Extreme Gulling in Mexico, in semi-abandoned agricultural lands and in active volcanic areas: field studies and modelling

Lorenzo Borselli*
Juana María Eguía del Pozo**
Azalea Judit Ortíz Rodríguez***

***Instituto de Geología, Universidad Autónoma de San Luis Potosí, San Luis Potosí, SLP, MEXICO**
lborselli@gmail.com lorenzo.borselli@uaslp.mx
http://www.lorenzo-borselli.eu

****Posgraduate student , Engineering Geology , Fac. of Engineering ,**
Universidad Autónoma de San Luis,SLP, MEXICO

***** Centro de Geociencias, Universidad Nacional Autónoma de Mexico,**
Campus Juriquilla, Queretaro, QRO, Mexico

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Gully erosion in mexico

Gully system on residuals soil cap above sedimentary rocks Photo by L.B. 2015 – san Luis potosí Mexico

Following Bolano et al. (2016)* , about 76% of soil surface in Mexico are affected by severe soil erosion and degradation. And 12% of total surface by severe and active erosion processes. as: gully – rill erosion

*Bolaños-González, M.A., Paz-Pellat, F., Cruz-Gaistardo, C.O., Argumedo-Espinoza, J.A., Romero-Benítez, V.M., De la Cruz-Cabrera, J.C., 2016, Mapa de erosión de los suelos de México y posibles implicaciones en el almacenamiento de carbono orgánico del suelo: Terra Latinoamericana, 34(3), p. 271-288

Evidences of severity of gully erosion and its posible causes:

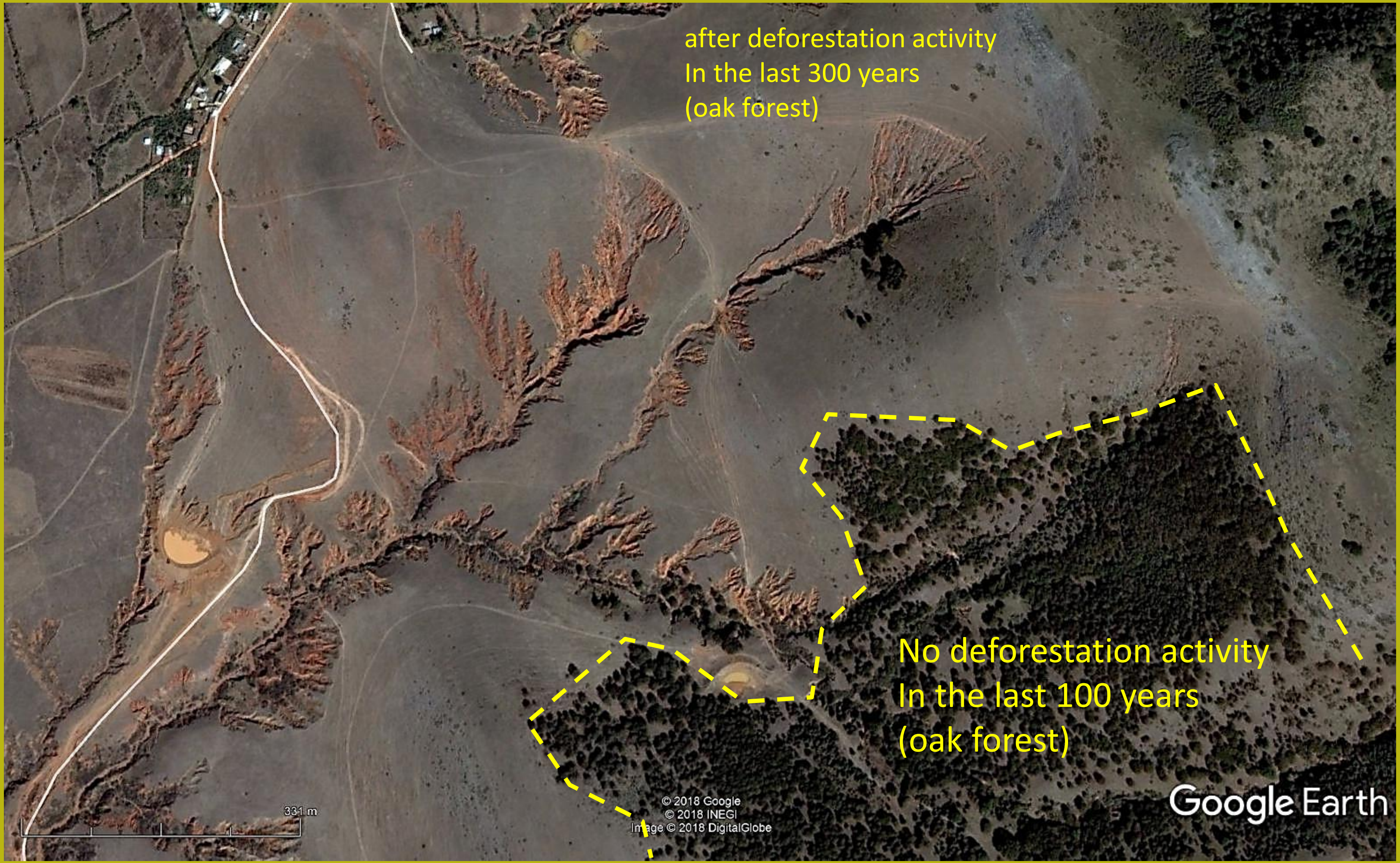
Gully system on soils cap above volcanic bedrock
Photo by L.B. 2012 – san Luis potosí Mexico

Possible causes

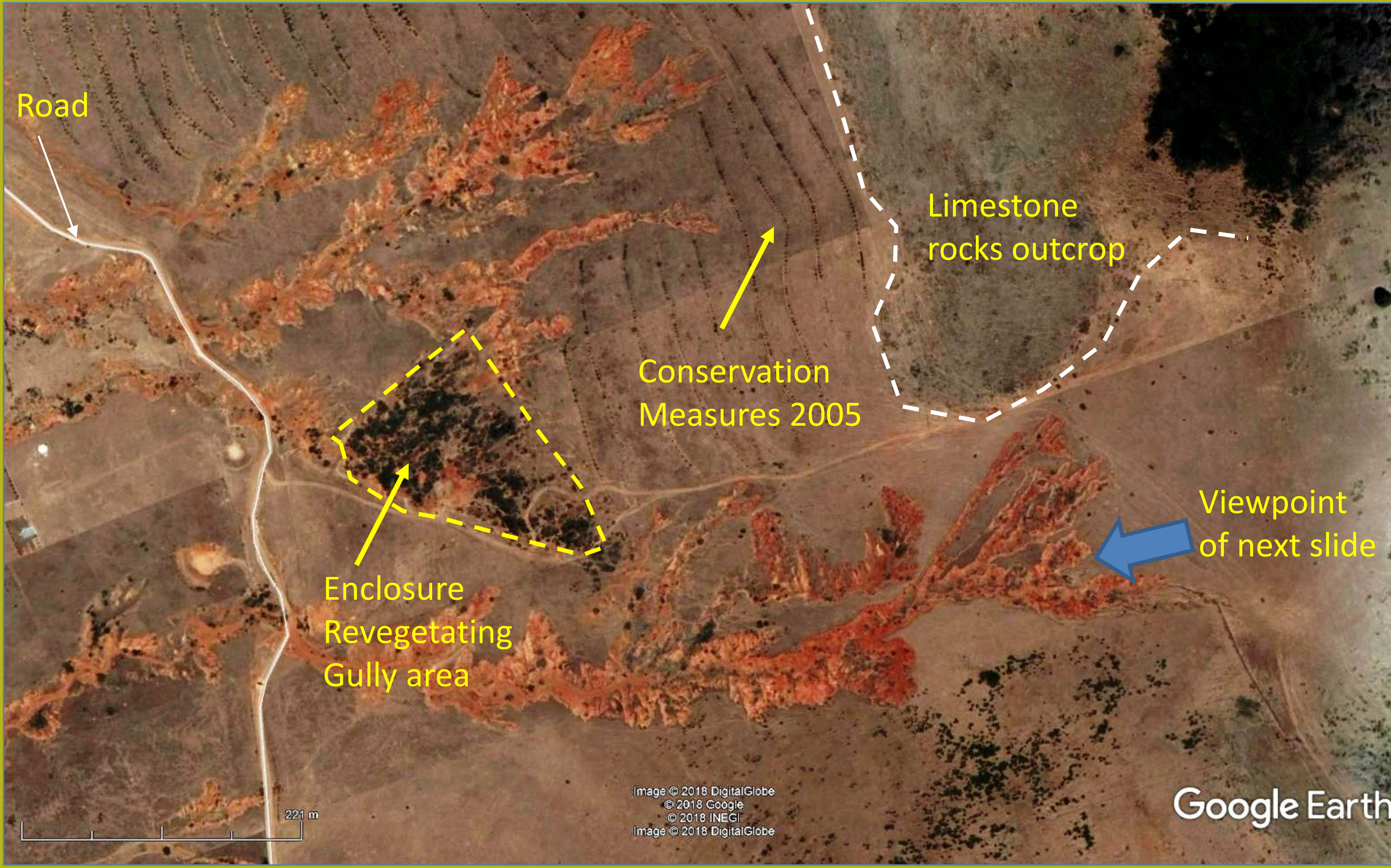
- **Nature of soils (e.g. high erodibility, dispersive nature, and structural instability)**
- **Climatic condition and extreme events (e.g. tropical storms ,hurricanes)**
- **Overgrazing**
- **Field Abandonments.. due to emigration (internal, and in USA)**
- **Absence of effective soil conservation measures**
- **Non maintained existing soil conservation measures**
- **Deforestation**
- **Insufficient land planning**
- **….**

Valle de la Palomas gully system

Valles de la Palomas
Gully erosion system



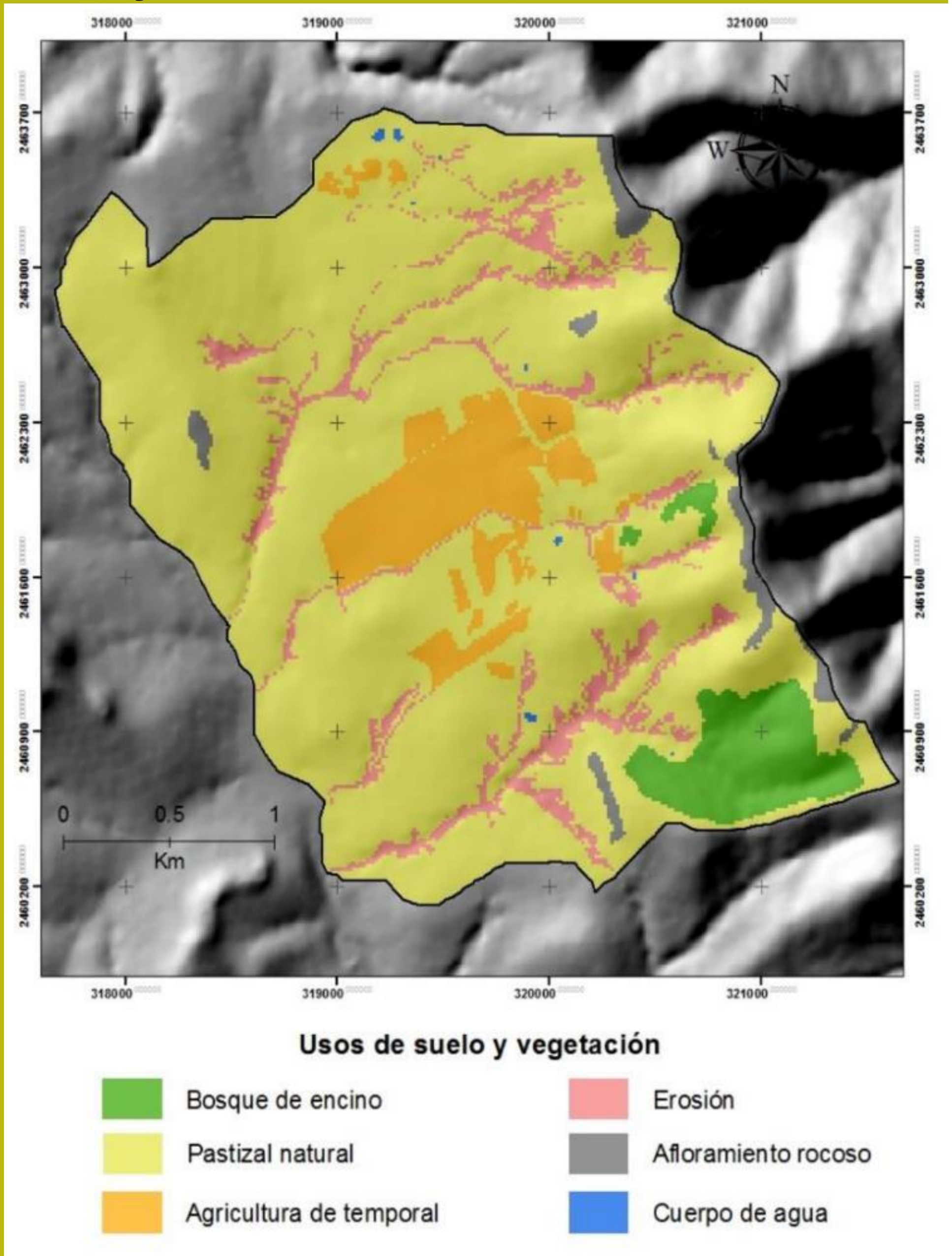
Valles de la Palomas Gully erosion system



Valle de la Palomas gully system

Details from the viewpoint of the previous slide

Valles de la Palomas Gully erosion system

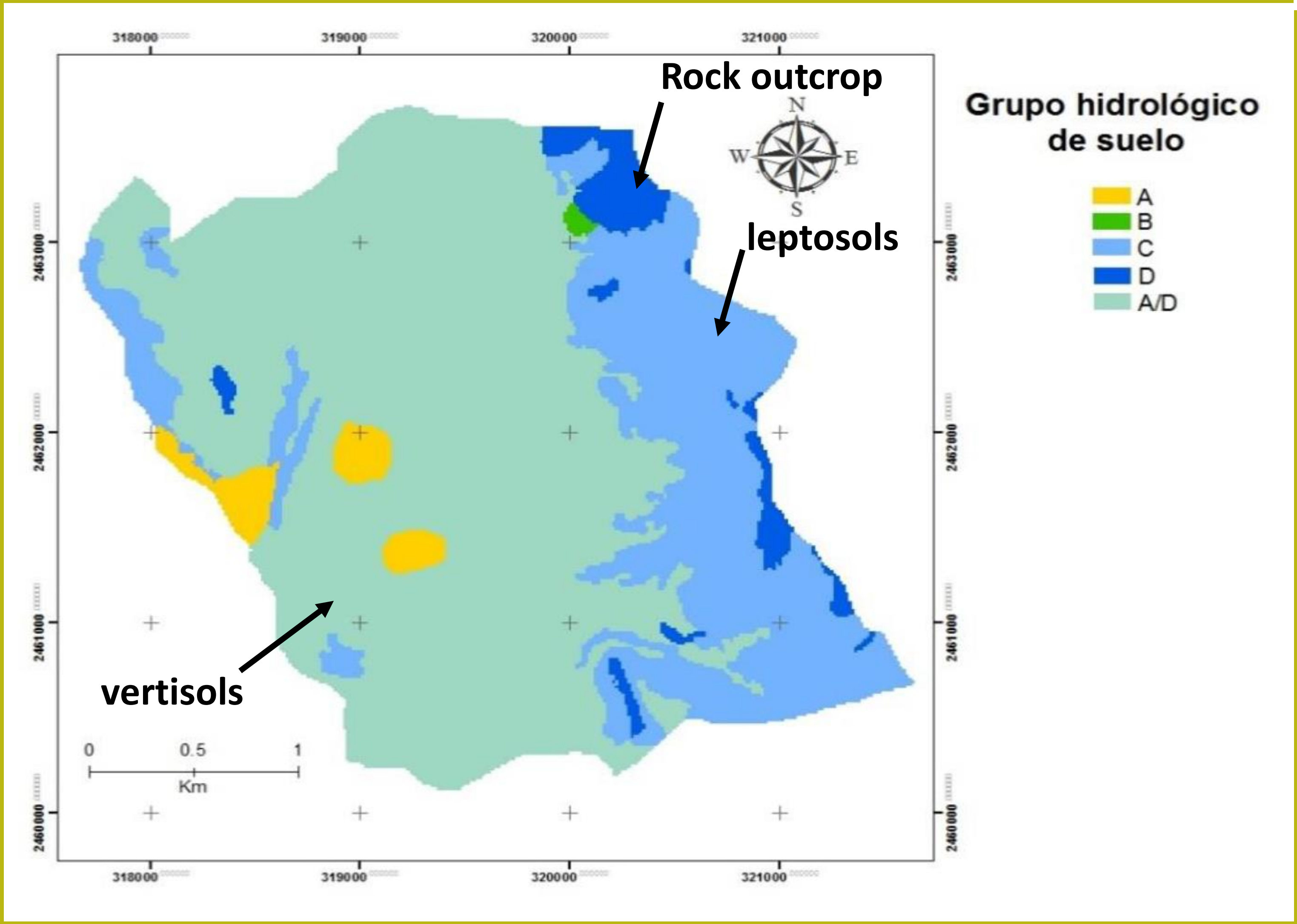


Land use map at present time.

The area received in the last 300 years strong deforestation of previous oak forest

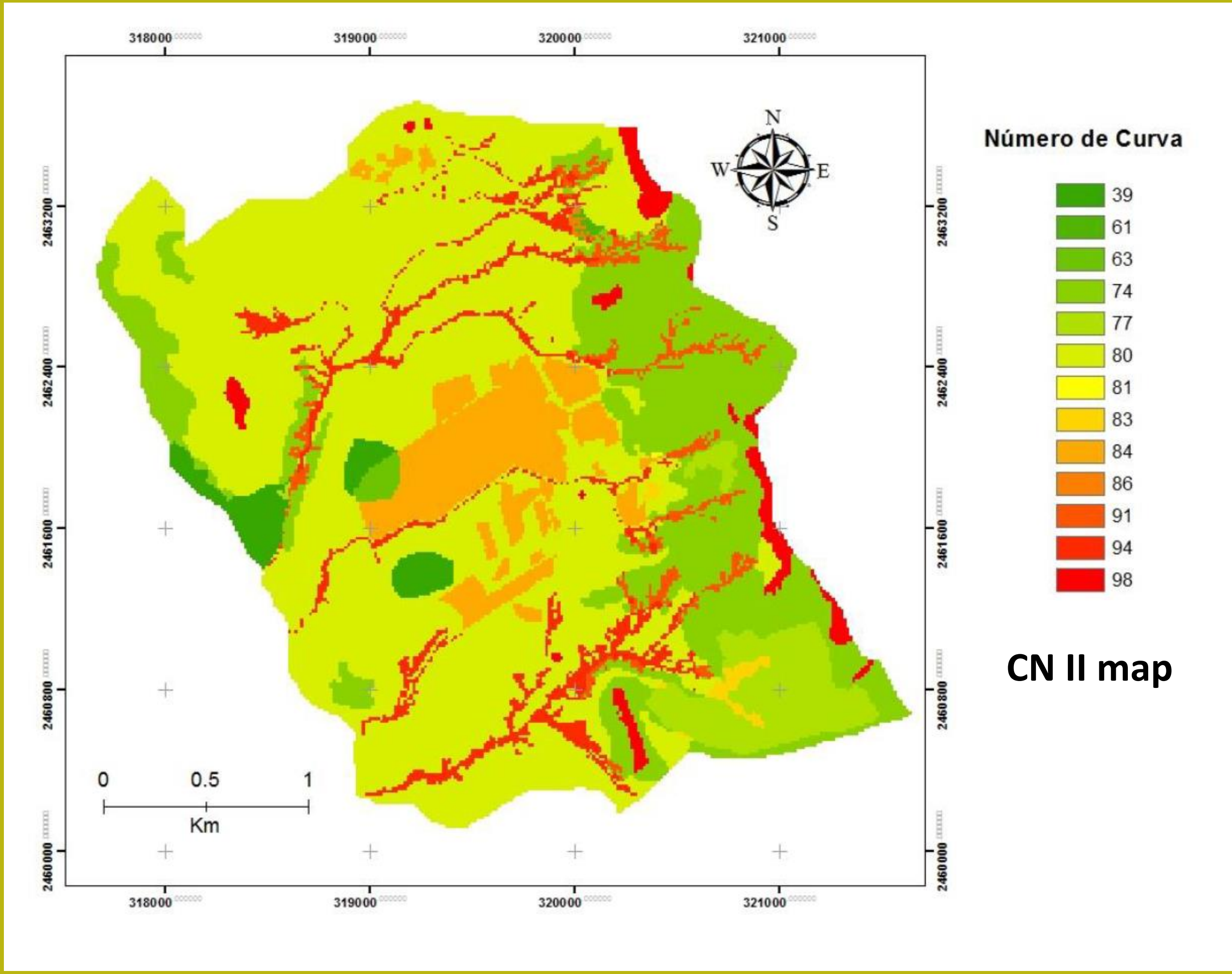
In order to produce charcoal for mining/metallurgical activities in San Luis Potosi area

Valles de la Palomas Gully erosion system



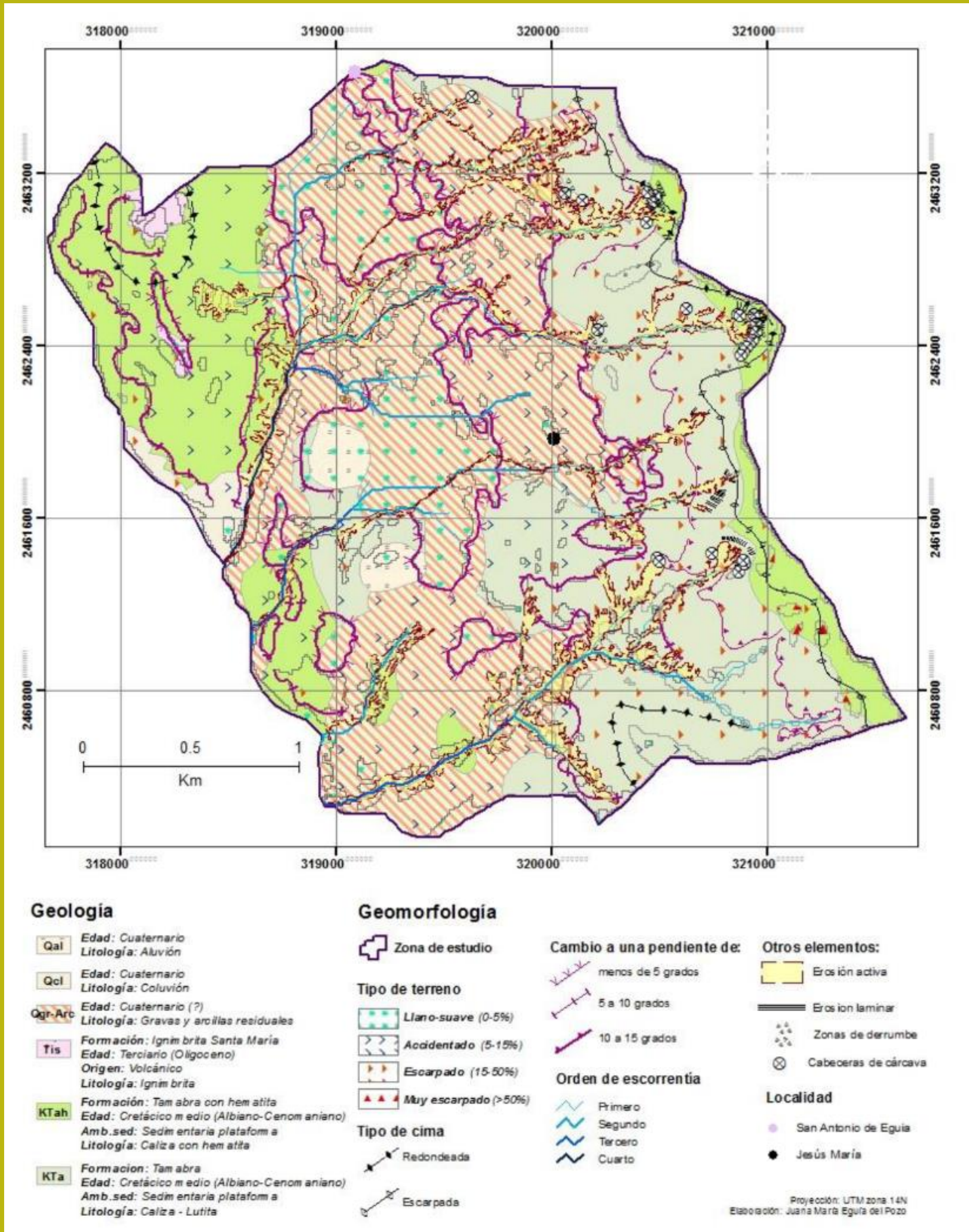
Hyrological soil group classified according to Bartolini et al. 2009

Valles de la Palomas Gully erosion system



CN II map

Valles de la Palomas Gully erosion system



Geological and Geomorphological Map

Using gully treshold for gully posible evolution on existing gully system

Gully threshold model of Torri and Poesen (2014), Rossi et al. (2015) was used with the final objective to assess future maximum extension of gully system

gully treshold survey above main head of gully system

Using gully treshold for gully posible evolution on existing gully system

Model an survey are mainly based on:

Torri, D., Poesen, J., 2014, A review of topographic threshold conditions for gully head development in different environments: Earth Science Reviews, 130, p. 73–85.

Rossi, M., Torri, D., Santi, E., 2015, Bias in topographic thresholds for gully heads: Natural Hazards, 79 (1), p. 51-69.

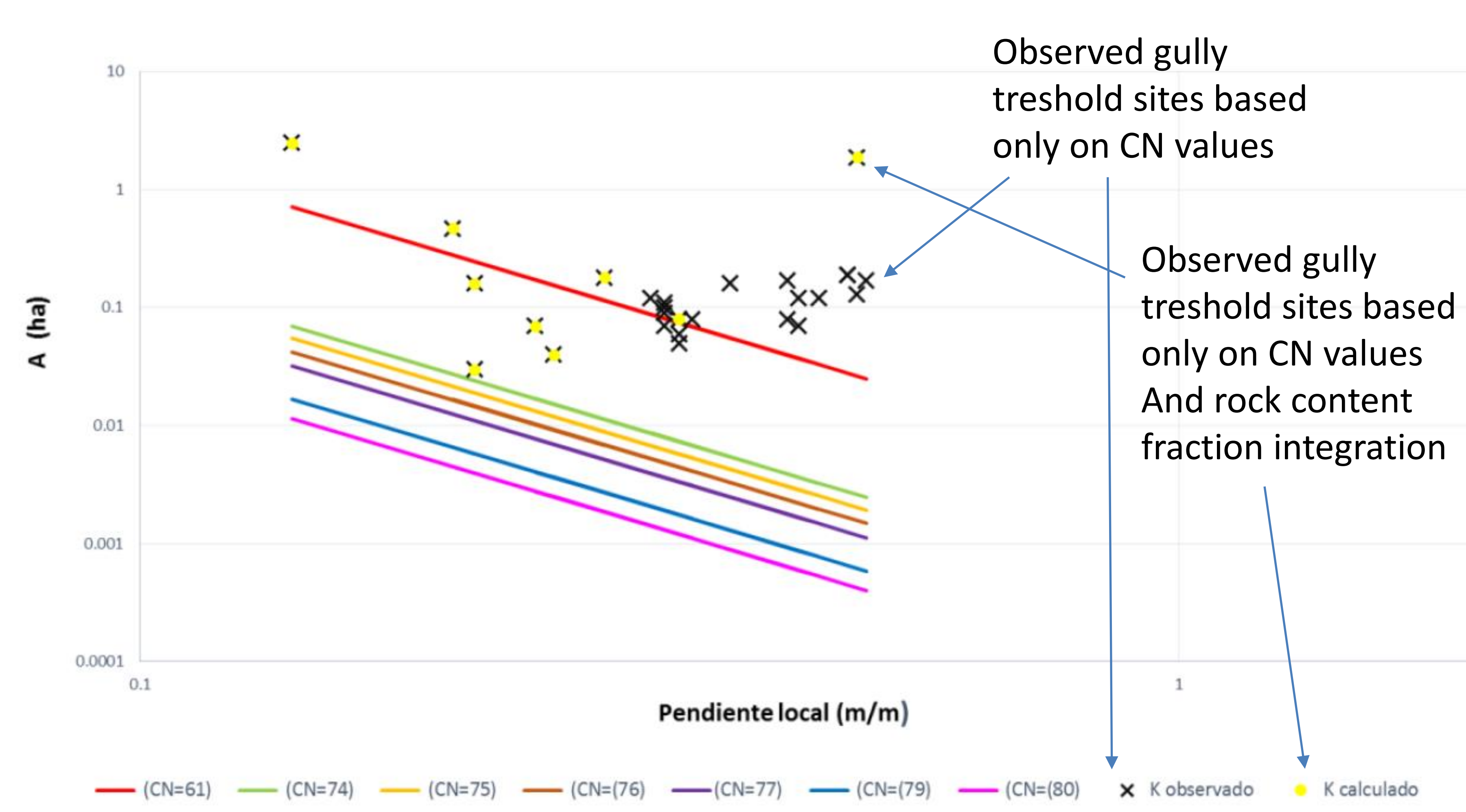
With some integration.

- **Dichotomic *soil HSG map for account vertisols in low gradient area***
- ***Use of texture and granulometric classification based full grain size analysis (block to clay distribution)***
- ***Comparison of CN based map of gully threshold with modified version based also on full rock contents.***

Derived by Torri and Poesen(2014) ⇒

$$A(ha) \geq \left(\frac{0.00104\left(\frac{25400}{\overline{CN}} - 254\right)^{1.15} - 0.04}{S} \right)^{2.63}$$

Using gully treshold for gully posible evolution on existing gully system



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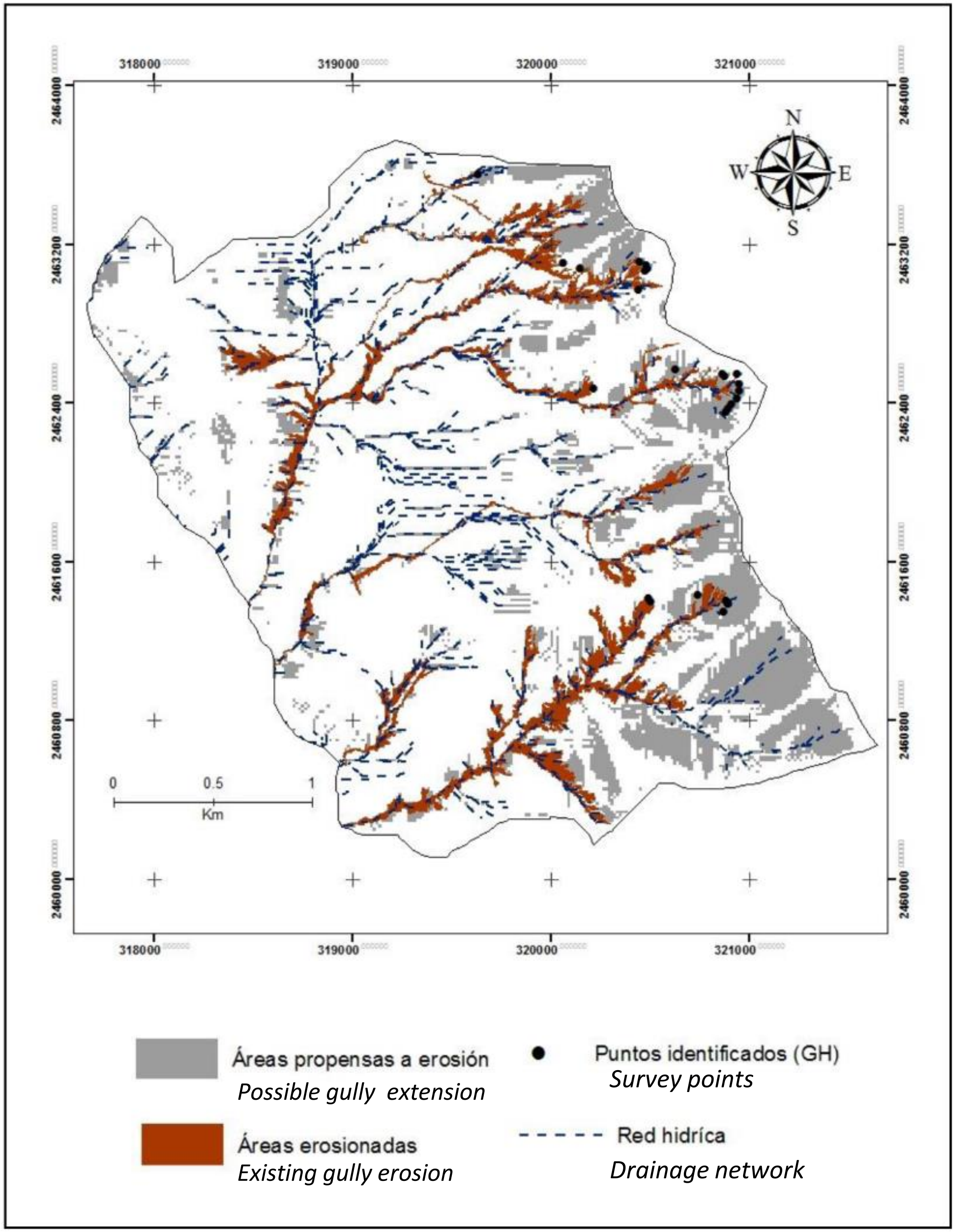
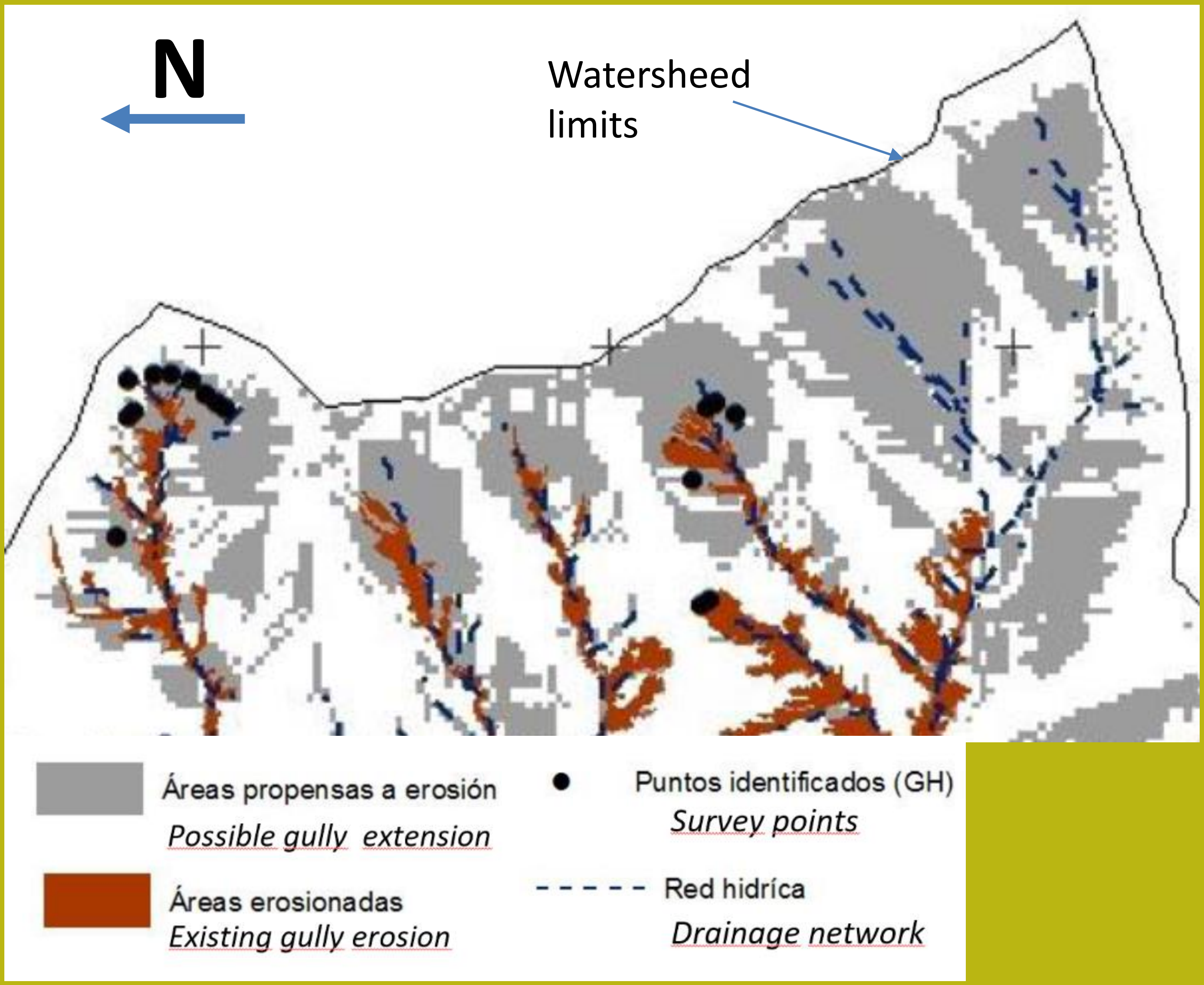


Results of model Application:
Possible future extensión of gully erosion system

Some Possible future planned soil conservation measures are not included.



Details of model results

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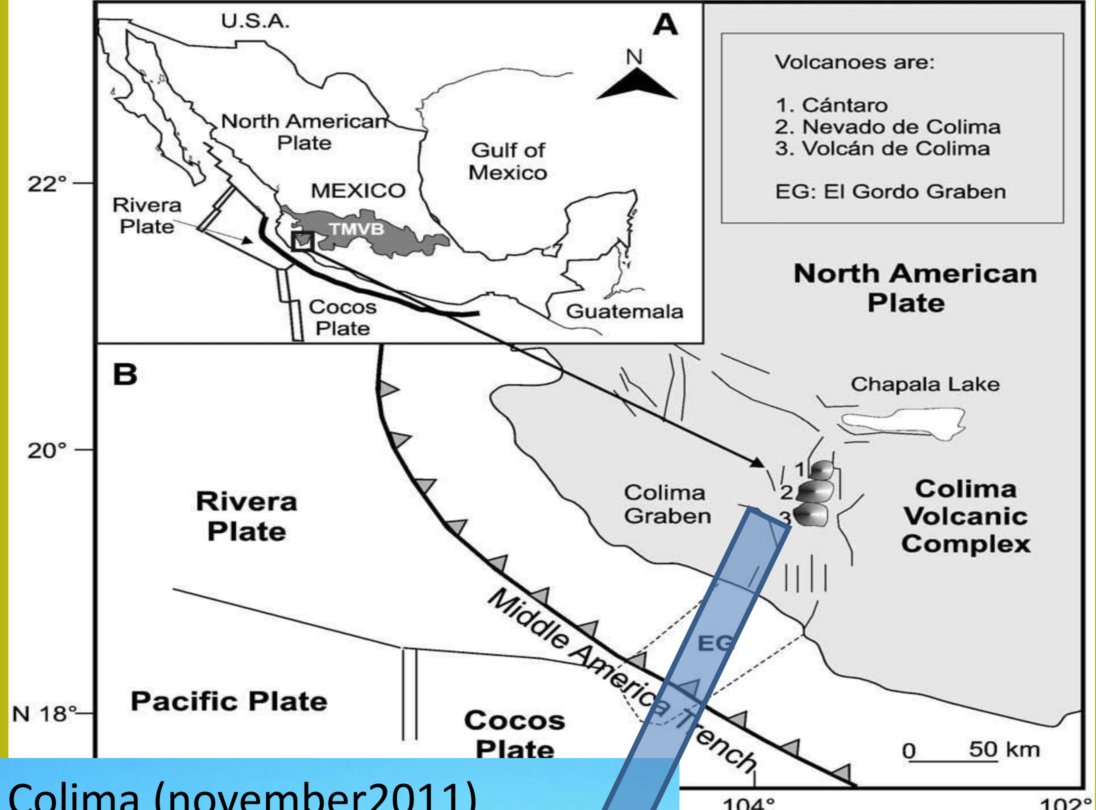
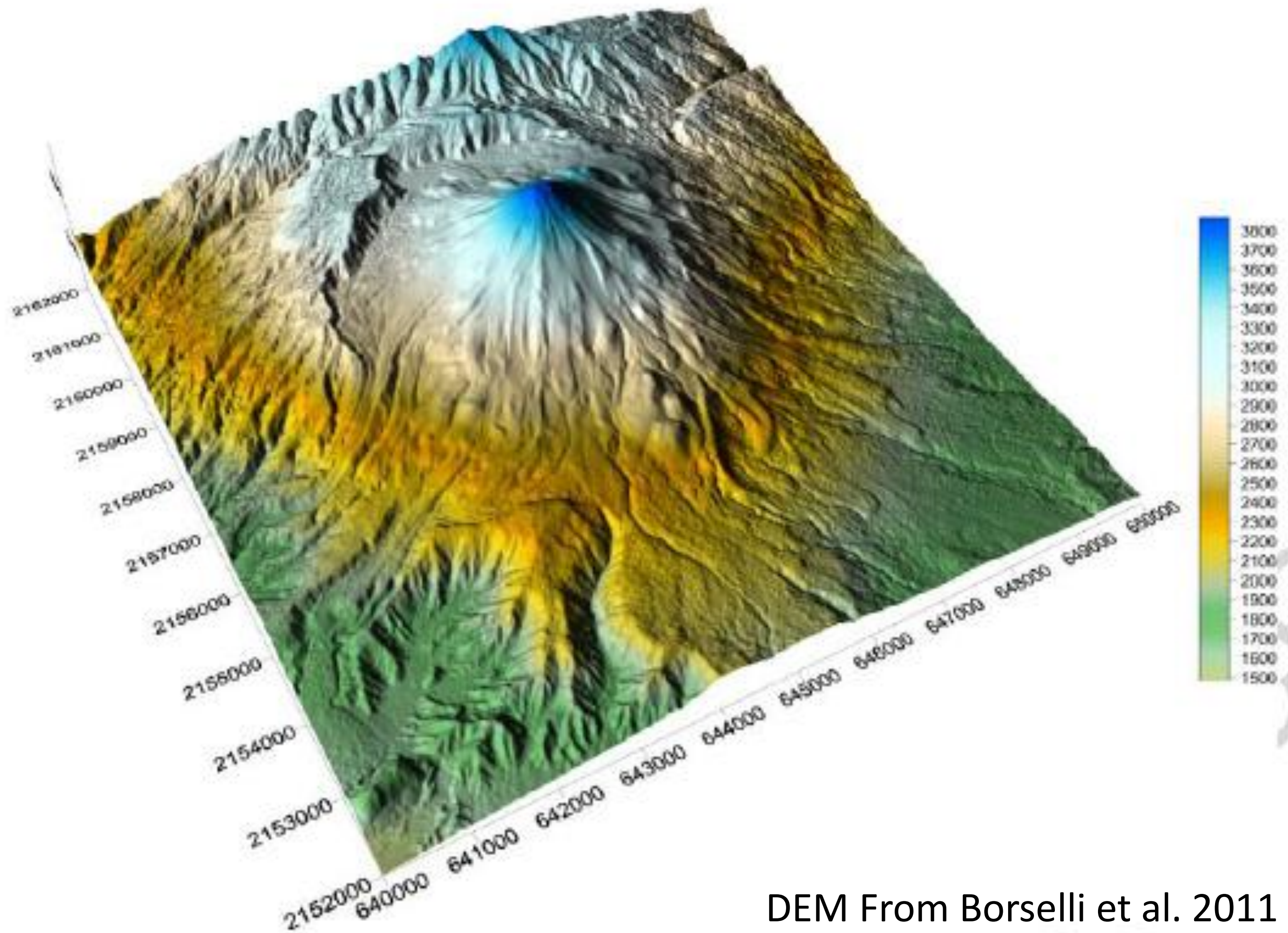


From, Saucedo et al. 2010

Volcan de Fuego, Colima (november2011)
W view

Volcan de fuego
Colima, MX
3900 m a.s.l.
Active volcano

Volcan de fuego
Colima, MX



DEM From Borselli et al. 2011

A intense geomorphological activity

Images from Capra et al. 2018

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Short communication

Preliminary report on the July 10–11, 2015 eruption at Volcán de Colima: Pyroclastic density currents with exceptional runouts and volume

L. Capra [a,*], J.L. Macías [b], A. Cortés [c], N. Dávila [d], R. Saucedo [e], S. Osorio-Ocampo [f], J.L. Arce [g], J.C. Gavilanes-Ruiz [h], P. Corona-Chávez [g], L. García-Sánchez [f], G. Sosa-Ceballos [b], R. Vázquez [i]

Nat. Hazards Earth Syst. Sci., 18, 781–794, 2018
https://doi.org/10.5194/nhess-18-781-2018

Natural Hazards and Earth System Sciences
Open Access
EGU

Hydrological control of large hurricane-induced lahars: evidence from rainfall-runoff modeling, seismic and video monitoring

Lucia Capra[1], Velio Coviello[1,2], Lorenzo Borselli[3], Víctor-Hugo Márquez-Ramírez[1], and Raul Arámbula-Mendoza[4]

[1]Centro de Geociencias, Universidad Nacional Autónoma de México (UNAM), Campus Juriquilla, Querétaro, Mexico
[2]Free University of Bozen-Bolzano, Facoltà di Scienze e Tecnologie, Bolzano, Italy
[3]Instituto de Geología, Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico
[4]Centro Universitario de Estudios e Investigaciones en Vulcanología (CUEIV), Universidad de Colima, Colima, Mexico

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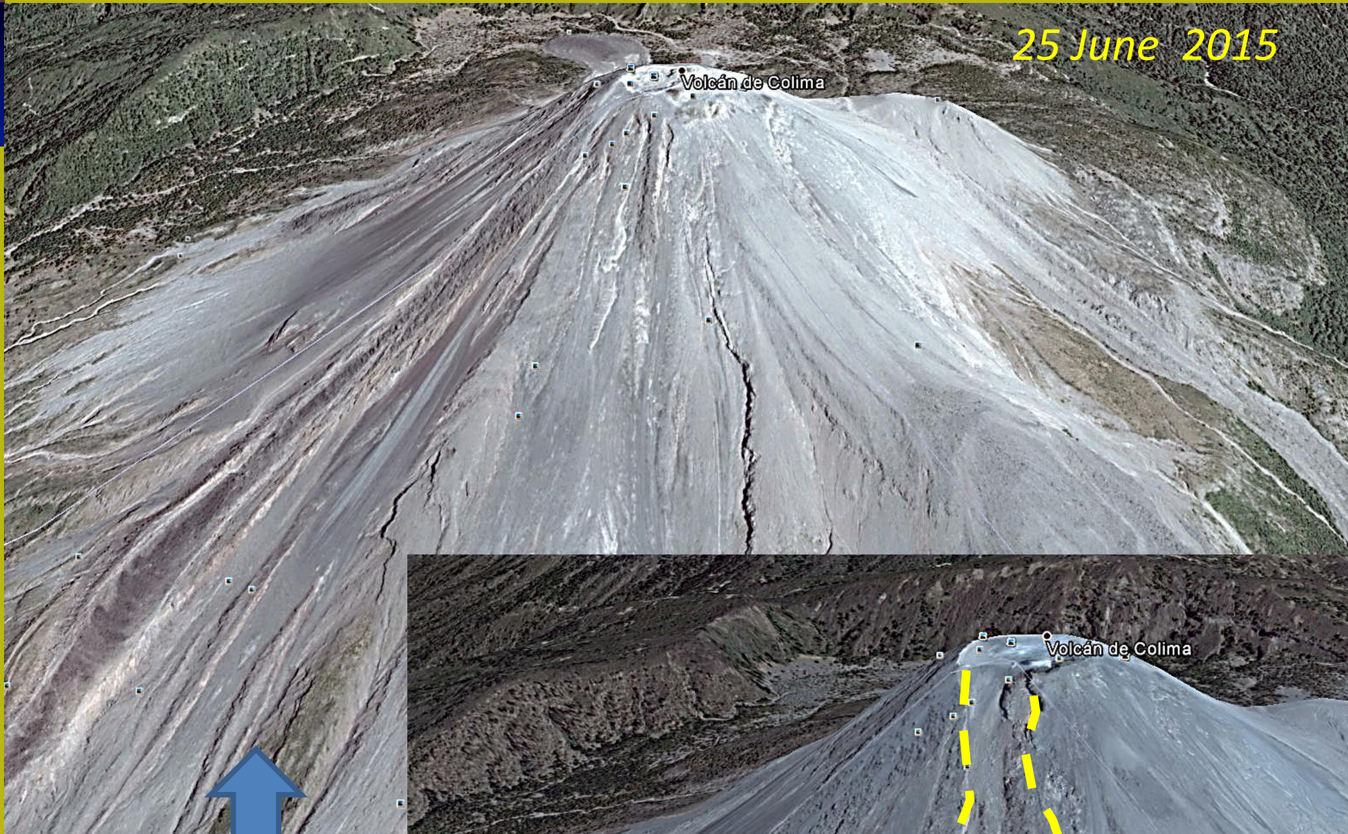
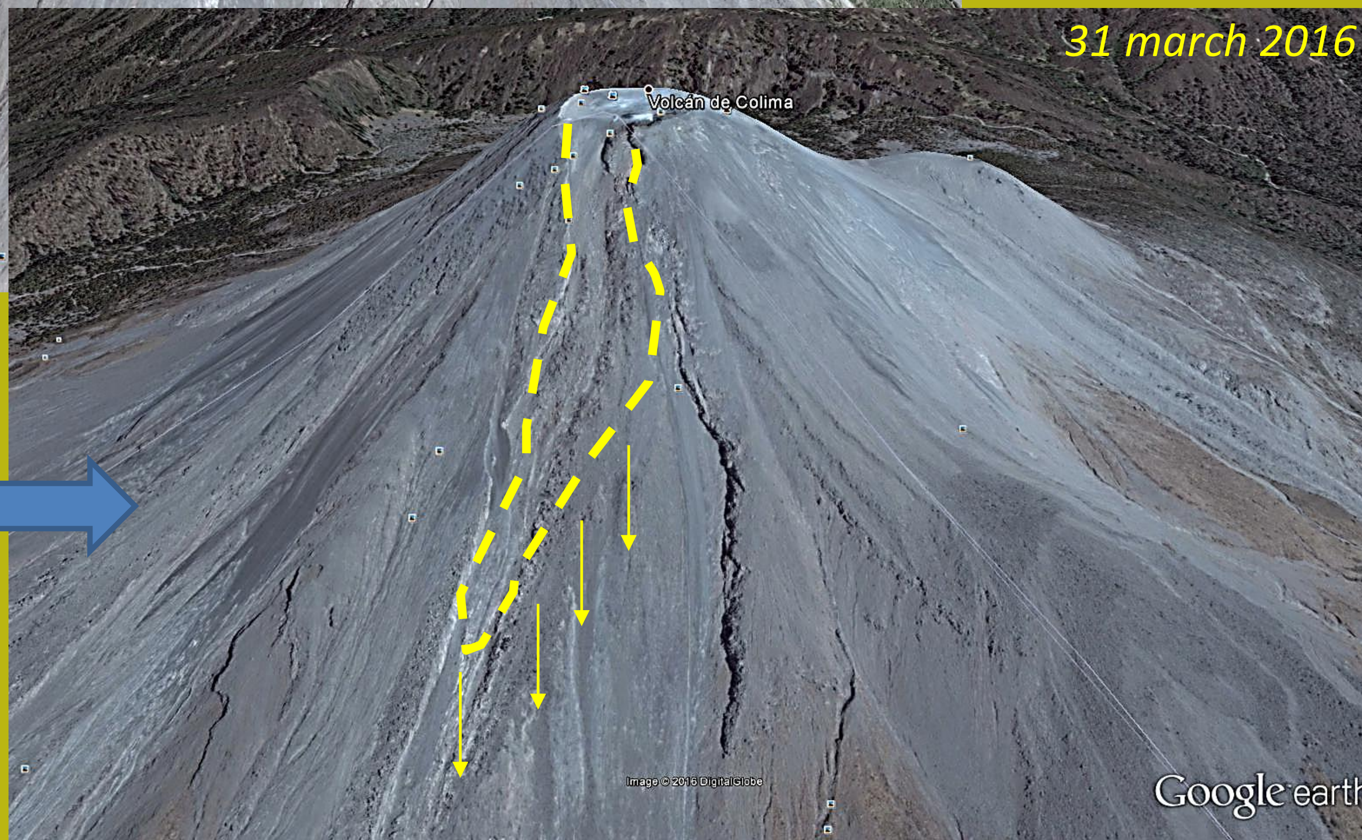


Colima volcán de Fuego upper edifice



Dome and side cráter partial collapse 10 july 2015, 10 km large runout and piroclastic flow, as block and ash flow SW wiew (images by Google Earth)

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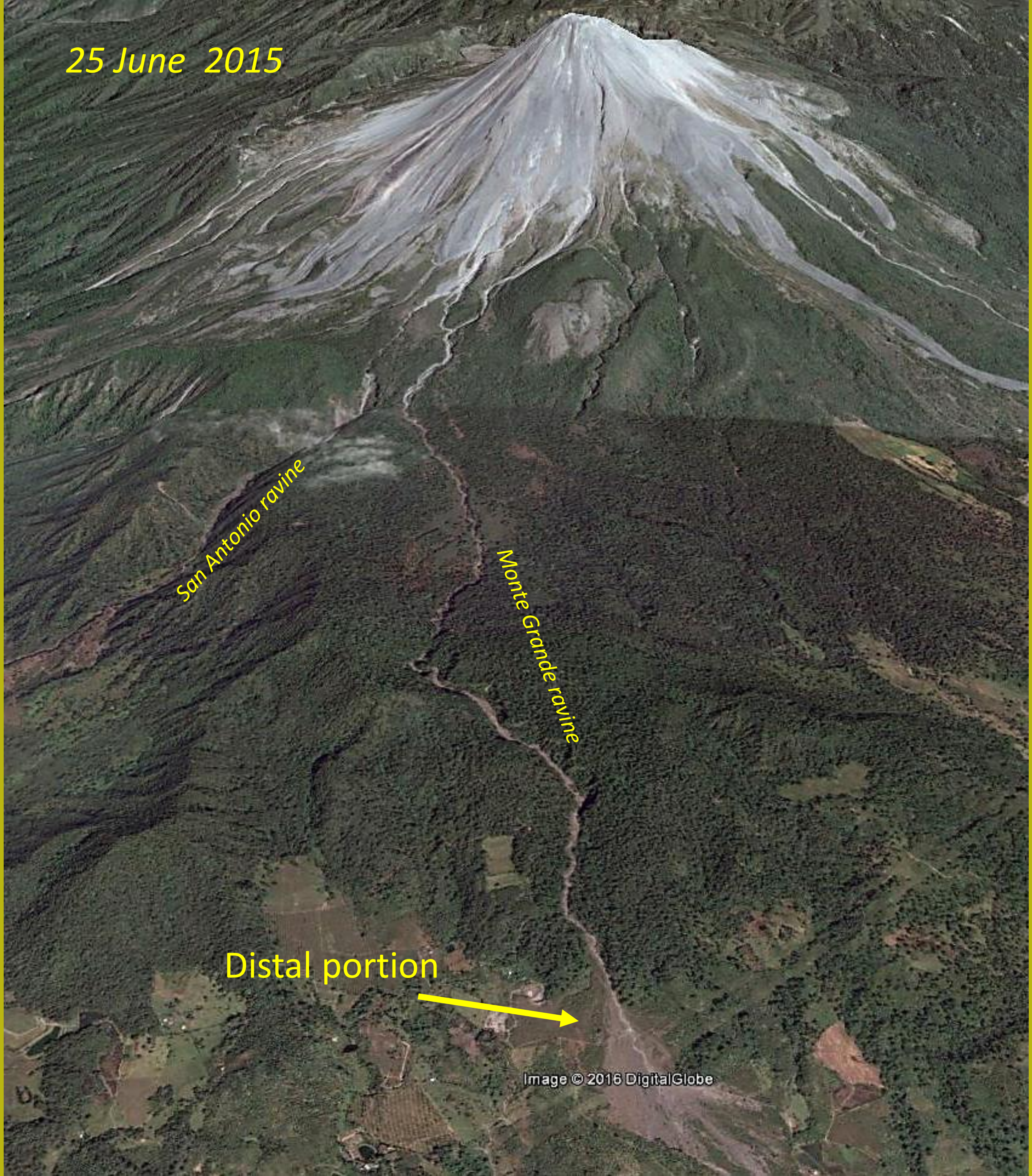
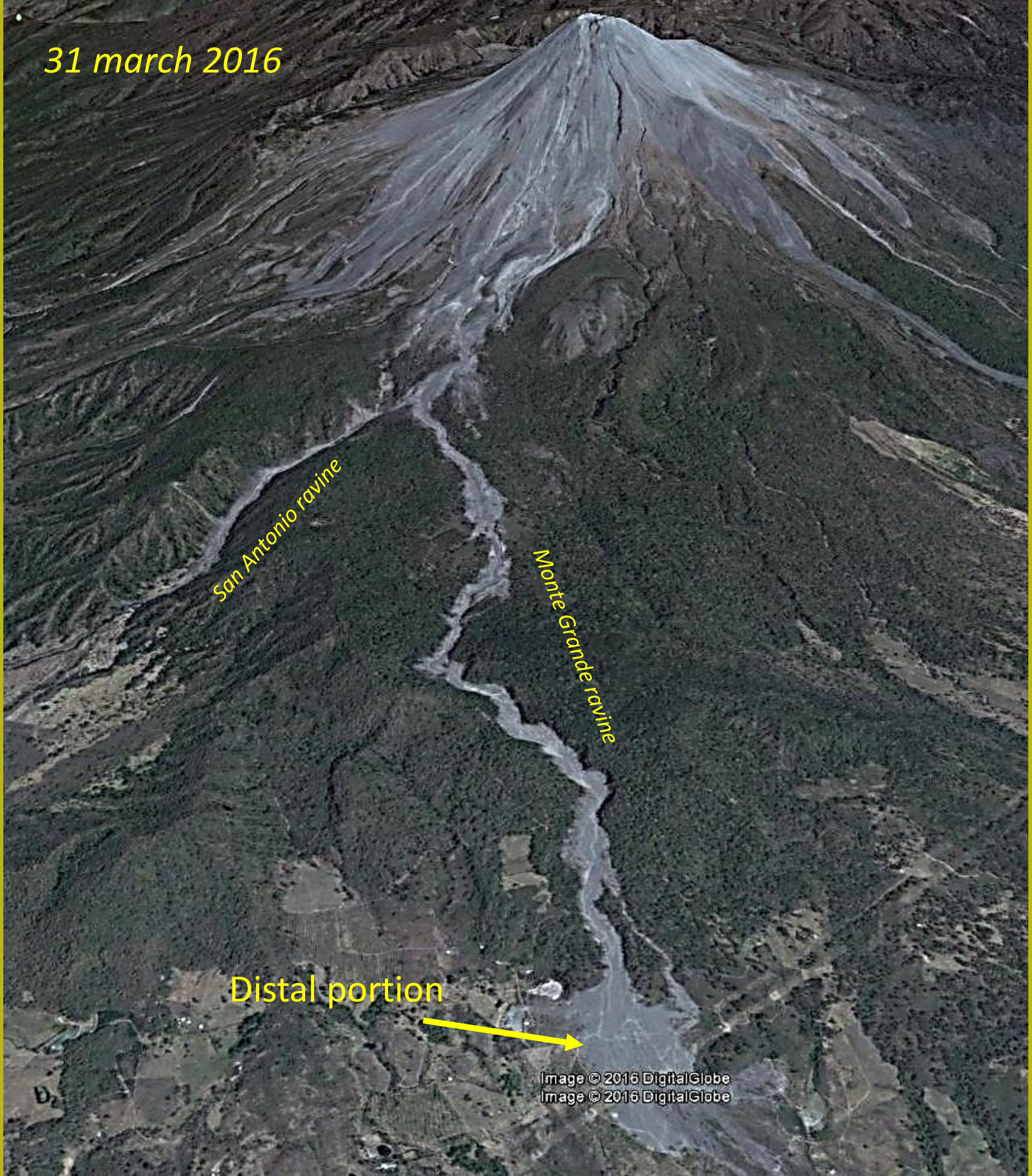
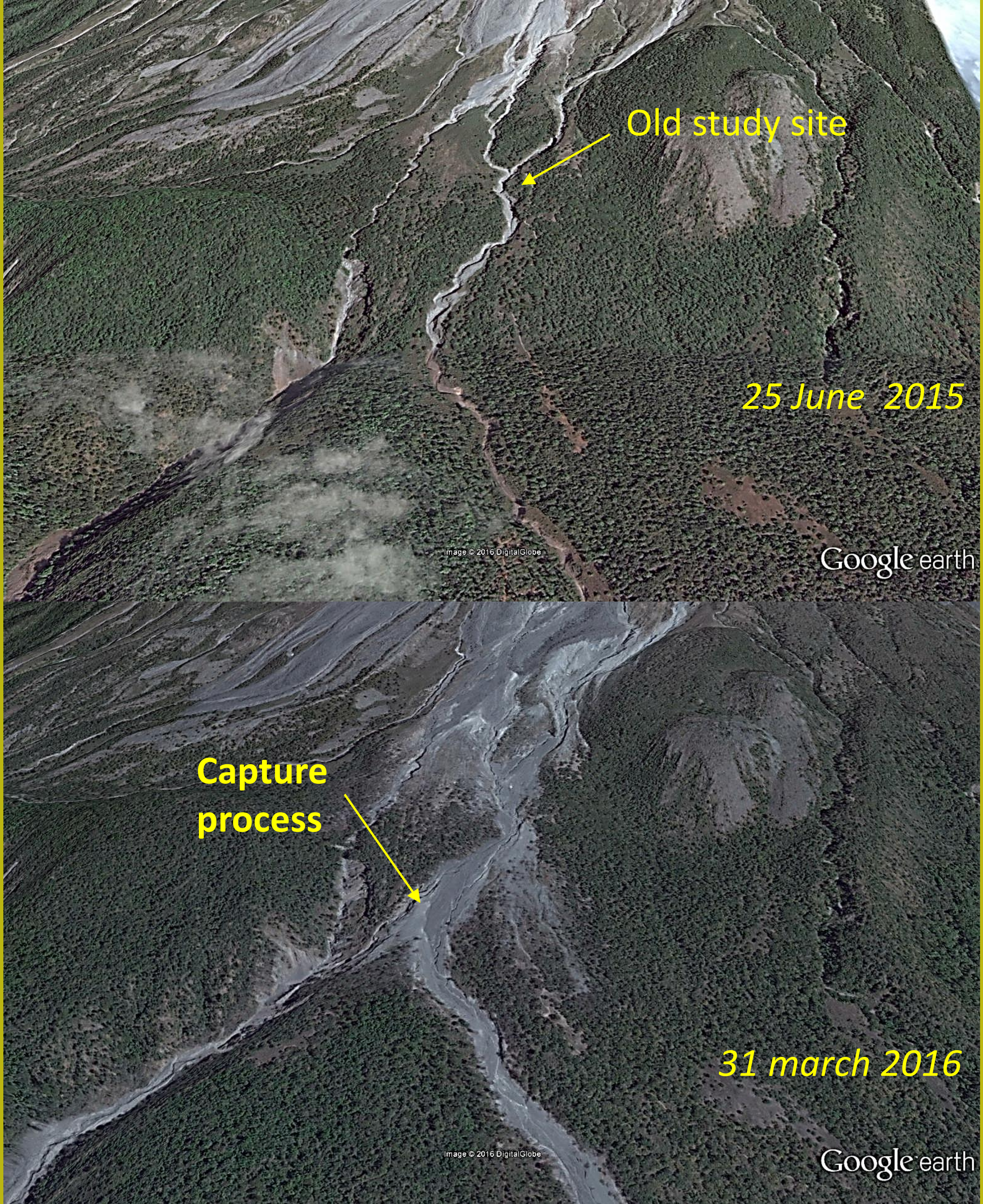
Colima volcán de Fuego Full SW wiew (images by Google Earth)



Colima volcán de Fuego Full SW wiew (images by Google Earth)



Colima volcán de Fuego Median portion Montegrande And san Antonio Ravine (images by Google Earth)



Workshop - Gully erosion inventory and proposal for a modelling activity -Joint Research Centre, Ispra, Italy, 19 – 20 March 2018

In this type of geomorphological environment we developed in the framework of CONACYT:Proyecto Ciencia Basica CB-2012/184060 a study of connectivity in active volcanic areas.

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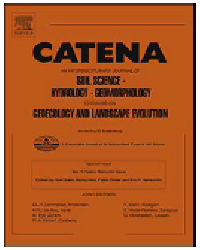


Flow connectivity in active volcanic areas: Use of index of connectivity in the assessment of lateral flow contribution to main streams

A.J. Ortíz-Rodríguez[a,b,*], L. Borselli[b], D. Sarocchi[b,c]

[a] Doctorado Institucional en Ingeniería y Ciencia de Materiales, Universidad Autónoma de San Luis Potosí, Sierra Leona No. 530 Col. Lomas 2ª, Sección Planta Baja, C.P. 78210 San Luis Potosí, S.L.P., Mexico

[b] Instituto de Geología, Universidad Autónoma de San Luis Potosí, Av. Manuel Nava No. 5. Zona Universitaria, C.P. 78240 San Luis Potosí, S.L.P., Mexico

[c] Department of Geosciences, Boise State University, 1910 University Drive, Boise, ID 83725-1535, United States

Algorithm for calcultating IC values In complex morphology and land use as in volcanic áreas.. Ortiz- Rodrigues et al. (2017) Integrating methods of Borselli et al. (2008) and Cavalli et al. (2013)

A.J. Ortíz-Rodríguez et al. Catena 157 (2017) 90–111

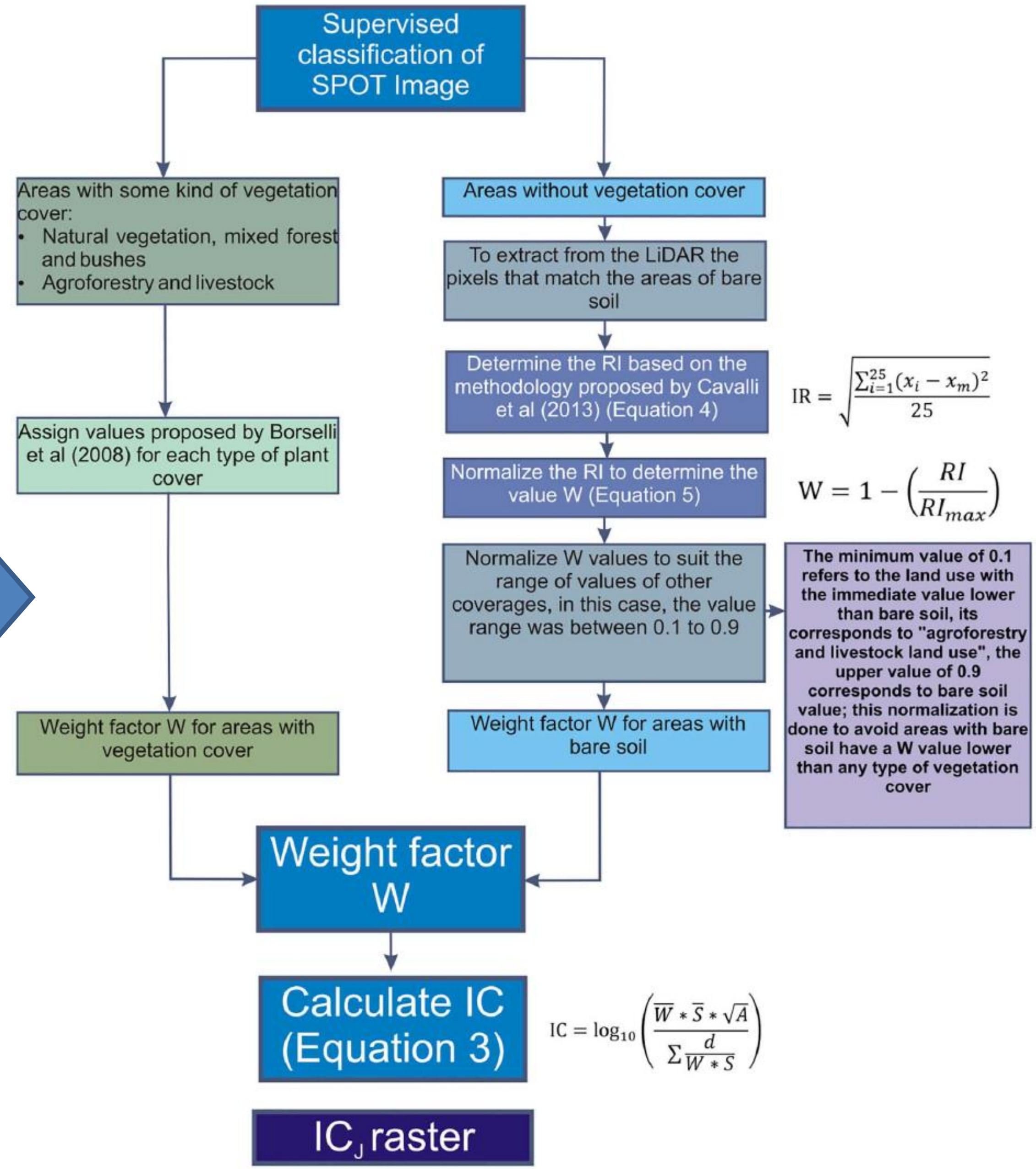


Fig. 8. Flowchart for calculating the weight factor W.

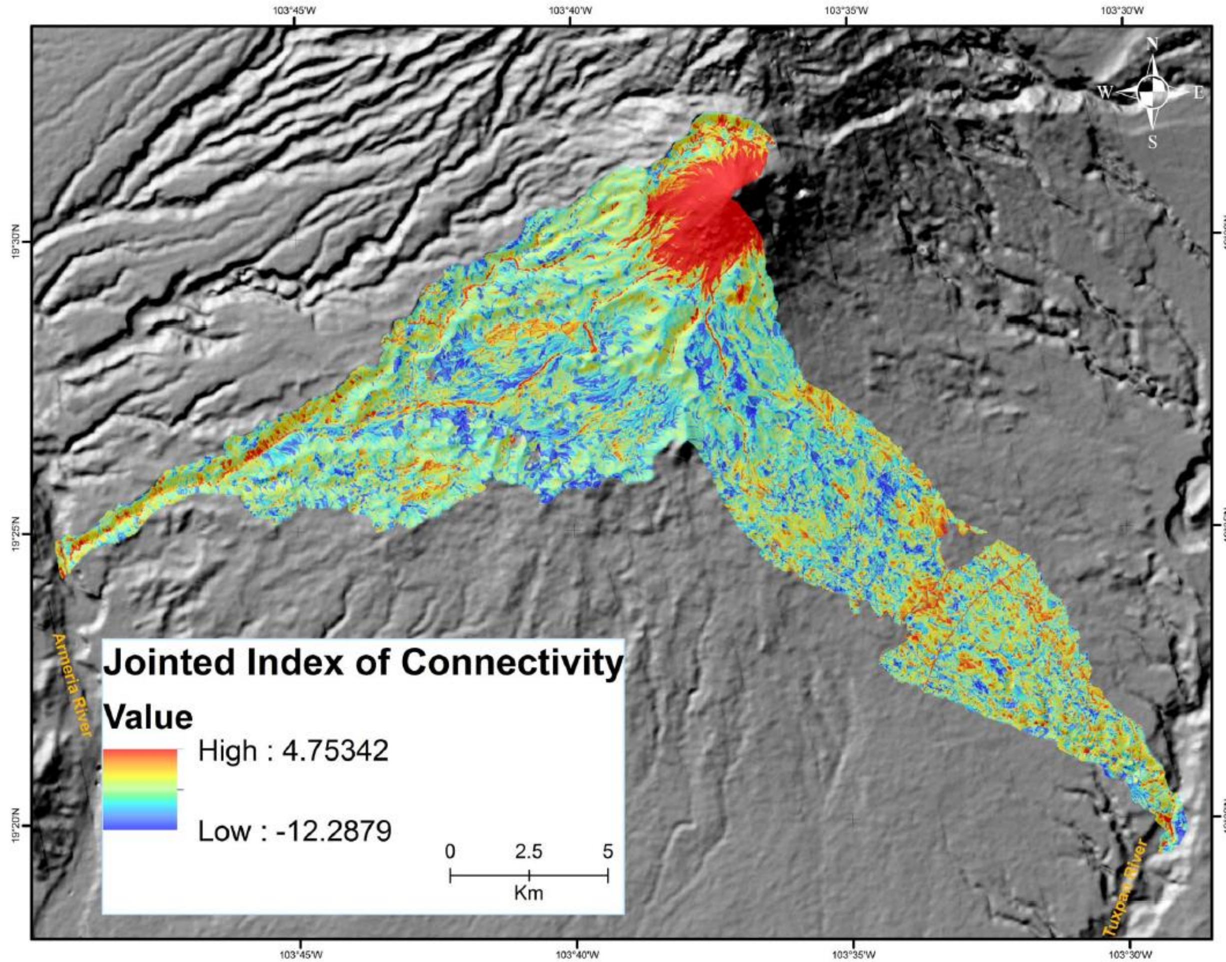
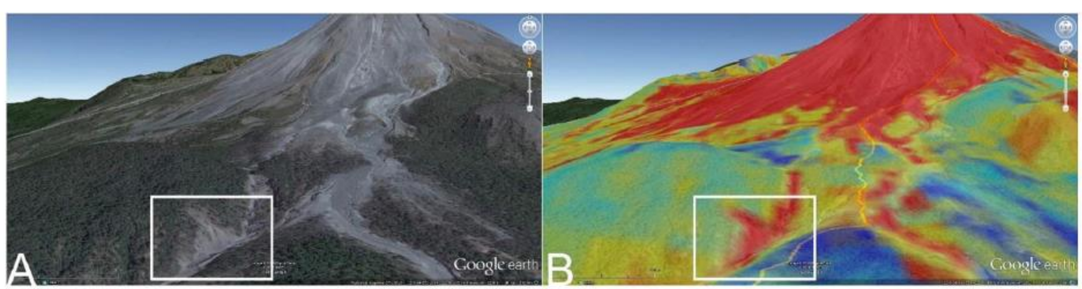


Fig. 11. Spatial distribution of joint index of connectivity (IC_J).



Source images: DigitalGlobe and NASA (2016) and coverage of IC_J developed in this research

Fig. 12. Example of lateral collapse and IC_J.

Algorithm for calcultating LHEI index values
In complex morphology and land use
as in volcanic áreas..
Ortiz- Rodrigues et al. (2017)

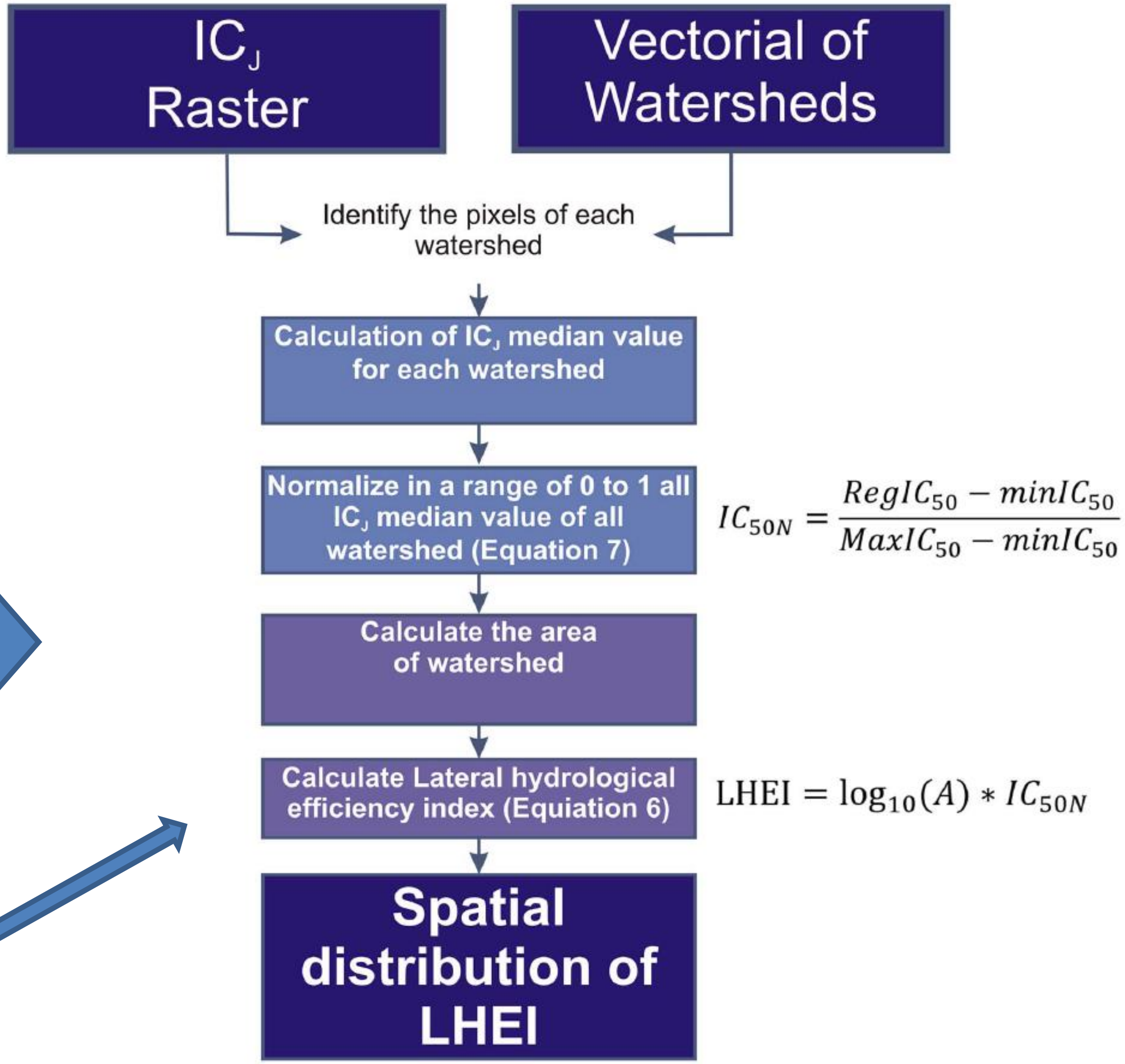


Fig. 10. Flowchart for calculating LHEI.

Lateral Hydrological efficeincy index (LHEI)

With respect to a median value of IC_j in a watershed, LHEI represents local statistics at sub watershed level and it allows a classification of different level of connectivity efficiency of the sub-watersheds with respect to mainstream.

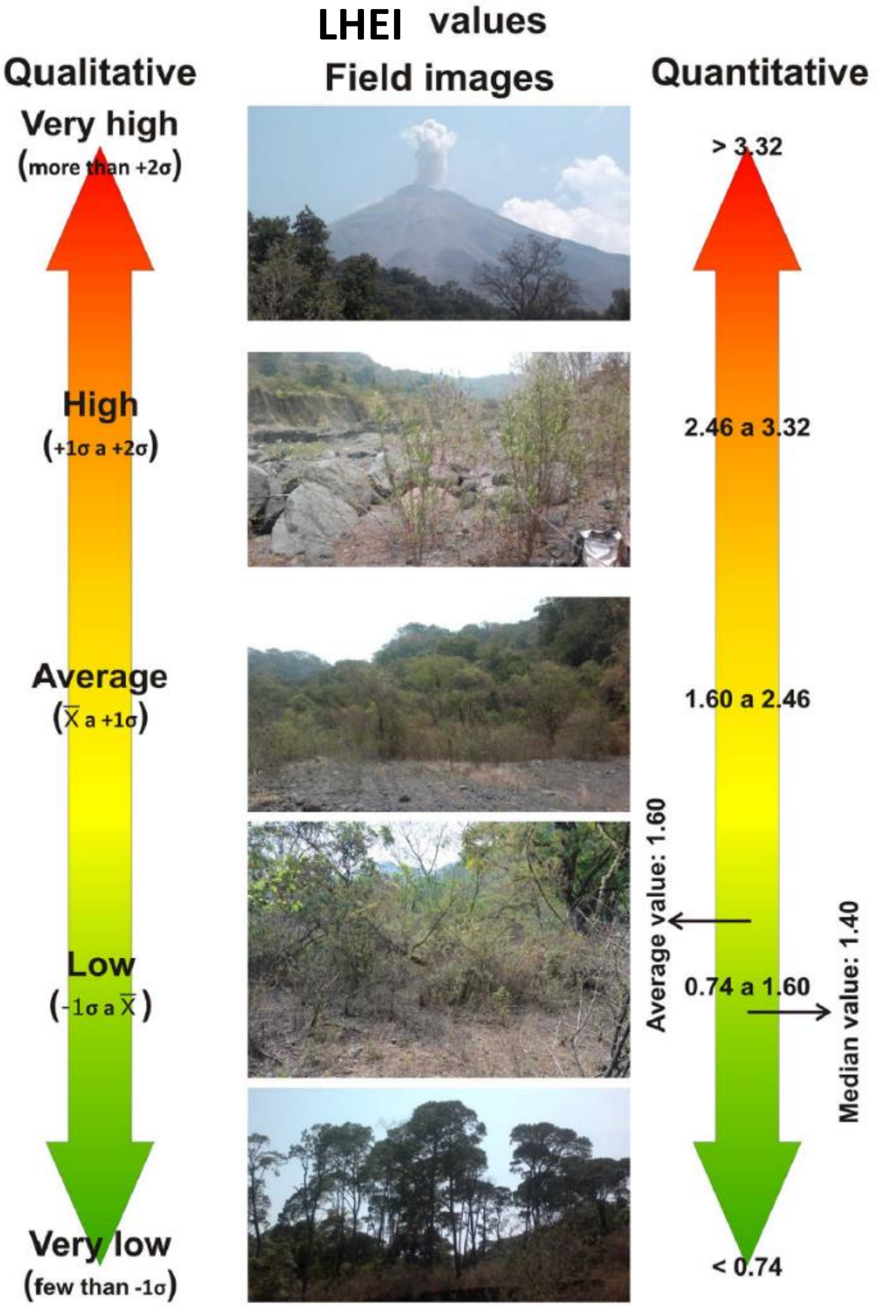


Fig. 17. Graphic scale of values and classes of LHEI values.

Main conclusion of this projects:

1) **Adjustments IC method proposed by Borselli et al. (2008)** for the analysis of connectivity in order to include details about areas devoid of vegetation and the characteristics of **various groundcovers enable better detail in characterizing areas that have highly dynamic geomorphology and therefore greater complexity.**

2) This modification enables the use of an index, the **LHEI**, which easily assesses hydrological efficiency at the watershed level and **identifies primary areas that provide sediment to streams**, material that is capable of being re-mobilized and assimilated in epiclastic processes that occur as in active volcanic areas.

3) The **application of the LHEI constitutes a quick way to recognize areas of greater efficiency outside the main source of material that makes it possible to identify areas where action can be taken that reduces connectivity and therefore risk** to populations and infrastructure.

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Suggested points for general discussion:

- **Possible improvements of gully thresholds models.**
- **Possibility to adopt IC_j , and/or integrating it in Gully threshold models ..**
- **Possibility IC_j variant in order to take in account within storm dynamic connectivity (*work now in progress.*.)**
- **Can improved connectivity maps help existing Gully erosion model (so non only gully threshold ones) ?**

This presentation will be available at *http:// www.lorenzo-borselli.eu*


North Appenine
Italy - spring 2003
Photo by L.B.
Gracias por su atención !!!
Many thanks for Your attention !!!