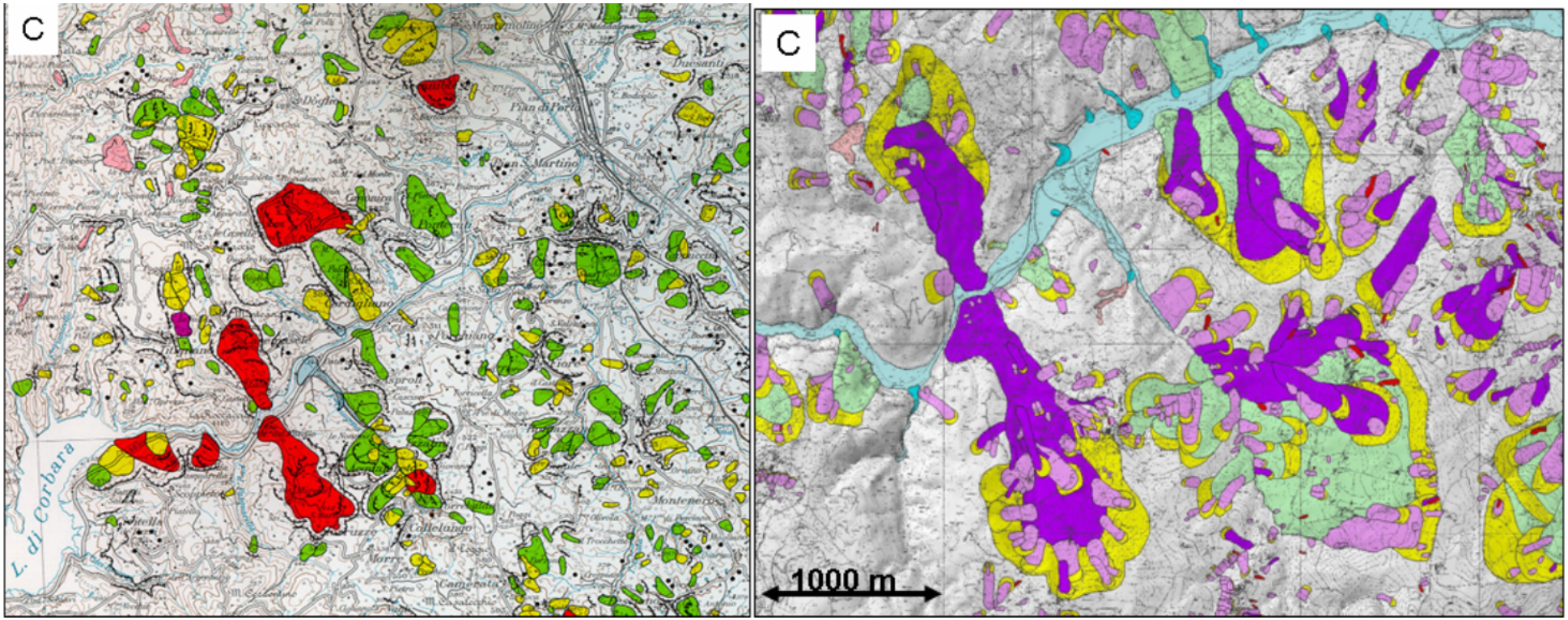

Fuente: Samia et al. (2016)

# Inventario evento



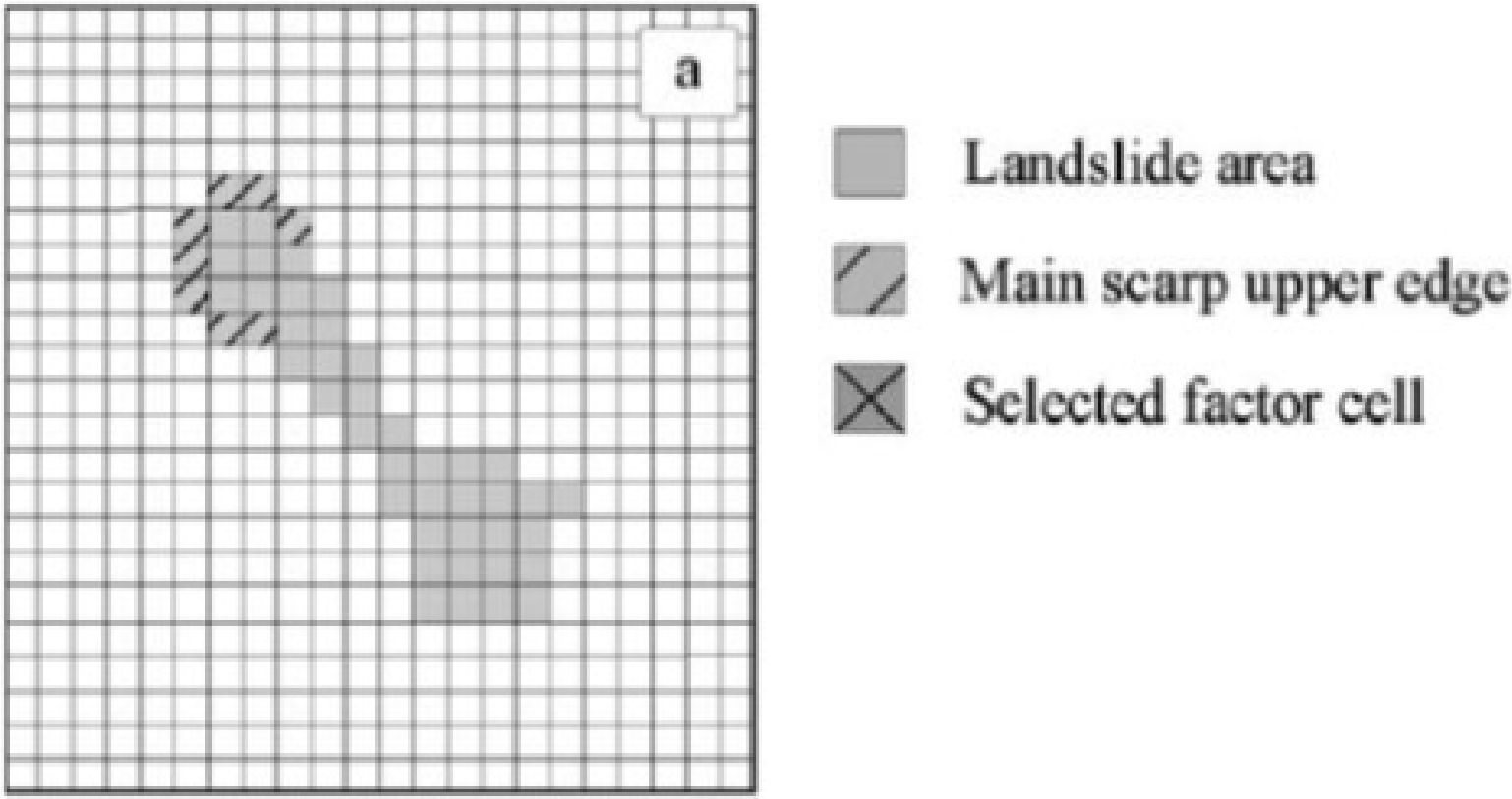

Fuente: van Westen en Landslide types and causes

# Escala de análisis



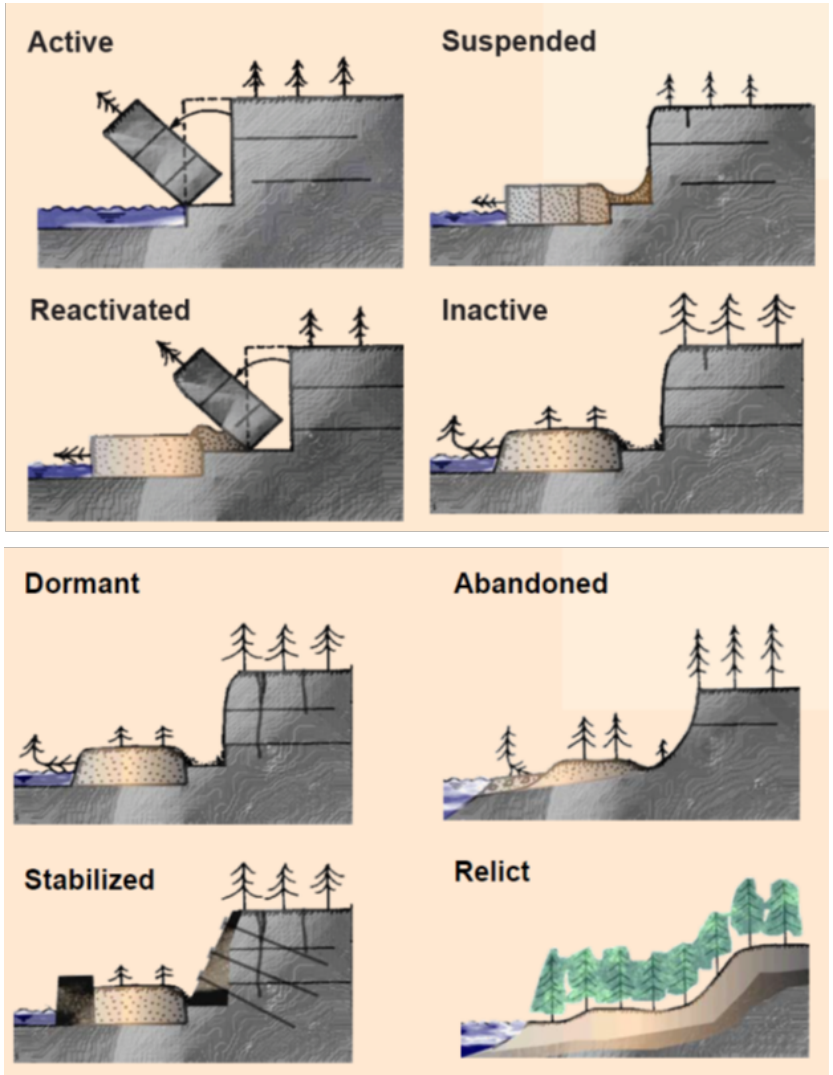

Fuente: Guzzetti (2005)

# Cartografía



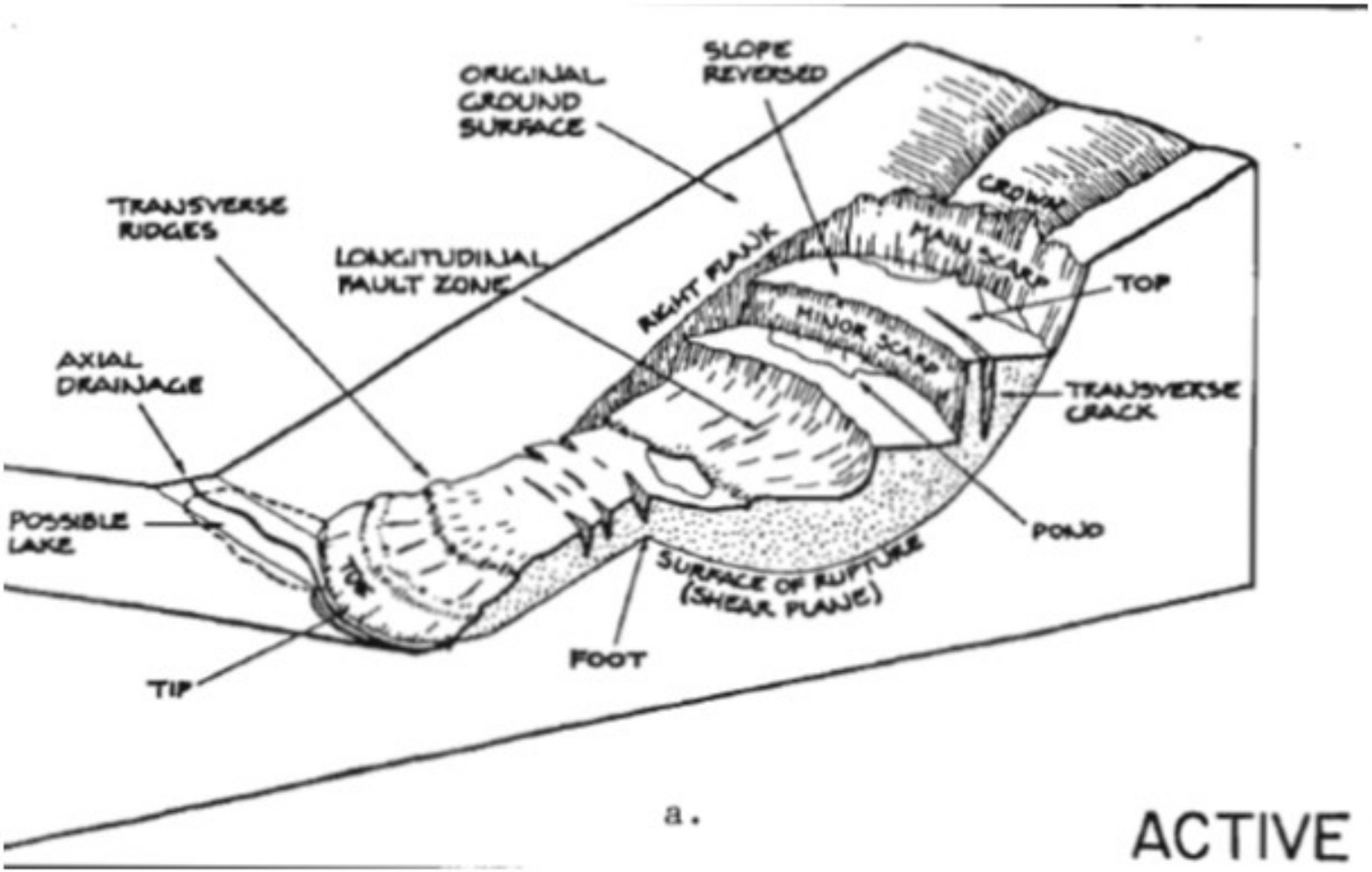

Fuente: Hussin et al., (2016); Clereci et al. (2006)

# Actividad



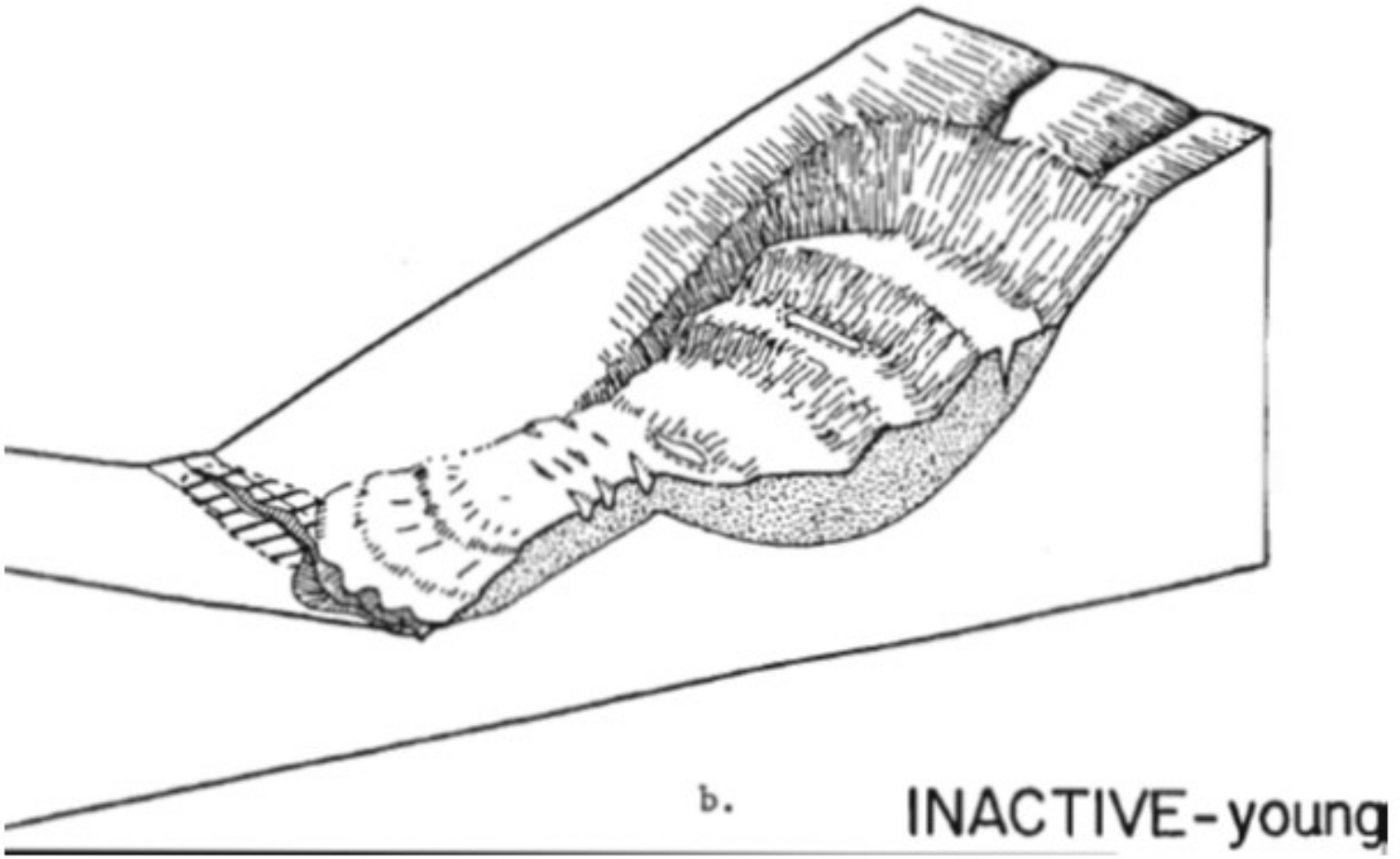

Fuente: tomado de Cruden & Varnes (1996)

# Activos




Fuente: McCalpin (1984)

# Inactivo joven

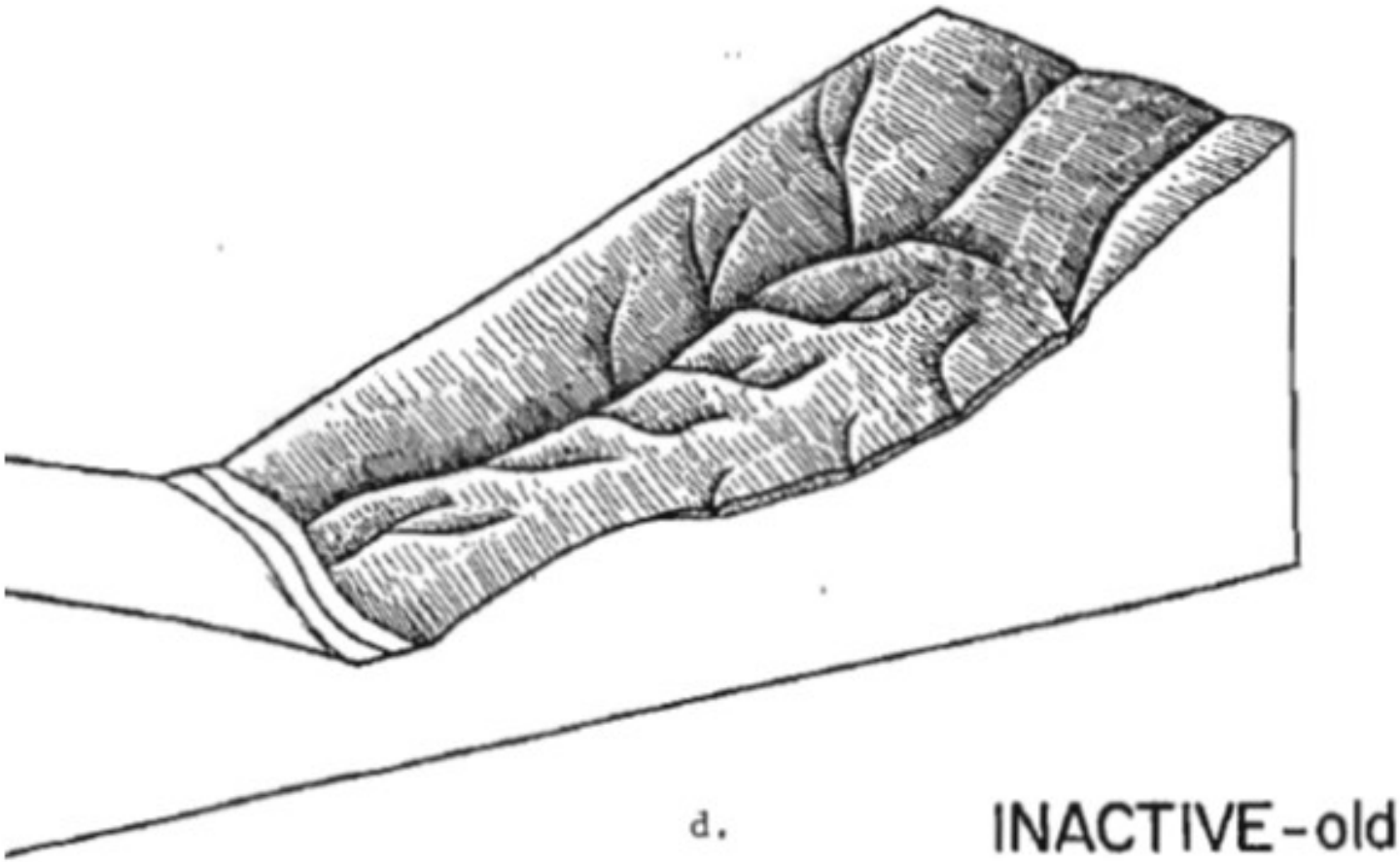



Fuente: McCalpin (1984)

# Inactivo maduro


Fuente: McCalpin (1984)

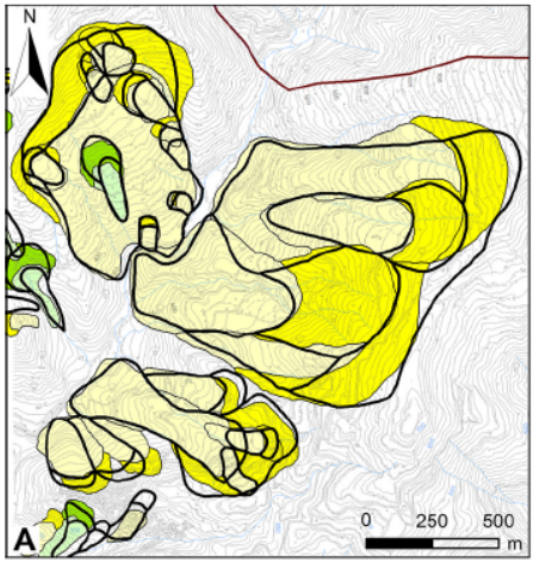
# Inactivo antiguo



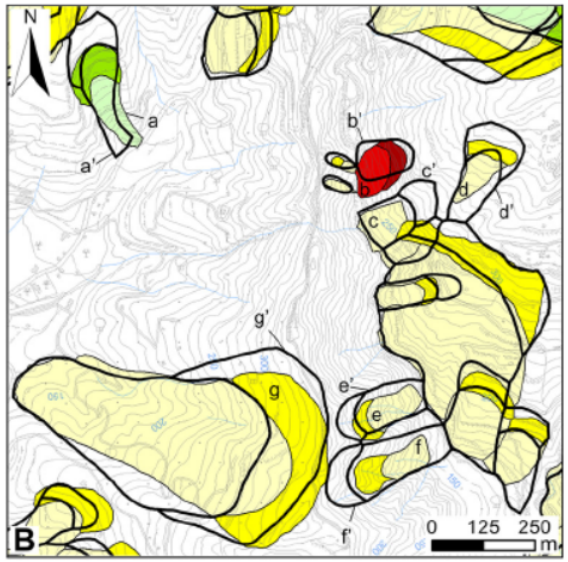

Fuente: McCalpin (1984)

# Errores

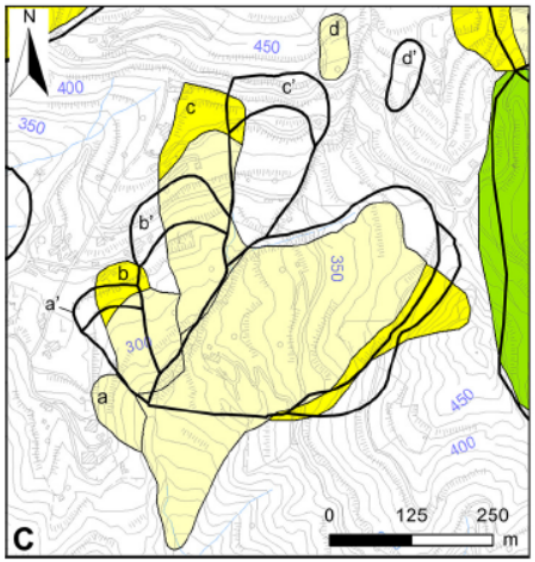
Aceptable



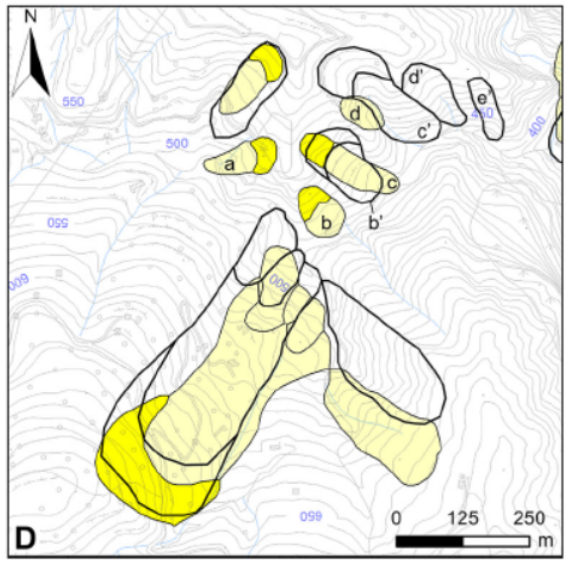

Tamaños equivocados




La ubicación es no aceptable




Localización y tamaño no aceptable



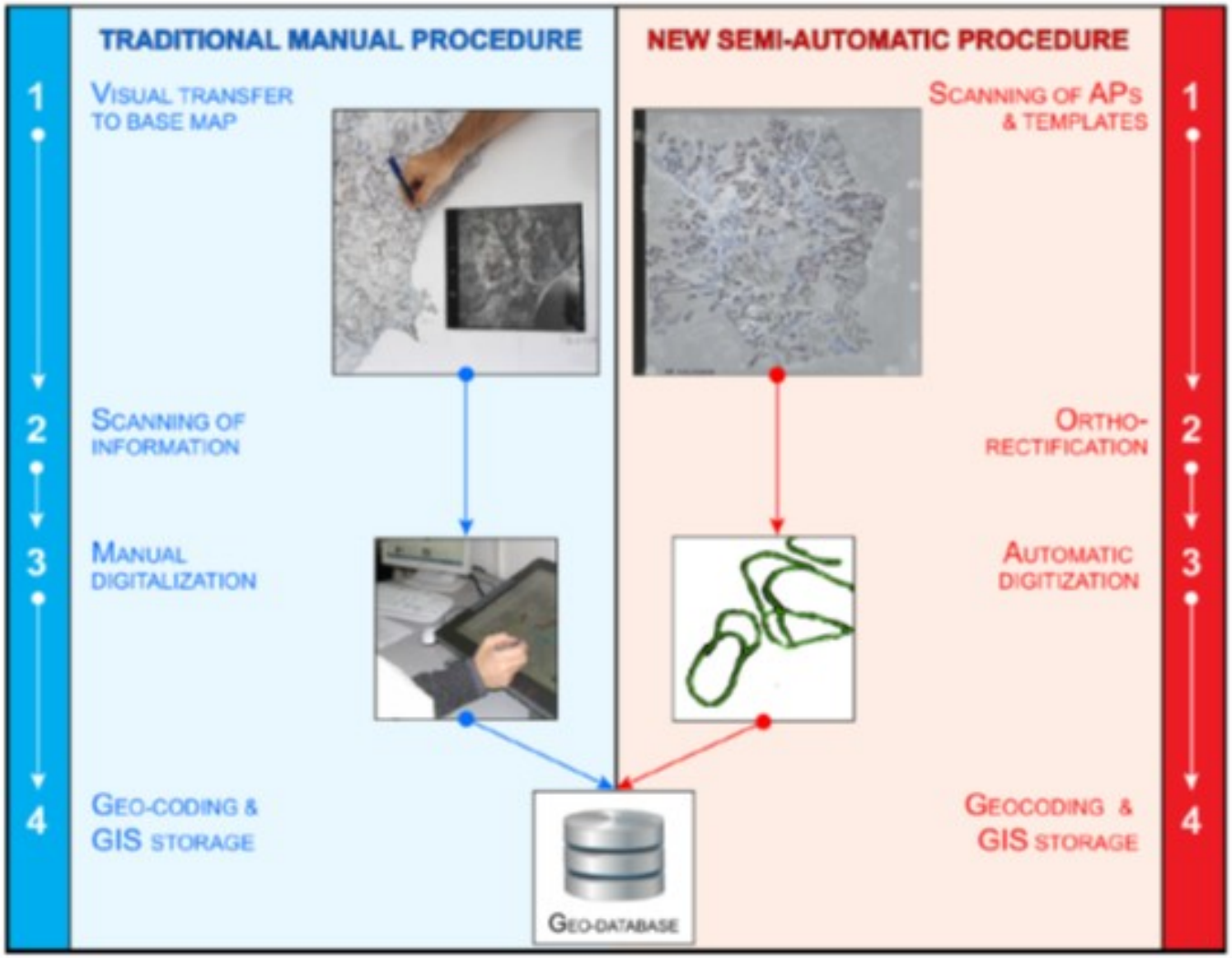
# Subregistro

Los inventarios de deslizamientos tienden a ser sesgados por la relación entre magnitud-frecuencia en los deslizamientos asociada a:

- Se desconoce la longitud del periodo de observación.
- Se desconoce el papel de eventos detonantes de alta intensidad tales como sismos.
- La geometría de los pequeños deslizamientos tiende a ser eliminada por procesos erosivos y la vegetación.


Fuente: Fuente: Korup (2005)

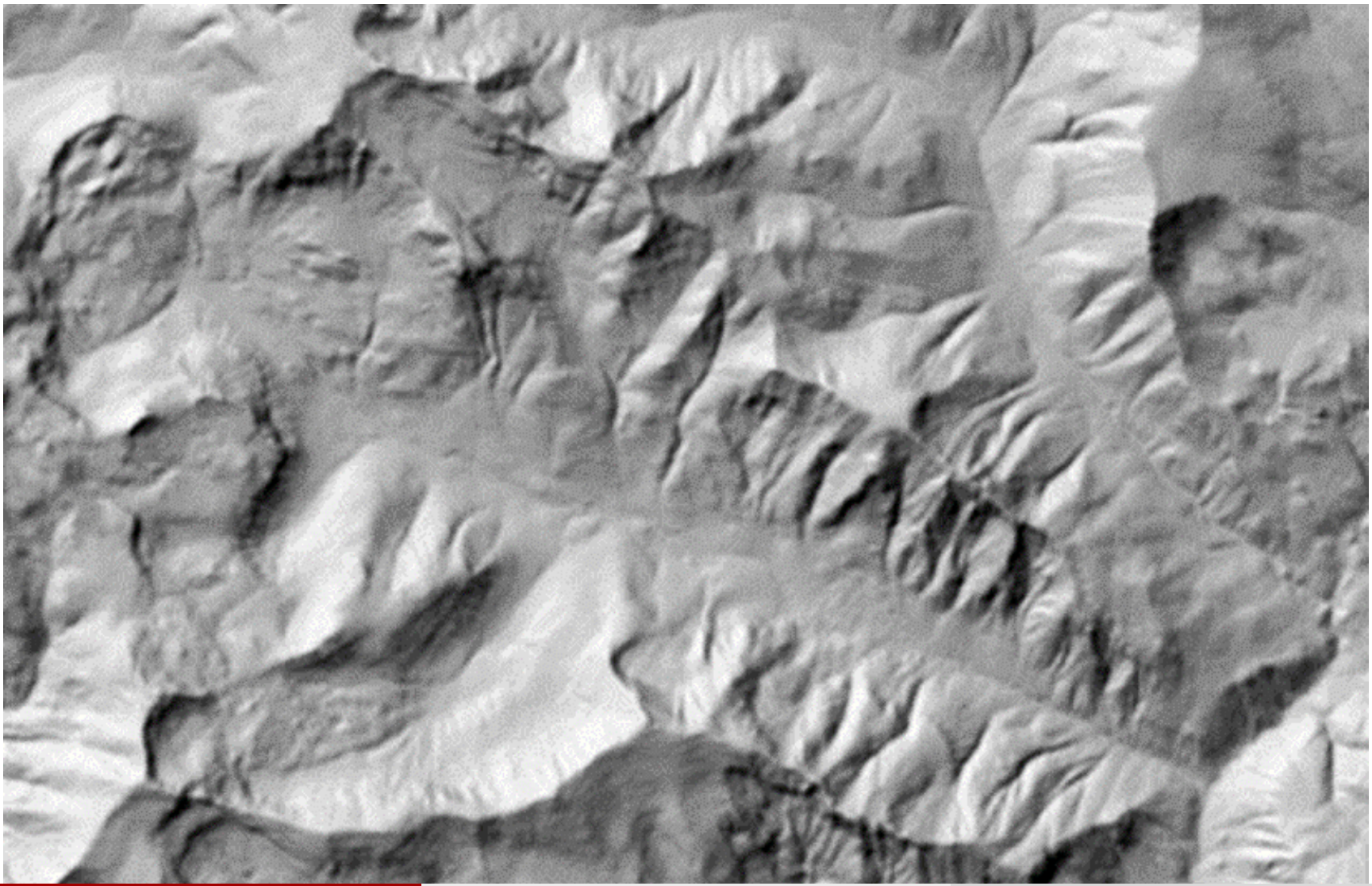
# Errores




Fuente: Santagelo et al. (2015)

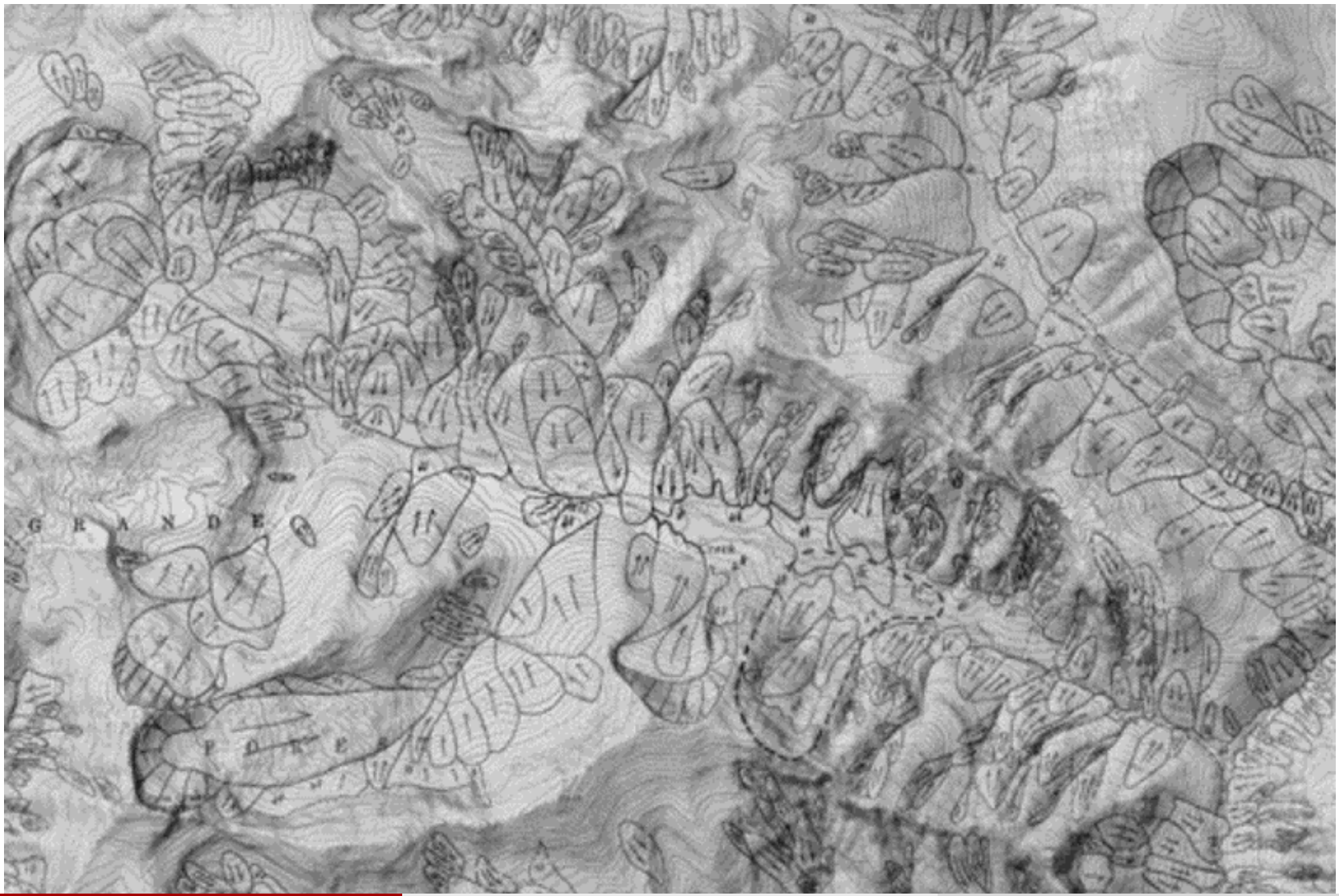
# Ejemplos

## DEM



# Ejemplos

## DEM

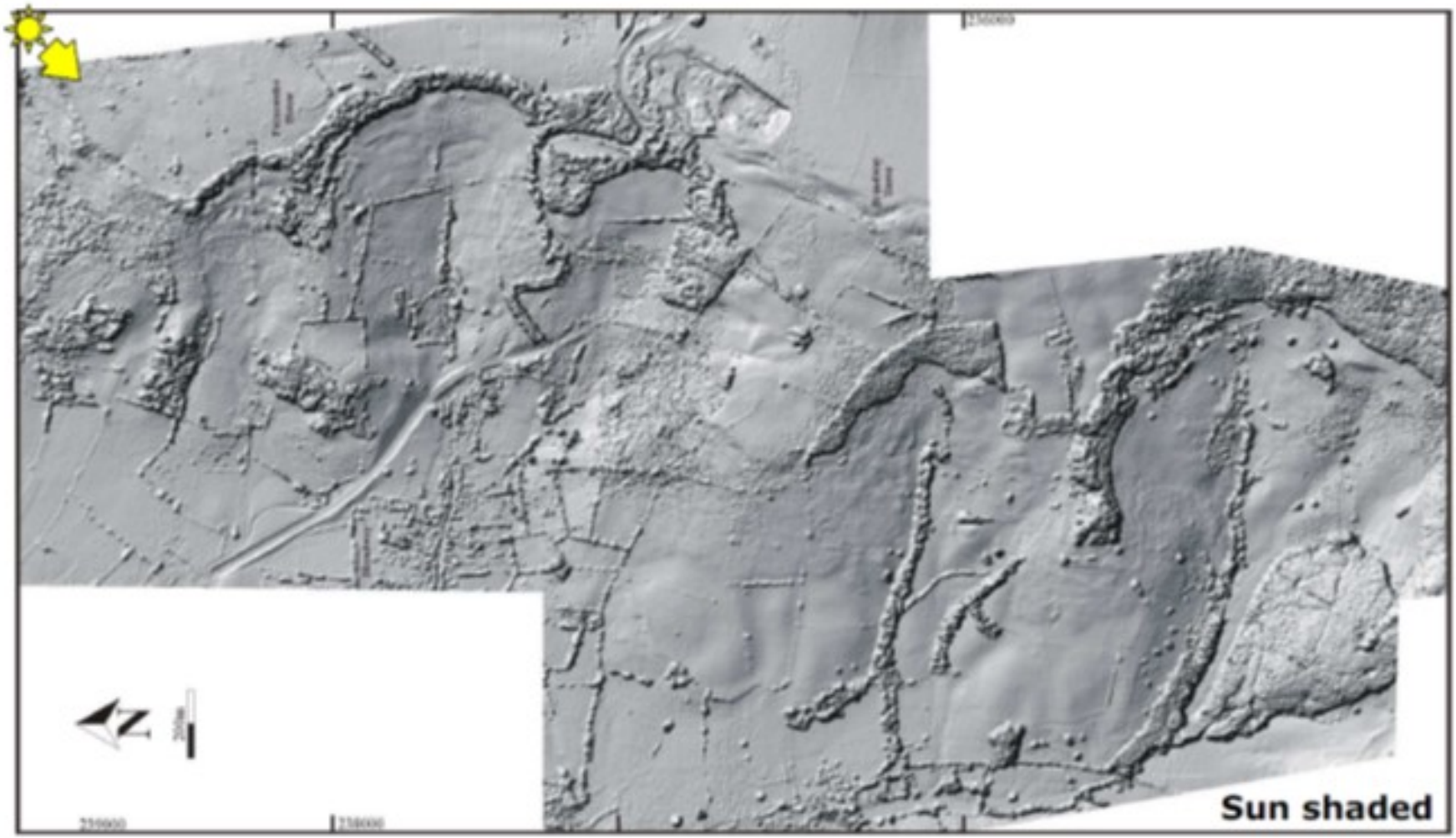


# Ejemplos

## LIDAR

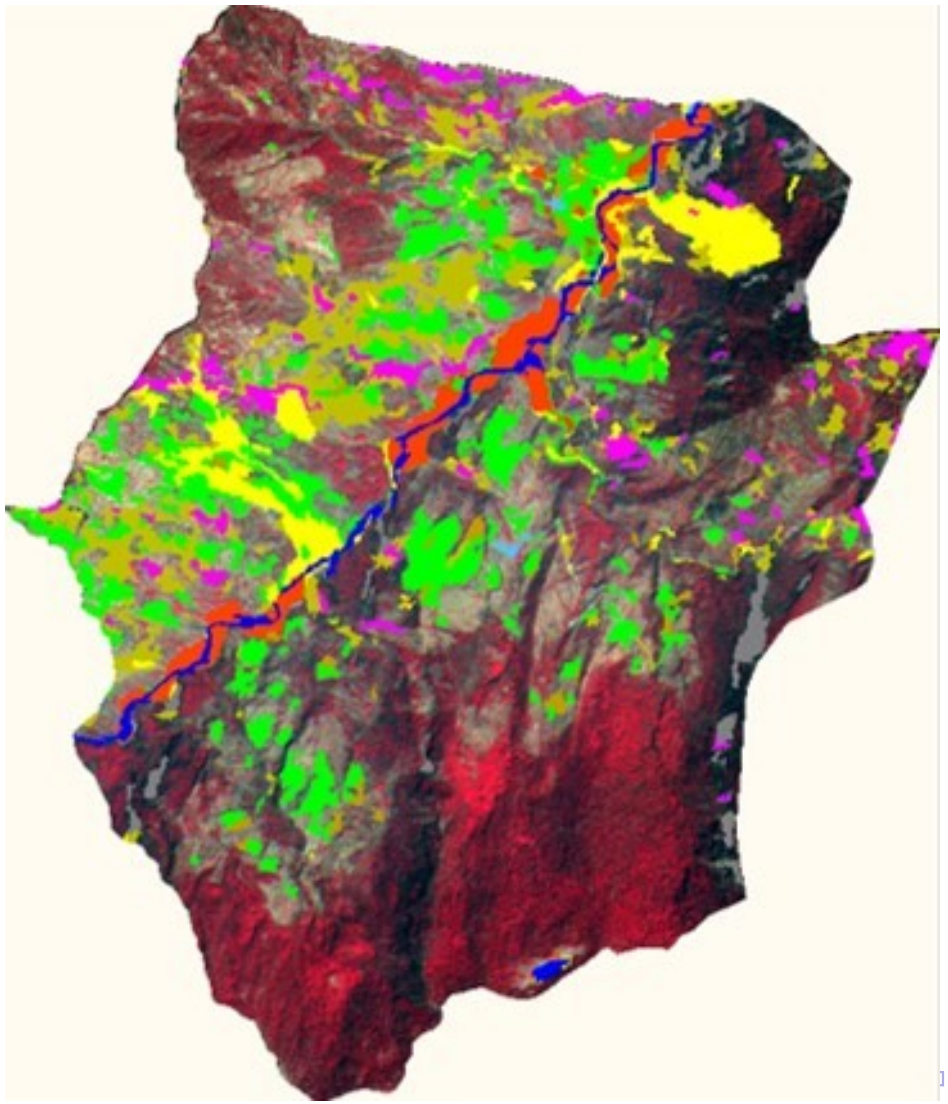
# Ejemplos

## LIDAR

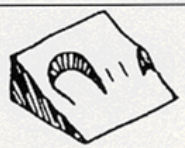
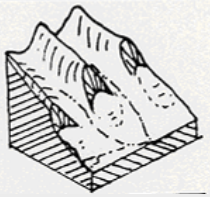
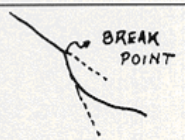


# Ejemplos

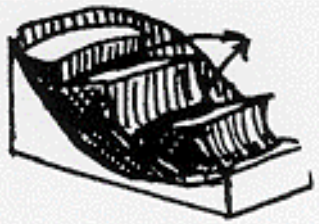
## NDVI



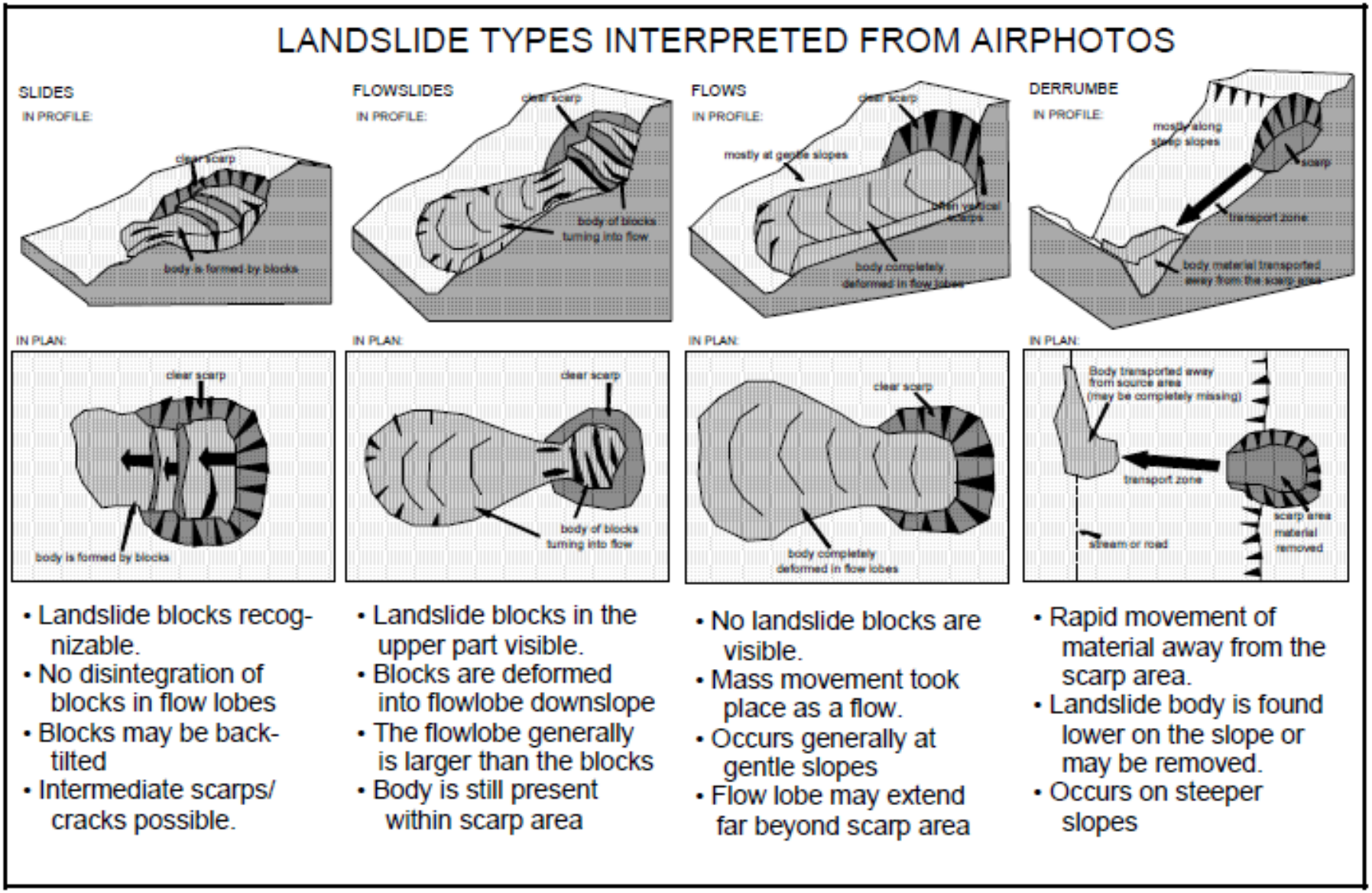
# Características en fotos

| Morphological Characteristics | Block diagram | Plant View/ Profile |
|---|---|---|
| 1. Concave-convex slopes  |   |   |
| 2. Semicircular niches |  |  |
| 3. Step-like morphology |  |  |
| 4. Back tilting of slope faces |  |  |
| 5. Hummocky relief |  |  |
| 6. Cracks formation |   |  |
| 7. Steeping of the slopes |  |   |

# Características en fotos

| Drainage Characteristics | | Sketch |
|---|---|---|
| 13. Disarranged drainage | Drainage lines broken | |
| 14. Anomaly in drainage pattern | | |
| 15. Zones of stagnated water | Ponds formation |  |
| 16. Seepage zones or well appearance | Darker tones leading to drainage line | |
| 17. Excessively drained masses (especially dried out landslide bodies) | Light phototones | |

# Características en fotos

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