

# **DEBRIS FLOW IN JICAMARCA BASIN DUE TO “NIÑO COSTERO” AND THE MONITORING SYSTEM**

**60th Anniversary Jicamarca Radio Observatory Workshop**





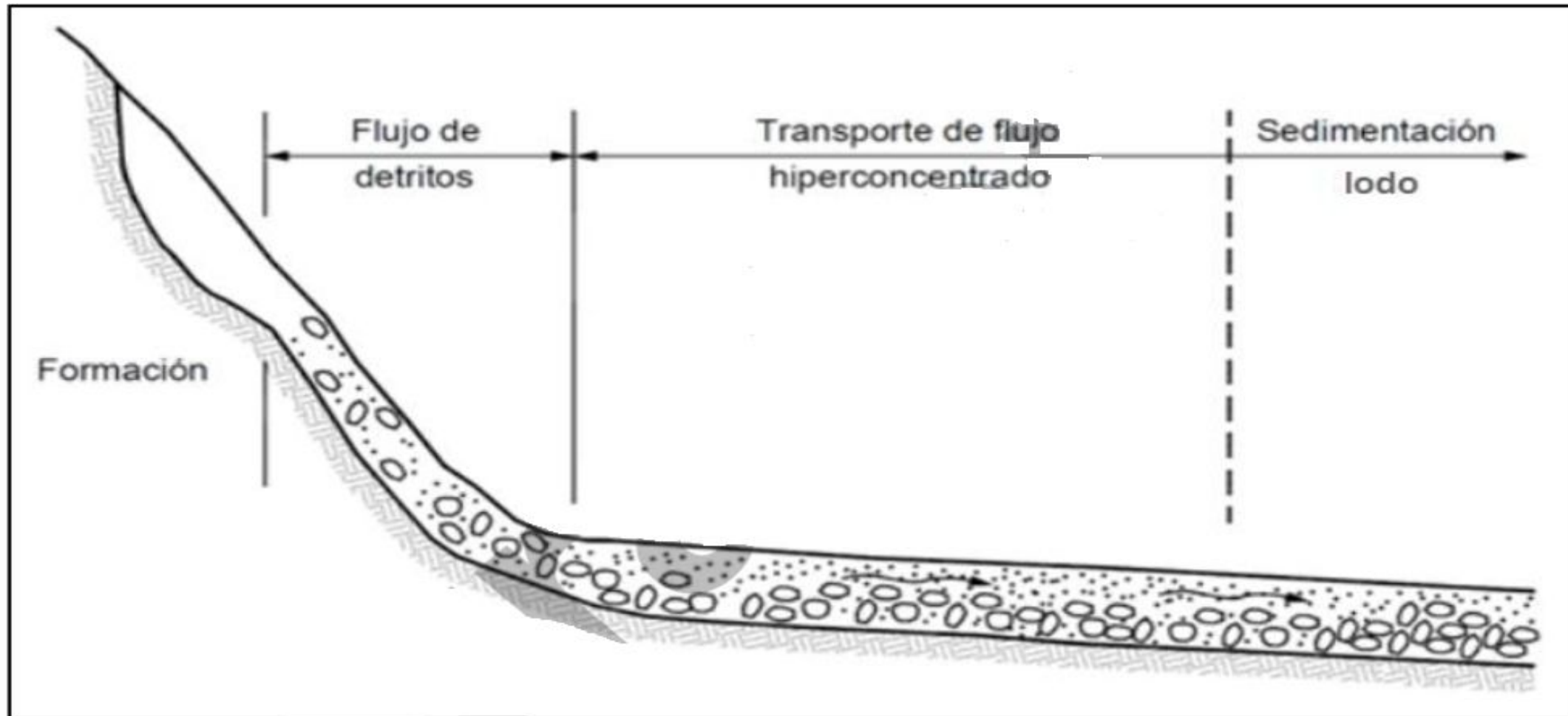
# Susceptibility zones by debris Flow in Perú



According to CENEPRED, there are approximately 6 million inhabitants in our country who are settled in areas with high susceptibility to debris flow.

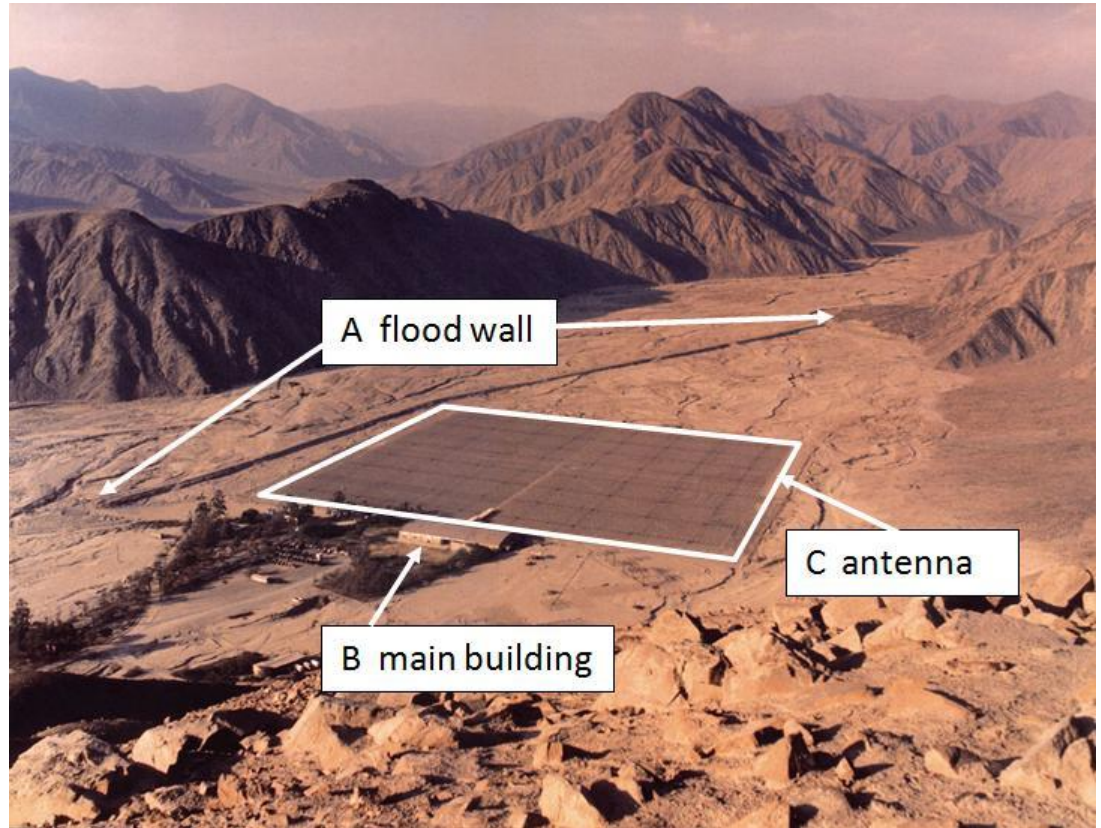


# Physical characteristics of debris flow





# Debris Flow in Jicamarca basin due Niño Phenomena since 1983 to 2017



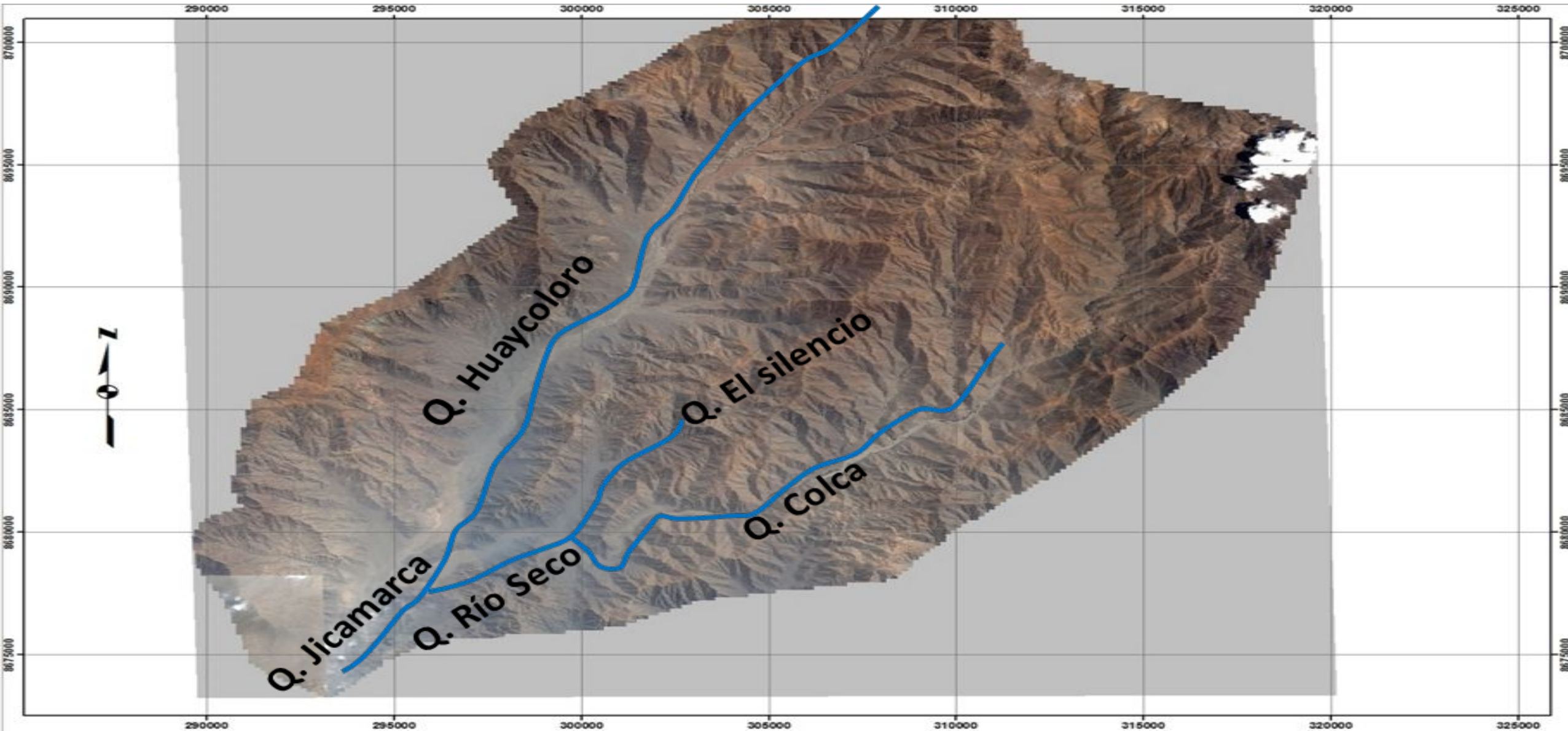


# Debris Flow in Jicamarca basin due Niño Phenomena since 1983 to 2017



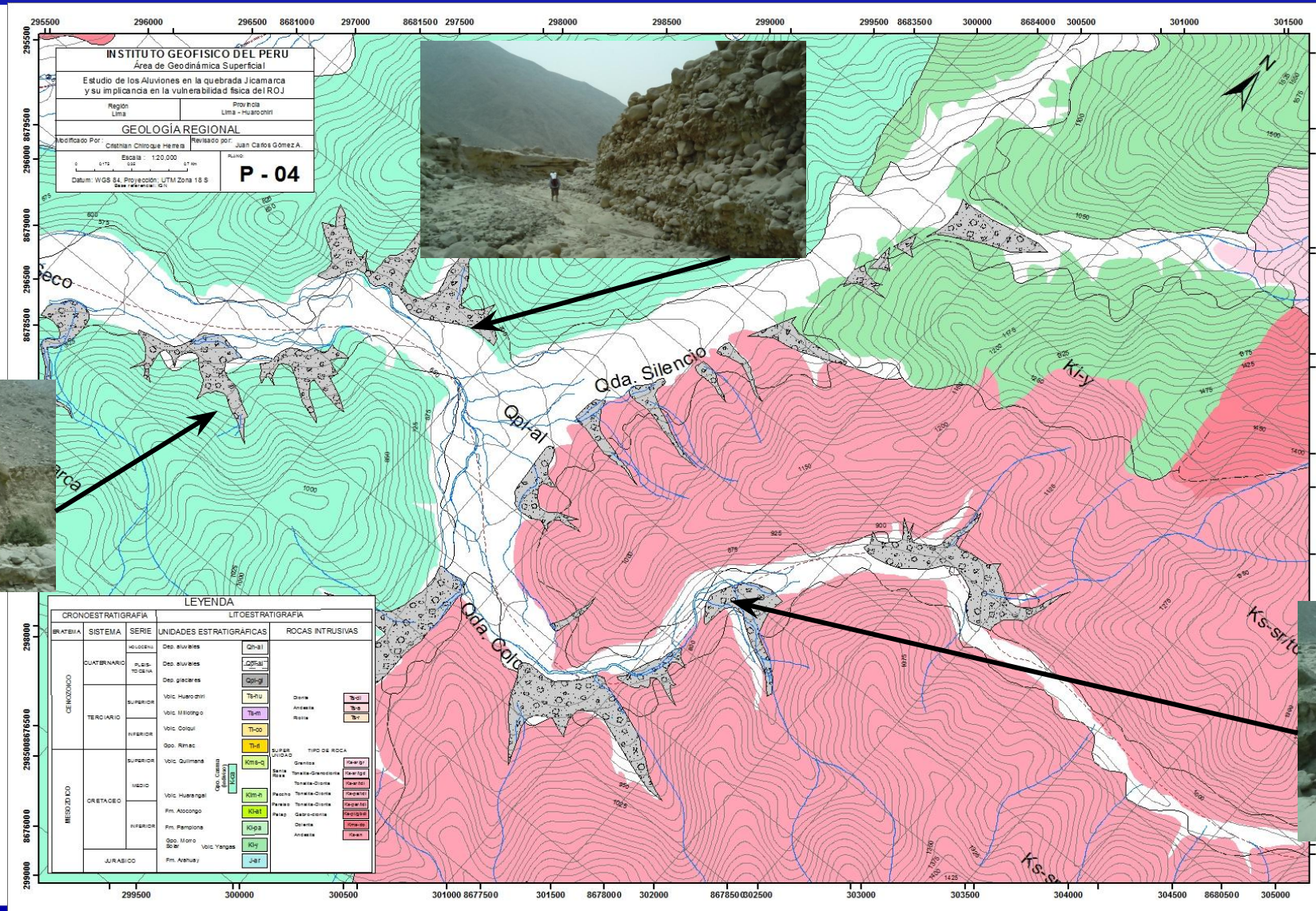


# Debris Flow in Jicamarca Stream - Lima





# Geological Settings in Jicamarca Steam



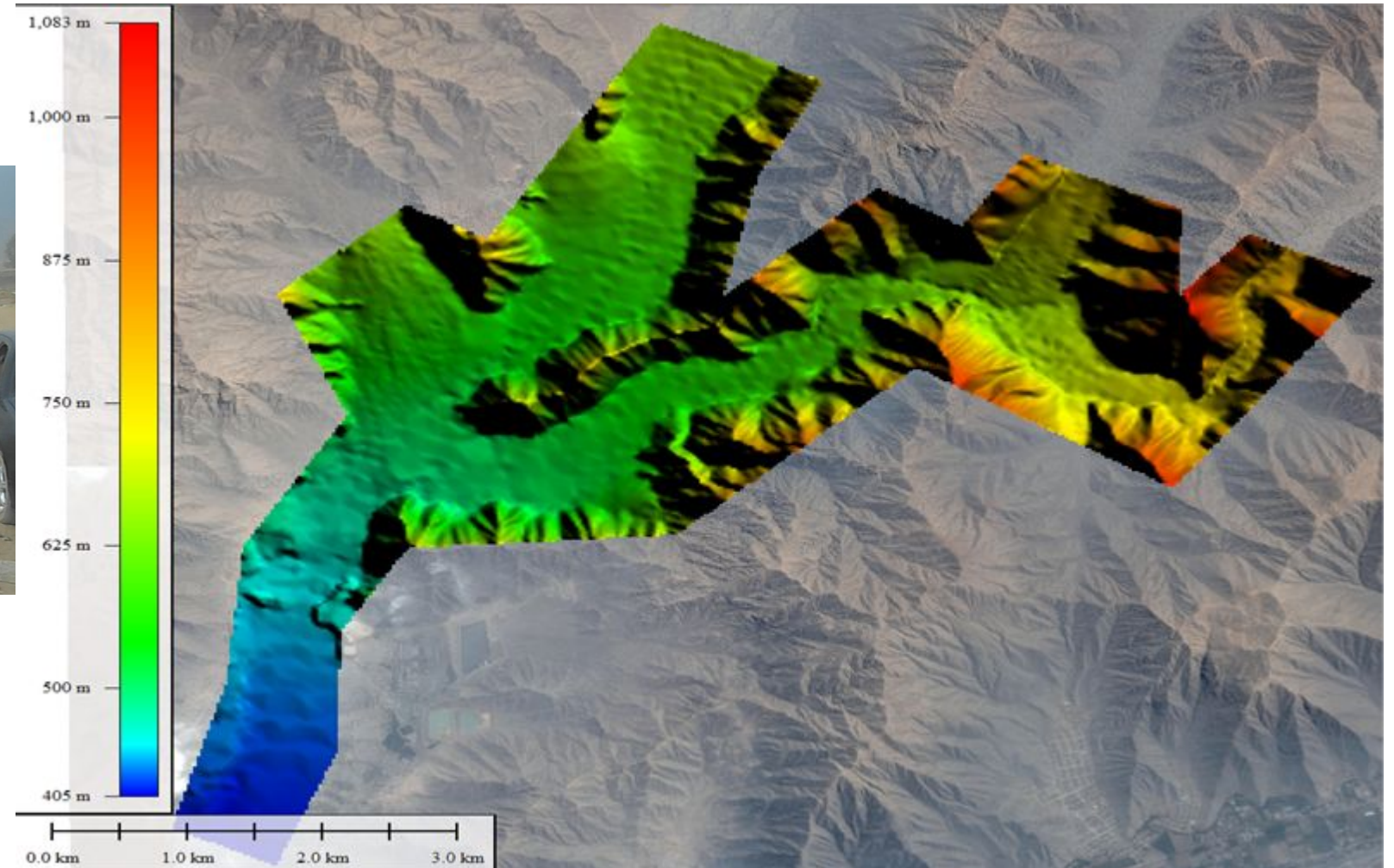


# Sedimentology Profiles



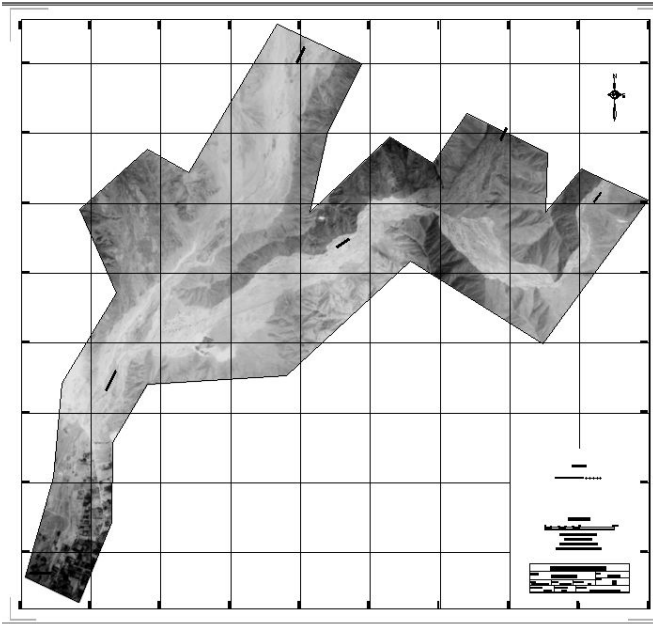


# Topographic Digital Data scale 1/20,000

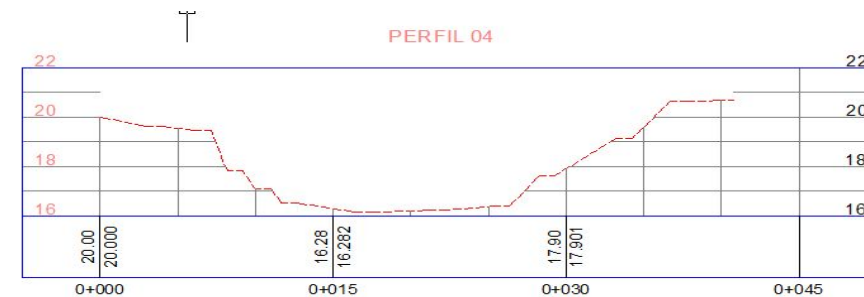




# Topographic profiles in streams



- 4 Perfiles en la quebrada Colca
- 4 Perfiles en la quebrada El Silencio
- 6 Perfiles en la quebrada Río Seco
- 8 Perfiles en la quebrada Jicamarca
- 6 Perfiles en la quebrada Huaycoloro





# Hidrological settings

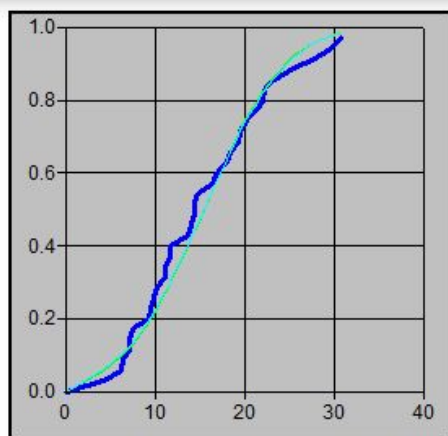


AÑO	Pmax24 (mm)
1989	4.10
1990	3.20
1991	3.70
1992	2.30
1993	2.40
1994	16.00
1995	3.00
1996	5.80
1997	S/D
1998	6.50
1999	6.50
2000	6.00
2001	5.20
2002	30.70
2003	2.80
2004	1.60
2005	1.20
2006	5.60
2007	7.70
2008	4.00
2009	8.00
2010	0.80
2011	5.70
2012	37.00
2013	2.30
2014	6.20

TABLA 01. Precipitaciones máximas en 24 horas anuales de la estación meteorológica Chosica.

DISTRIBUCIÓN	Delta teórico	Delta tabular
NORMAL	0.30930	0.2667
LOG NORMAL 2P	0.13340	0.2667
LOG NORMAL 3P	0.13030	0.2667
LOG PEARSON TIPO III	0.10951	0.2667
GUMBEL	0.23900	0.2667
LOG GUMBEL	0.13350	0.2667

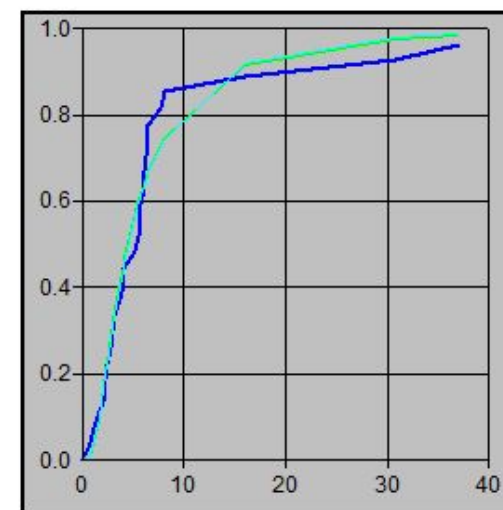
TABLA 03. Deltas teóricos y tabulares para las distintas distribuciones teóricas de la estación meteorológica Chosica.



GRÁFICA 07. Distribución Normal.

DISTRIBUCIÓN	Delta teórico	Delta tabular
NORMAL	0.10350	0.2332
LOG NORMAL 2P	0.07300	0.2332
LOG NORMAL 3P	0.07720	0.2332
LOG PEARSON TIPO III	-	-
GUMBEL	0.07960	0.2332
LOG GUMBEL	0.13230	0.2332

TABLA 04. Deltas teóricos y tabulares para las distintas distribuciones teóricas de la estación meteorológica Autisha.



GRÁFICA 04. Distribución Log Pearson tipo III.

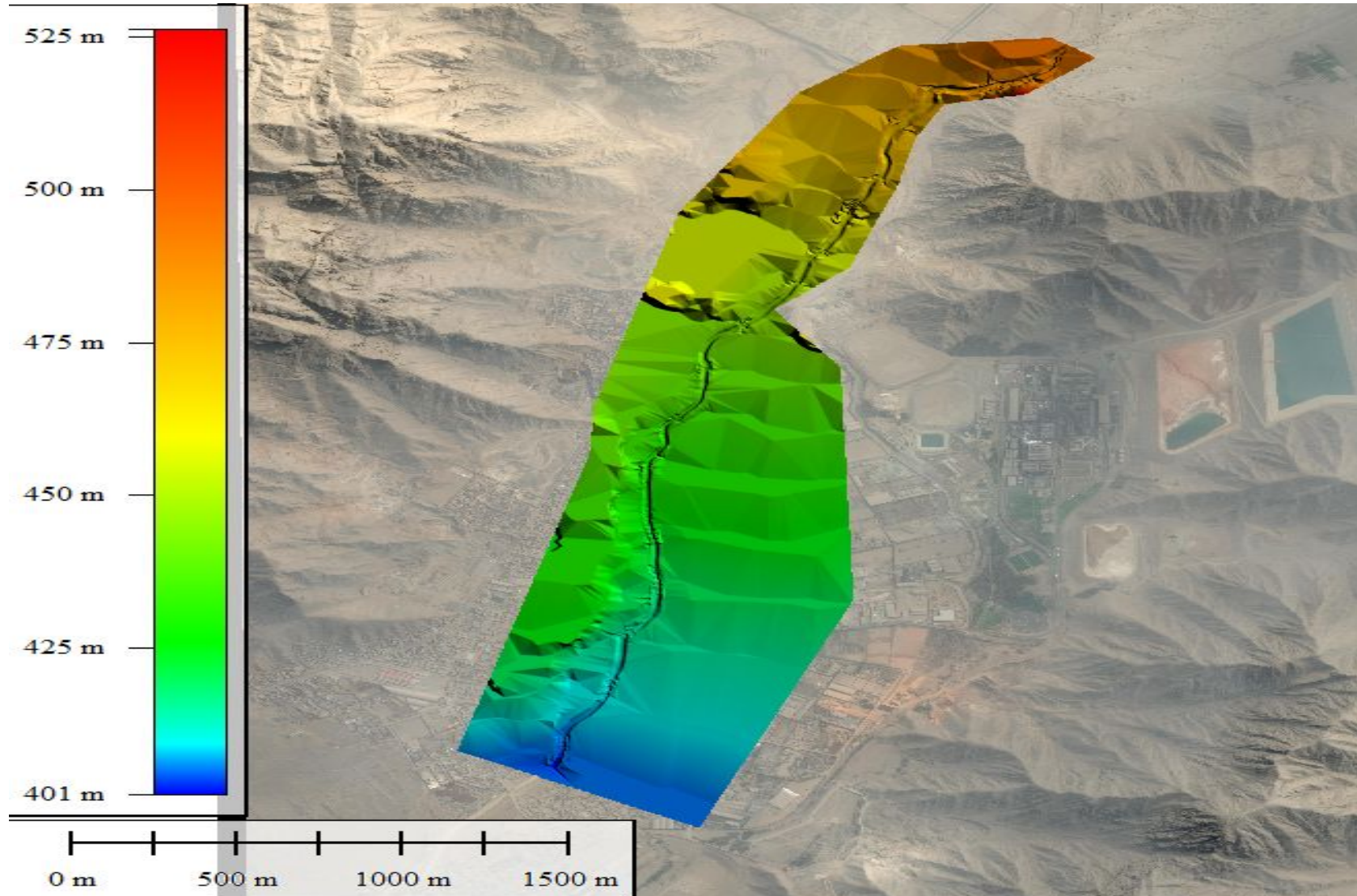
AÑO	Pmax24 (mm)
1980	7.50
1981	13.70
1982	11.20
1983	7.10
1984	7.20
1985	6.40
1986	4.30
1987	11.60
1988	9.80
1989	20.30
1990	14.70
1991	29.70
1992	6.30
1993	23.30
1994	11.20
1995	9.30
1996	18.40
1997	10.20
1998	22.20
1999	22.10
2000	9.50
2001	14.10
2002	16.40
2003	25.50
2004	14.40
2005	11.70
2006	30.80
2007	27.80
2008	16.90
2009	19.30
2010	19.60
2011	14.40
2012	21.30
2013	18.00

TABLA 02. Precipitaciones máximas en 24 horas anuales de la estación meteorológica Autisha.

la precipitación máxima probable para un periodo de retorno de 100 años es 46.66 mm. para la estación meteorológica Chosica; y 43.81 mm. para la estación meteorológica Autisha.



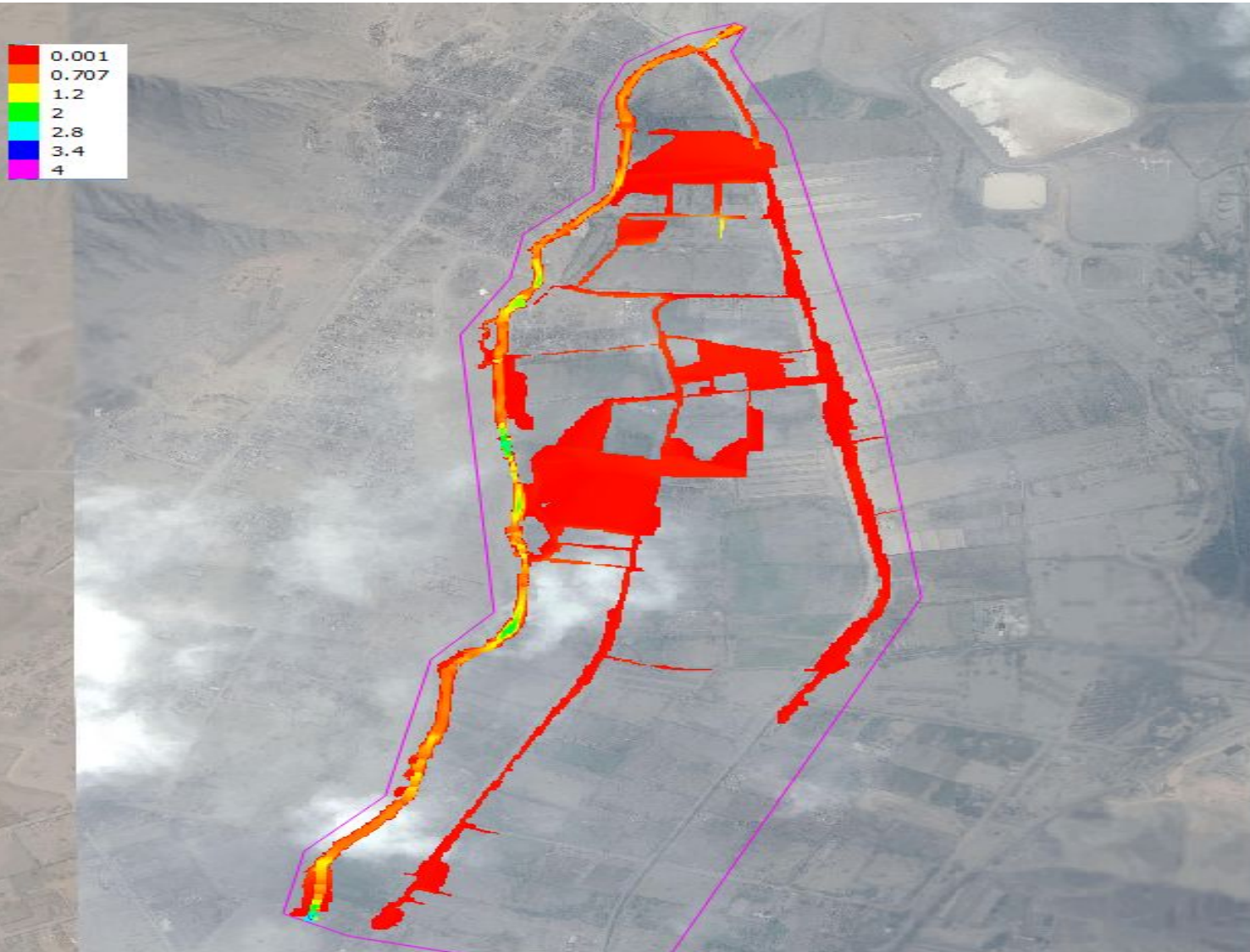
# Digital Topographic in high resolution to Numeric Simulation







# Debris Flow flood scenery

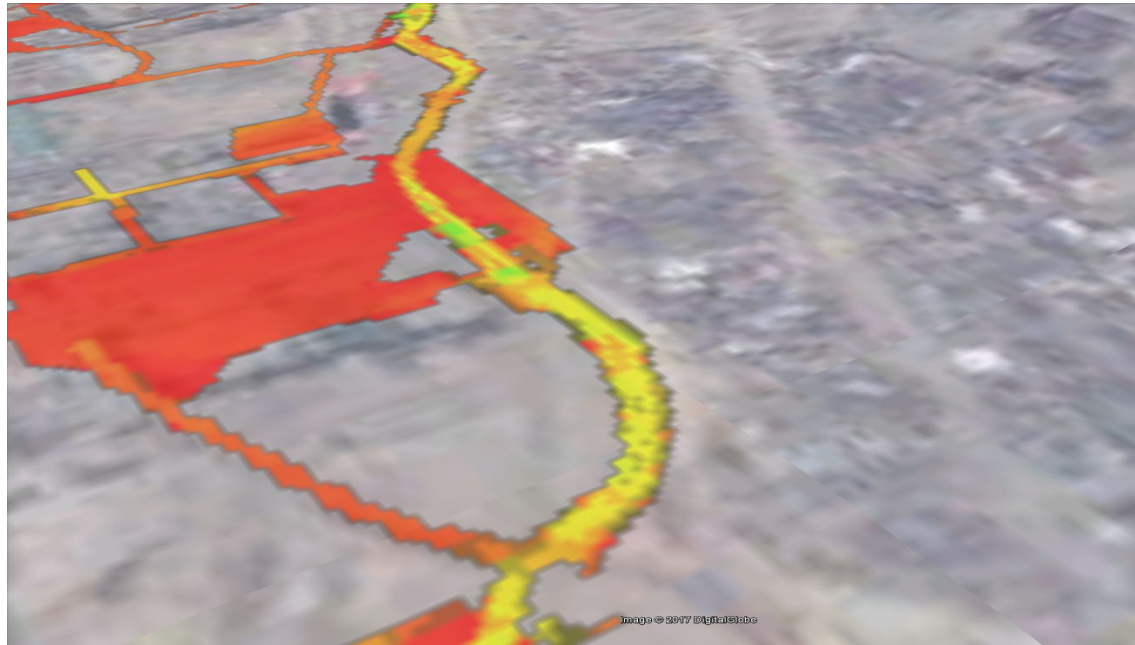


## SCENARIO

Simulation of an alluvial Flow with a constant Flow with rate of 45 m<sup>3</sup>/s and 20% concentration of the particles. Simulation time 5 hours



# Validation of flood scenery



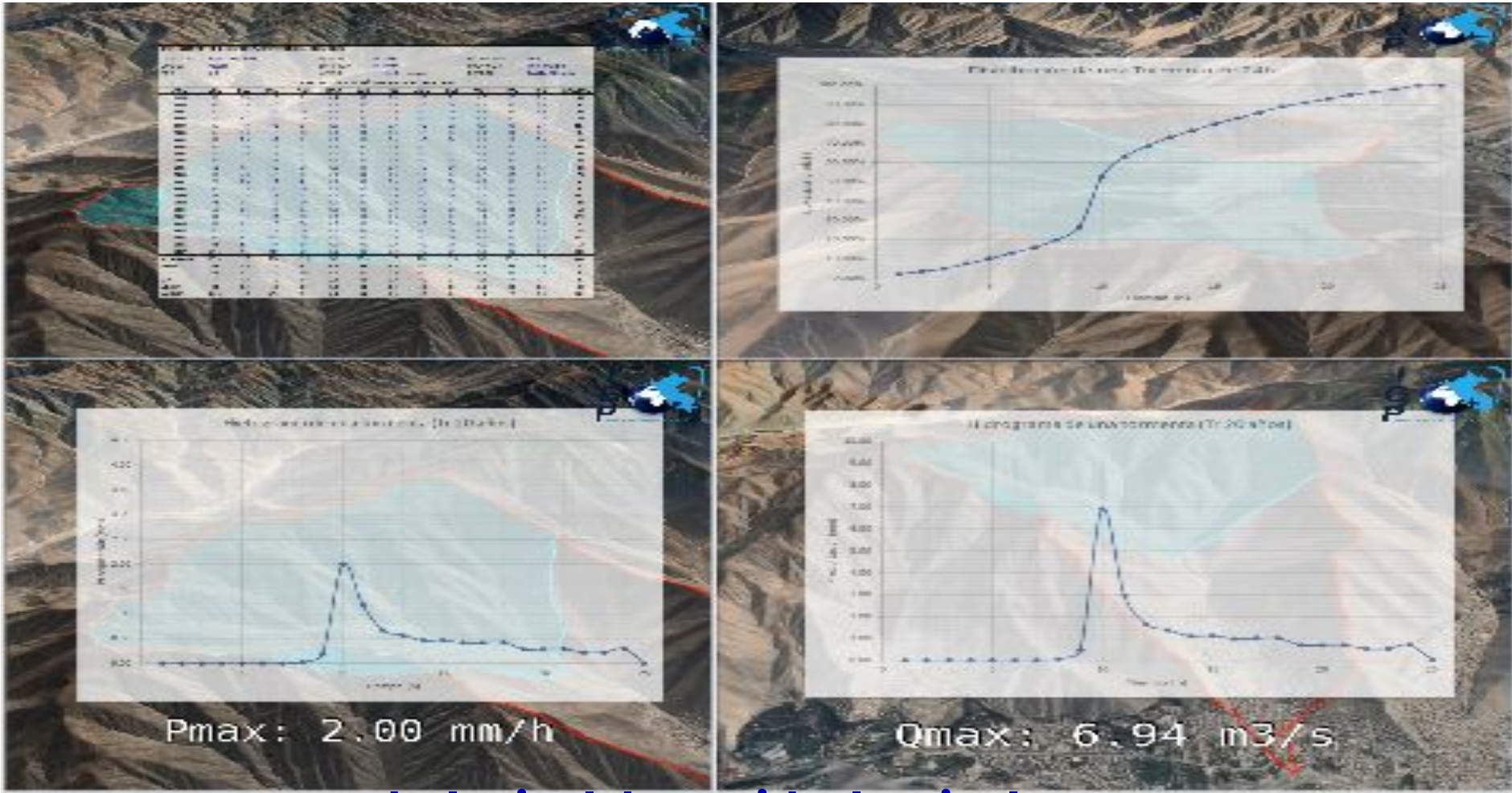
**Flood áreas calculated with the simulations carried out**



**Areas affected by debris flow in 2017  
“Niño Costero”**



# Debris Flow Monitoring System- Improvements



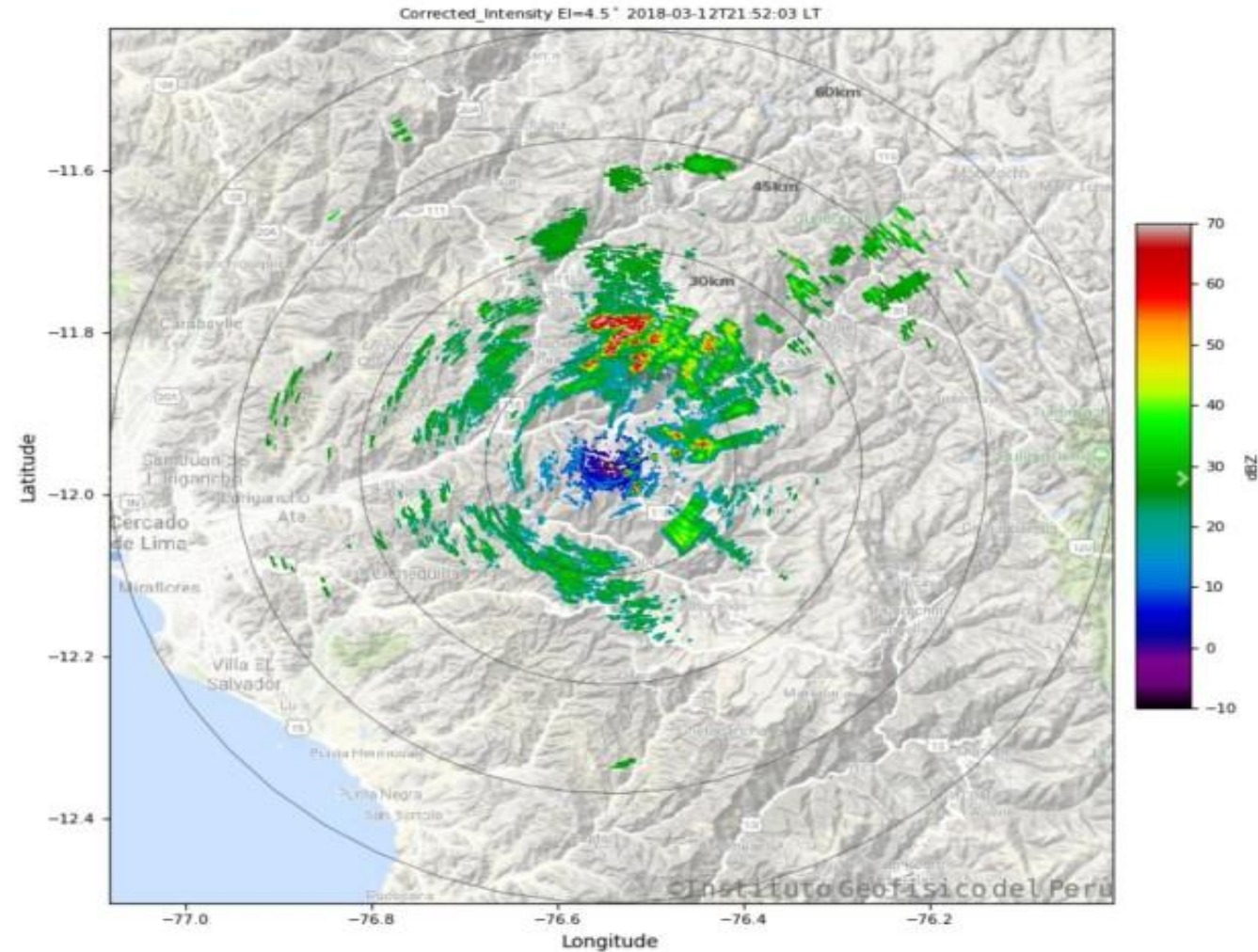
**Hydrological data with classical  
log**



# SOPHY The Weather precipitation radar

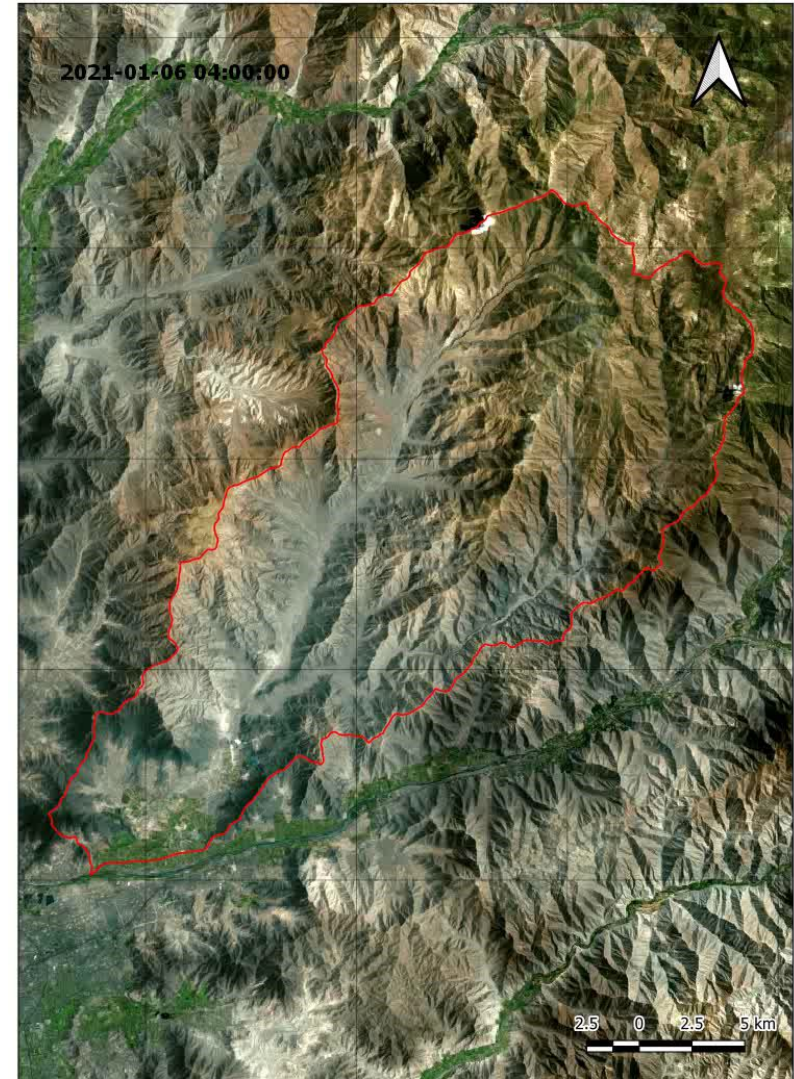
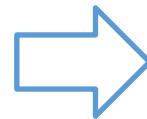


Radar PX1000



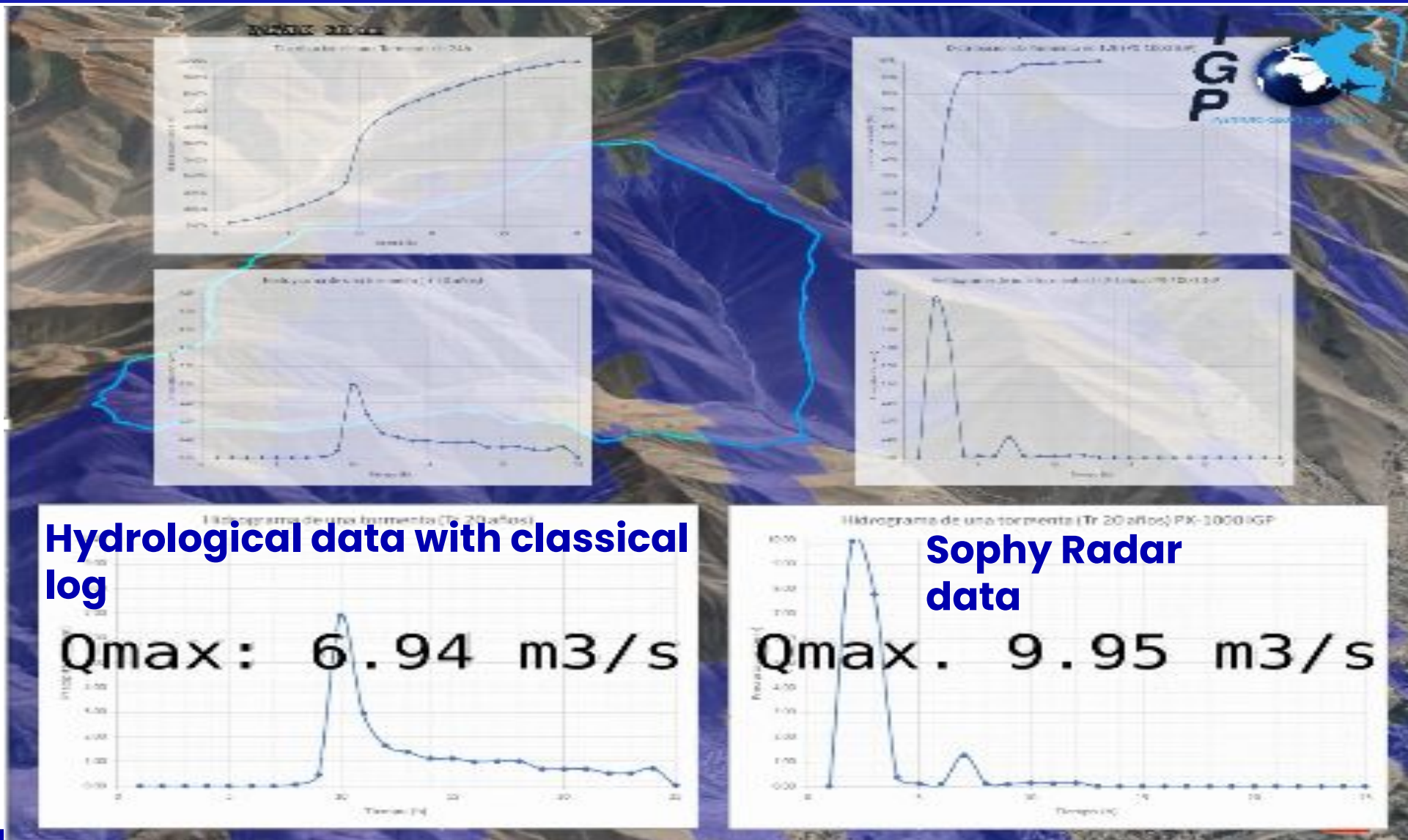


# SOPHY The Weather precipitation radar





# SOPHY Radar Data – Chosica, Lima





# DEBRIS FLOW MONITORING CENTER



Debris Flow Monitoring Center is a service developed by the Geophysical Institute of Peru (IGP), to issue reports, bulletins on activation of debris Flow (huaicos) in areas with high susceptibility to the occurrence of these events in all country. To do this, it makes use data coming in real time, from the Debris Flow Monitoring System, as is the case of the Jicamarca stream.

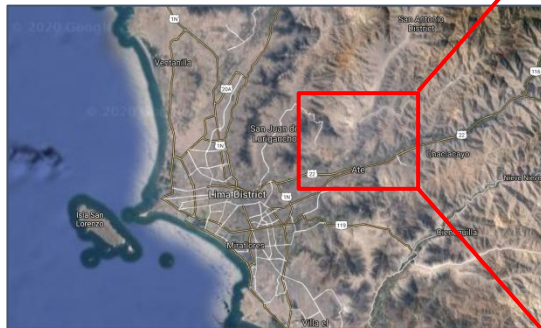




# DEBRIS FLOW MONITORING SYSTEM IN JICAMARCA STREAM – LIMA



Lima

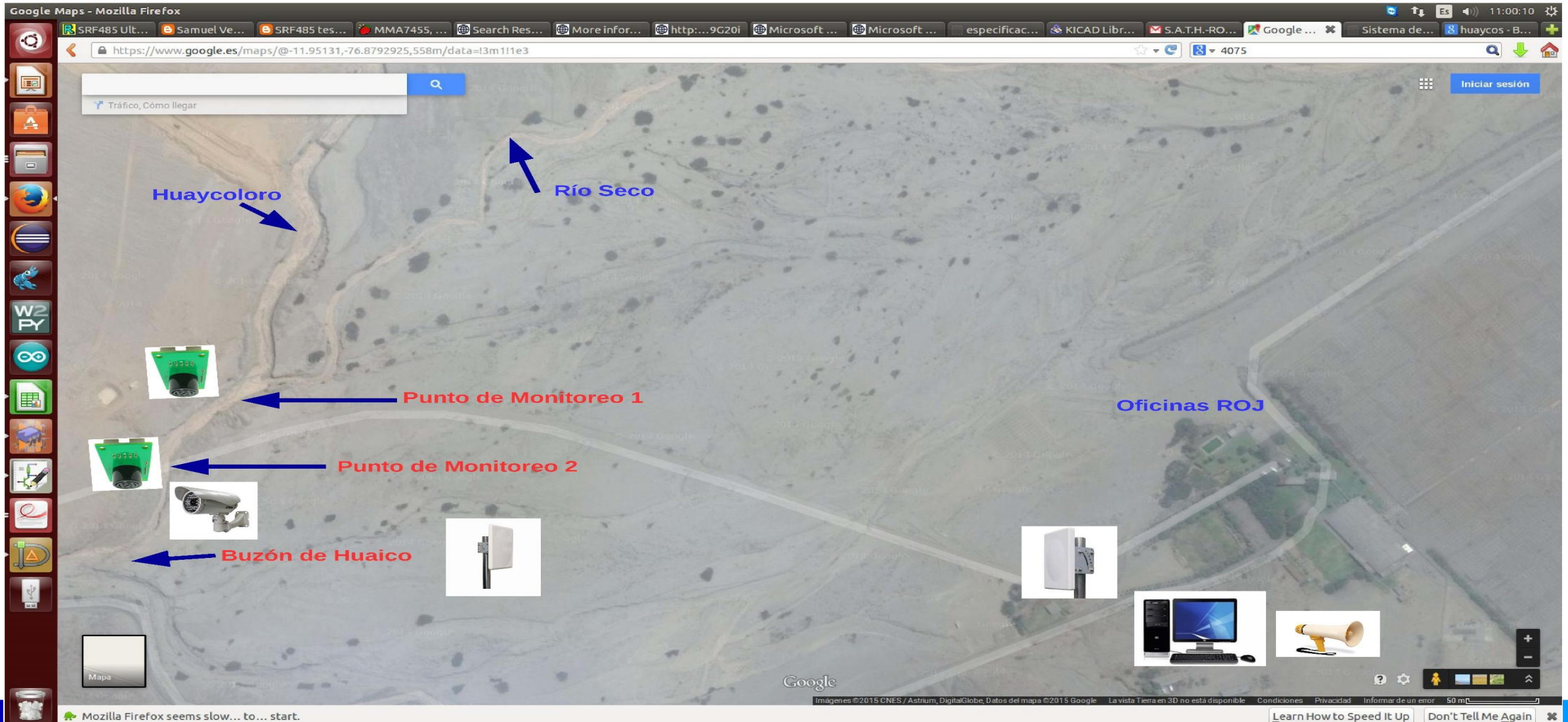




# Design of the Risk Alert System Debris Flow in Jicamarca Stream



## UBICACIÓN DEL SISTEMA DE ALERTA TEMPRANA DE HUAICOS



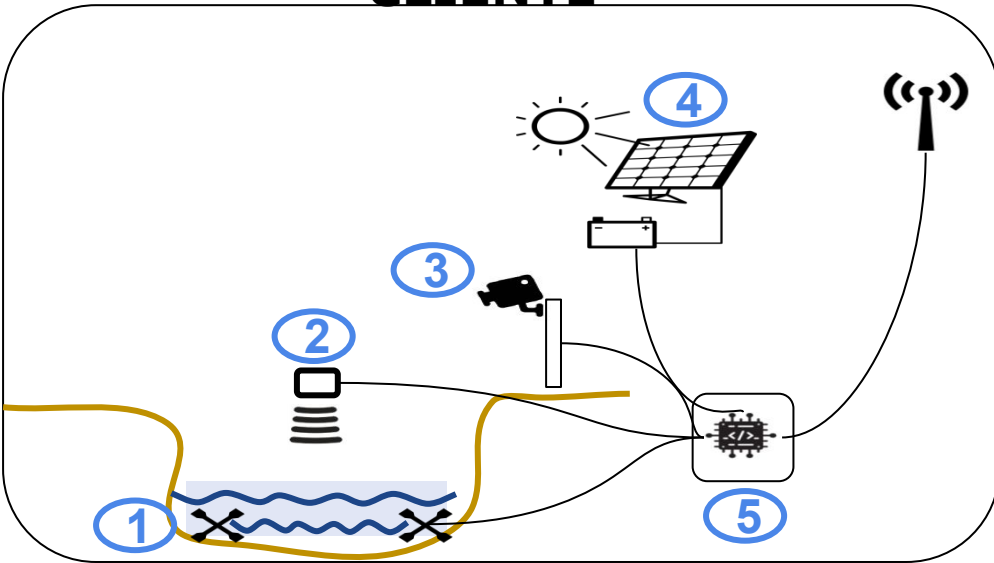


# Instrumentation of the Risk Alert System

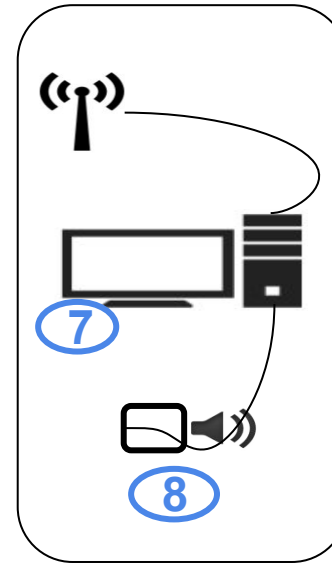
## Debris Flow in Jicamarca Stream



### CLIENTE



### SERVIDOR



- |                             |                                   |
|-----------------------------|-----------------------------------|
| 1. Sensor de presencia      | 5. Sistema Embebido               |
| 2. Sensor de nivel          | 6. Enlace inalámbrico hasta 10 Km |
| 3. Camara IP                | 7. Servidor web                   |
| 4. Sistema de energía Solar | 8. Sirena de evacuación           |

**Alertas de activación de quebradas**



**Alertas de funcionamiento autónomo:**

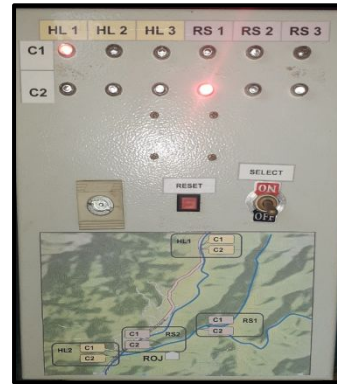
- Nivel de baterías
- Pérdida de conexión



# The Risk Alert System Debris Flow in Jicamarca Stream



Ubicación de sensores en el cauce



Módulo de activación de sirena de evacuación ROJ



Electrónica de campo



Instalación de estación de monitoreo en la quebrada Huaycoloro

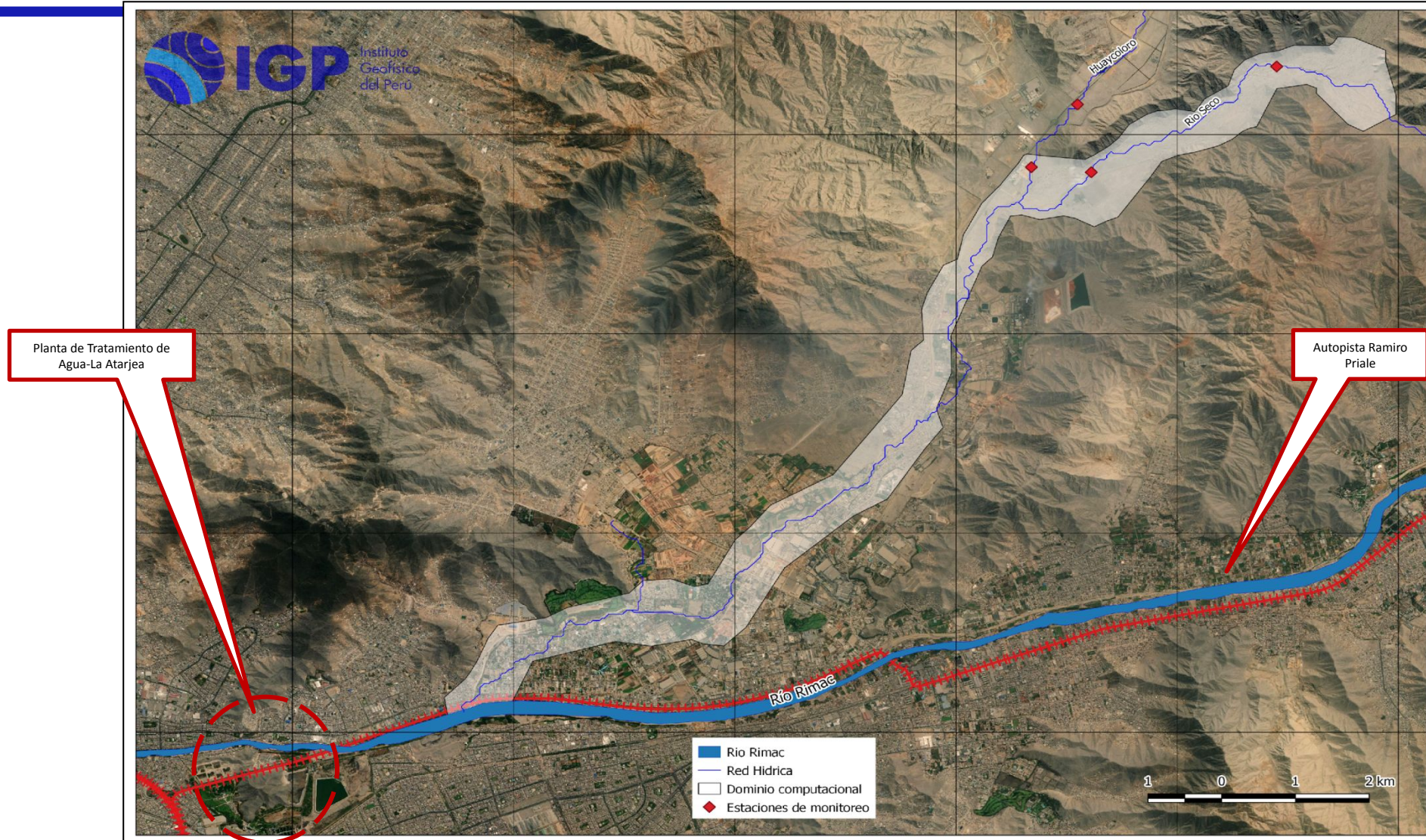


# The Risk Alert System Debris Flow in Jicamarca Stream – Reports





# Numerical Flow Simulation of the Jicamarca Stream 2018

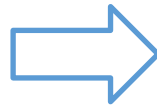
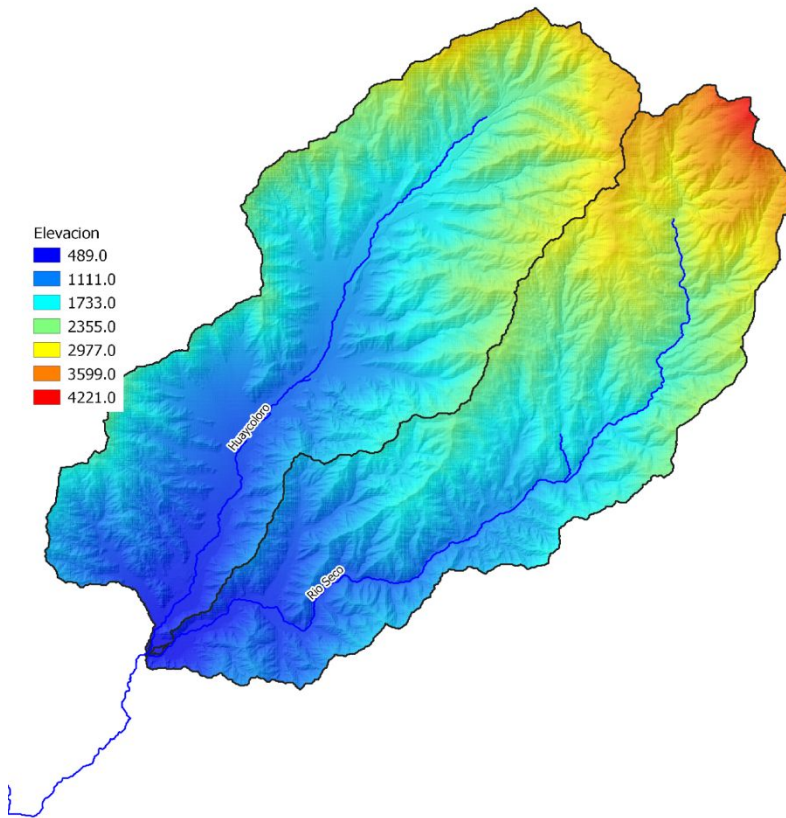




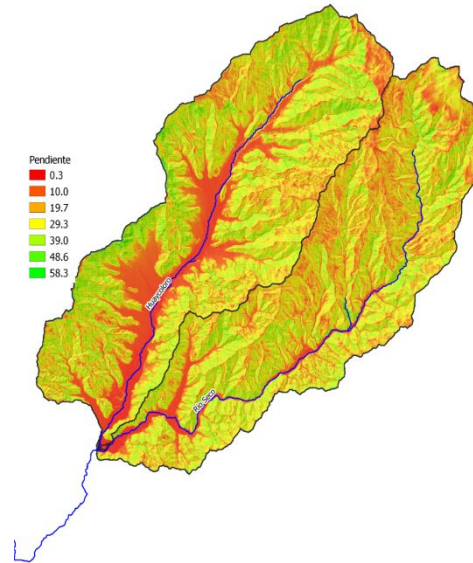
# Digital Elevation Model – Results



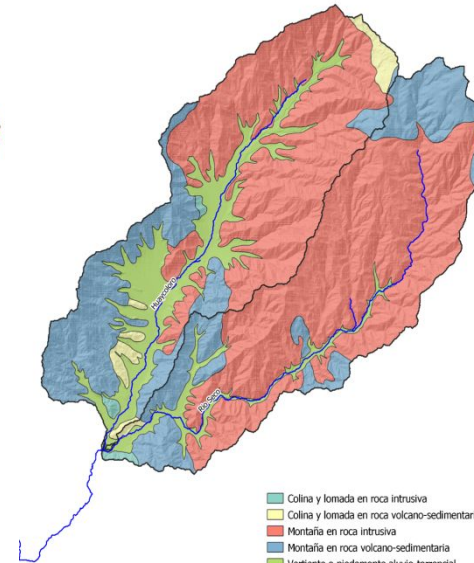
Modelo Digital de Elevaciones (MDE)



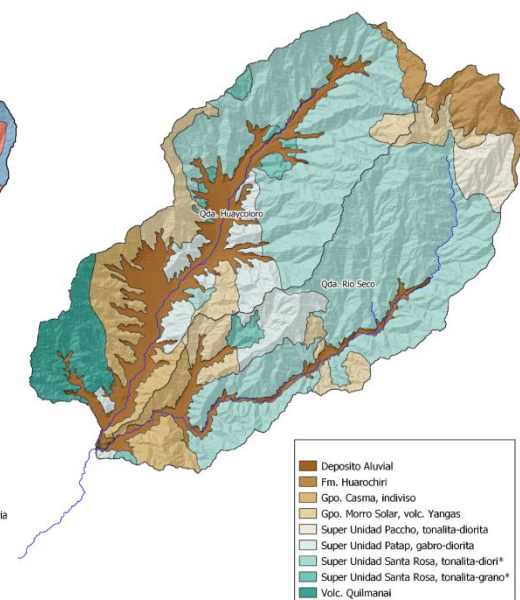
Pendientes



Geomorfología



Geología

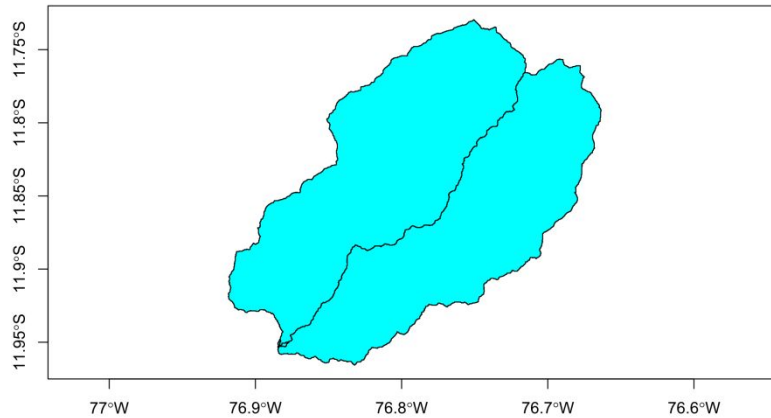




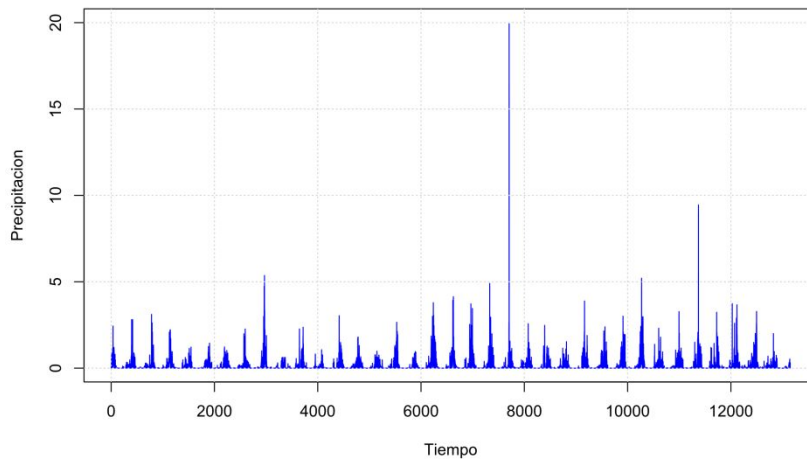
# Triggering Agents - Results



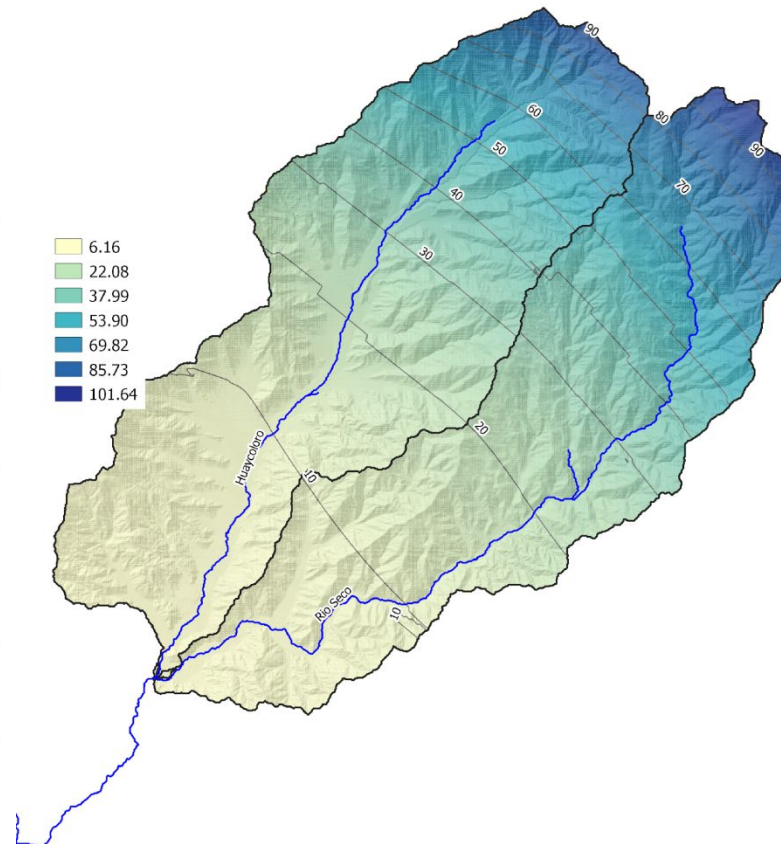
Subcuenca Jicamarca



Precipitación media Areal Subcuenca Jicamarca (1981 - 2016)



Precipitación acumulada  
Febrero 2017



Caudales máximos

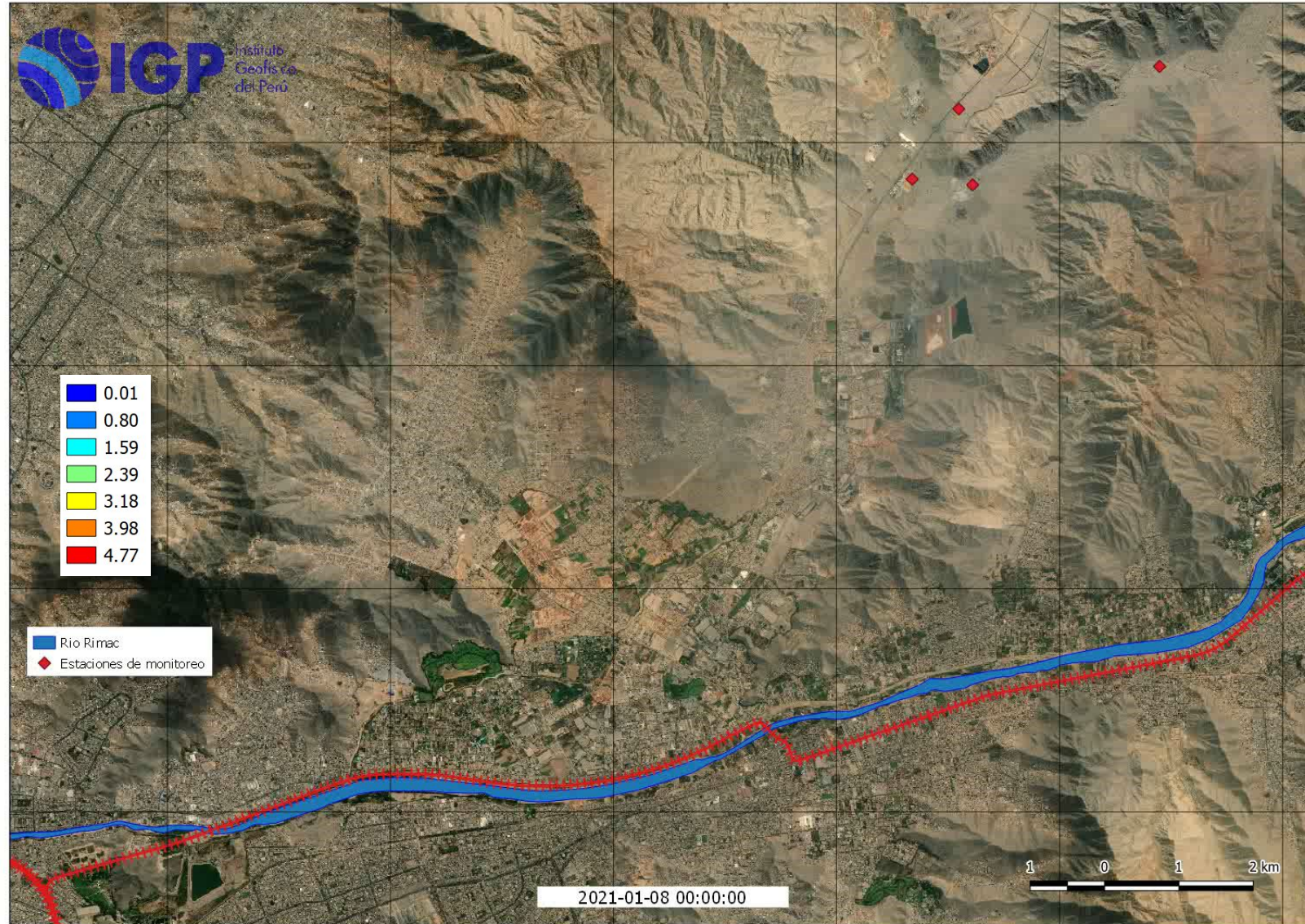
N°	PERÍODO DE RETORNO (Años)	DESCARGAS (m <sup>3</sup> /s)
01	5	13.20
02	10	18.36
03	25	28.71
04	50	50.40
05	100	97.00
06	200	116.91



# Numerical Flow Simulation Results

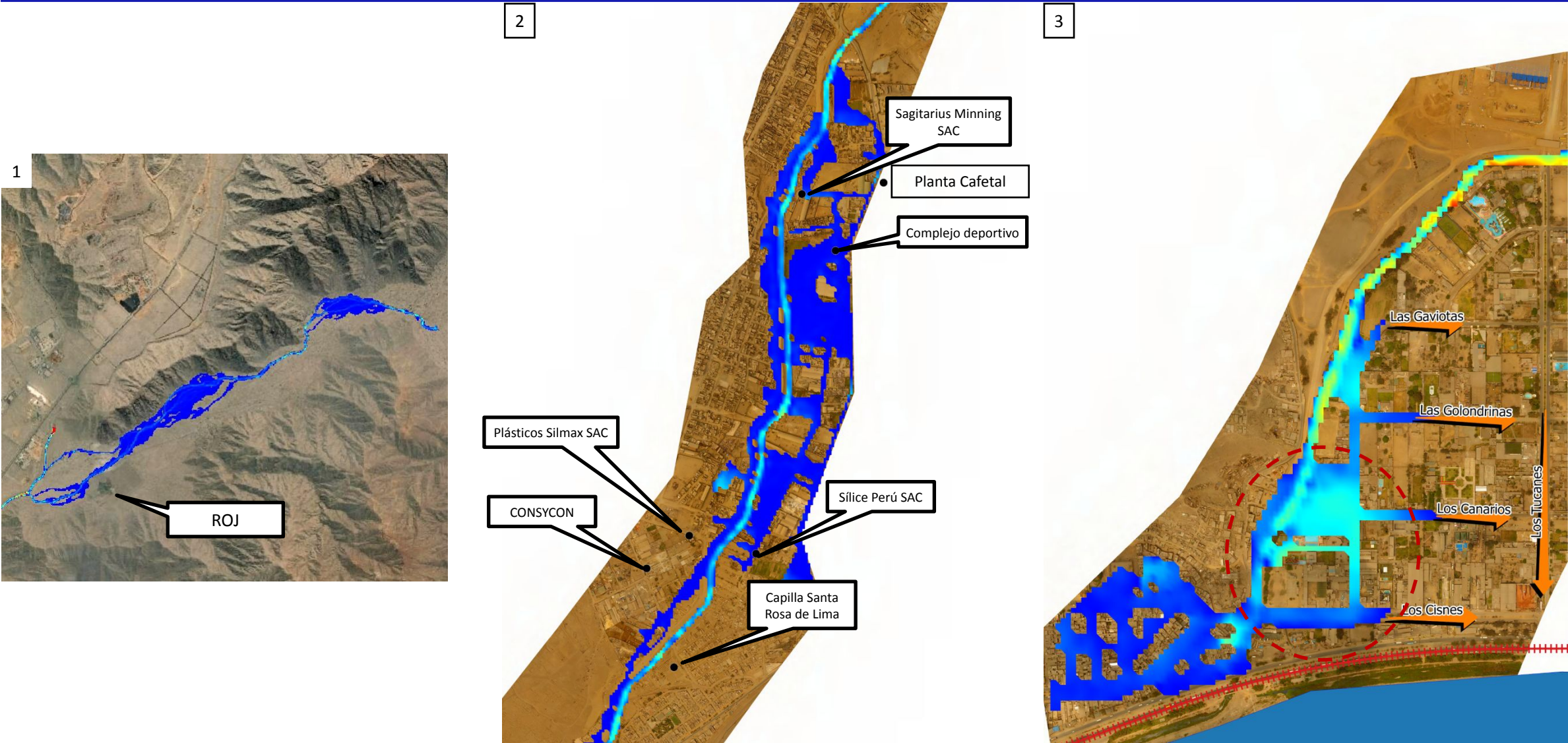


Alturas máximas de  
flujo obtenidas a partir  
de la simulación  
numérica de flujos  
hiperconcentrados:  
Caudal máximo 67.94  
m<sup>3</sup>/s  
(Niño Costero 2017)





# Numerical Flow Simulation Results





***Ciencia para protegernos  
Ciencia para avanzar***

**[www.IGP.gob.pe](http://www.IGP.gob.pe)**

