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19–24 September 2010

An Operative Warning System of Rainfall-Triggered Landslides at Manizales, Colombia

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Justification

- The meteorological information is very scarce along the country, and spreading the use of meteorological stations and networks will help to improve the spatial and temporal distribution of data in the Andes region.
- Manizales is a rainy city, influenced by ITCZ, located in a hilly area. So, the rainfall-triggered landslides are the potential risk which can be monitored.
- Local entities and Academia have been working together in order to implement a Landslide Warning System based on a meteorological network.

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Objective

- To implement an operative Landslide Warning System based on a meteorological network data
- To use the current relationship between rainfall and landslides reported in the Andes region.
- Look for the support of the local entities (Mayor's office) in order to perform a liable maintenance and a constant growth of the meteorological network.

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Background

- Since the 80's, a interdisciplinary group of teachers and students focused to develop electronic instruments for the measurement of climatological variables (rainfall)
- In 90's politicians did not consider the relevance to get a modern network of weather stations along the city.
- So, Academia look for the support of private entities to install the initial two stations, to configure the network.
- Since 2003 local authorities began to support the initiative of a climatological network in Manizales.

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Manizales as a Lab city

- Manizales spatially coincides with the area of the country most threatened by **earthquakes, landslides, volcanic eruptions, flooding** (minor)
- Public entities and Academia have focused on Risk Management, which includes:
 - Relocation of communities programs in areas of imminent danger.
 - Stabilization of slopes susceptible to landslide.
 - Insurance on buildings
 - **Hydro-meteorological monitoring of urban and rural watersheds**

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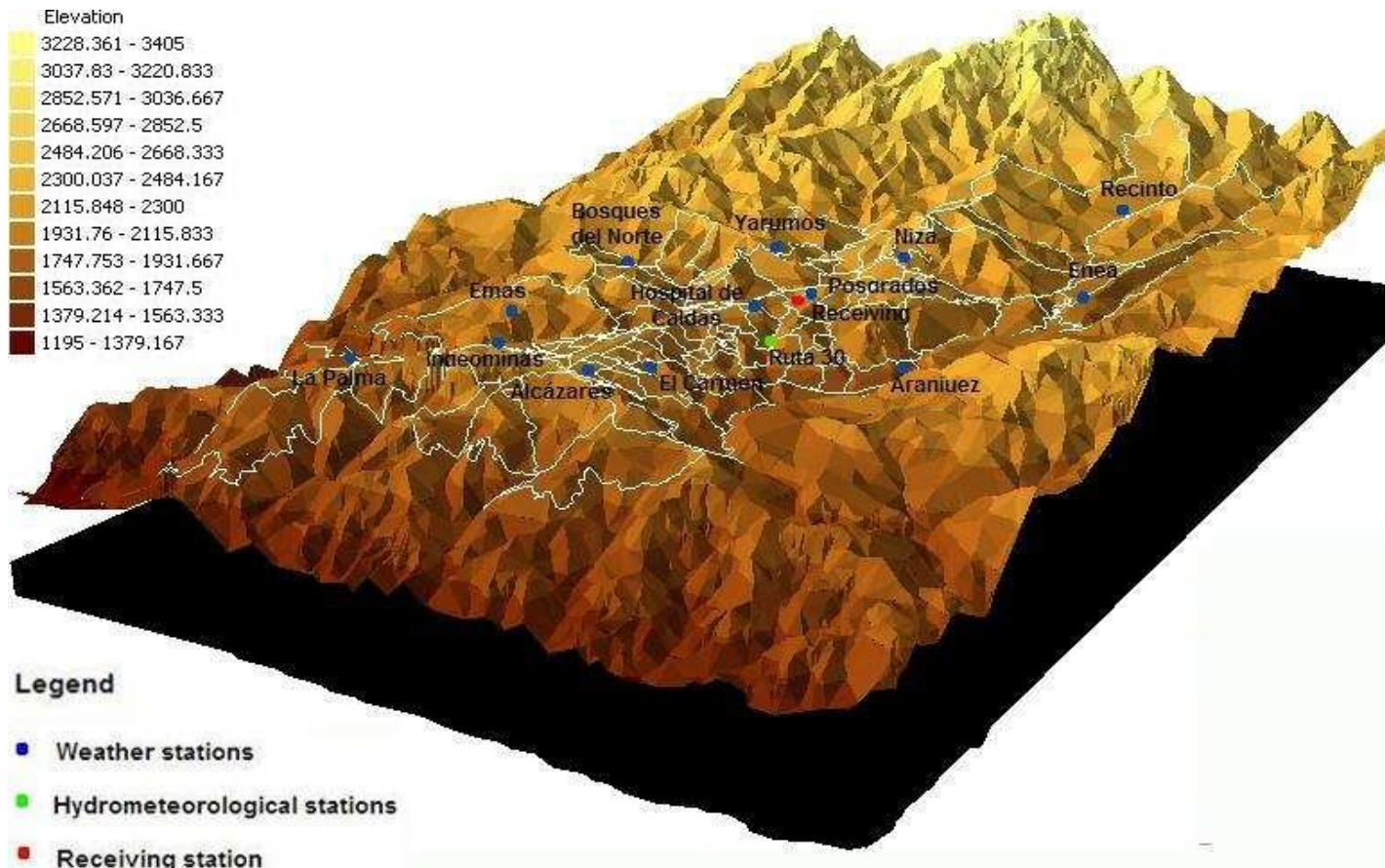


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General location





General description

- Mean annual Precipitation (2003-2009): 2240 mm/year
- Mean annual Temperature 18°C
- Mean Altitude 2.160 m.a.s.l.
- Surface 580 km²
- Population 400.000 hab. (2005)
- Landslides reported: 519 (2003-2009)
- Affected families: 4105 (2003-2009)
- Evacuated families: 1394 (2003-2009)

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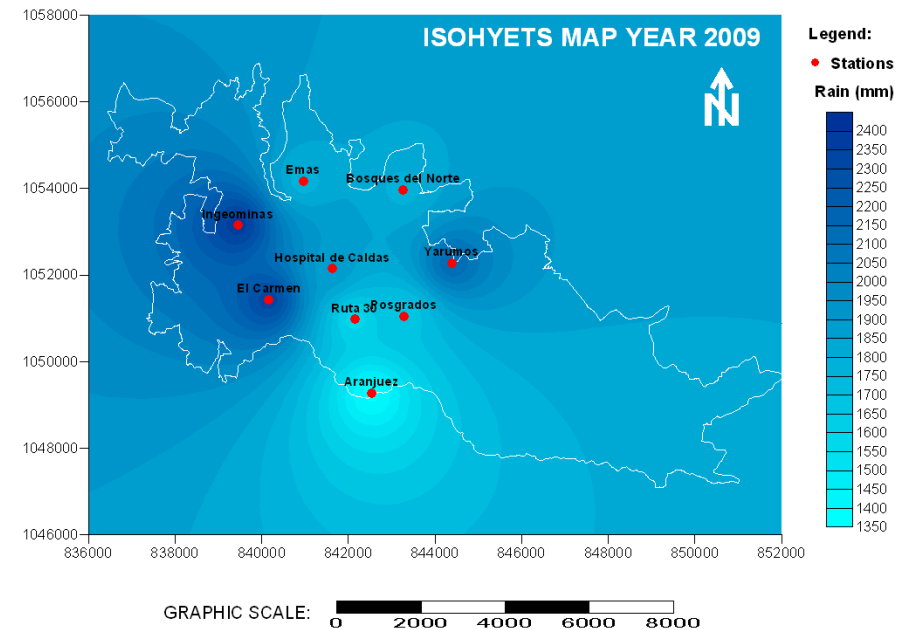
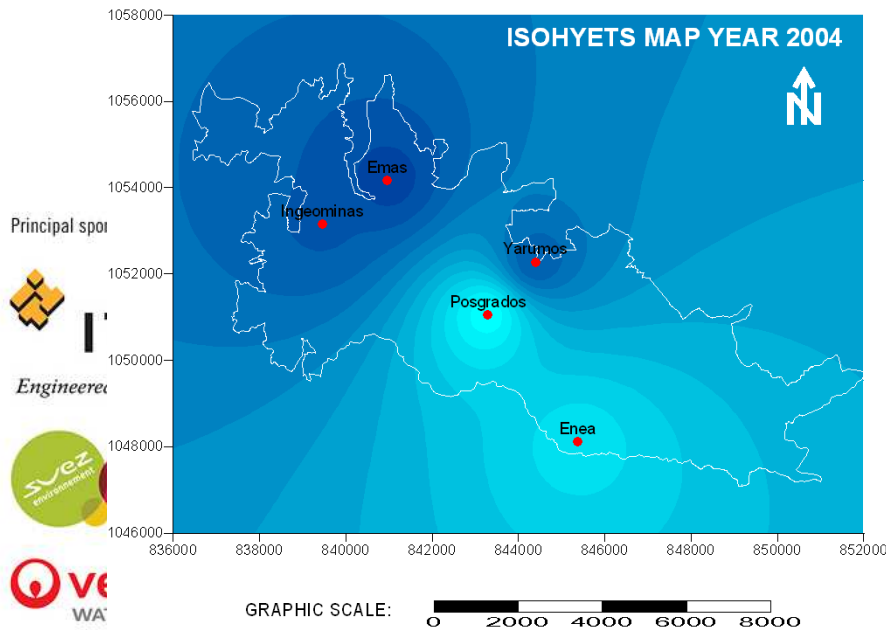


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Annual mean PPT



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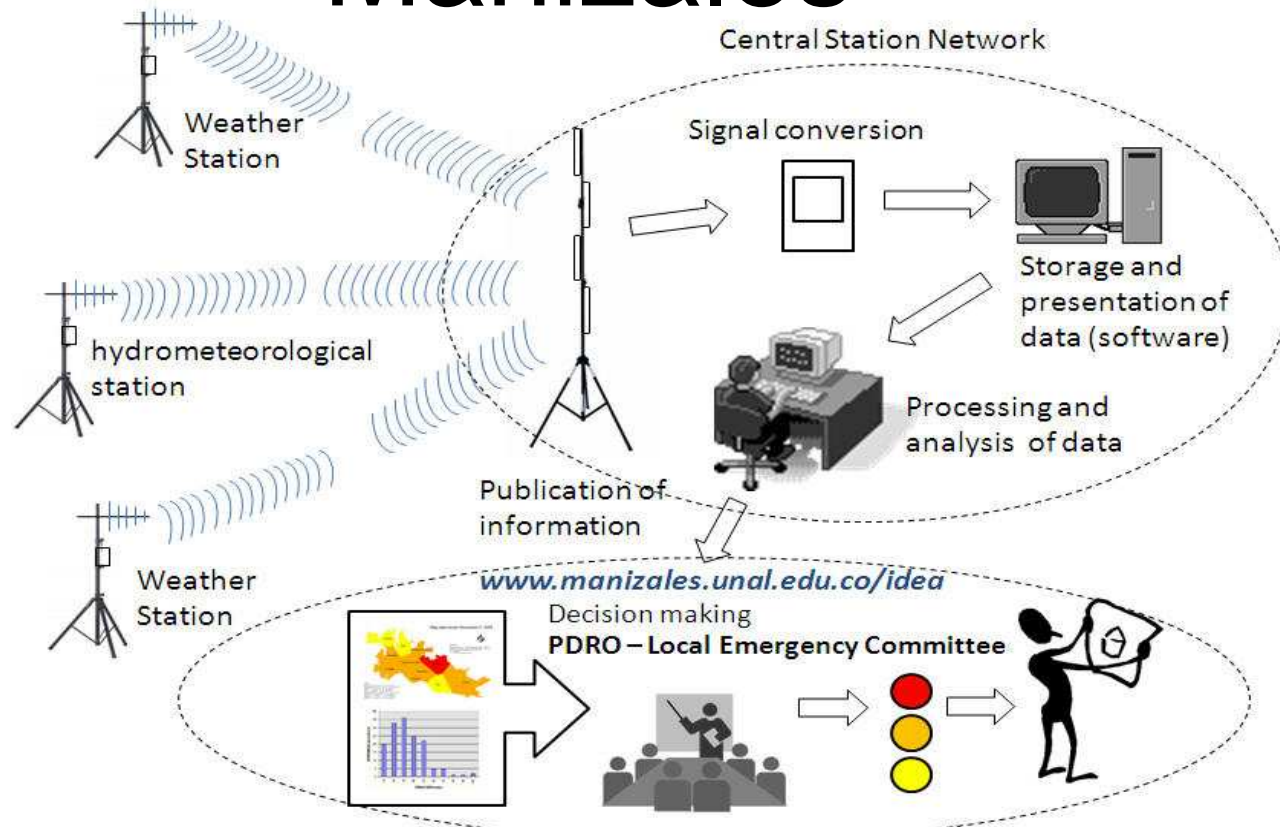


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Operative Warning System at Manizales



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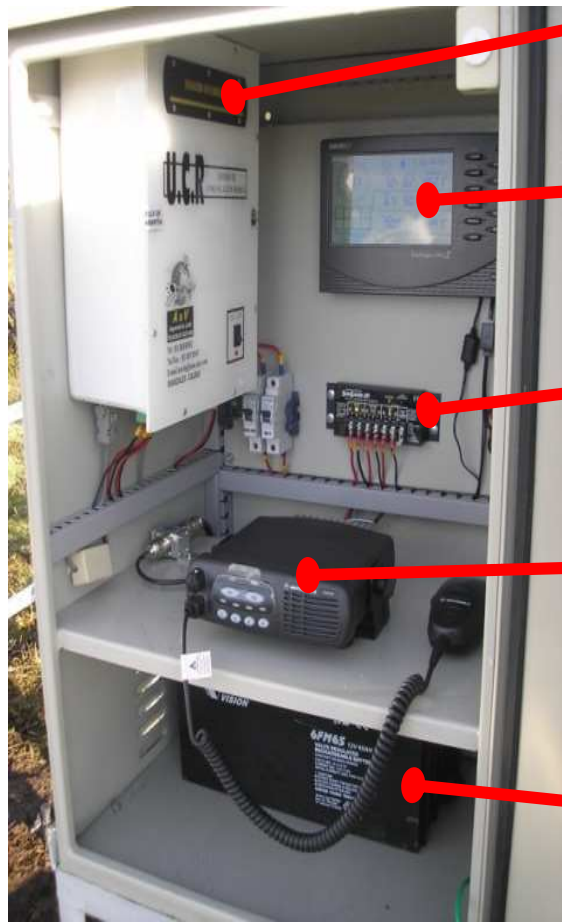


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Telemetric Weather Station



Remote Communications Unit (U.C.R)

Weather Station Console

Battery Charger – Solar Panel Controller

Communications Equipment

Battery 12VDC





Software - webpage



- Sobre el IDEA
- Proyectos especiales
- Eventos y noticias
- Boletín meteorológico
- Boletín ambiental
- Estado del tiempo en Manizales
- Grupos de trabajo académico
- Programas curriculares
- Laboratorios afines al IDEA
- Redes
- Historias de vida
- Otros capítulos

link

INSTITUTO DE ESTUDIOS AMBIENTALES

Principal > Estado del tiempo

Estado del Tiempo en la Ciudad de Manizales

Datos hidrometeorológicos en tiempo real registrados por las catorce (14) estaciones ubicadas en puntos estratégicos de la ciudad de Manizales.

Estación	Temperatura	Última Transmisión	Enlaces	Símbolo
METEOROLÓGICA ALCÁZARES (Instituto de Valorización de Manizales INVAMA)	21.61 °C	2010-08-30 16:42:08	Otros datos	
METEOROLÓGICA ARANJUEZ (Liceo Mixto Aranjuez)	23.27 °C	2010-08-30 16:42:12	Otros datos	
METEOROLÓGICA BOSQUES DEL NORTE (Colegio Bosques del Norte)	20.88 °C	2010-08-30 16:42:19	Otros datos	
METEOROLÓGICA EL CARMEN (Centro Cultural y Comunitario El Carmen)	22.83 °C	2010-08-30 16:42:25	Otros datos	

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www.manizales.unal.edu.co/idea/





The semaphore strategy

Semaphore color	Cumulative precipitation, A25
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Yellow alert

$200 \text{ mm} \leq A25 < 300 \text{ mm}$

Orange alert

$300 \text{ mm} \leq A25 < 400 \text{ mm}$

Red alert

$A25 \geq 400 \text{ mm}$

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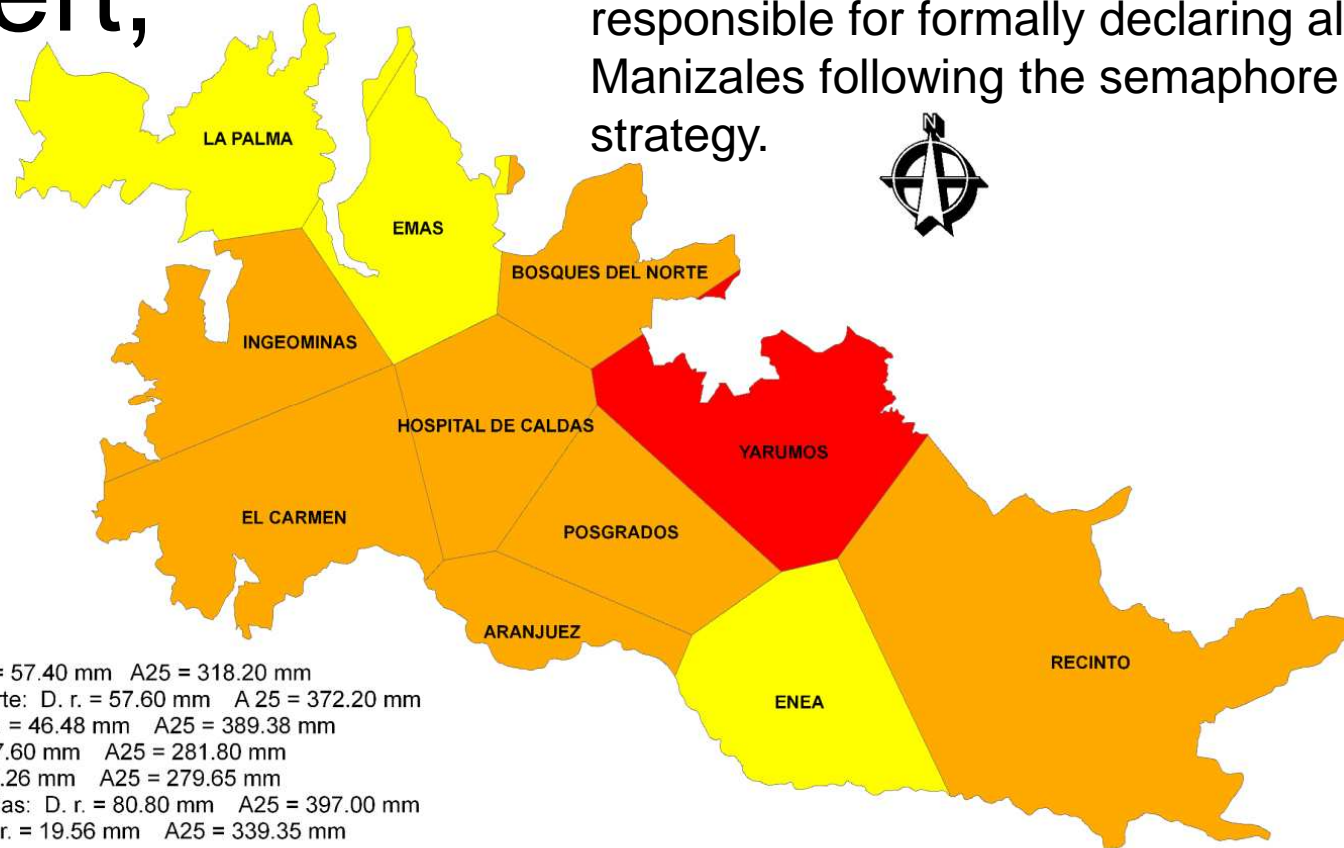
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Map alert, A25

The Local Emergency Committee is responsible for formally declaring alerts in Manizales following the semaphore strategy.



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Legend:

Aranjuez: D. r. = 57.40 mm	A25 = 318.20 mm
Bosques del Norte: D. r. = 57.60 mm	A 25 = 372.20 mm
El Carmen: D. r. = 46.48 mm	A25 = 389.38 mm
Emas: D. r. = 27.60 mm	A25 = 281.80 mm
Enea: D. r. = 32.26 mm	A25 = 279.65 mm
Hospital de Caldas: D. r. = 80.80 mm	A25 = 397.00 mm
Ingeominas: D. r. = 19.56 mm	A25 = 339.35 mm
La Palma: D. r. = 9.40 mm	A25 = 273.60 mm
Posgrados: D. r. = 71.37 mm	A25 = 394.46 mm
Recinto: D. r. = 49.40 mm	A25 = 373.80 mm
Yarumos: D. r. = 101.35 mm	A25 = 478.54 mm

Note: Daily rainfall: D.r. - Cumulative precipitation, A25





Emergency balance at Manizales 2003-2005

Date	Affected families	Victims			Homes			Landslides	Unstable hillslope	Alert level, A25	PDRO Alert
		Wounded	Deaths	Missings	Destroyed	Affected	Evacuated				
2003/03/18-19	388	32	19	0	74	51	294	100	0		Red
2003/10/28-29	320	10	5	0	16	43	240	90	0		Red
2003/12/04	112	7	16	0	6	10	101	1	0		Red
2005/06/10	170	0	9	0	3	8	133	54	0		Orange
2005/11/20-21	405	0	0	0	11	5	67	44	16		Red





Emergency balance at Manizales 2006-2009

Date	Affected families	Wounded	Deaths	Missings	Destroyed	Affected	Evacuated	Landslide	Unstable hillslope	Alert level, A25	PDRO Alert
2006/12/14	1000	0	0	0	9	7	10	1	0		Red
2007/10/10	264	0	2	0	18	117	158	16	0		Orange
2007/11/06	271	0	1	1	1	15	42	11	0		Red
2008/05/26-27	289	0	6	0	1	288	200	42	0		Red
2008/11/13-15	806	15	1	0	10	182	104	150	0		Red
2009/11/05	80	1	1	0	4	29	45	10	0		Orange





	2003	2005	2006	2007	2008	2009	2003-2009	
Annual Precipitation	2068	2324	2093	2031	2845	1894	2240	mm
Affected families	820	575	1000	535	1095	80	4105	
Wounded	49	0	0	0	15	1	65	victims
Deaths	40	9	0	3	7	1	60	victims
Missings	0	0	0	1	0	0	1	victim
Destroyed	96	14	9	19	11	4	153	homes
Affected	104	13	7	132	470	29	755	homes
Preventive evacuation	635	200	10	200	304	45	1394	homes
Landslides	191	98	1	27	192	10	519	
Unstable hillslope	0	16	0	0	0	0	16	
Yellow alert (A25)	2	0	1	1	0	0	4	
Orange alert (A25)	1	1	0	0	1	0	3	
Red (A25)	0	1	0	1	1	1	4	
Yellow alert (PDRO)	0	0	0	0	0	0	0	
Orange alert (PDRO)	0	1	0	1	0	1	3	
Red alert (PDRO)	3	1	1	1	2	0	8	



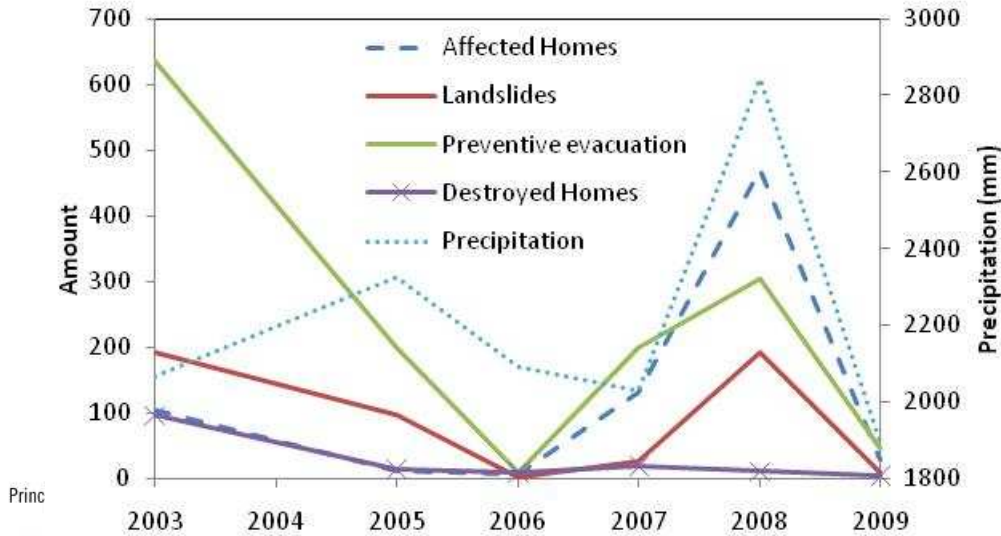


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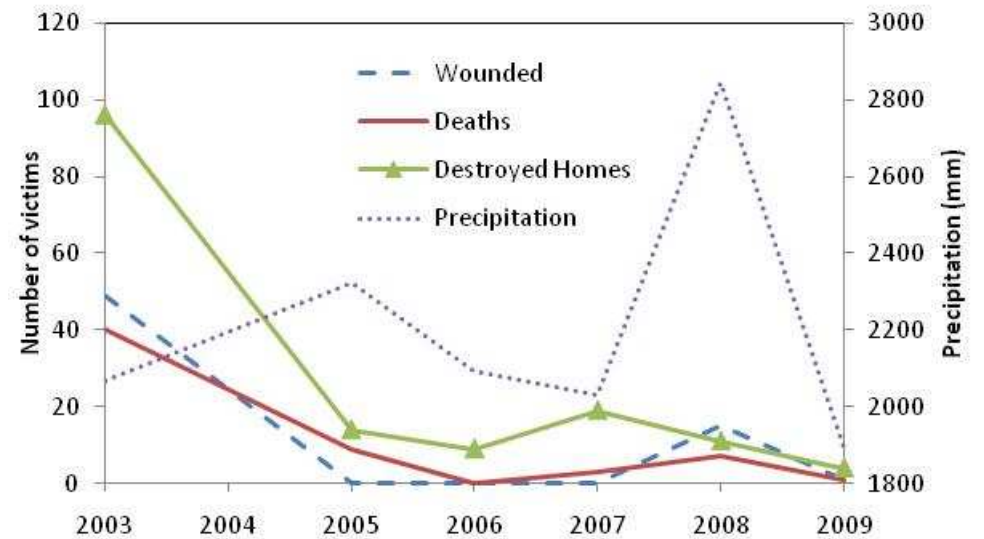
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Conclusions

- The relationship among high intensity rainfalls, cumulative precipitation and landslides allowed us to implement the Warning System using the semaphore strategy to issue the landslides alerts.
- The A25 indicator is calculated daily and PDRO have online access during the rainy season.
- The obtained results were adapted for the local entities to focus the investment in the risk management throughout structural and non-structural stabilization of the most vulnerable areas.

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Conclusions

- The PDRO office have reported a reduction of fatalities and losses since the network is operating.
- Hydrometeorological data variables stored by the Network are processed and published on the website of the Institute for Environmental Studies - IDEA of the National University of Colombia at Manizales, breaking the paradigm of information privacy and providing access to any person in the world.

An accurate measurement of the rainfall will help to the authorities to mitigate the risk associated to landslides.

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Conclusions

- The hydroclimatological network is a constant source of data which are available to be used in research
- The role that Urban Planning play in order to mitigate the risk and Manizales is an excellent example which deserves to be replicated in the Andes area.
- There are not a direct measurement of the soil moisture and soil properties.

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Next challenges

- To relate direct measurements of soil moisture and landslides with the antecedent 25 days precipitation, A25, in order to find the proper relationship between these variables.
- Other cities in Colombia have started their own Warning System under our supervision and advisory.
- The value of monitoring meteorological variables in the city is being diffused into the community, in order to promote the knowledge on natural hazards, vulnerabilities and risks.

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