“Valutazione del rischio idrogeologico in Messico: metodologie e software tools”

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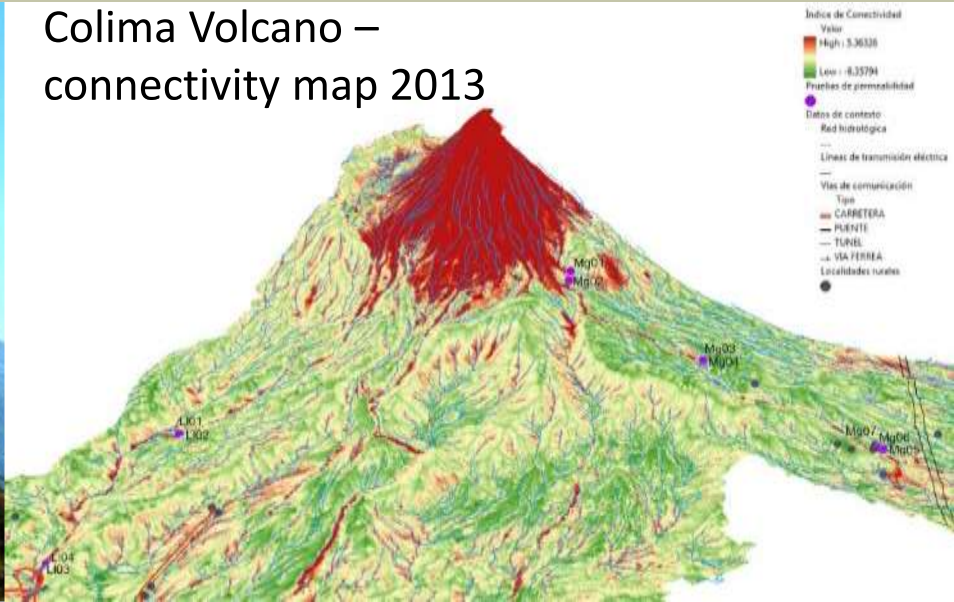
Colima Volcano - 2011

Colima Volcano – connectivity map 2013

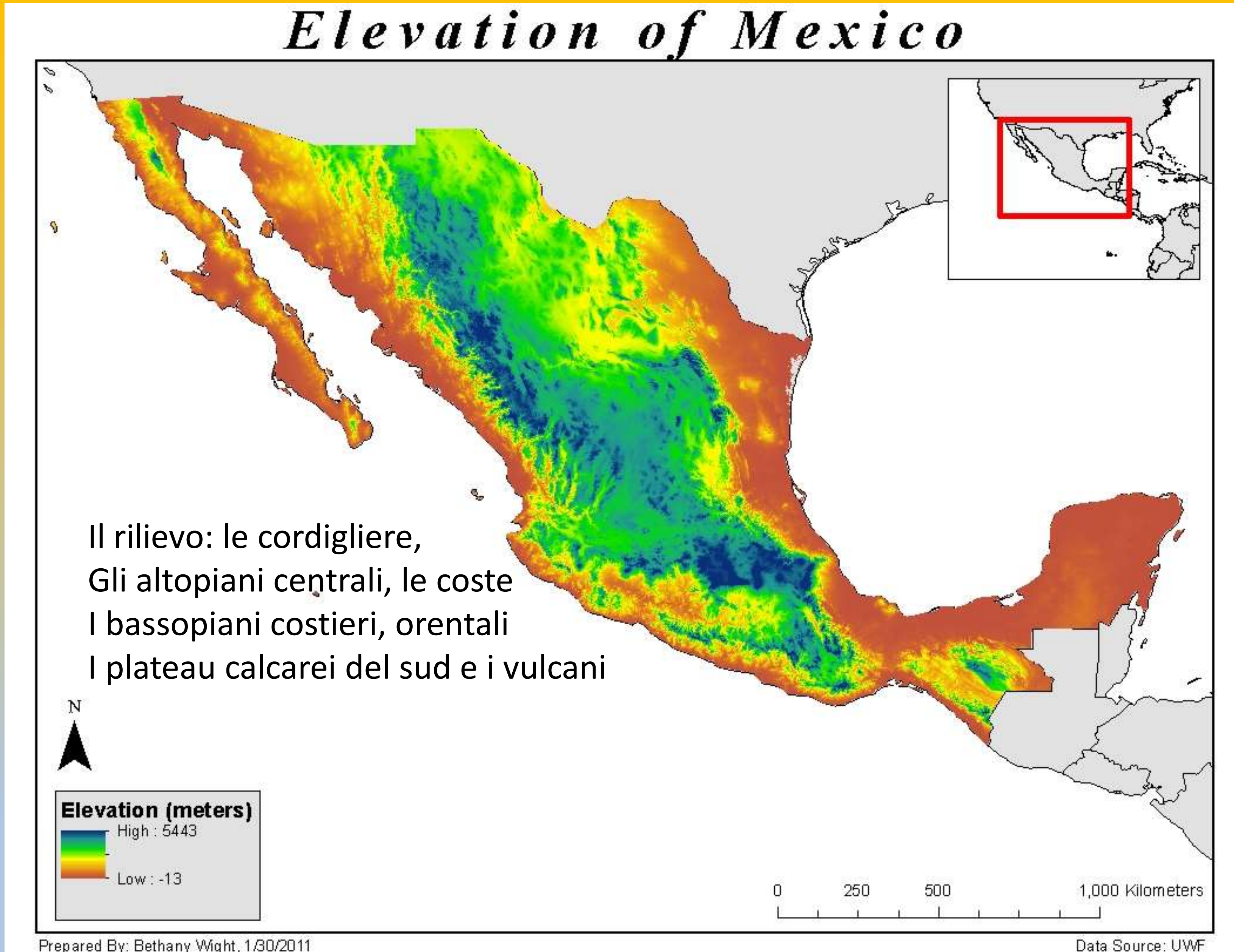


Highlights:

- **Una panoramica ragionata delle peculiari componenti del rischio idrogeologico in Messico**
- **Attivita' e metodologie di ricerca passate, presenti e future In Messico**
- **Strumenti software gia sviluppati e operativi.. e quelli in fase di sviluppo.**

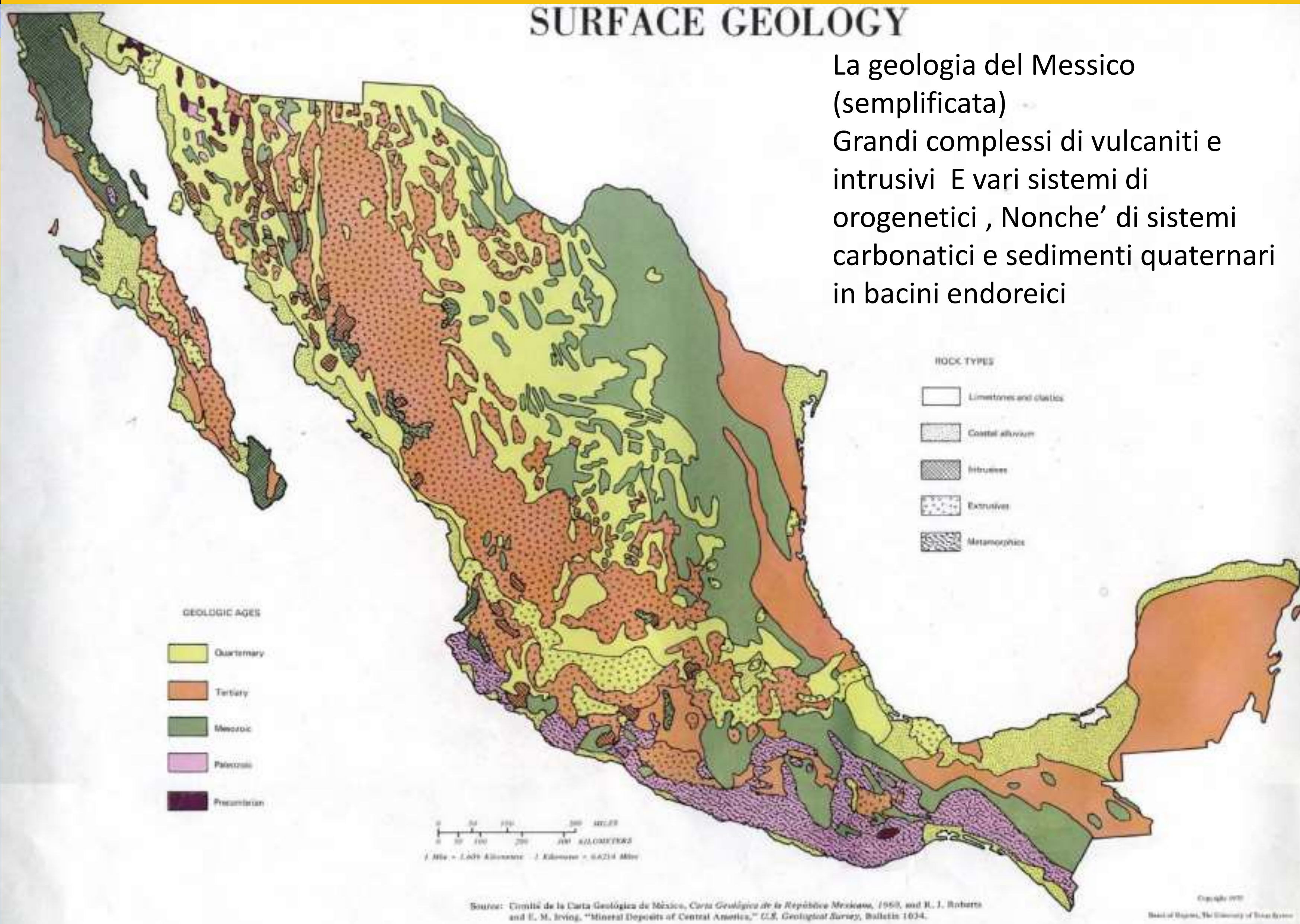
Il Messico. Una superficie totale di quasi 2 milioni di Km^2 (6 volte l'Italia)
Con circa 120 milioni di abitanti (il doppio della popolazione italiana).

Un Microcosmo' di molteplici Condizioni Ambientali, Fisiografiche, Climatiche, vegetazionali, geologiche e Socio-economiche….



Il rilievo: le cordigliere,
Gli altopiani centrali, le coste
I bassopiani costieri, orentali
I plateau calcarei del sud e i vulcani

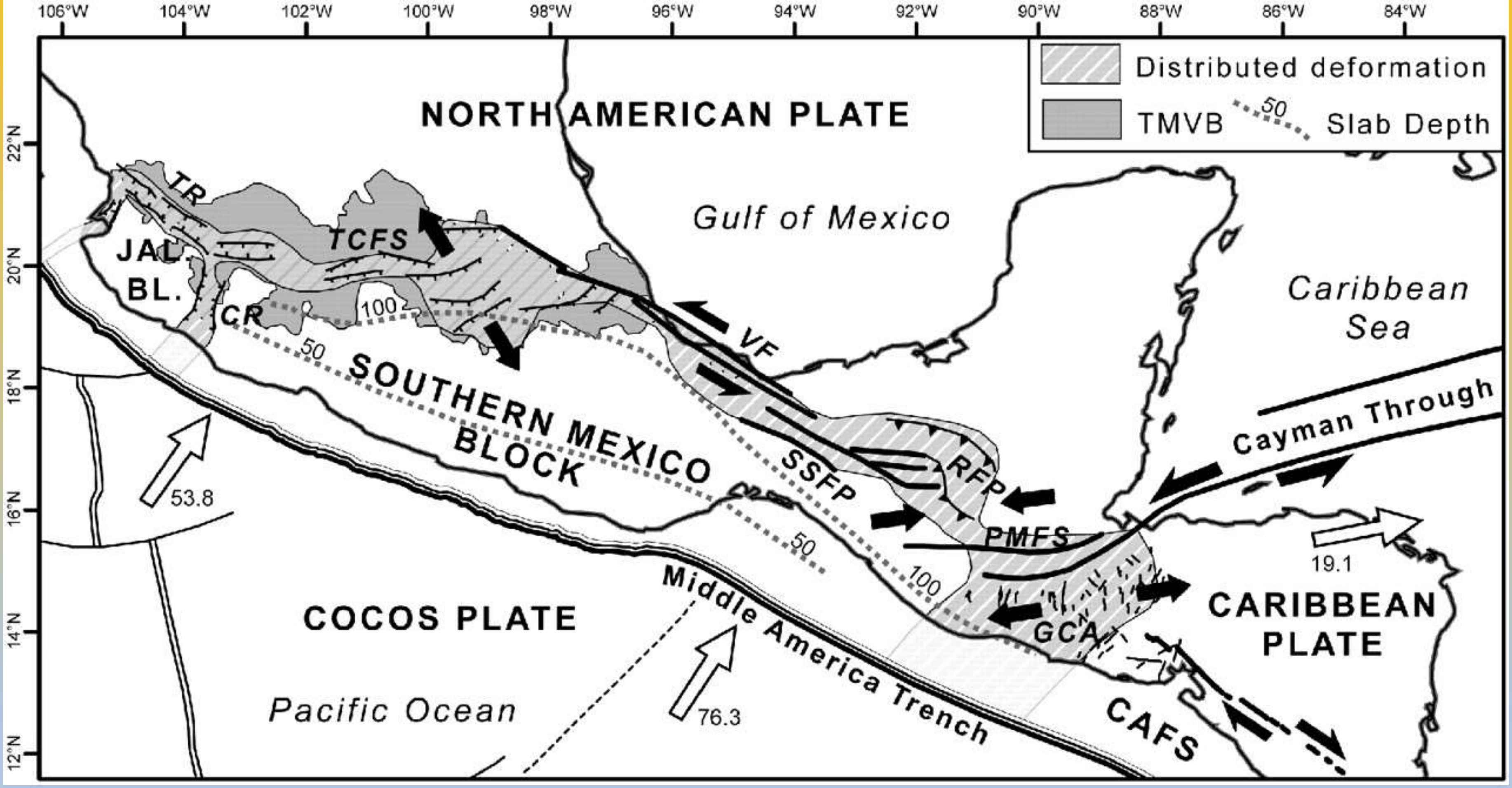
I climi del Messico
Da climi di tipo
umido tropicale pluviale
A semiarido a desertico



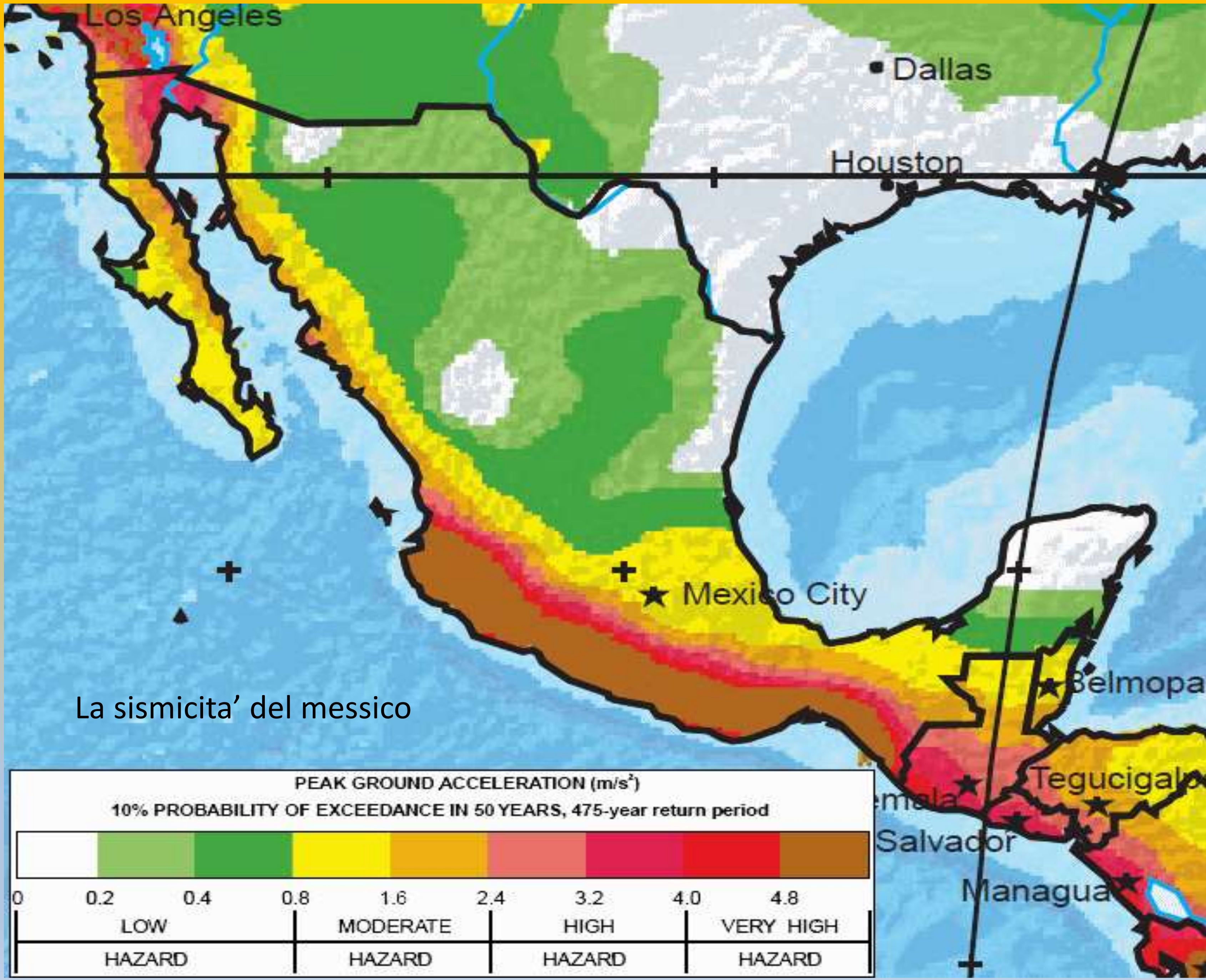
La geologia del Messico (semplificata)

Grandi complessi di vulcaniti e intrusivi E vari sistemi di orogenetici , Nonche' di sistemi carbonatici e sedimenti quaternari in bacini endoreici

L’assetto geodinamico attuale e’ determinato dalla subduzione della zolla di cocos e dal sovrascorrimento con la zolla caraibica e dall’alaucogeno pesso il blocco di Jalisco



La sismicita' del messico



La trans-mexican volcanic belt

(le frecce gialle indicano i vulcani al momento attivi)

La pericolosita’ idrogeologica: cosa, dove, come e quando

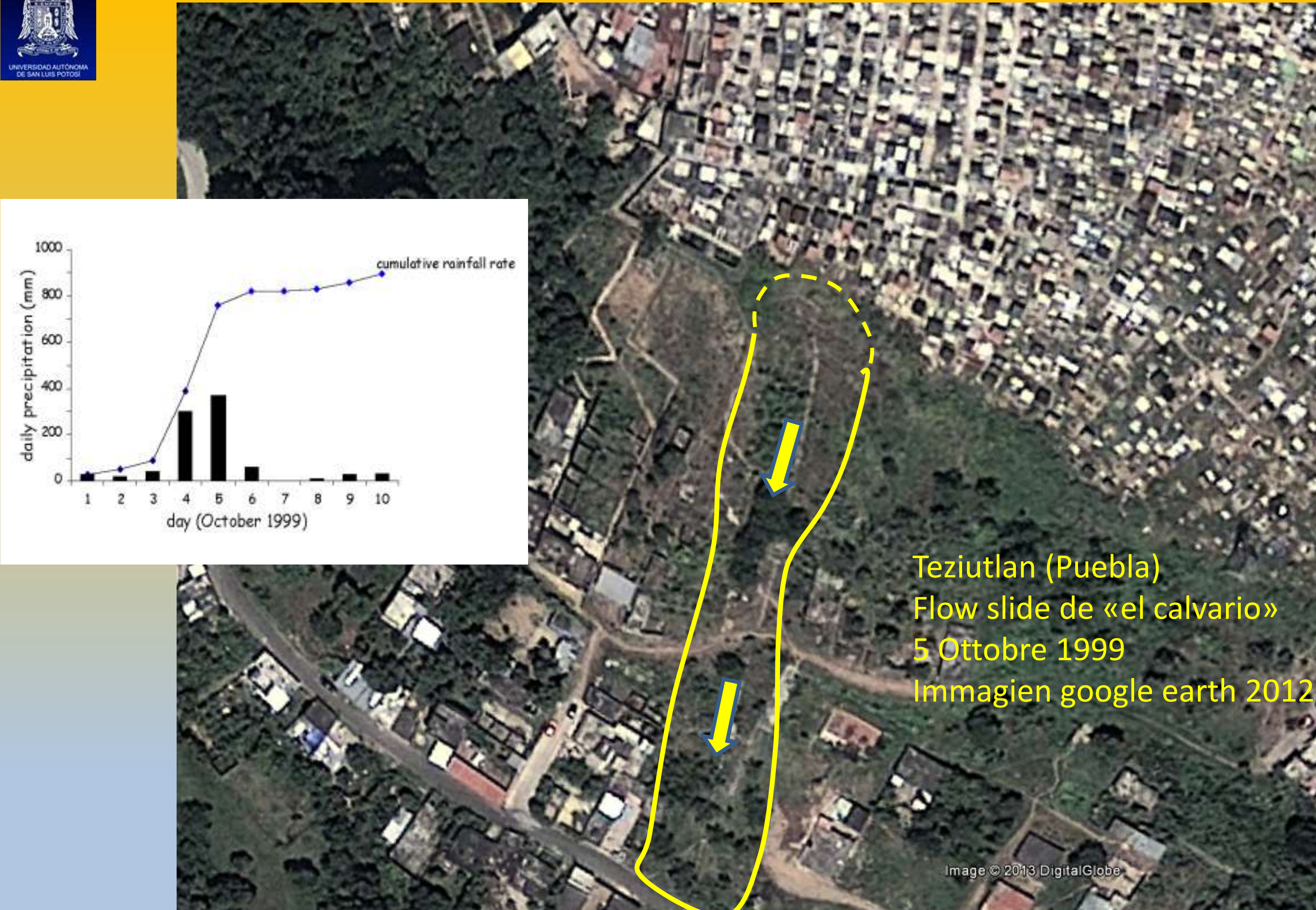
(By L. B. 2013)

Attività di ricerca attuali
In Messico
Volcan de Fuego Colima
San lusi potosi’

Le attivita’ di ricerca

Attività di ricerca passate
In Messico.
Sierra Northe de Puebla
Sierra del Chiapas
Volcan de Fuego Colima
Graben de acambay

Periodo 2002.-2004
Come responsabile di
Progetto bilaterale
CNR-CONACYT
Italia-messico

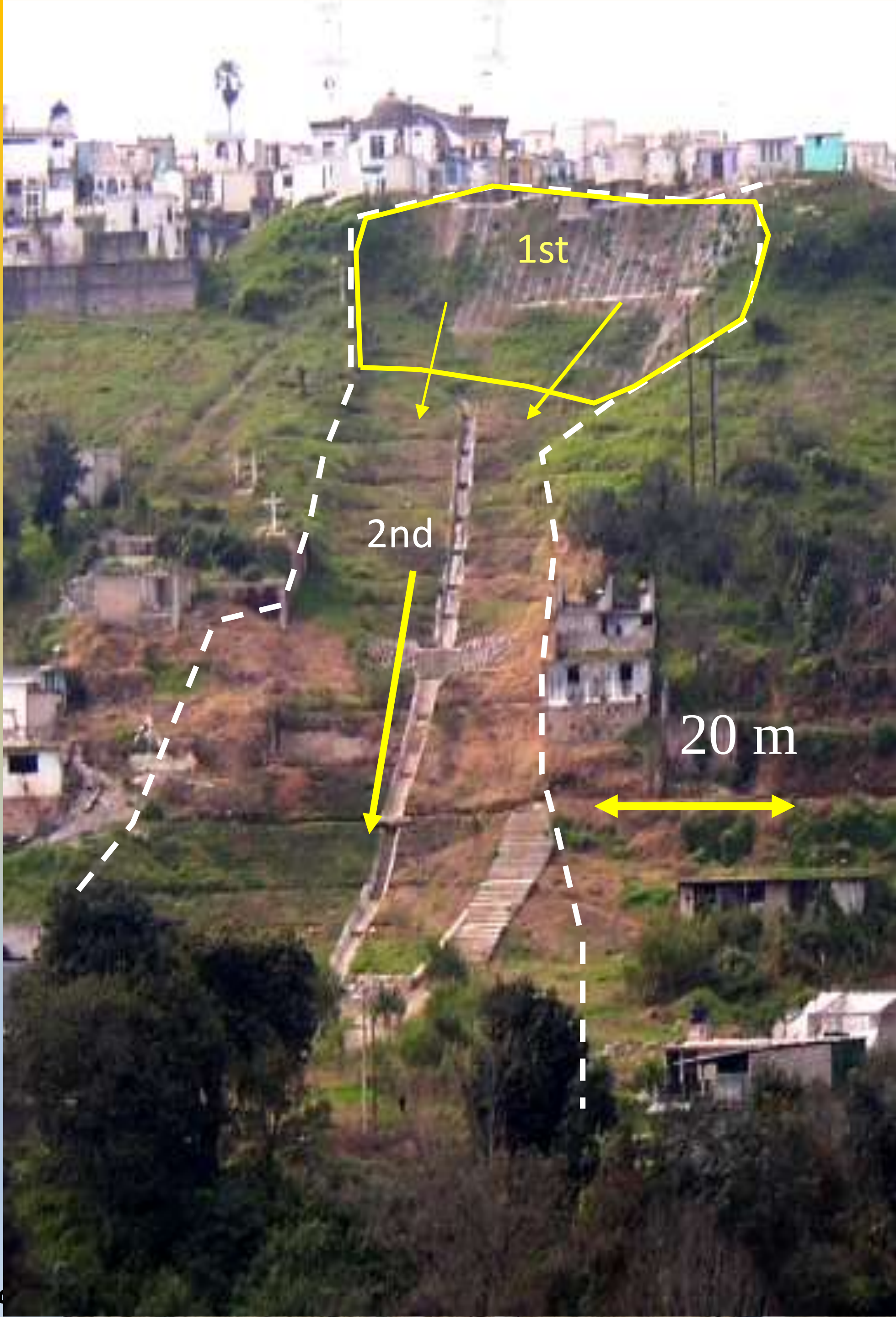

cumulative rainfall rate
daily precipitation (mm)
1000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
day (October 1999)
Teziutlan (Puebla)
Flow slide de «el calvario»
5 Ottobre 1999
Immagien google earth 2012
Image © 2013 DigitalGlobe

Teziutlan cemetery:
Reconstruction of the event by
Information from direct witnesses.
Classification of the
Landslide as a *FLOW SLIDE*.
10 A.M. of 5 oct. 1999

Two phases:
1st: rotational landslide at the top of the slope.
Modest soil mass formed by soil and resulting material due to tombs excavation and demolitions works in the cemetery (old tombs).
The landslide accumulate temporarily along the slope and surcharge it.

2nd : flow of a larger soil mass + small houses.
High speed and a run out of approx 100 m .
Witness report a sort of nebulized water sprayed out of the soil during the event. High velocity class 6-7 -following IUGS(1995) criteria.

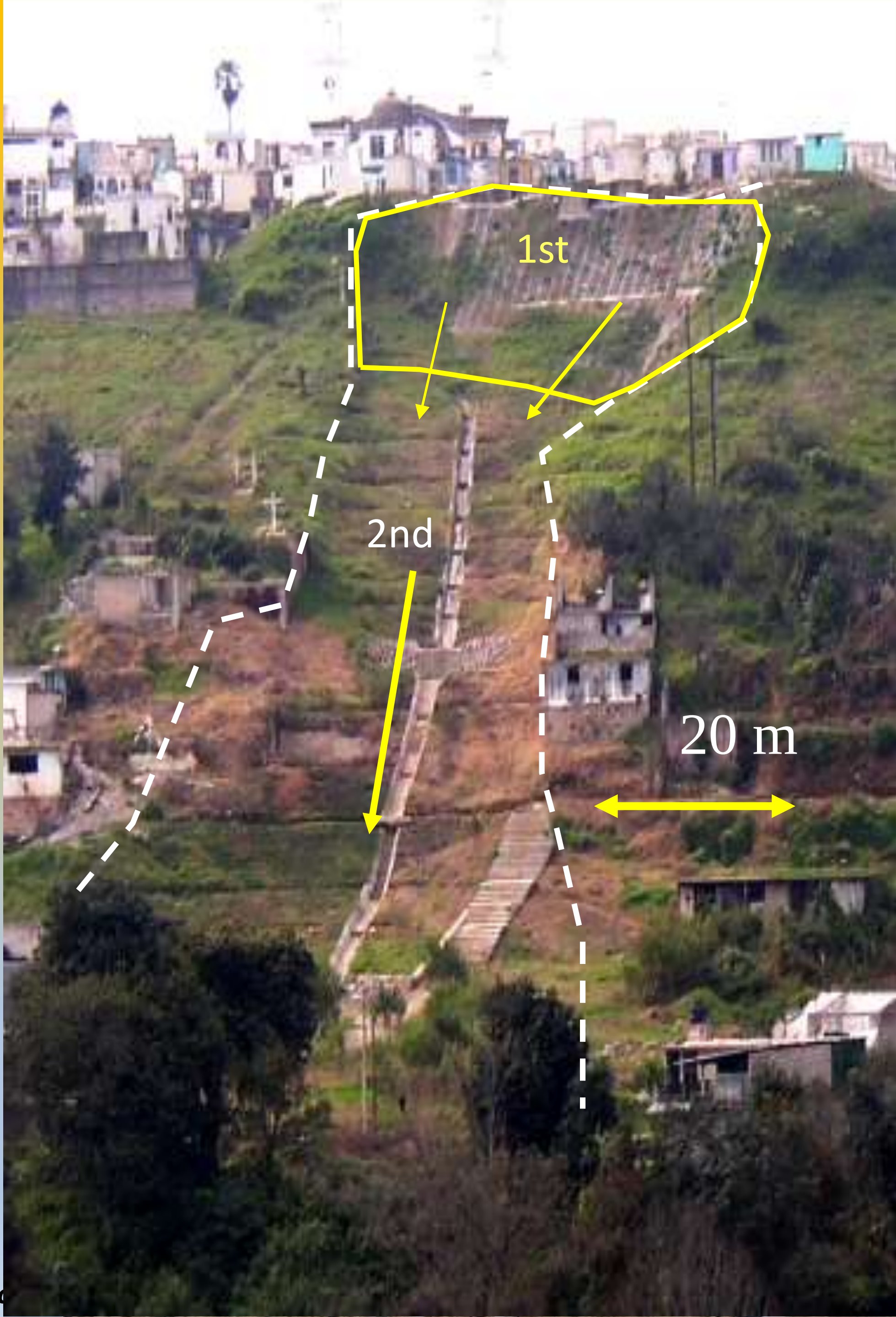
140 vittime…



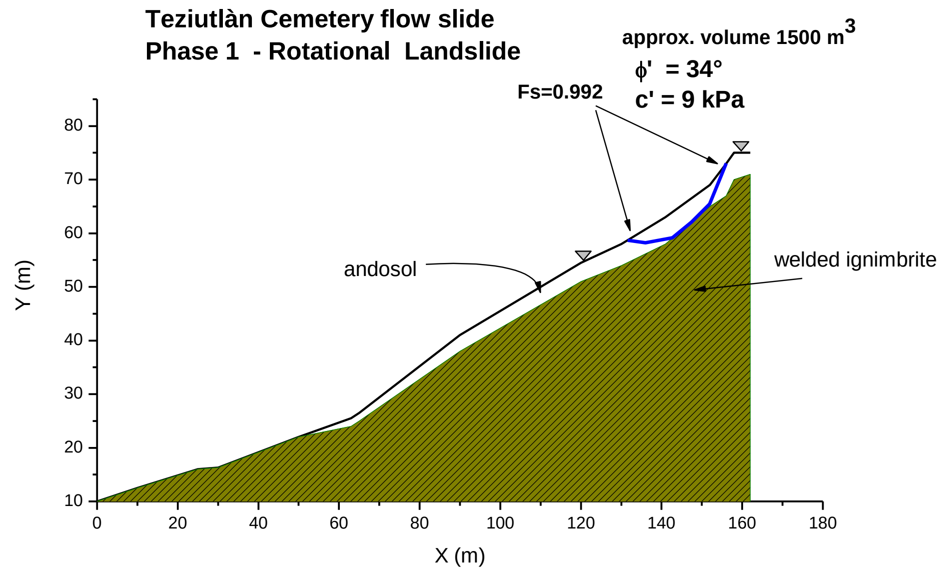
Back analysis of Landslides in Teziutlan Area

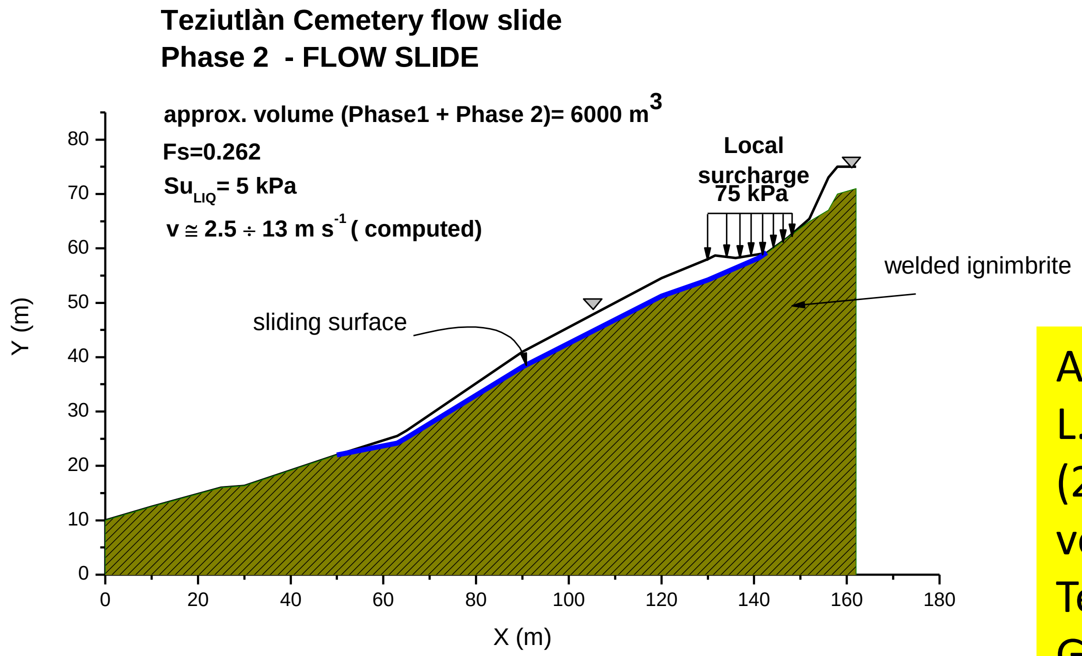
Data and assumptions for back analysis in andosols and pyroclastic deposits:

- Hydrologic condition → Fully saturated profiles – based on simulations of Capra et al. (2003).
- Profiles → Horizons B, B/C and 2Bb 2B/Cb of the andosols are poor in Clay fraction (less than 2% finer than 2 μm) and fines (less than 9% finer than 20 μm). BD density variable between 10 and 17 kN/m^3, depending from the degree of leaching and profile evolution (e.g. Formation of halloysite)
- LL,LP,IP →Medium to High plastic and liquid limits of the soil at sliding surfaces (e.g. LL up to 90%) with respect to low % of clay and fines
- Percentage of amorphous material less then 10 %. Tixotropic but Sometime absent because fully transformed in halloysite.
- High angle of internal friction compared to the high Attenberg limits. This is the typical behaviour of the andosols (Rao, 1995,1996)
- Relevant role of the effective cohesion (and apparent cohesion for unsaturated condition) for the stability of fully saturated steep slopes with low effective unit weight.



Kinematic analysis
Assessment of Su_{LIQ} based on two Simplified models:
4-10 kPa(Ishihara 1990)
1-3.5 Kpa(Olson & Stark 2002)
Assumed in the analysis:<u>5 kPa</u>
$\Sigma F=ma=mv/\Delta t$
acceleration → $a=3\ (m\ s^{-2})$

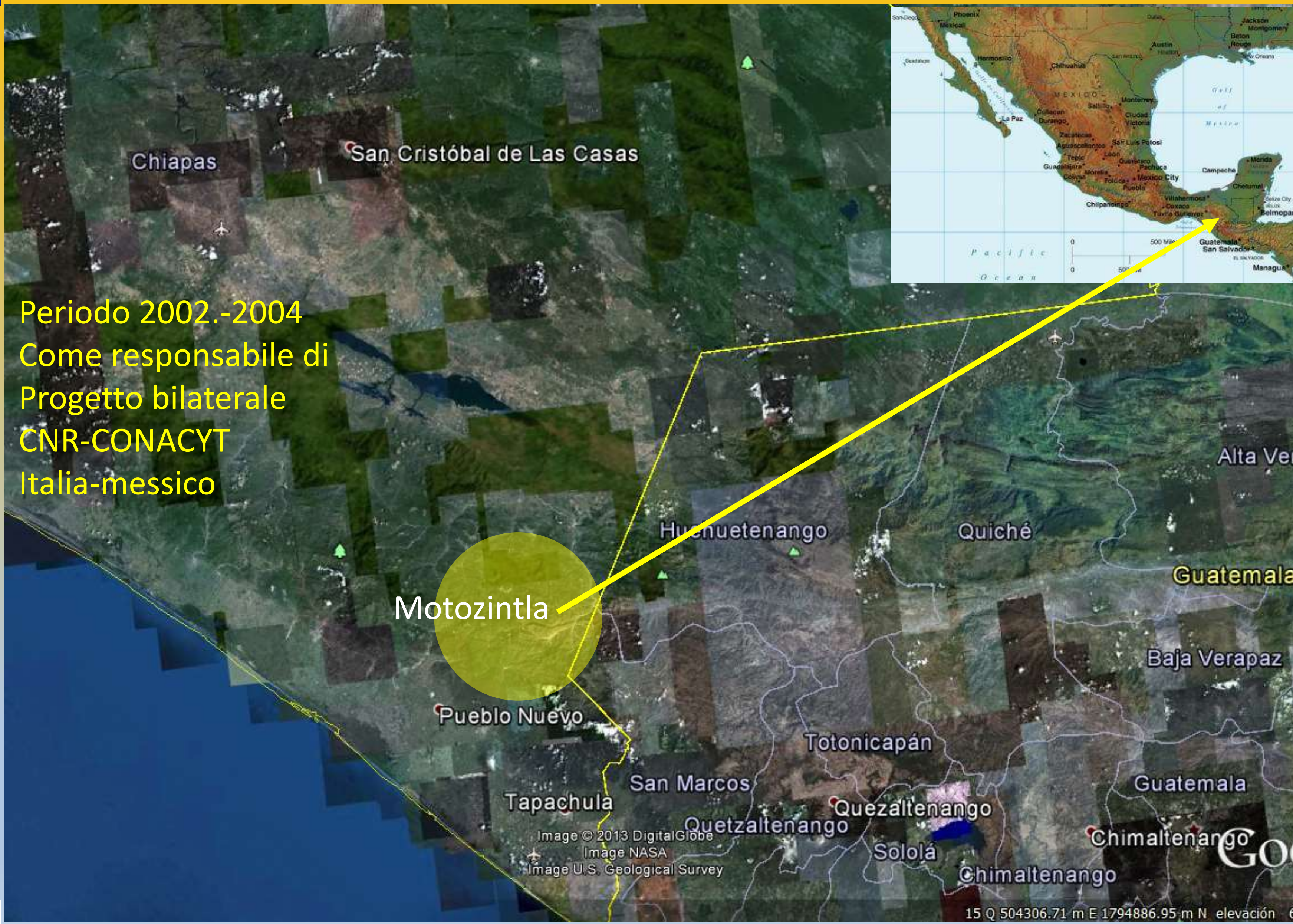


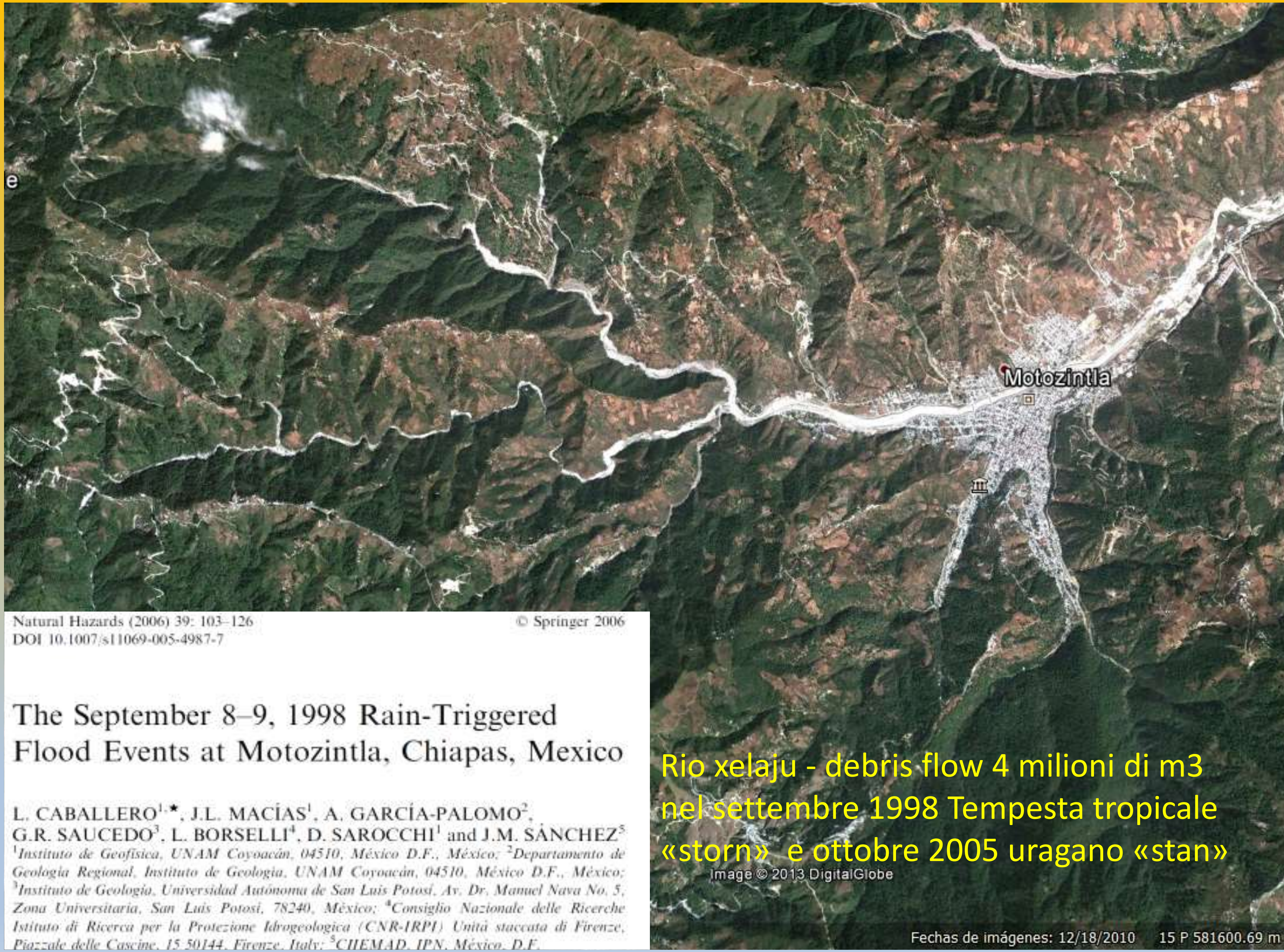


Analisi effettuata con ssap2003 (rel 2.9) basata sul deficit di resistenza per grantire i campi osservati di mobilita'

Altre informazioni..
L. Capra, J. Lugo-Hubp,L. Borselli (2003). Mass movements in tropical volcanic terrains: the case of Teziutlán (México). Engineering Geology. 68(3-4):359-379. "

Periodo 2002.-2004
Come responsabile di
Progetto bilaterale
CNR-CONACYT
Italia-messico





Natural Hazards (2006) 39: 103–126
DOI 10.1007/s11069-005-4987-7

The September 8–9, 1998 Rain-Triggered Flood Events at Motozintla, Chiapas, Mexico

L. CABALLERO[1,*], J.L. MACÍAS[1], A. GARCÍA-PALOMO[2], G.R. SAUCEDO[3], L. BORSELLI[4], D. SAROCCHI[1] and J.M. SÁNCHEZ[5]
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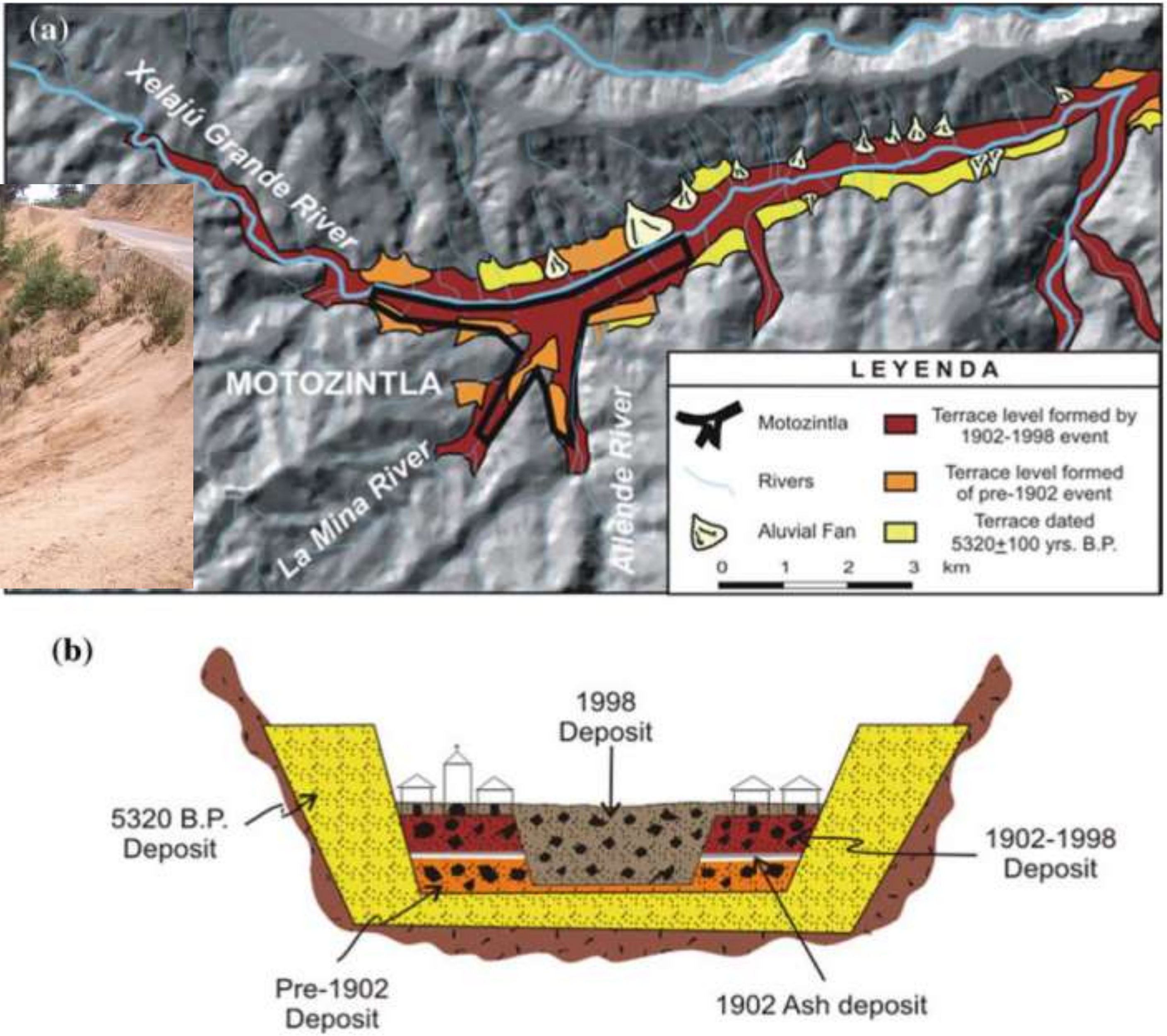
Rio xelaju - debris flow 4 milioni di m3 nel settembre 1998 Tempesta tropicale «storn» e ottobre 2005 uragano «stan»

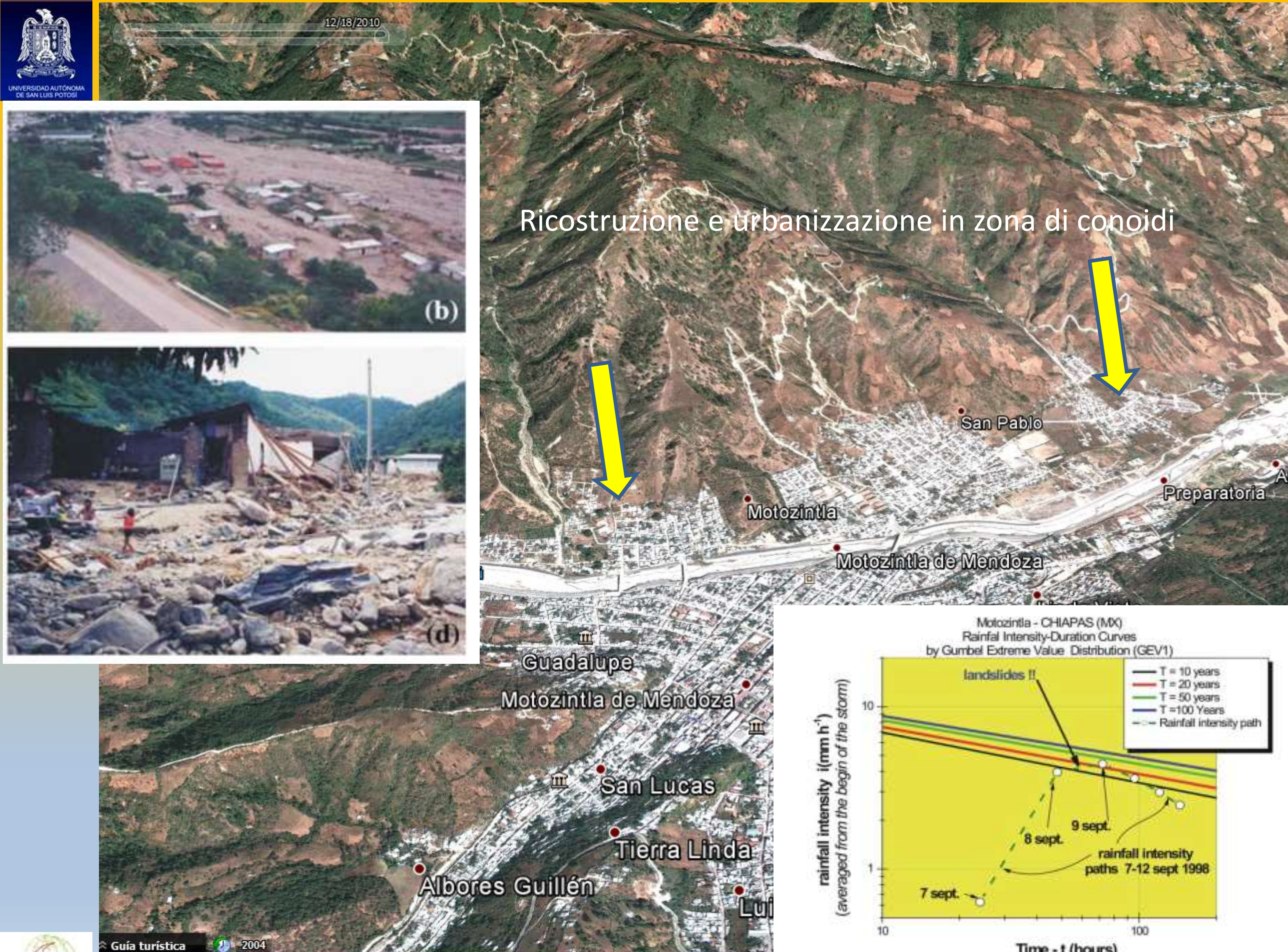
Deforestazione per allevamento estensivo . Con conseguente dissesto idrogeologico generalizzato
Creazione aree sorgenti primarie di deflussi e sedimenti

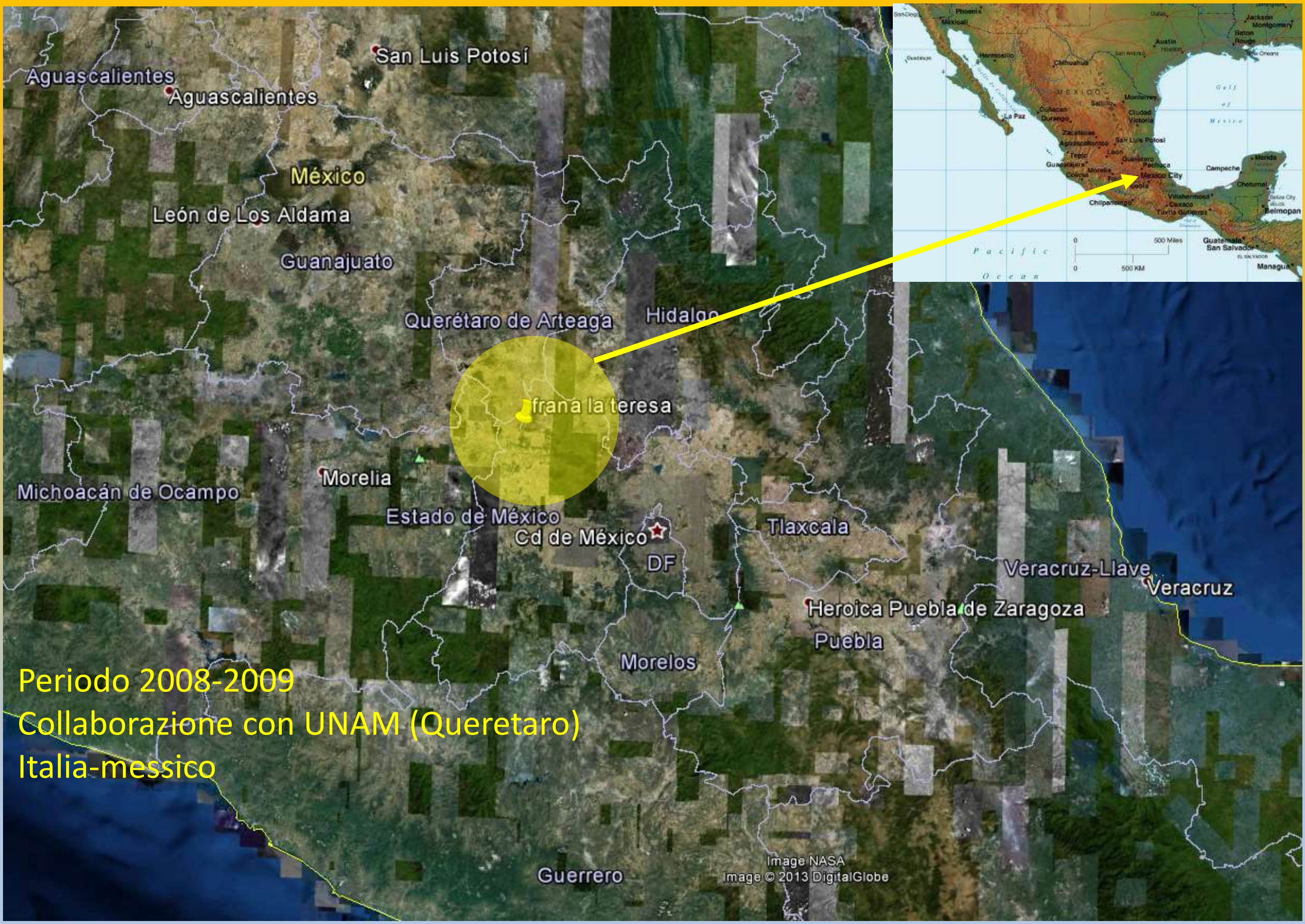
Deforestazione per agricoltura di sussistenza. Con conseguente dissesto idrogeologico generalizzato

Creazione aree sorgenti primarie di deflussi e sedimenti e alimentazione per i debris flow

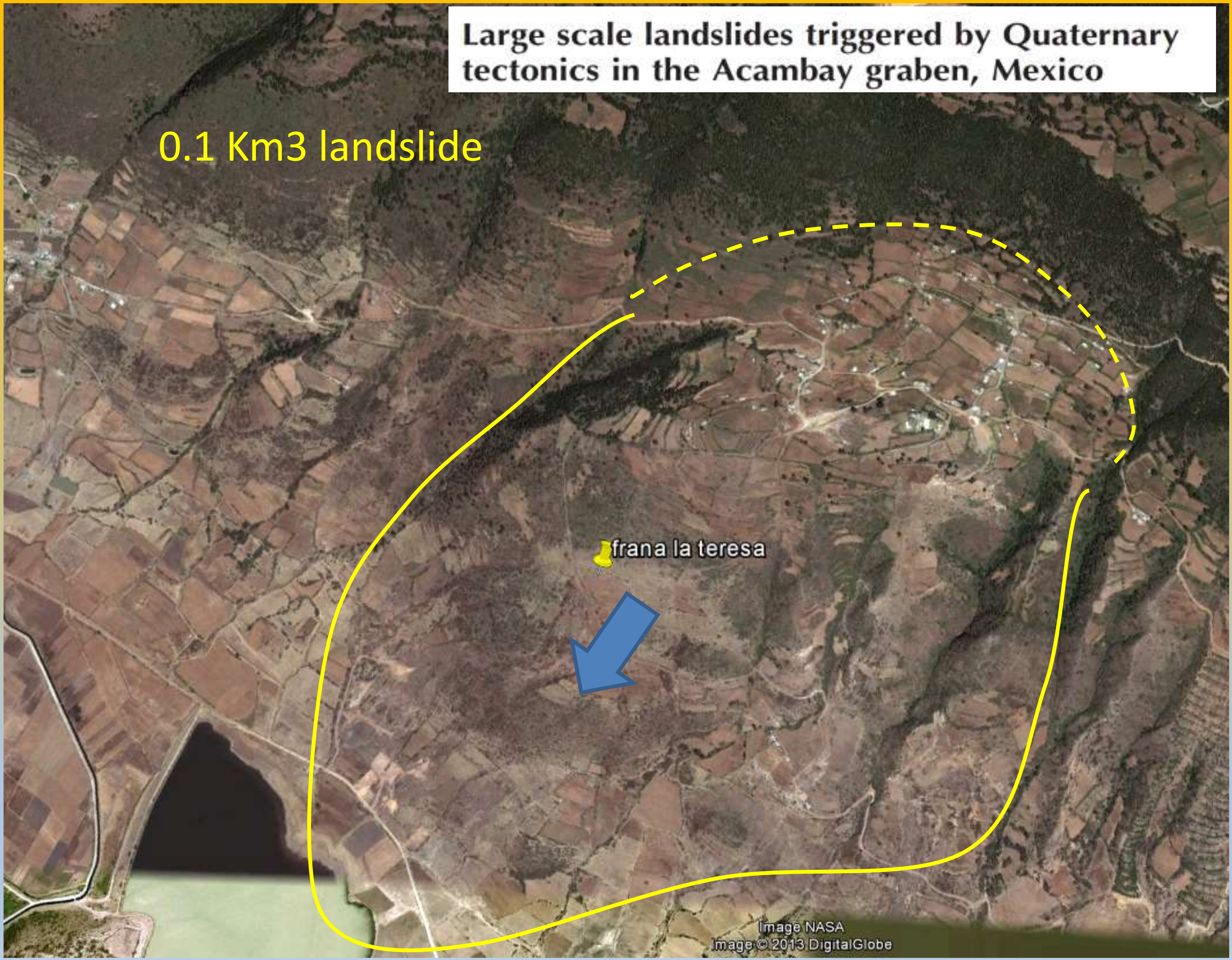

(a)
Xelajú Grande River
MOTOZINTLA
La Mina River
Allende River
LEYENDA
Motozintla
Rivers
Aluvial Fan
Terrace level formed by 1902-1998 event
Terrace level formed of pre-1902 event
Terrace dated 5320±100 yrs. B.P.
0 1 2 3 km
(b)
1998 Deposit
5320 B.P. Deposit
1902-1998 Deposit
Pre-1902 Deposit
1902 Ash deposit

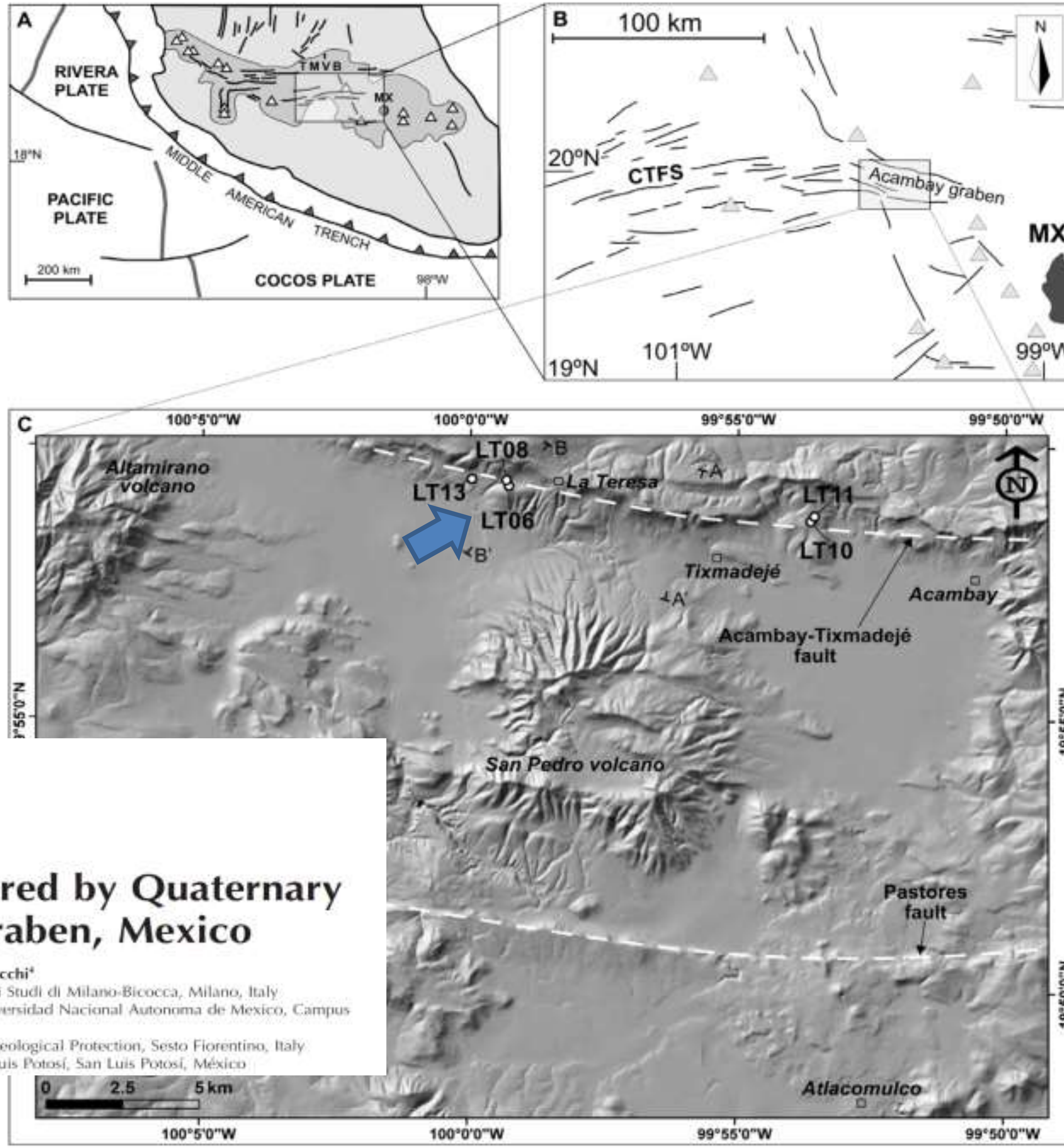
Ricostruzione e urbanizzazione in zona di conoidi





Periodo 2008-2009
Collaborazione con UNAM (Queretaro)
Italia-messico


Large scale landslides triggered by Quaternary tectonics in the Acambay graben, Mexico
0.1 Km3 landslide
frana la teresa
Image NASA
Image © 2013 DigitalGlobe



EARTH SURFACE PROCESSES AND LANDFORMS
Earth Surf. Process. Landforms **35**, 1445–1455 (2010)

Published online 20 April 2010 in Wiley Online Library
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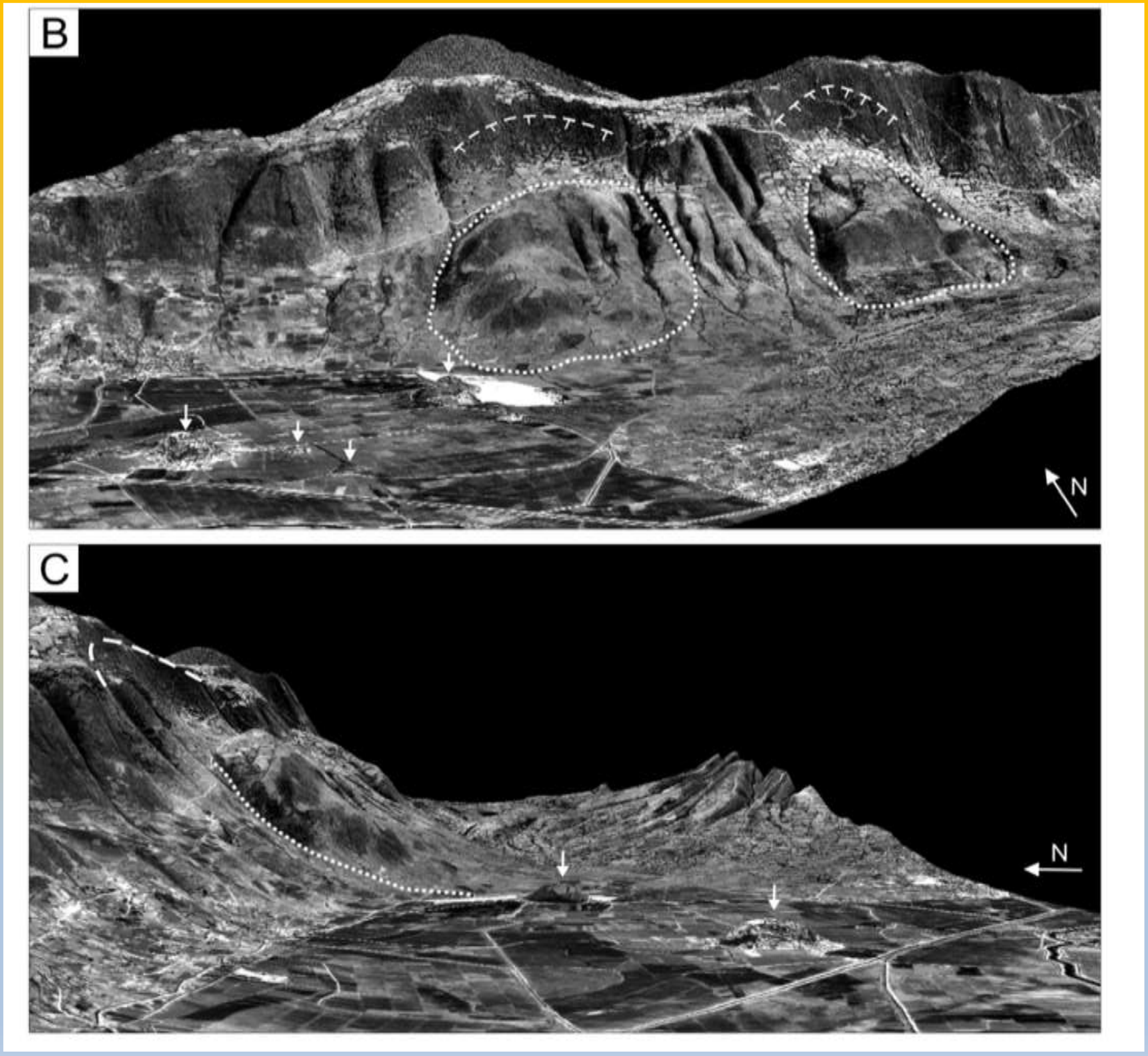
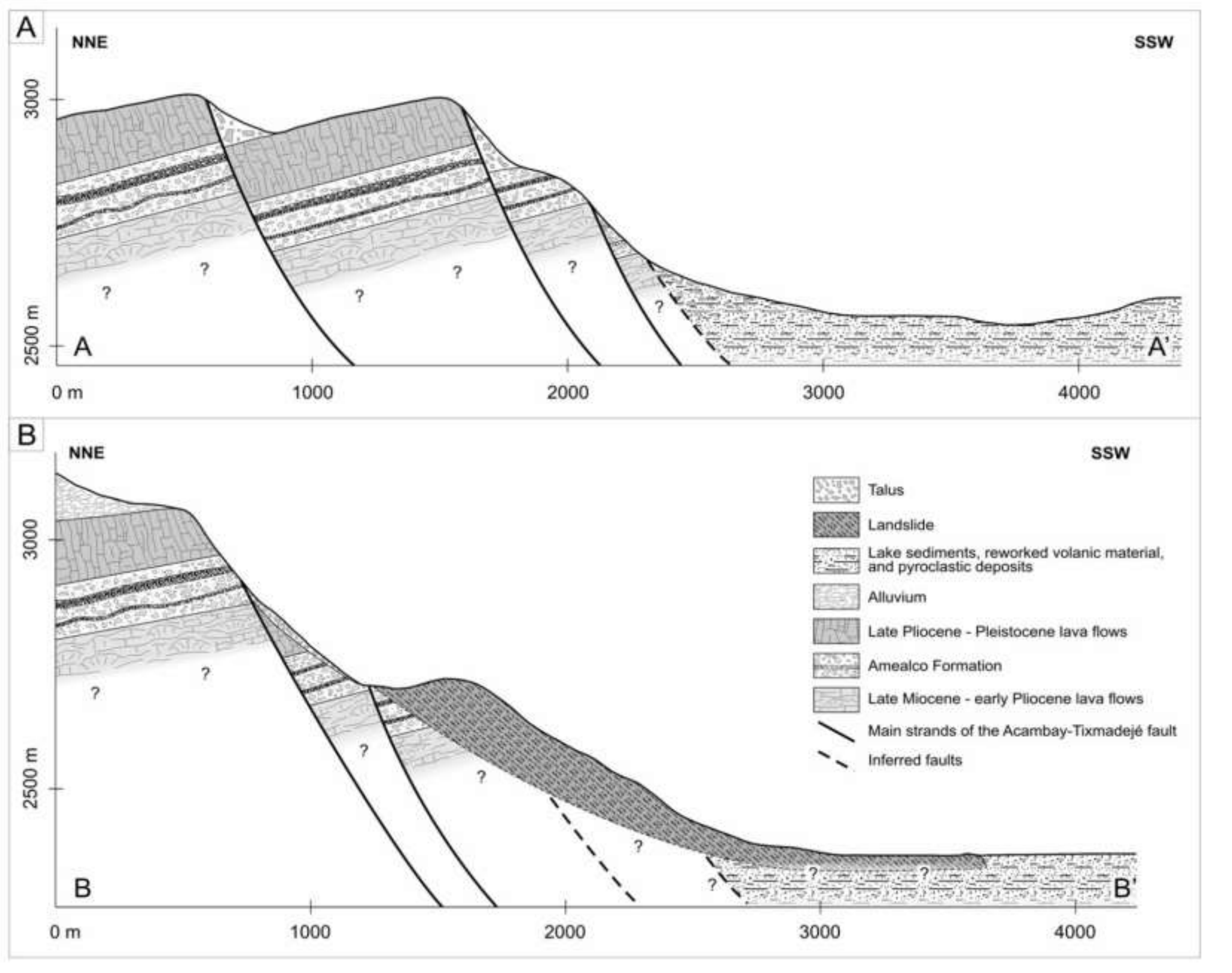
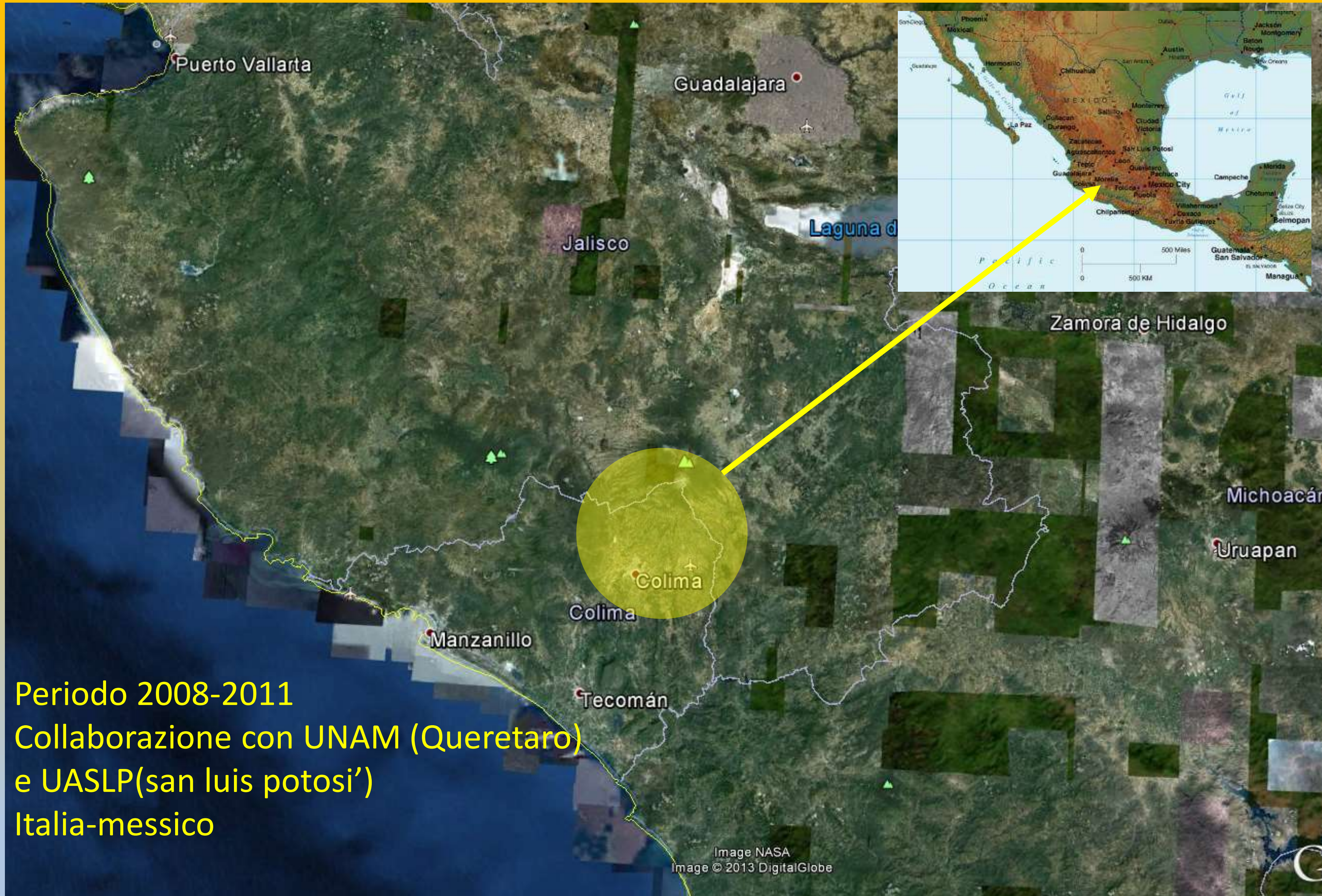
Large scale landslides triggered by Quaternary tectonics in the Acambay graben, Mexico

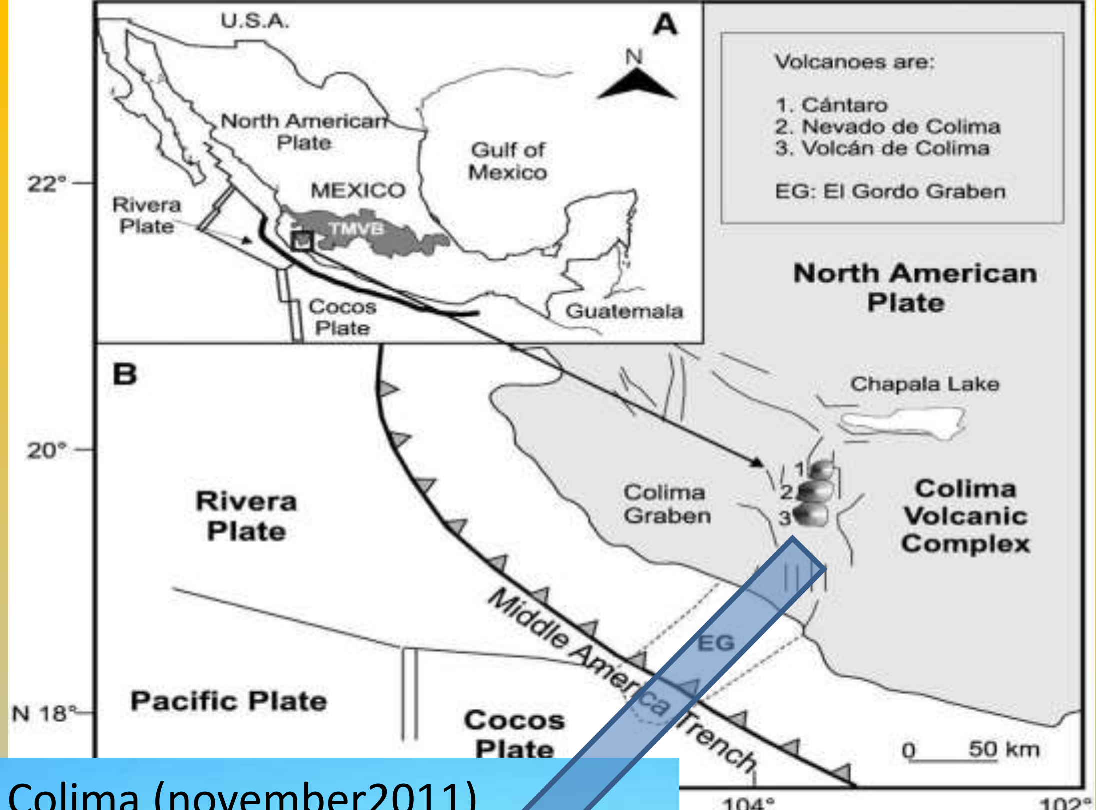
G. Norini,[1,2] L. Capra,[2] L. Borselli,[1] F. R. Zuniga,[2] L. Solari[2] and D. Sarocchi[4]
[1] Dipartimento di Scienze Geologiche e Geotecnologie, Università degli Studi di Milano-Bicocca, Milano, Italy
[2] Computational Geodynamics Laboratory, Centro de Geociencias, Universidad Nacional Autonoma de Mexico, Campus Juriquilla-UNAM, Querétaro, Mexico
[3] Consiglio Nazionale delle Ricerche, IRPI Research Institute for Hydrogeological Protection, Sesto Fiorentino, Italy
[4] Instituto de Geología-Fac. Ingeniería, Universidad Autónoma de San Luis Potosí, San Luis Potosí, México


B
N
C
N


A
NNE
SSW
3000
2500 m
A
A'
0 m
1000
2000
3000
4000
B
NNE
SSW
3000
2500 m
B
B'
0 m
1000
2000
3000
4000
Talus
Landslide
Lake sediments, reworked volanic material, and pyroclastic deposits
Alluvium
Late Pliocene - Pleistocene lava flows
Amealco Formation
Late Miocene - early Pliocene lava flows
Main strands of the Acambay-Tixmadejé fault
Inferred faults



Periodo 2008-2011
Collaborazione con UNAM (Queretaro)
e UASLP(san luis potosi')
Italia-messico



Da Saucedo et al. 2010

Volcan de Fuego, Colima, MX (Approx 3880 m a.s.l.)

Reticolo di drenaggio
con sistemi attivi
stagionalmente
nella generazione di debris flow
(lahars) che rimobilizzano
flussi piroclastici recenti
e depositi
di debris avalance anteriri

Journal of Volcanology and Geothermal Research 189 (2010) 105–117

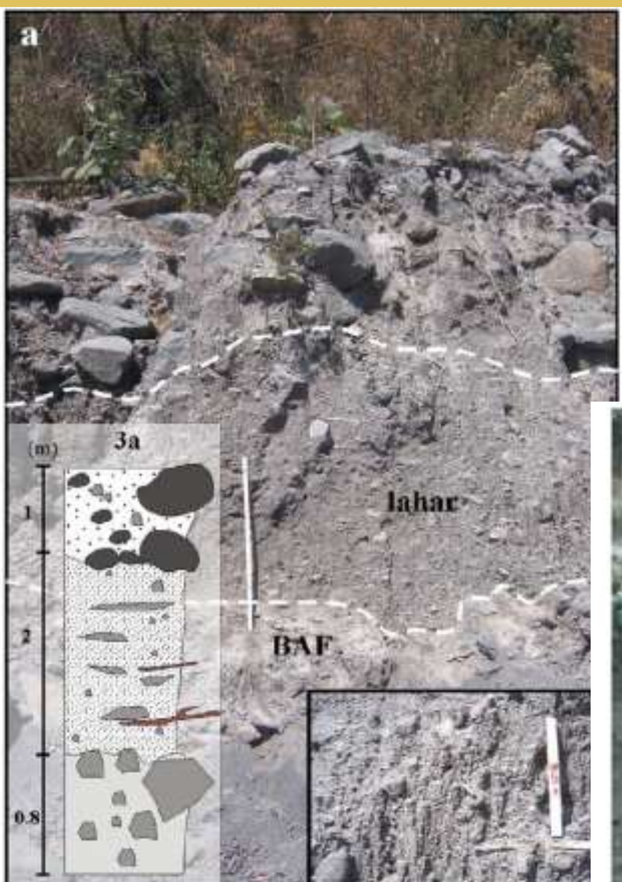
Contents lists available at ScienceDirect

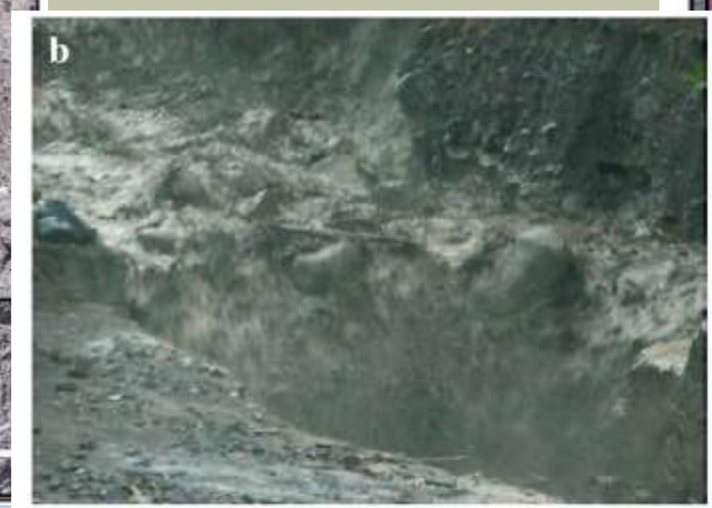
Journal of Volcanology and Geothermal Research

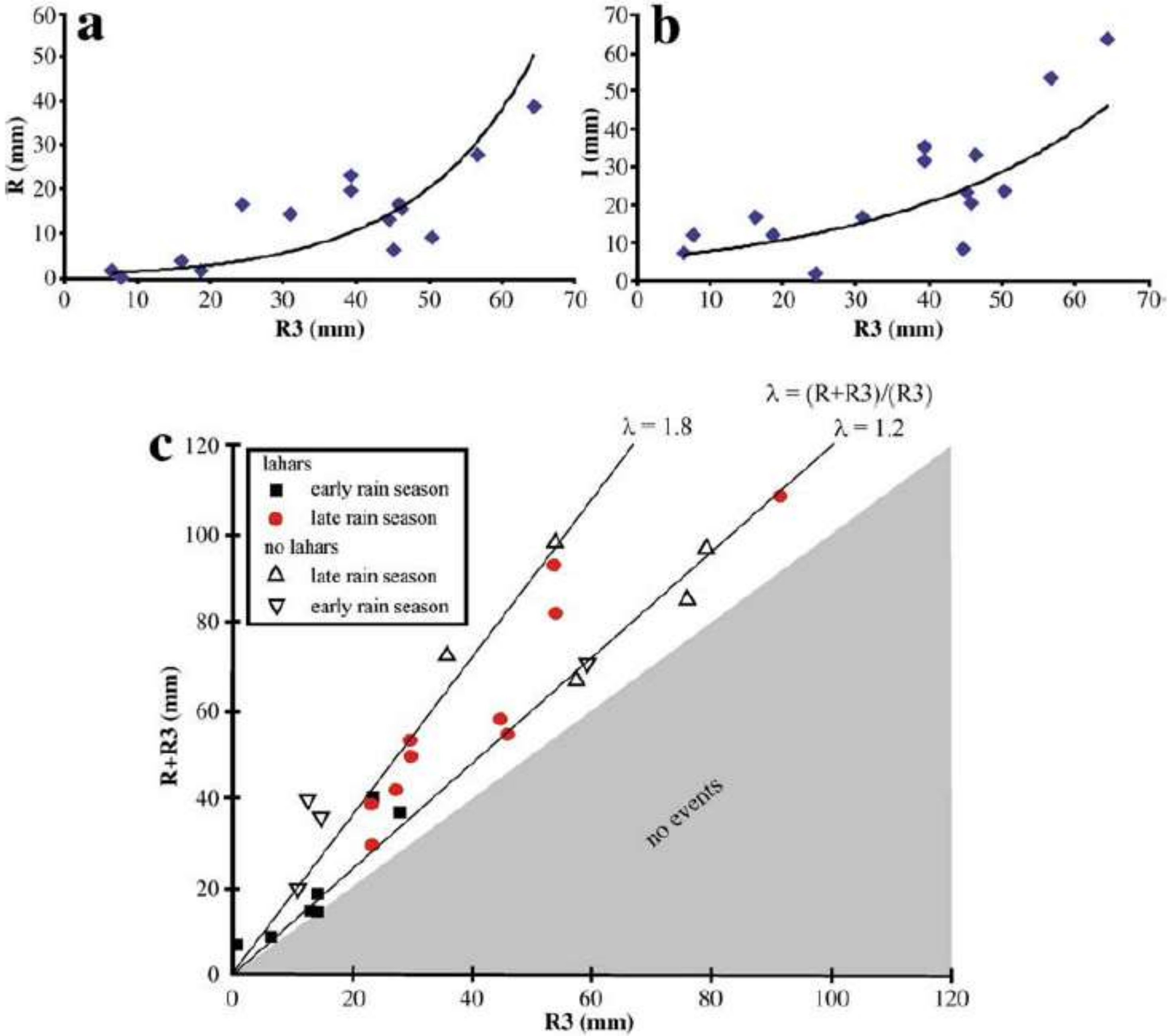
journal homepage: www.elsevier.com/locate/jvolgeores

Rainfall-triggered lahars at Volcán de Colima, Mexico: Surface hydro-repellency as initiation process

L. Capra [a,*], L. Borselli [b], N. Varley [c], J.C. Gavilanes-Ruiz [c], G. Norini [a,d], D. Sarocchi [e], L. Caballero [f], A. Cortes [g]







a
R (mm)
R3 (mm)
b
I (mm)
R3 (mm)
c
λ = (R+R3)/(R3)
λ = 1.8
λ = 1.2
lahars
early rain season
late rain season
no lahars
late rain season
early rain season
no events
R+R3 (mm)
R3 (mm)

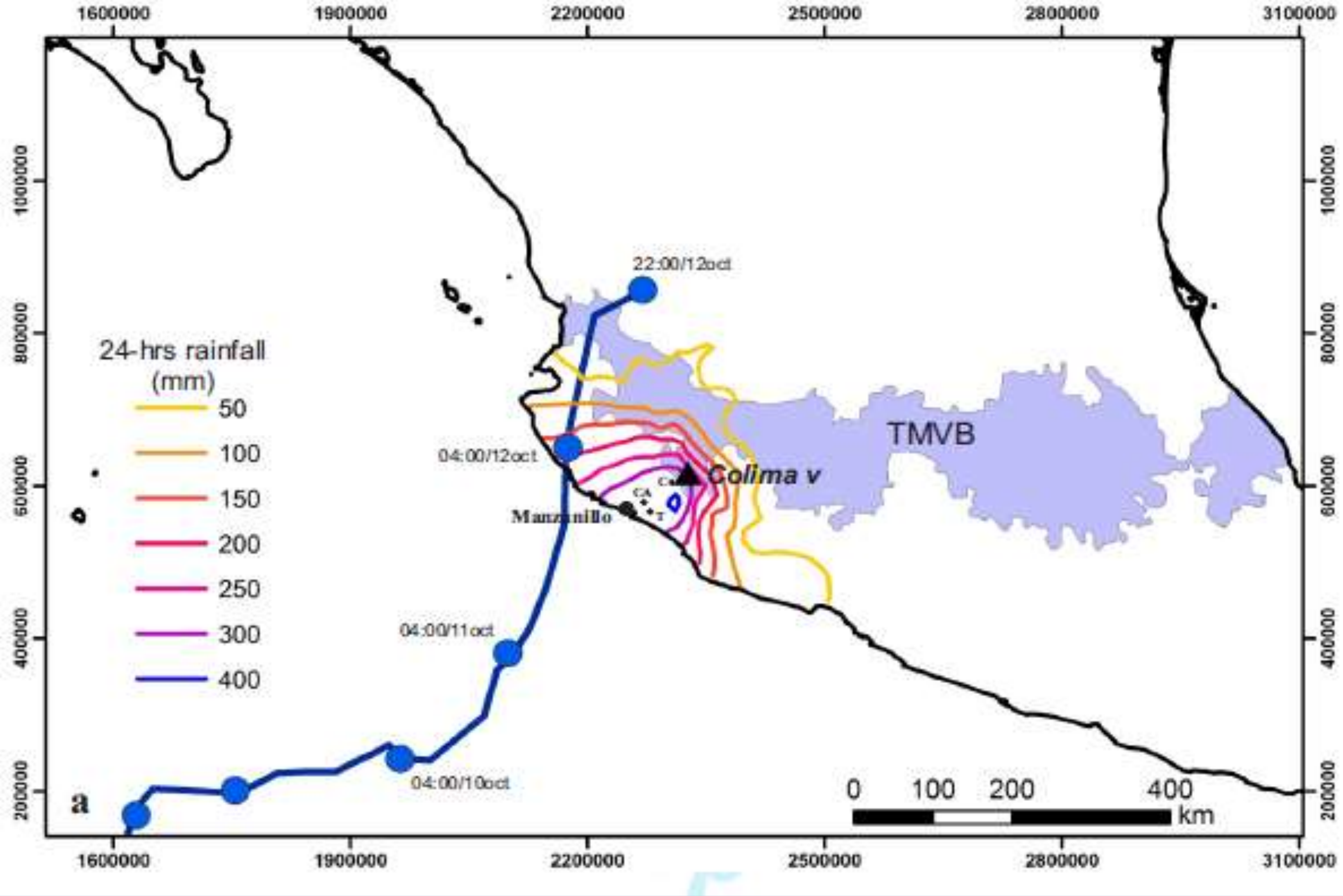

a
Boulder
(20%)
Matrix
(< 2mm)
(55%)
Gravel
(25%)
b
c
10 cm
d
e

Earth Surface Processes and Landforms

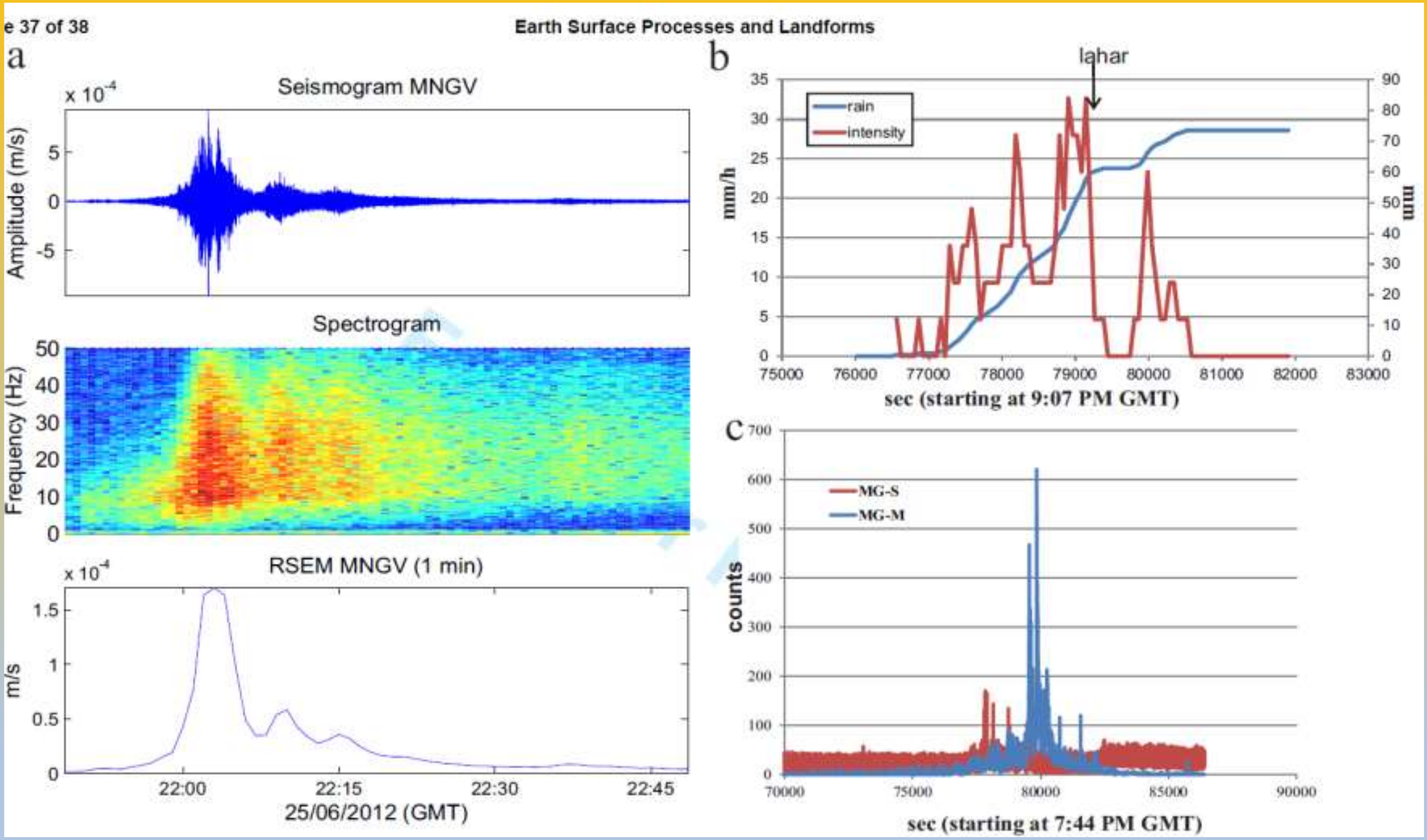
Hurricane–triggered lahars at Volcán de Colima, western Mexico: evidences of flow dynamics from monitoring and field survey.

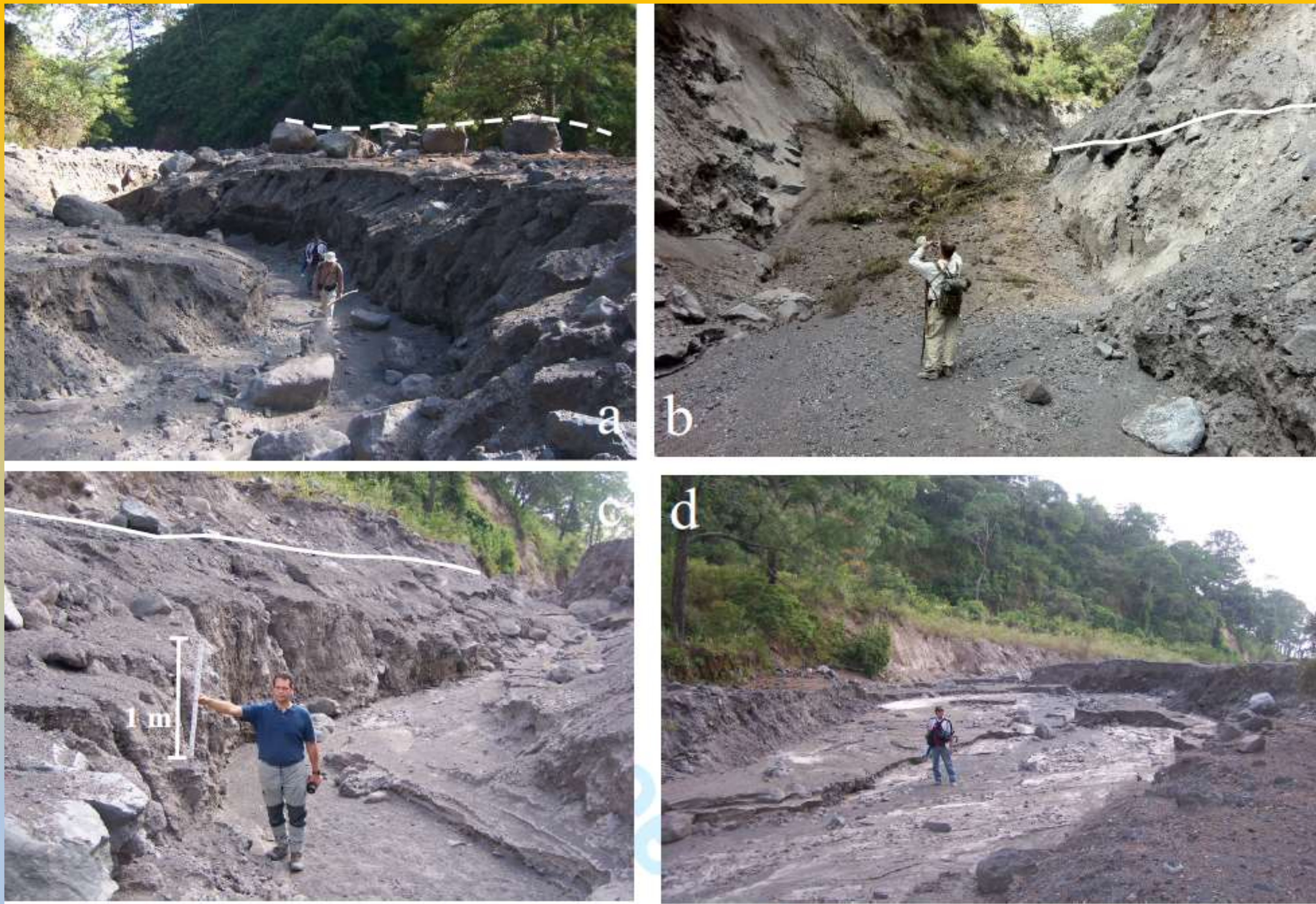
In press

Capra[1*], L., Roverato[1], M., Gavilanes-Ruiz[2], Groppelli[3], G., J.C., Arambula[4], R., Sulpizio[5,6], R., Reyes Dávila[4], G. A., Borselli[7], R., Sarocchi[7] D., Lube[8], G., Cronin[8] S., Rodriguez[9], L.A..



1600000
1900000
2200000
2500000
2800000
3100000
1000000
800000
600000
400000
200000
22:00/12oct
04:00/12oct
04:00/11oct
04:00/10oct
24-hrs rainfall
(mm)
50
100
150
200
250
300
400
TMVB
Colima v
Manzanillo
a
0
100
200
400
km


e 37 of 38
Earth Surface Processes and Landforms
a
Seismogram MNGV
Amplitude (m/s)
Spectrogram
Frequency (Hz)
RSEM MNGV (1 min)
m/s
25/06/2012 (GMT)
b
lahar
rain
intensity
mm/h
mm
sec (starting at 9:07 PM GMT)
c
MG-S
MG-M
counts
sec (starting at 7:44 PM GMT)


a
b
c
d
1 m

Journal of Volcanology and Geothermal Research 208 (2011) 51–65

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Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

Flank collapse scenarios at Volcán de Colima, Mexico: A relative instability analysis

Lorenzo Borselli [a,*], Lucia Capra [b], Damiano Sarocchi [a], Servando De la Cruz-Reyna [c]

[a] *Instituto de Geologia/ Fac. de Ingeniería - Universidad Autónoma de San Luis Potosí–UASLP, Av. Dr. Manuel Nava 5, C.P. 78240 San Luis Potosí, Mexico*
[b] *Centro de Geociencias, UNAM, Campus Juriquilla, 76230 Queretaro, Mexico*
[c] *Departamento de Vulcanología, Instituto de Geofísica, Universidad Nacional Autónoma de México, Coyoacán 04510, D.F., Mexico*

A **recently developed technique** of analysis applied to stratovolcanoes by Borselli et al. (2011)*, offers **new insights for assessment of degree of instability for flank collapse of volcanic edifices**.

BORSELLI L., CAPRA L., SAROCCHI D., De La CRUZ-REYNA S. (2011). Flank collapse scenarios at Volcán de Colima, Mexico: a relative instability analysis. Journal of Volcanology and Geothermal Research. 208:51–65.

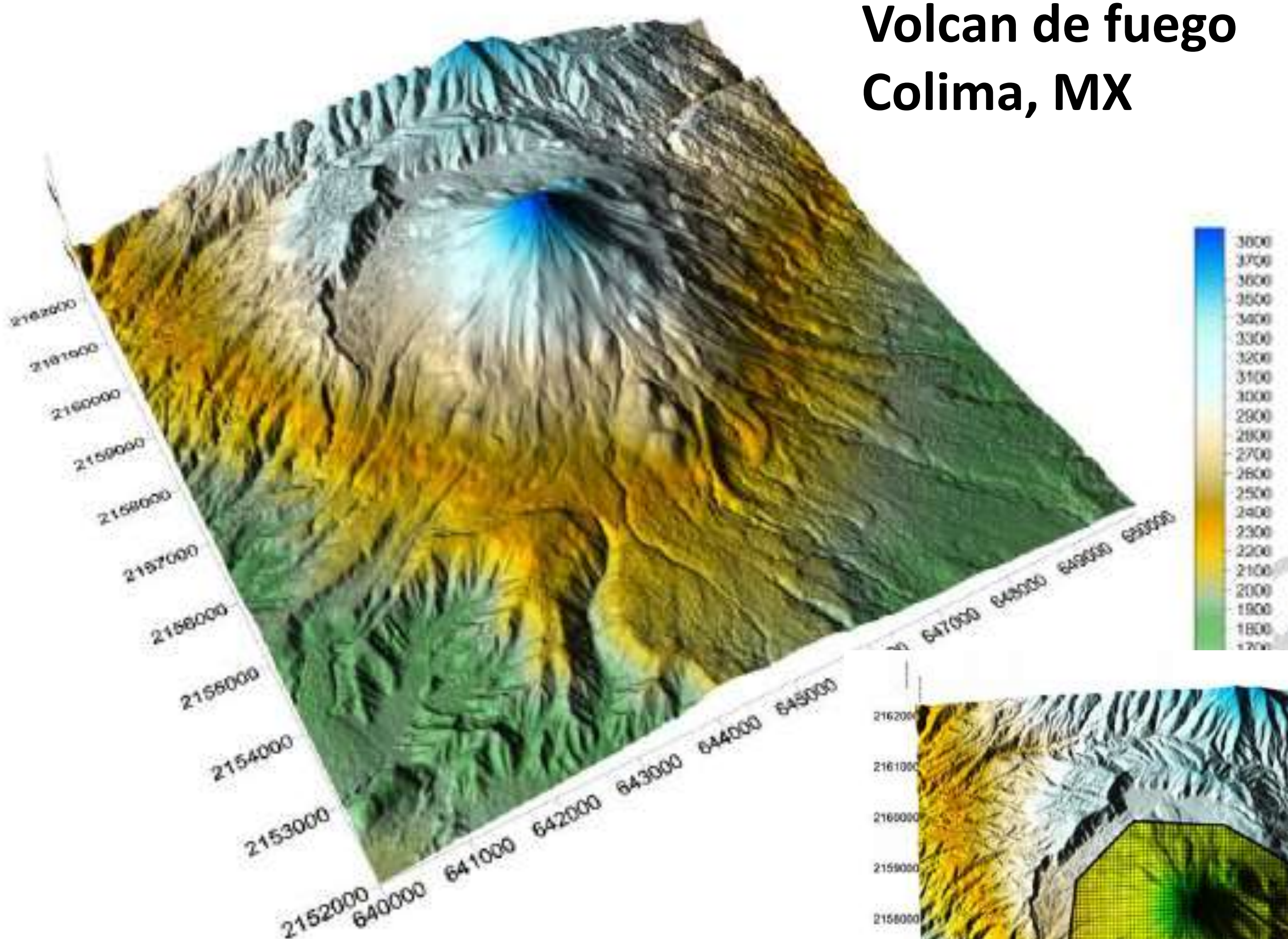
The new technique combines three methodologies:

- 1) **slope stability by limit advanced equilibrium analysis (ALEM) of multiple sectors on the volcano** using **SSAP 4.0** (***Slope Stability Analysis Software***, Borselli 2011) which include fluid internal overpressure or progressive dissipation (Borselli et al. 2011), and rock mass strength criteria (Hoek et al. 2002,2006) for local, stress state dependent, shear strength;

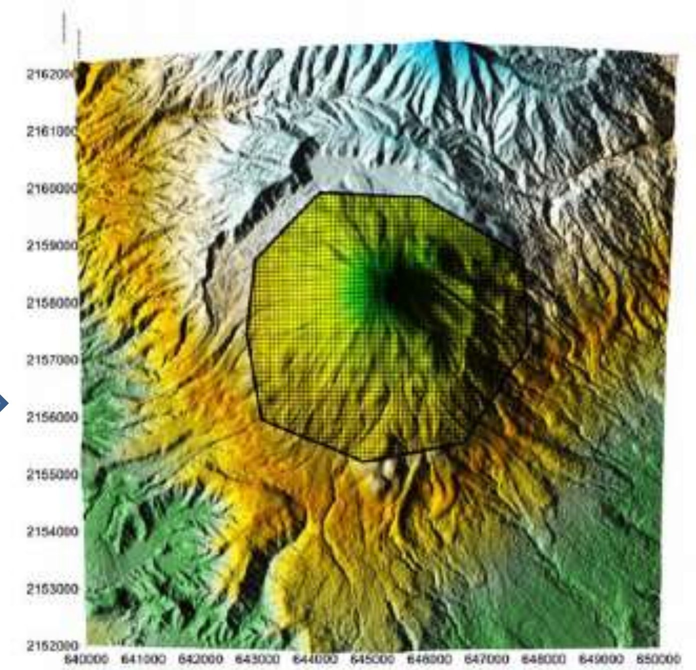
- 2) the analysis of **relative mass/volume deficit in the volcano structure**, made using the new **VOLCANOFIT 2.0** software (Borselli et al.2011);

- 3) **Statistical analysis of major flank debris avalanche ages in the last 10,000 BP**, using **stochastic arithmetic methods** (Vignes, 1993), and calculating the mean time of recurrence of them.

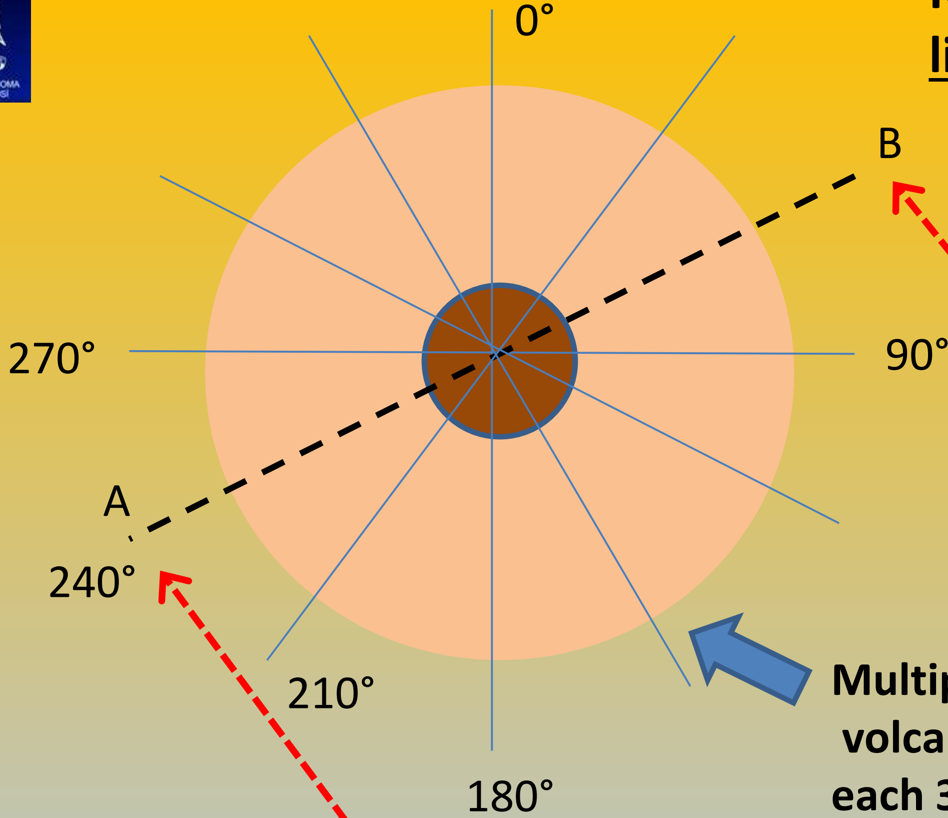
Volcan de fuego Colima, MX



Selected area for analysis



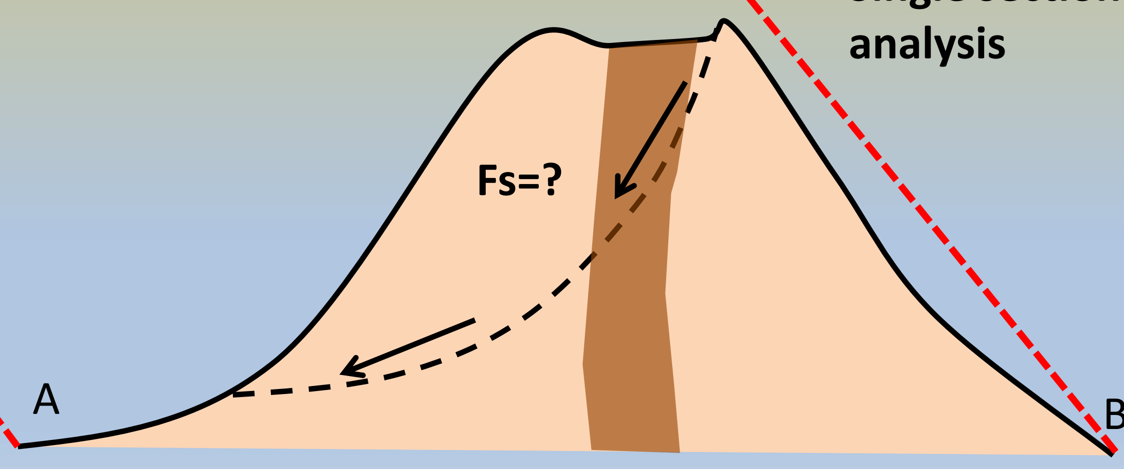
Relative slope stability by advanced limit equilibrium method (ALEM)



Limit equilibrium method (LEM) Slope stability analysis (Duncan 1996): Calculation of **Factor of Stability (FS)** which is associated to each section of volcanic edifice

Multiple sections of volcanic structure each 30° clockwise

Single section analysis



Factor of stability determination:

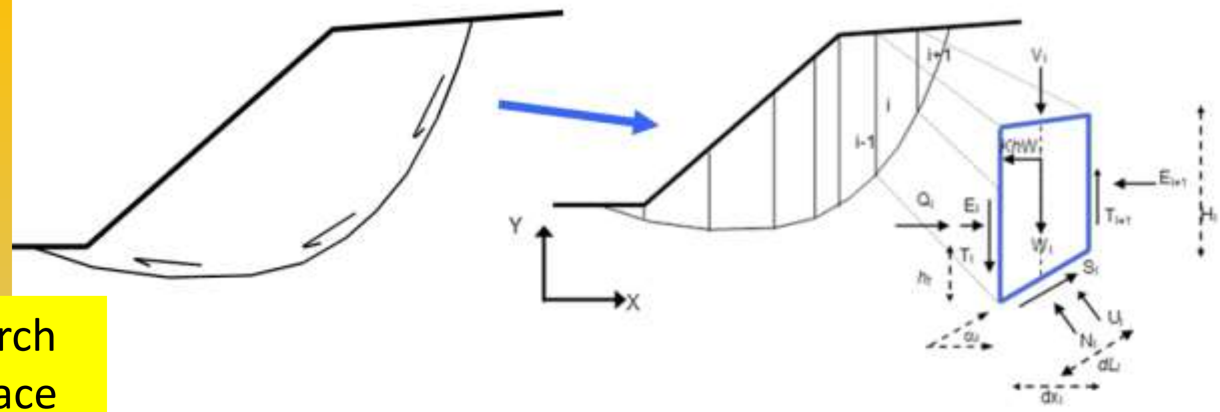
Fs <=1.0 unstable

Fs > 1.0 stable

According to standad rigorous LEM

SSAP 4.0 is a full freeware software

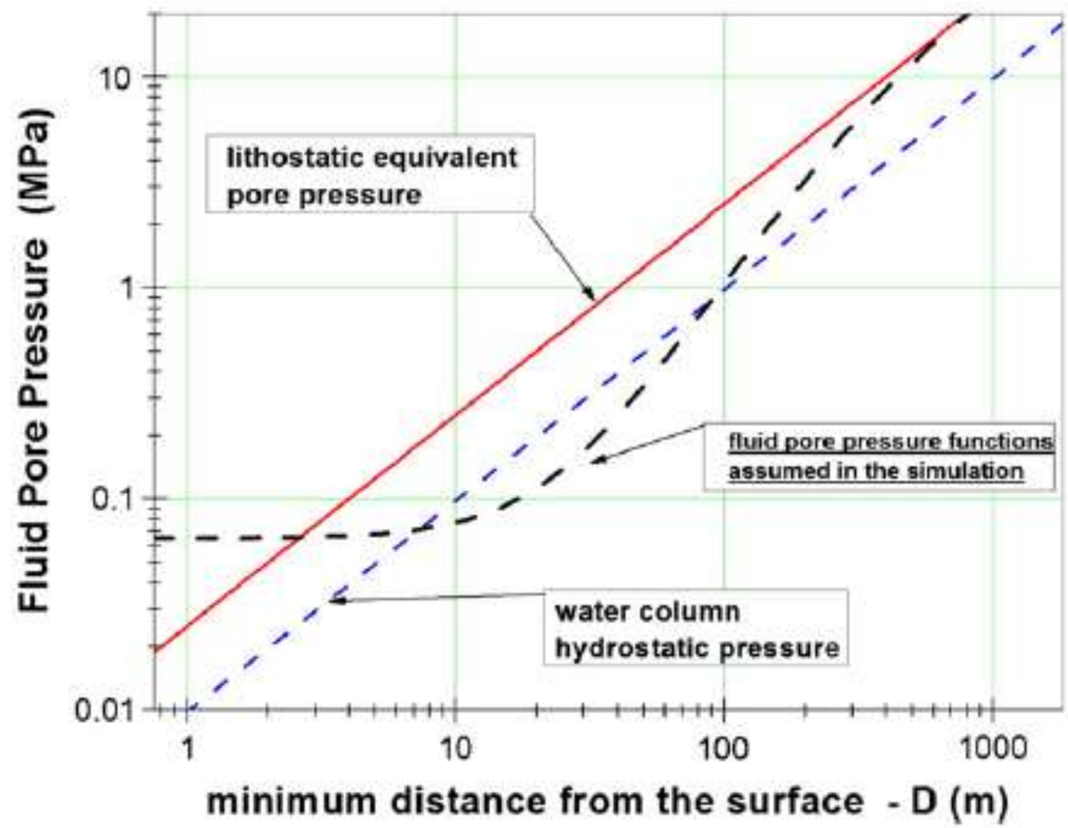
http://www.ssap.eu
(Borselli 1991, 2013)



- Generic shape random search of minimum FS sliding surface by Monte Carlo method
- Rock mass strength criterion (Hoek et al. 2002,2006).
- Fluid pressure function (overpressure and dissipation fields Inside volcanic edifice) (Borselli et al. 2011)

$$\sigma_f = \gamma_w z F_D + U_{0_{MIN}}$$

$$F_D = 1 - Ae^{-kD}$$



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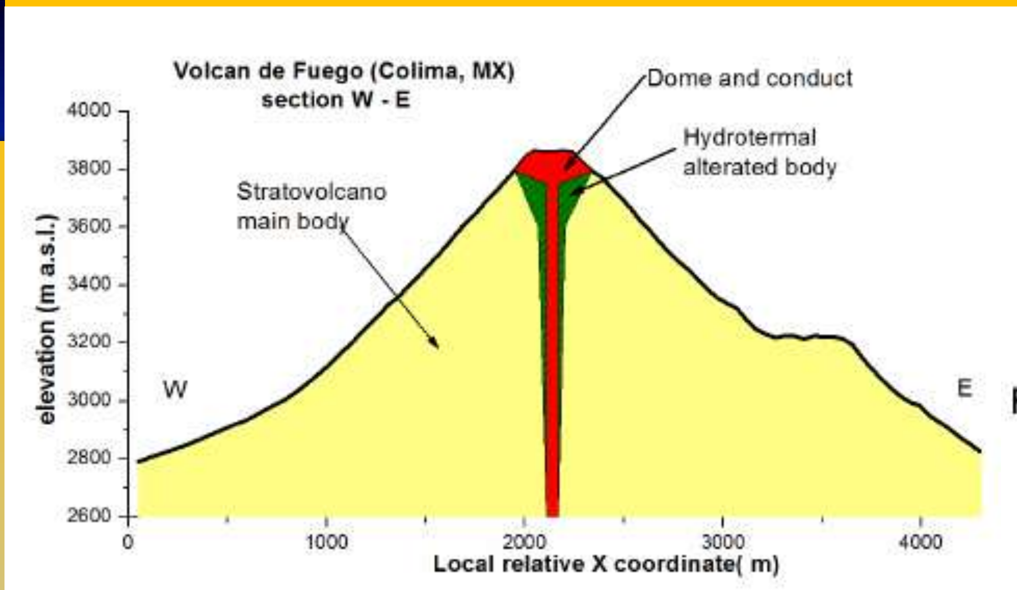
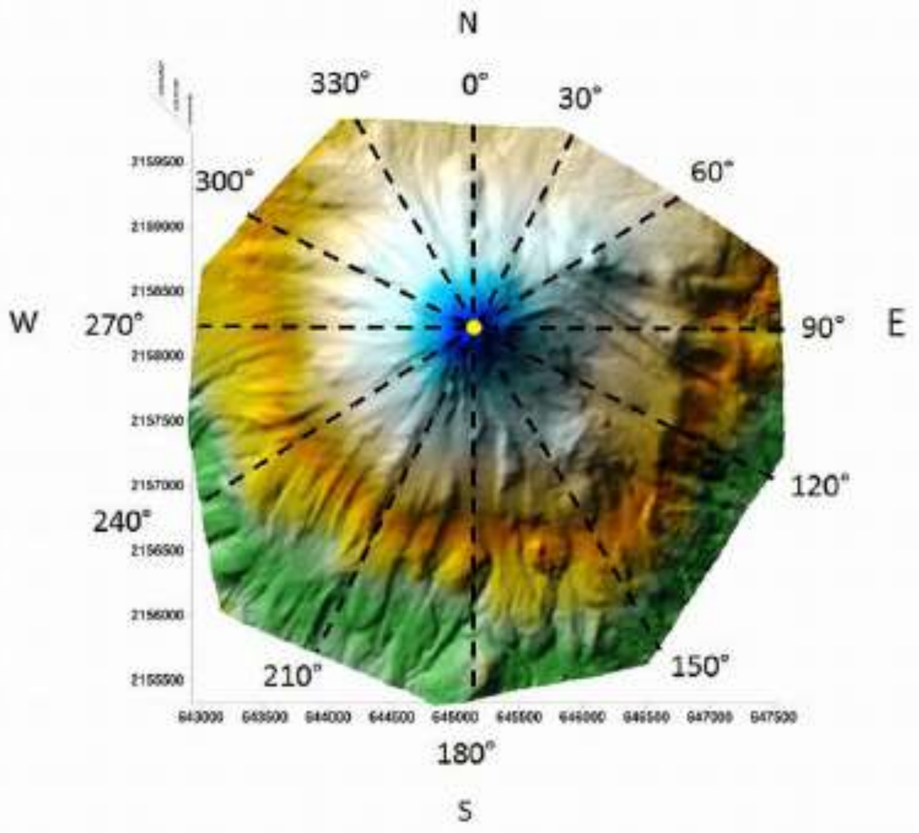
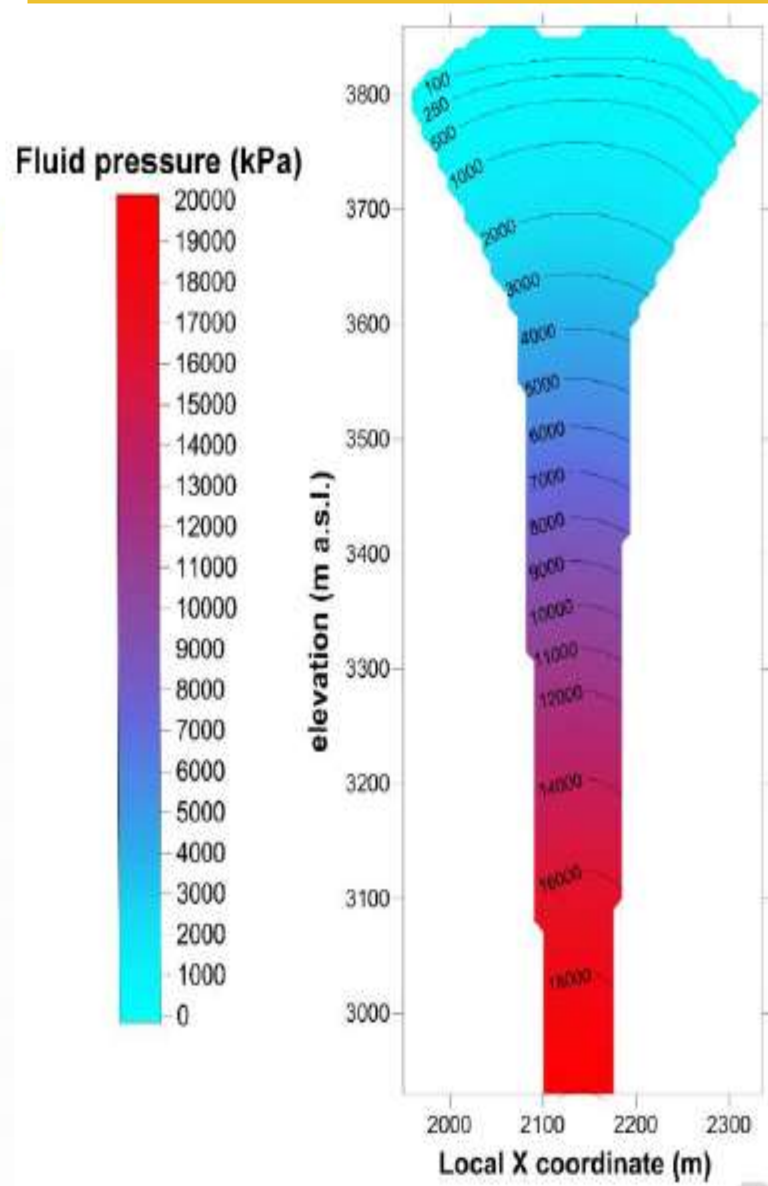






Instituto de Geología

The advanced Limit equilibrium method (ALEM) and Relative instability analysis
Scenarios and mechanical parameters

Shear strength parameterization of main bodies of the stratovolcano following the Hoek and Brown strength criterion (Hoek et al., 2002).

	γ unsaturated unit weight (kN/m³)	γs saturated unit weight (kN/m³)	σI uniaxial compressive strength of intact rock element (MPa)	GSI geological strength index (adimensional)	m_i lithological index (adimensional)	D disturbance factor (adimensional)
Strato volcano main body	24.5	25.0	50	40, (60)*	22	1.0
Hydrothermal altered body	24.0	24.5	40	30, (45)*	22	1.0
Dome and conduct	24.0	24.5	25	20, (30)*	22	1.0

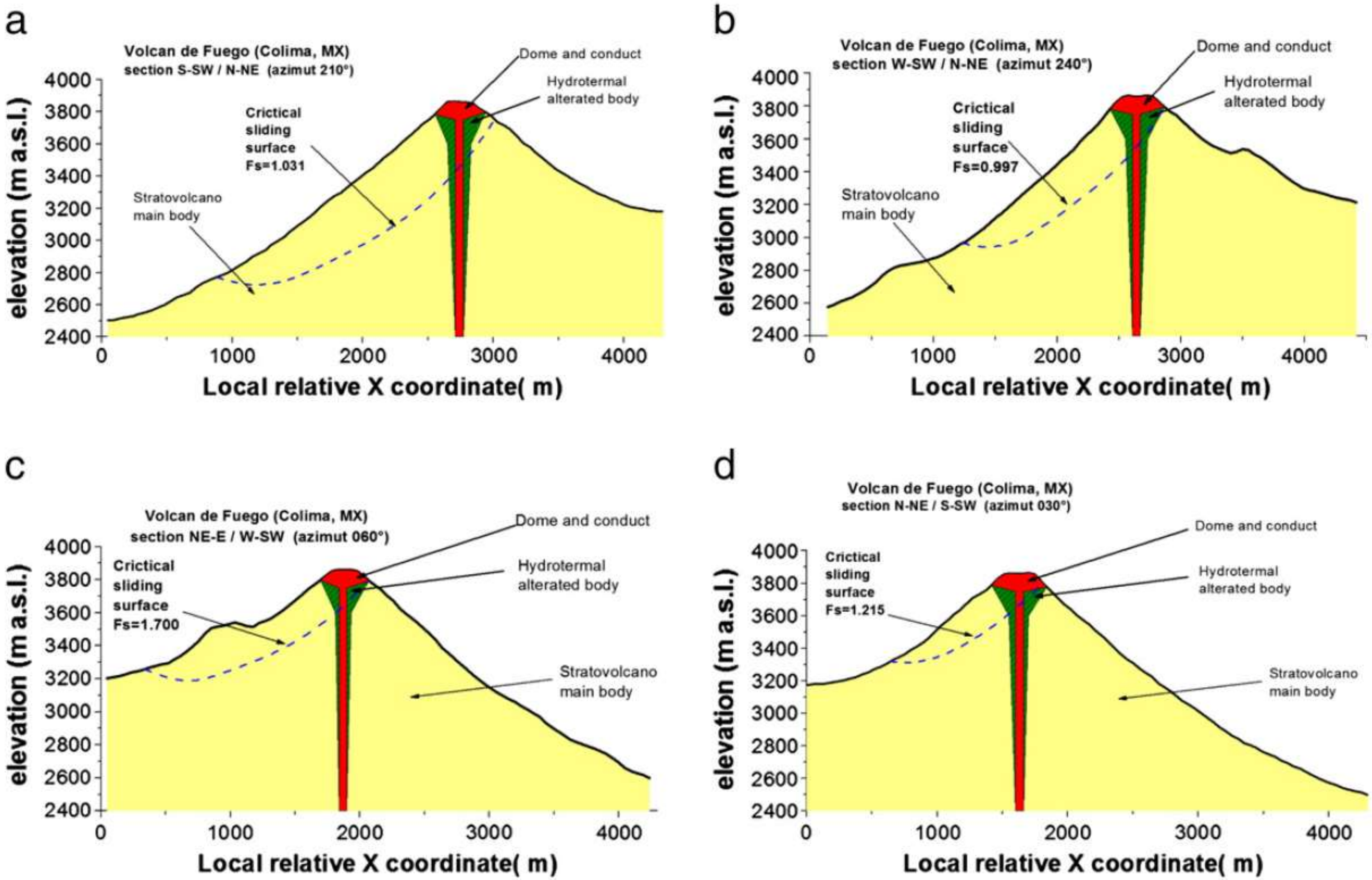
*In parentheses the GSI value for scenario analysis Nos. 2, 3 and 4 (50% increase assumed with respect to GSI of scenario no. 1).

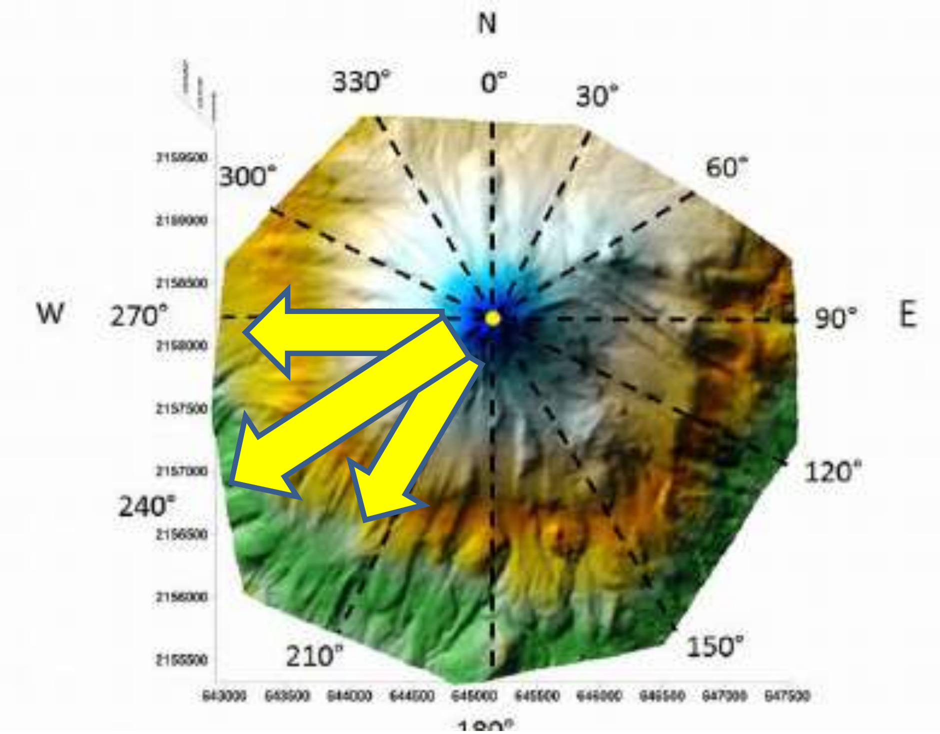
Characteristics of scenario analysis adopted for limit equilibrium analysis.

Scenario no. 1	Description	Notes
1	Geomechanical parameters as in Table 2	No seismic effect
2	Geomechanical parameters as in Table 2 with GSI increase of 50%	No seismic effect
3	The same as scenario 2, but seismic coefficients $Kh = 0.2$; $Kv = 0.1$	Seismic effect by LEM pseudostatic analysis
4	The same as scenario 2, but seismic coefficient $Kh = 0.25$; $Kv = 0.125$	Seismic effect by LEM pseudostatic analysis

Final results colima with ALEM

L. Borselli et al. / Journal of Volcanology and Geothermal Research 208 (2011) 51–65



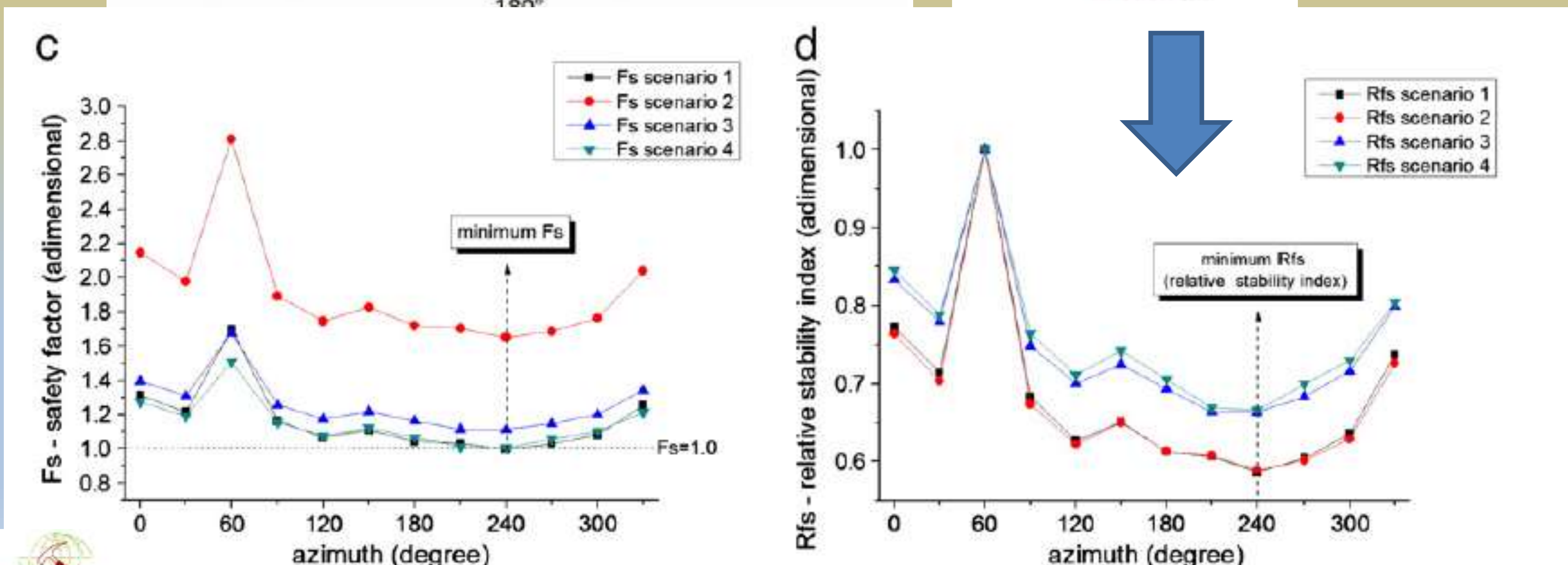


The sector with minimun relative stability is W-SW flank (between 270° and 210°)

The Relative stability index

$$R_{fs_i} = \frac{Fs_i}{Fs_{max}}$$

(Borselli et al. 2011)



Volcanofit 2.0
WWW. VOLCANOFIT.ORG

$$Z = a\, e^{-\frac{\sqrt{(x-x_0)^2+(y-y_0)^2}}{b}} + c \quad \text{if } Z \leq Z_1$$

VOLCANOID SURFACE OF REVOLUTION

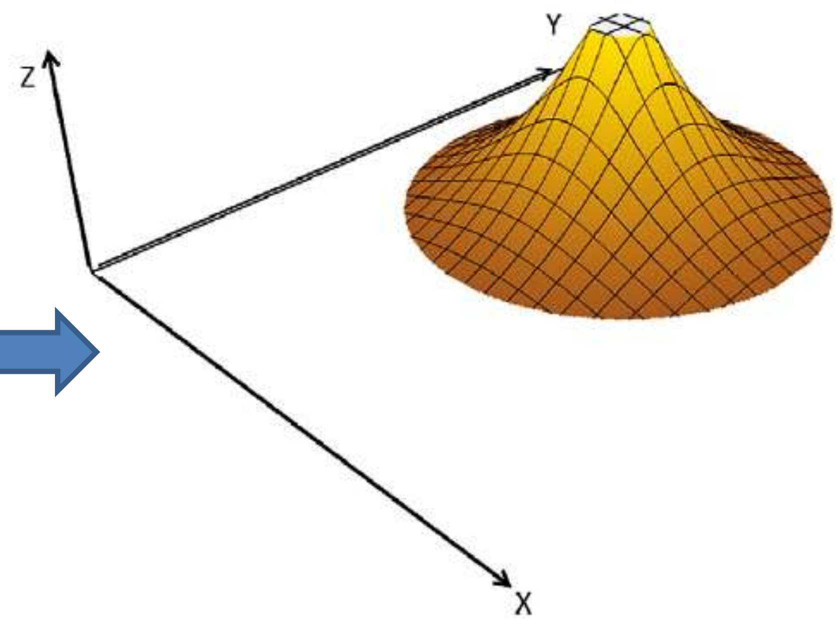


Fig. A.2. Example of volcanoid with constant negative curvature (Eq. (A.5)).

ALTERNATIVE VOLCANOID'S GENERATRIX

$$Z = a \cosh\left(\frac{r-c}{b}\right)$$

for $\forall r < c$ and $a, b, c > 0$.

$$Z = \frac{z_1 - a}{1 + e^{\frac{r-c}{b}}}$$

with $z_1 > a$ and $z_1, a, b, c > 0$.

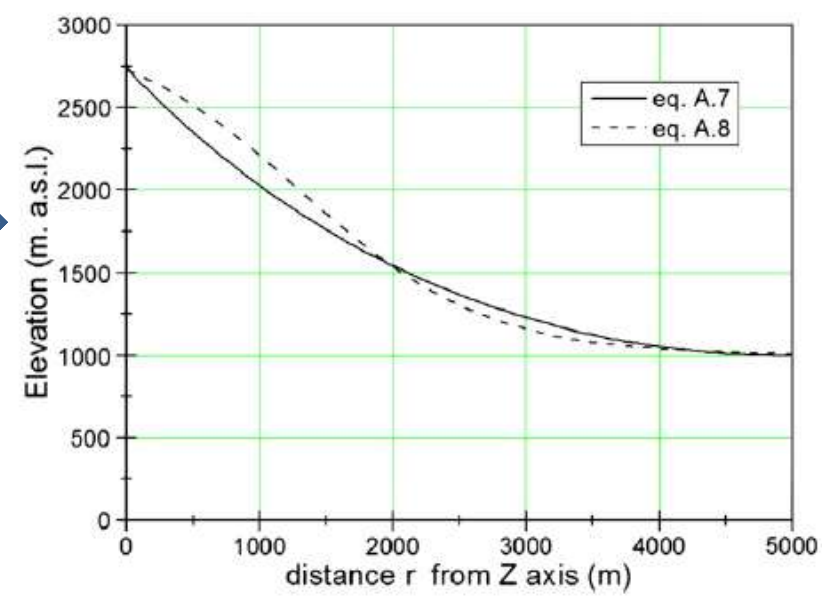


Fig. A.5. Alternative generatrix function of 3D volcanoid.

Colima
Volcanofit 2.0
Result:
Using Negative exponential *Volcanoid*'s generatrix

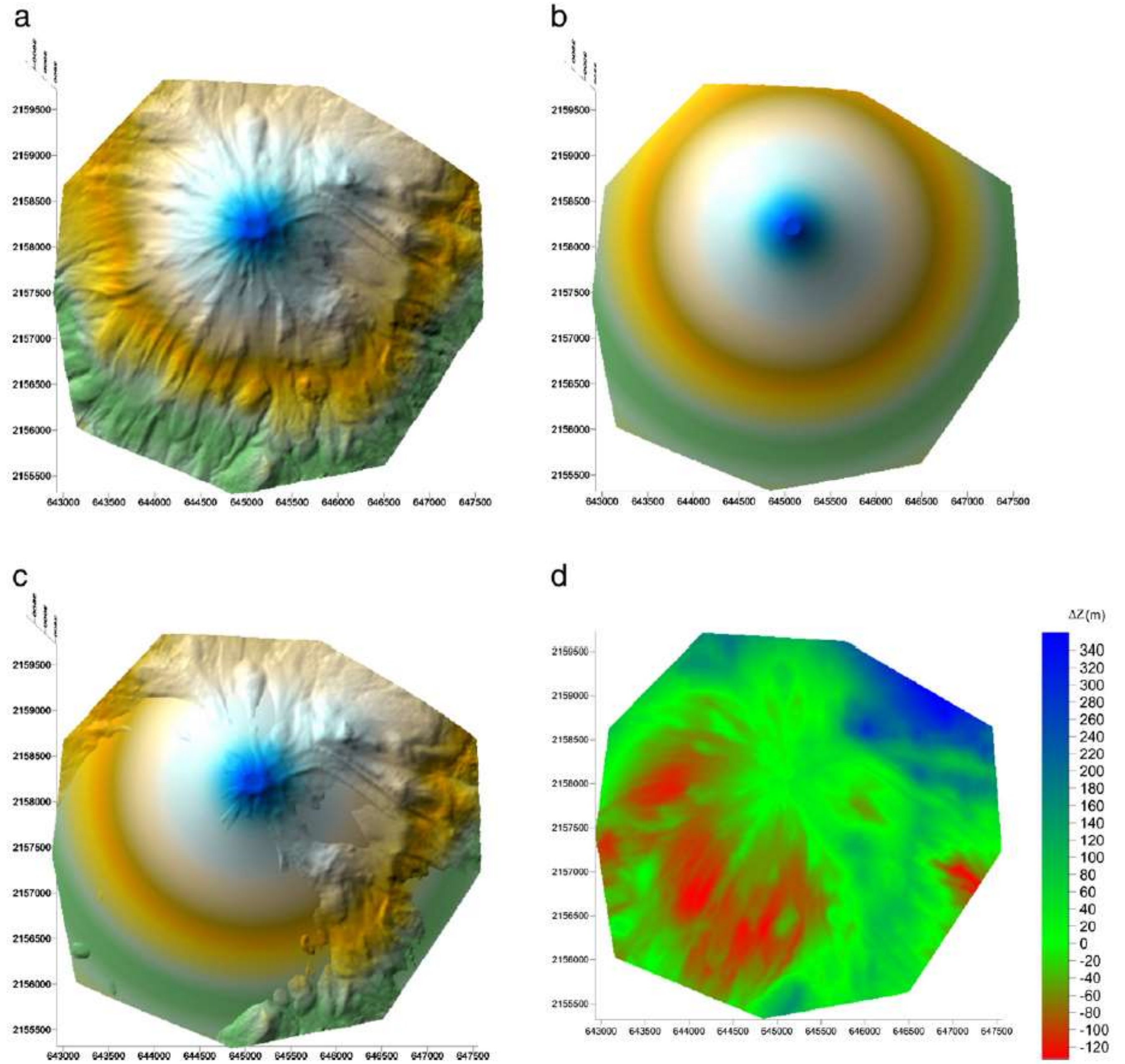
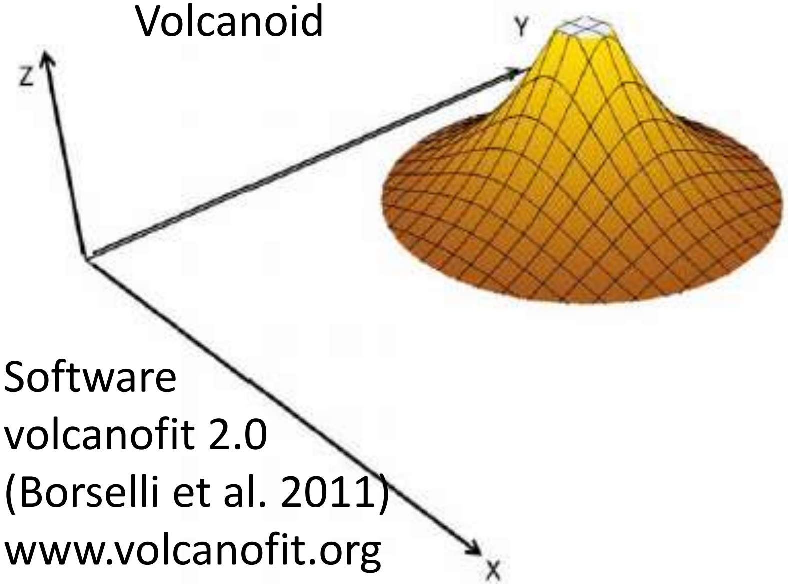


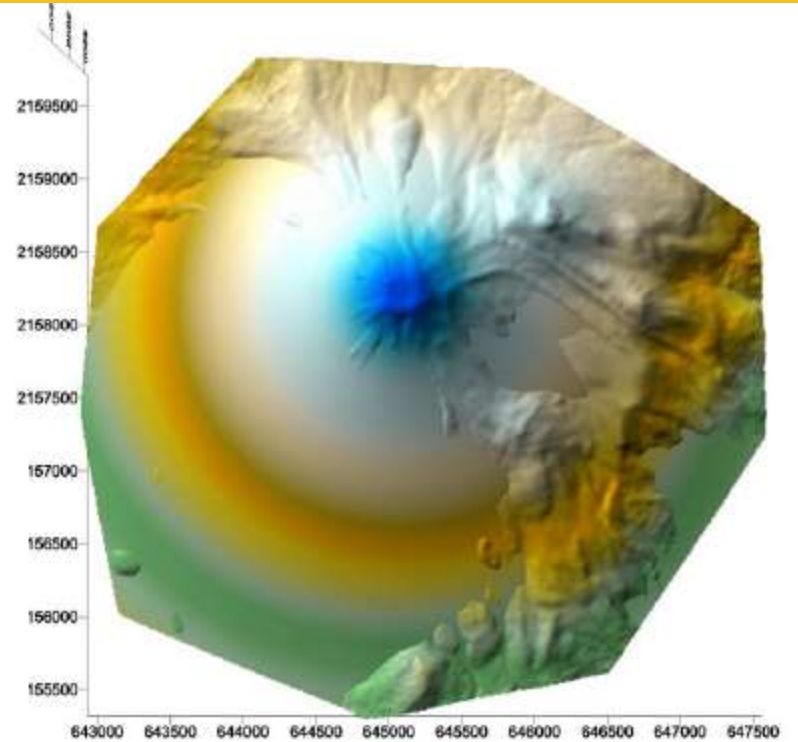
Fig. 7. a) Upper edifice of Colima volcano DEM (2005) b) fitted volcanoid 3D surface Eq. (A.5); c) Upper edifice Colima Volcan de Fuego DEM with overlaid volcanoid Eq. (A.5); d) plot of local deficit (negative values) or surplus (positive values) calculated with Eq. (A.6).

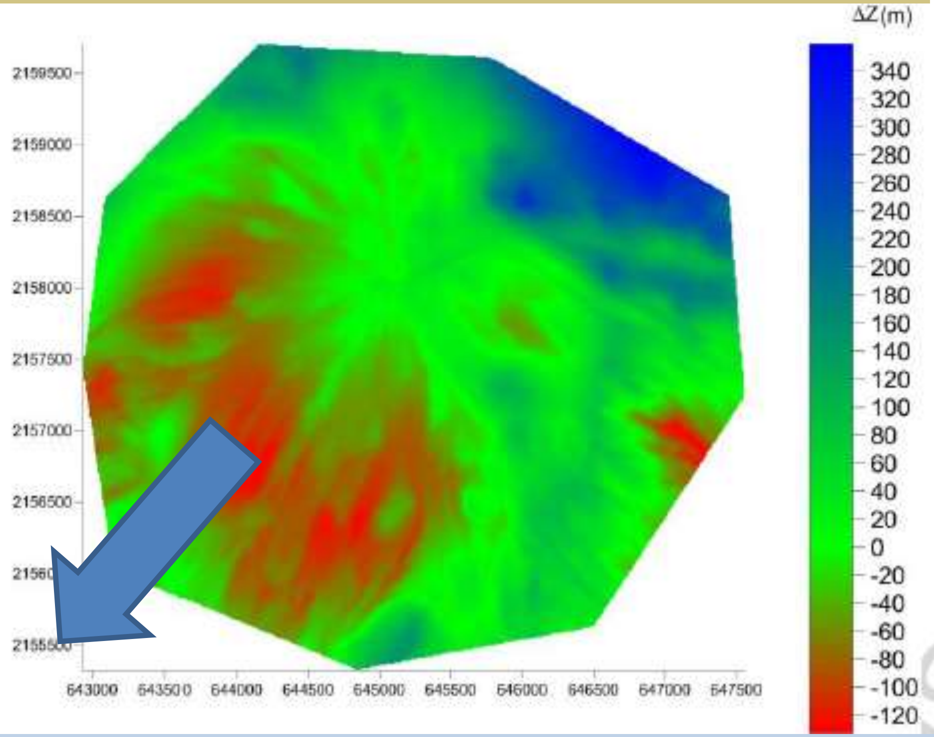
Volcanoid



Software
volcanofit 2.0
(Borselli et al. 2011)
www.volcanofit.org

Details overlay DEM and Fitted Volcanoid

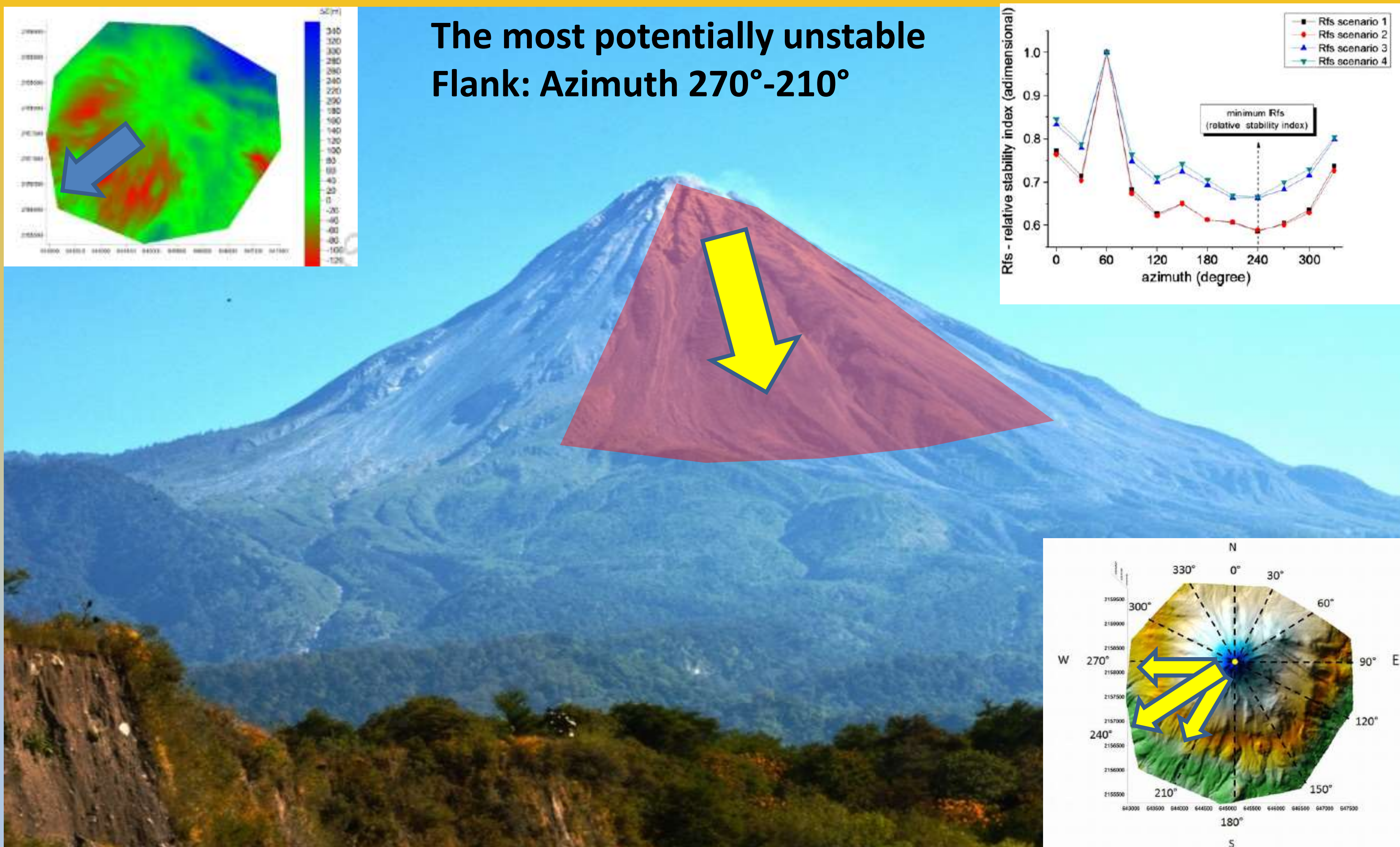




Volume (mass) Deficit
in SW flank

Combined resulys of ALEM (by SSAP 4.0) and VOLCANOFIT2.0

The most potentially unstable Flank: Azimuth 270°-210°



Volcan de Colima
time of recurence of last 5 debris avalance events (DAE) (Borselli et al. 2011)

Available ages of debris avalanche in the last 10,000 years BP, VEI and calculated intervals between the successive collapses and their corresponding band of uncertainty.

Data source	Event ID Number (–)	VEI* (–)	Te_i Debris avalanche events (DAE) (years BP)	εTe_i Uncertainty on DAE (years)	ΔTe_i Interval from previous DAE (years)	$\varepsilon\Delta Te_i$ Uncertainty on interval from previous DAE (years)
1,2,3	4	5	2580	140	1020	184
2,3	3	5	3600	120	3440	200
2,3	2	6	7040	160	2631	183
2,3	1	5-6	9671	88	3699	149
1,2	0	5-6	13370	120	n.a	n.a
Mean interval of last four DAE (expressed as stochastic number)					ΔTe Mean interval of last four DAE (years) 2698	$\varepsilon\Delta Te$ Standard deviation associated to mean DAE interval (years) 180

1 Komorowski et al. (1997); 2 Cortes et al. (2005); 3 Cortes et al., 2010; *from Mendoza-Rosas and De La Cruz-Reyna (2008).

Mean interval of last 4 DAE interval is 2698 years
with a mean standad deviation of +/- 180 years

Using **stochastic arithmetic**
(Vignes, 1993; Markov and Alt, 2004)

USE of Stochastic arithmetic for Debris avalance recurrence time

The **number of DAE is much lower than the number of total explosive events**. De la Cruz-Reyna (1993) established a Poissonian model for the recurrence intervals and occurrence frequency of explosive eruptions, and Mendoza-Rosas and De la Cruz-Reyna (2008, JVGR 176, 277–290) analysed the distribution of events **with VEI>4, *which may be related to large DAEs*, finding an 85% probability of a VEI>4 event within the next 500 yr, and an average recurrence time for VEI>=5 over 2500 yr. (this analysis include all events 2<VEI <6)**

Instead we use a stochastic arithmetic techniques (***Vignes, 1993; Markov and Alt, 2004***) **adapted to the mean age of DAE and its band of uncertainty**. This technique **accounts for the error propagation and uncertainty** associated with the **computation of successive intervals between collapses**. The proposed methodology resembles that proposed by **Akçiz et al. (2010, Geology 38 (9), 787–790**) for the assessment of large earthquake recurrence times at the San Andreas Fault (California, st. Andreas Fault system). In this chase the recurrence time for the Big Ones is much more shorter than previous assessments.

By Borselli et al. (2011)

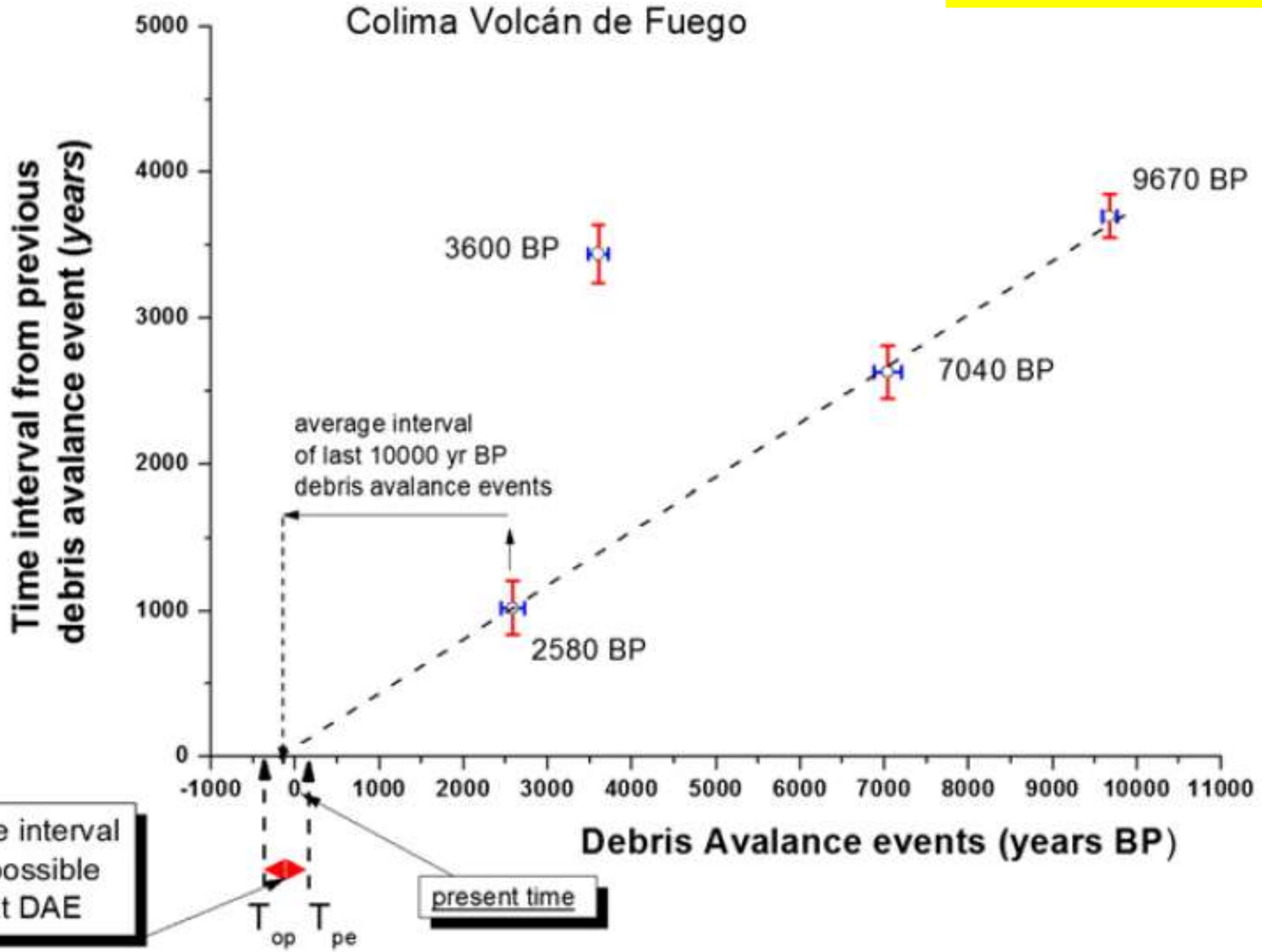
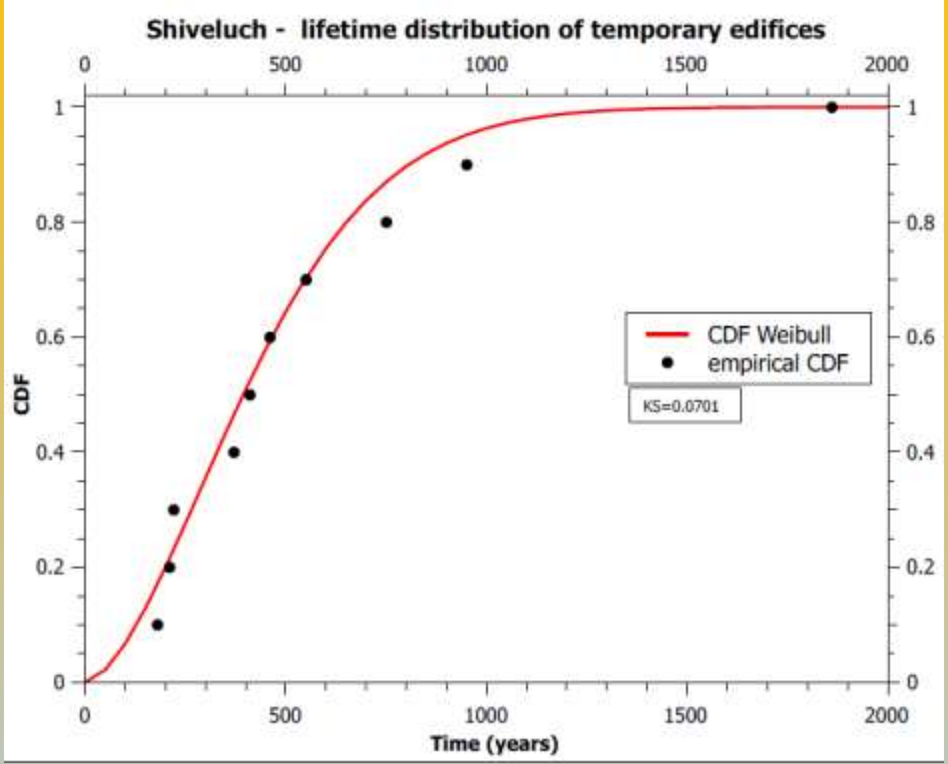


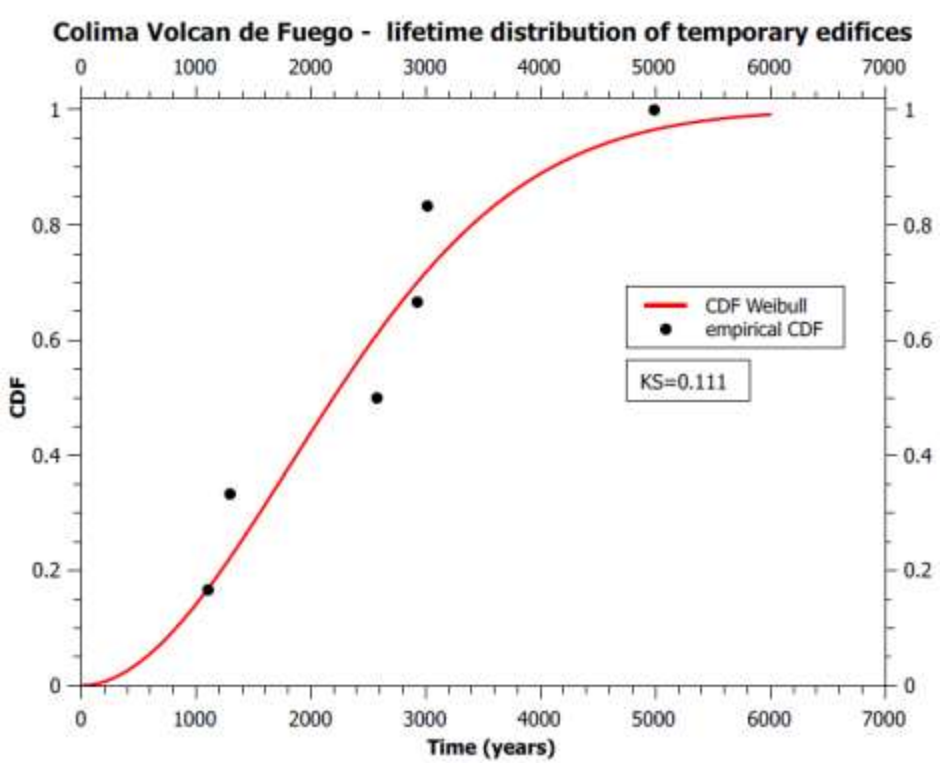
Fig. 6. DAE events vs. time interval from previous debris avalanche event. The projection of a possible scenario for the next DA event is included in the horizontal axis.

Highlights

- **ALEM techniques** applied to Volcán de Colima point to the **W-SW quadrant as potentially the most unstable sector of the edifice** under a wide range of scenarios.
- The VOLCANOFIT application to **Colima shows a n important deficit of volume in the same W-SW quadrant (approx. 0.4 km^3)**.. The **VOLCANOFIT Application to Mt. St. Helens pre-eruption1980** DEM shows the distribution of local mass deficit/surplus association that may be easily correlated with the 1980 incipient flank collapse process. **So there is the possibility that Sector Volume Deficit/Excess anomalies** may be **correlated to a possible mayor relative instability**..
- **The recurrence interval of major collapse events in Colima volcano , during the last 10,000 years, calculated here using a stochastic arithmetic approach, yielding a mean recurrence interval of 2698 yrs, with an uncertainty range of 180 yrs**.
- Our analysis point out an increased **possibility of flank collapse in the interval between -110 yrs and +345 yrs from the present.** This generates a series of scenarios ranging from **optimistic, considering a collapse within the next 345 years**, to **pessimistic, derived from the 110-year delay**.
- The proposed **new approach may be applied to any stratovolcano with a potential of flank collapse and for his future hazard assessments.**

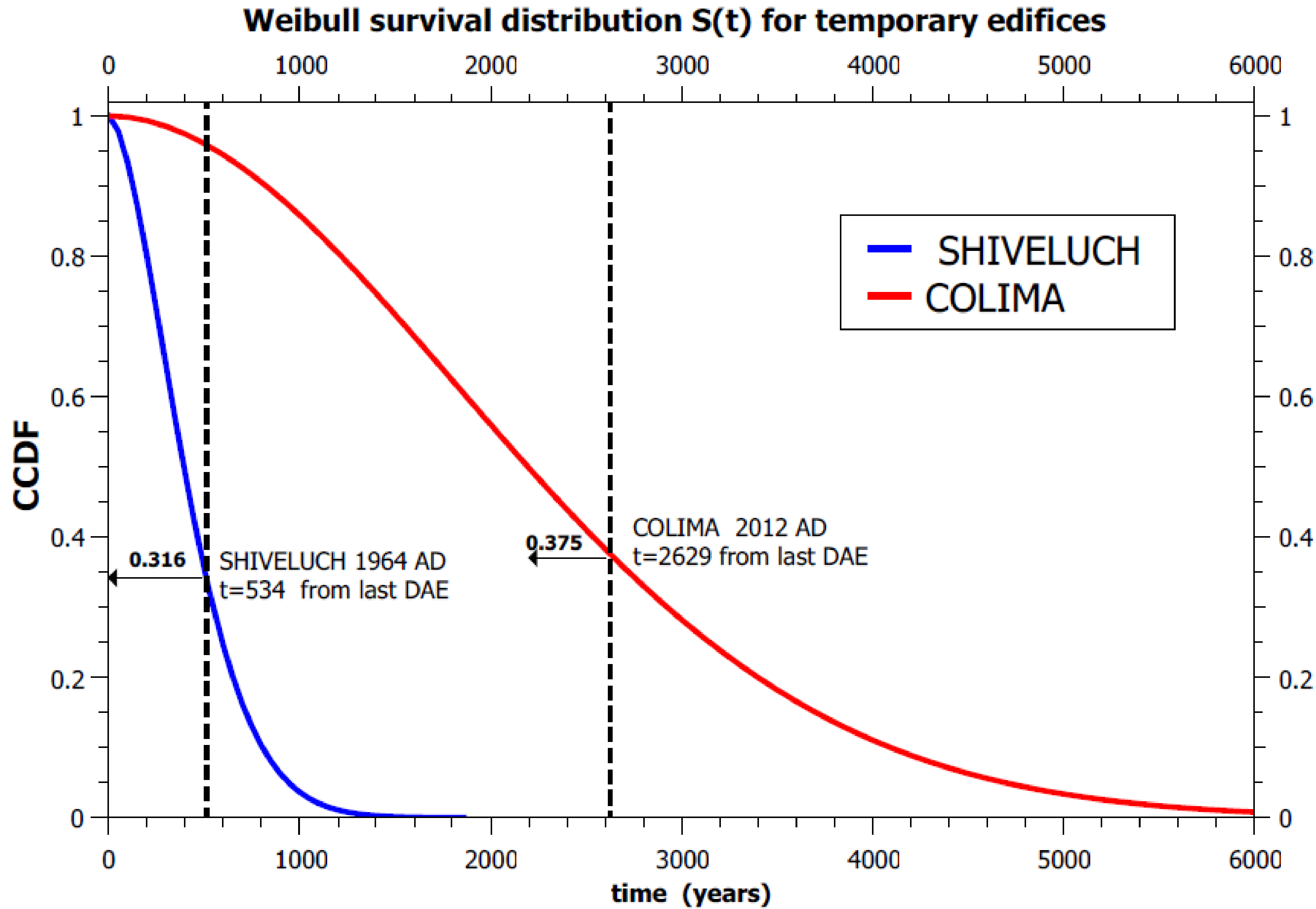
Da Borselli e Sarocchi 2012 in “Cities on Volcanoes 2012”
7th international volcanological cogress





Non linear fitting of empirical CDF (lifetime distribution) of Shiveluch and Colima temporary edifices lifetime By Weibull CDF

Da Borselli e Sarocchi 2012 in “Cities on Volcanoes 2012”



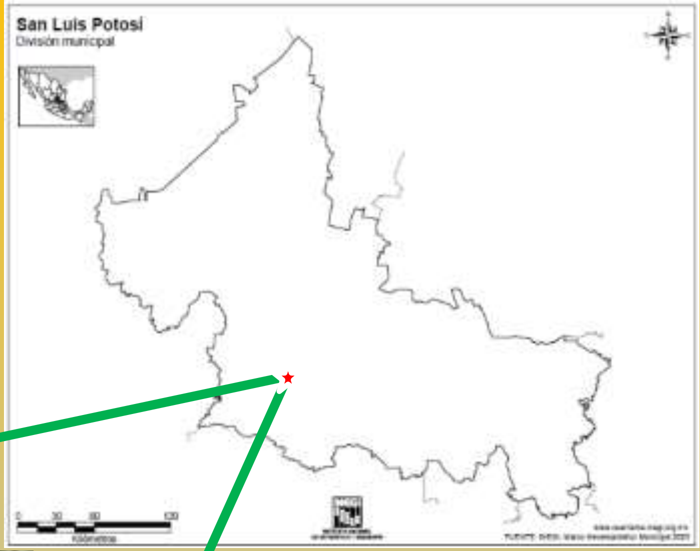
Progetti attuali

- **Estudio geotécnico y hidrologico por la evaluación del peligro geomorfológico de la sierra de San Miguelito, SAN Luis Potosí (SLP) (2012-2013)(PROMEP uaslp-ptc-372) . (Scientific Coordinator dr. Lorenzo)**

- **Modelado de procesos hidrológico, dinámica de hidrofobicidad e infiltración, para su aplicación en la evaluaciones del riesgo debido a inundaciones y lahares: aplicación en la ciudad de San Luis Potosì y en el Volcán De Colima (2013-2015)(CONACYT-Ciencia Basica-2012-01 -184060) (Scientific Coordinator dr. Lorenzo Borselli)**

Area di studio

Estudio geotécnico y hidrologico por la evaluación del peligro geomorfológico de la sierra de San Miguelito, SAN Luis Potosí (SLP) (2012-2013)(PROMEP uaslp-ptc-372)

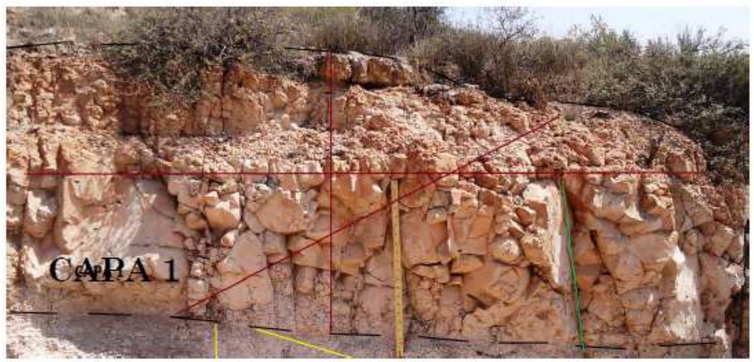


Area di studio sierra san miguelito SLP

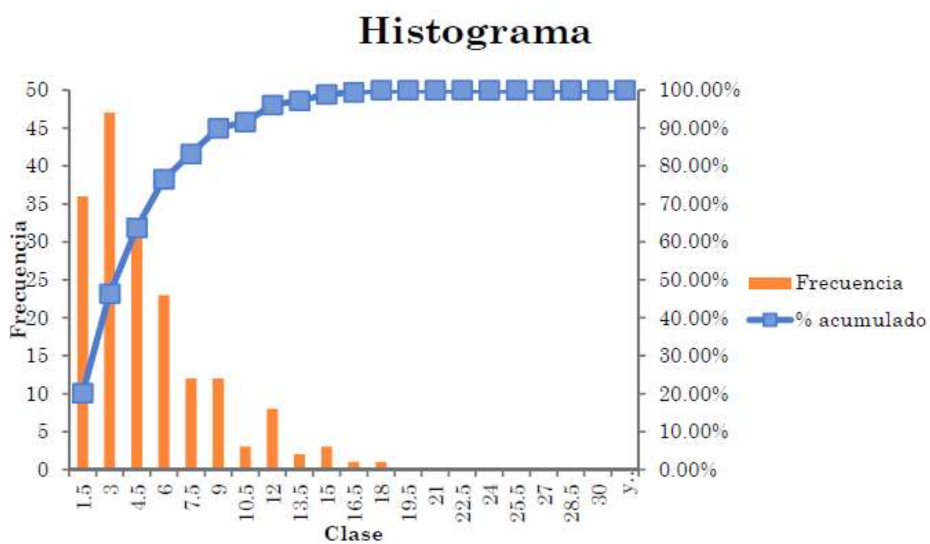
Asociar las propiedades geomecánicas de los macizos rocosos y suelos, a zonas de peligros geomorfológicos, con **elaboración de mapas** de caída de bloques, flujos de detritos, derrumbes e inundaciones y otros procesos que están modificando la superficie de la porción ubicada al noreste y centro de la Sierra de San Miguelito, San Luis Potosí,

Obbiettivo del progetto

SITIO 4, CAPA 1



Columna1	
Media	4.50872376
Error típico	0.31714616
Mediana	3.458
Moda	8.15
Desviación estánd	4.2667652
Varianza de la mu	18.2052853
Curtosis	11.572553
Coeficiente de as	2.76683476
Rango	28.989
Mínimo	0.607
Máximo	29.596
Suma	816.079
Cuenta	181
IQ	4.0305
n	180
h	1.4277065 diaconis h

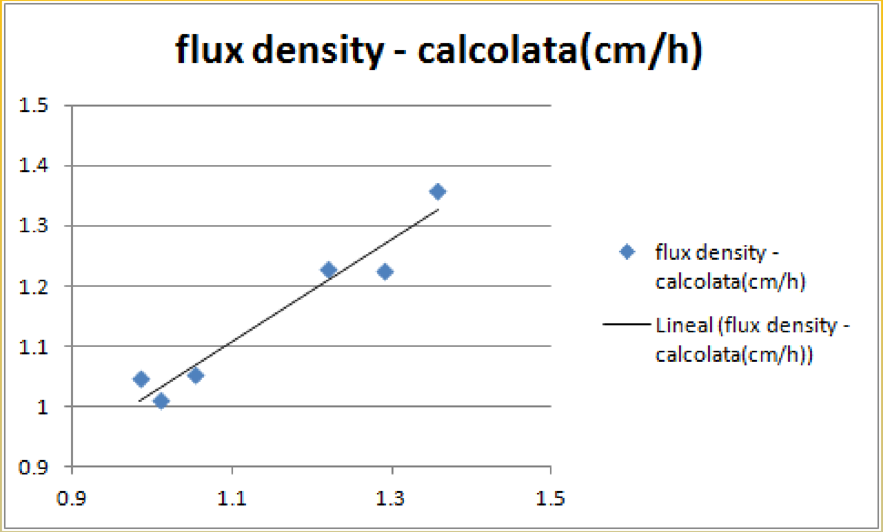


Portable drip infiltrometer
(PDI) Modificato

Misure di Ks (mm/h) e
net capillary drive (G)

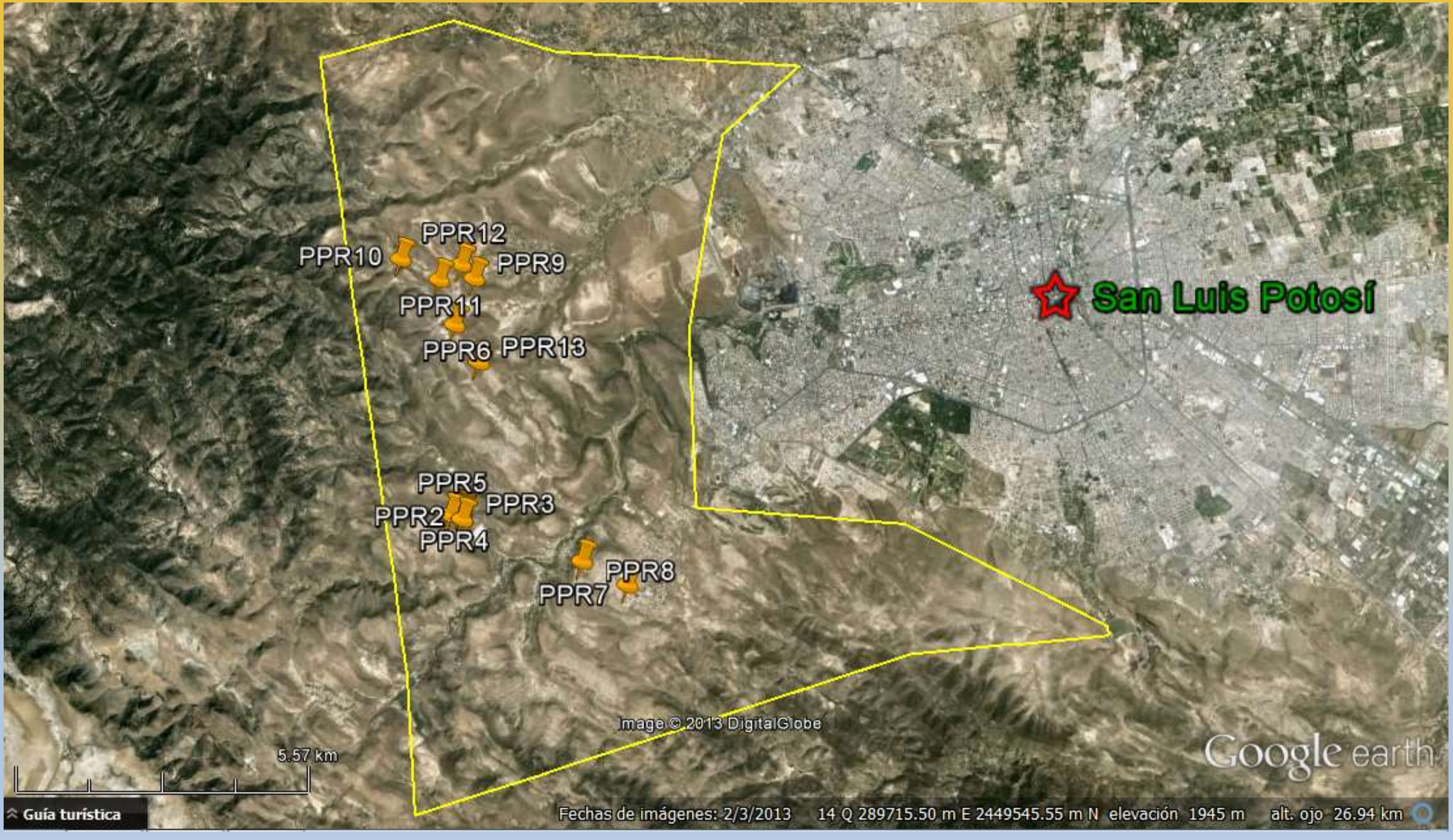
Area di studio sierra san miguelito SLP
Misure di infiltrazione

Ks (mm/h)	8.528446283
G(mm)	404.0117575



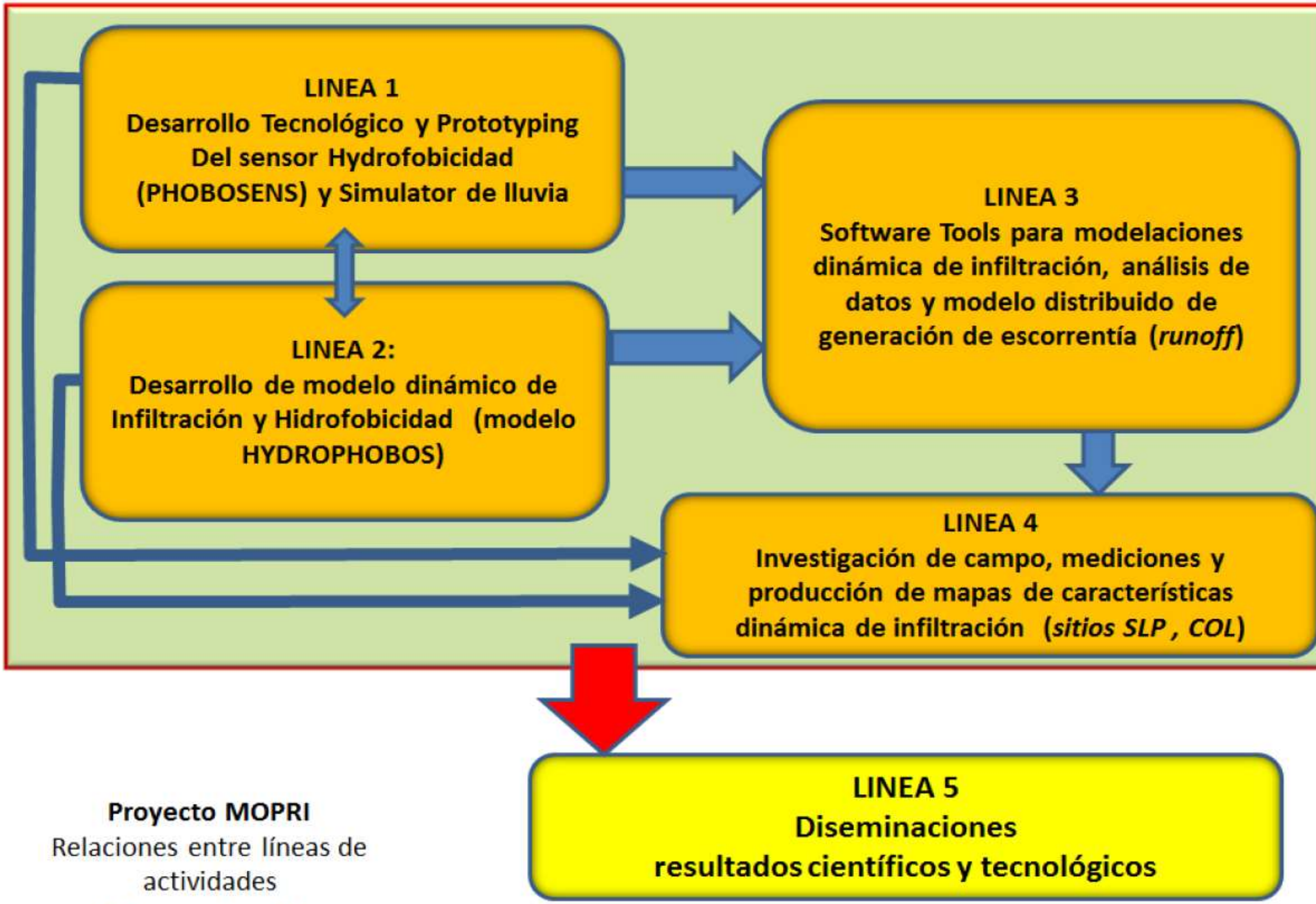
Modello di infiltrazione sferica, Warrick 1968
Con inversione numérica non lineare per
Determinare i principali parametri idraulici
Di infiltrazione

Ubicazione prove di permeabilita' superficiale con PDI



Modelado de procesos hidrológico, dinámica de hidrofobicidad e infiltración, para su aplicación en la evaluaciones del riesgo debido a inundaciones y lahares: aplicación en la ciudad de San Luis Potosì y en el Volcán De Colima (2013-2015)(CONACYT-Ciencia Basica-2012-01 -184060)

Progetto MOPRI



Proyecto MOPRI
Relaciones entre líneas de actividades científicas y tecnológicas

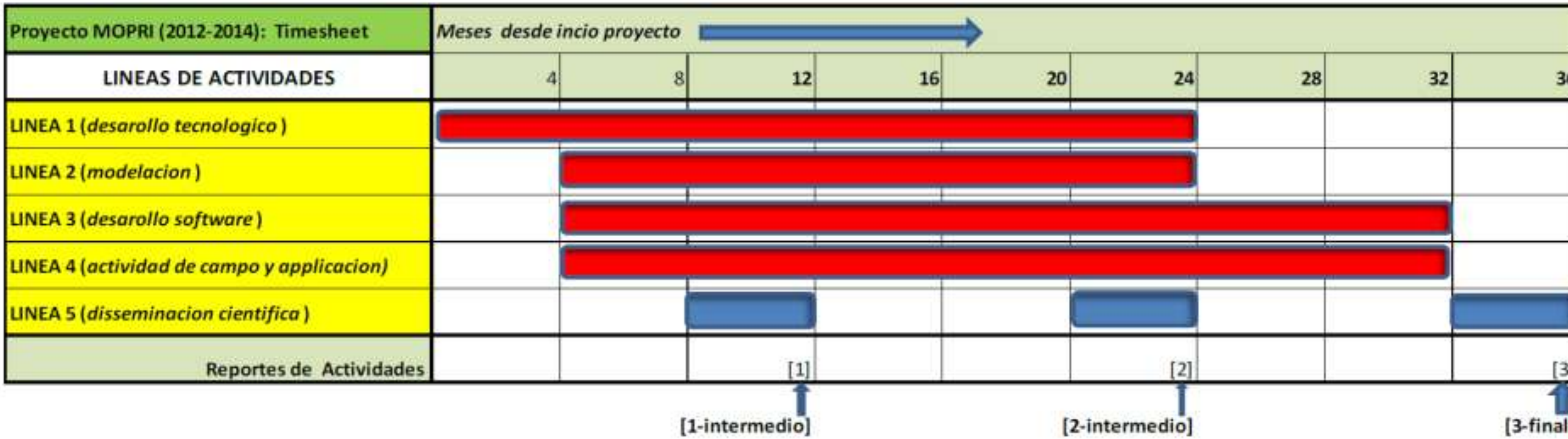


Figura 2: Desarrollo temporal (Ghant chart) Proyecto MOPRI,

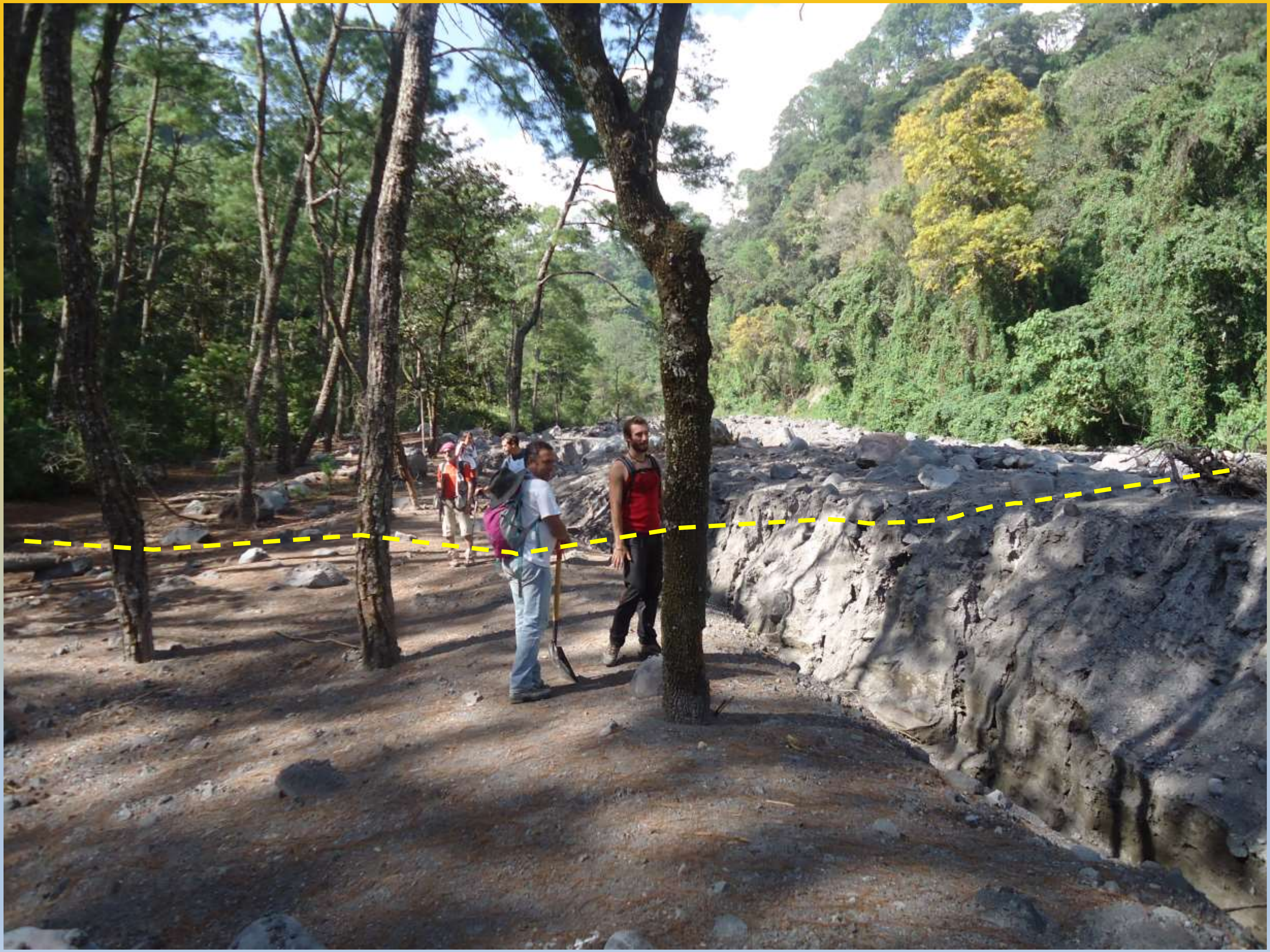
Collaborazioni con UNAM (mexico) e CNR-IRPI (Dino Torri)

Tesi di dottorato 2012-2016: Azalea Ortiz : *Modelado de conectividad y contribución de escorrentía superficial lateral en la dinámica de flujos granulares de áreas volcánicas*

Altri possibili dottorandi…

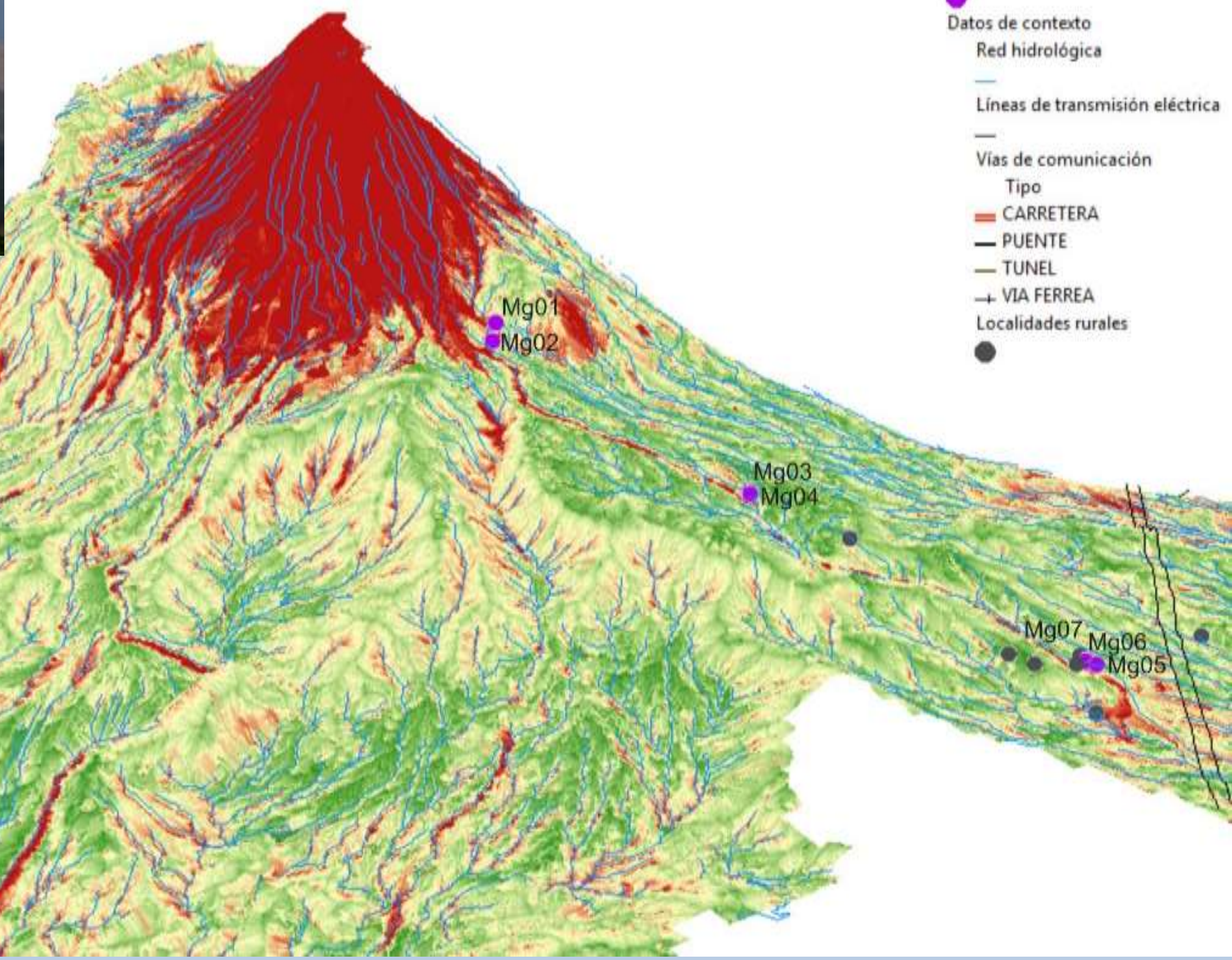
Colima Barranca la lumbre lahar ottobre 2011

Barranca montegrande lahar ottobre 2011



Mappa índice di connettivita' e ubicazione Delle prove di permeabilita' eseguite nella campagan maggio 2013

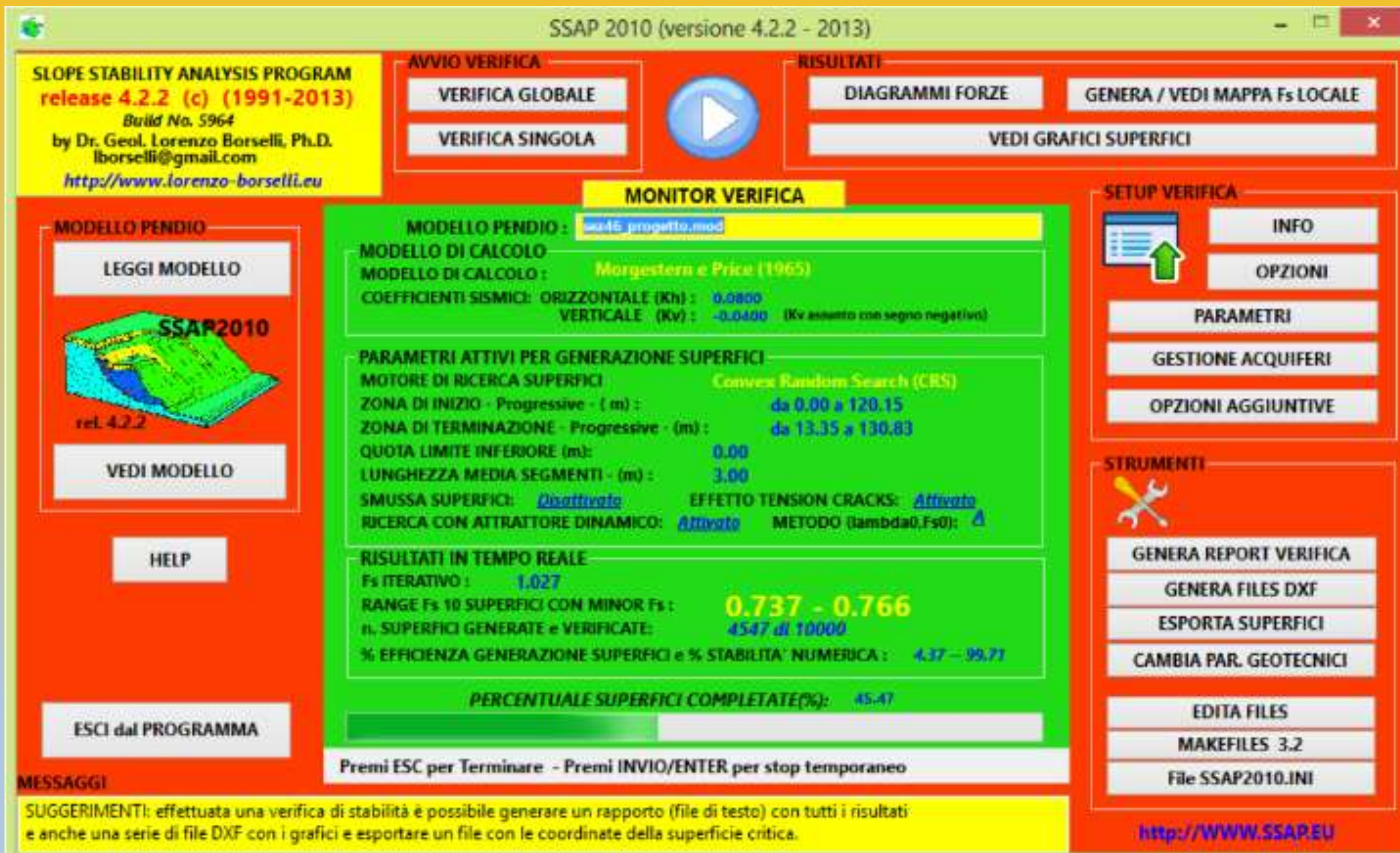
Basato su Borselli eta la. 2008 e Cavalli et al. 2013



Software tools..

- SSAP2010 rel 4.2.2 (2013)
- DECOLOG 4.0.4 (2002-2013)
- Kuery 1.3 (2009-2012)
- PESERA-L (2010-2013)

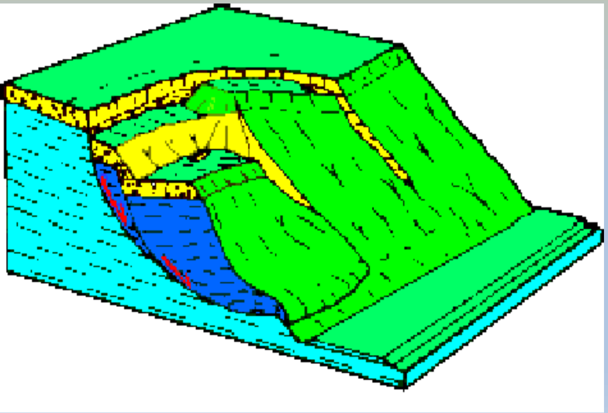
SSAP 2010


SSAP 2010 (versione 4.2.2 - 2013)
SLOPE STABILITY ANALYSIS PROGRAM
release 4.2.2 (c) (1991-2013)
Build No. 5964
by Dr. Geol. Lorenzo Borselli, Ph.D.
lborselli@gmail.com
http://www.lorenzo-borselli.eu
AVVIO VERIFICA
VERIFICA GLOBALE
VERIFICA SINGOLA
RISULTATI
DIAGRAMMI FORZE
GENERA / VEDI MAPPA Fs LOCALE
VEDI GRAFICI SUPERFICI
MONITOR VERIFICA
SETUP VERIFICA
INFO
OPZIONI
PARAMETRI
GESTIONE ACQUIFERI
OPZIONI AGGIUNTIVE
MODELLO PENDIO
LEGGI MODELLO
SSAP2010
rel. 4.2.2
VEDI MODELLO
HELP
ESCI dal PROGRAMMA
MODELLO PENDIO :
MODELLO DI CALCOLO
MODELLO DI CALCOLO :
Morgestern e Price (1965)
COEFFICIENTI SISMICI: ORIZZONTALE (Kh) : 0.0800
VERTICALE (Kv) : -0.0400
PARAMETRI ATTIVI PER GENERAZIONE SUPERFICI
MOTORE DI RICERCA SUPERFICI
Convex Random Search (CRS)
ZONA DI INIZIO - Progressive - (m) : da 0.00 a 120.15
ZONA DI TERMINAZIONE - Progressive - (m) : da 13.35 a 130.83
QUOTA LIMITE INFERIORE (m): 0.00
LUNGHEZZA MEDIA SEGMENTI - (m) : 3.00
SMUSSA SUPERFICI: Disattivato
EFFETTO TENSION CRACKS: Attivato
RICERCA CON ATTRATTORE DINAMICO: Attivato
METODO (lambda0,Fs0):
RISULTATI IN TEMPO REALE
Fs ITERATIVO : 1.027
RANGE Fs 10 SUPERFICI CON MINOR Fs : 0.737 - 0.766
n. SUPERFICI GENERATE e VERIFICATE: 4547 di 10000
% EFFICIENZA GENERAZIONE SUPERFICI e % STABILITA' NUMERICA : 4.37 -- 99.71
PERCENTUALE SUPERFICI COMPLETATE(%): 45.47
Premi ESC per Terminare - Premi INVIO/ENTER per stop temporaneo
STRUMENTI
GENERA REPORT VERIFICA
GENERA FILES DXF
ESPORTA SUPERFICI
CAMBIA PAR. GEOTECNICI
EDITA FILES
MAKEFILES 3.2
File SSAP2010.INI
MESSAGGI
SUGGERIMENTI: effettuata una verifica di stabilità è possibile generare un rapporto (file di testo) con tutti i risultati
e anche una serie di file DXF con i grafici e esportare un file con le coordinate della superficie critica.
http://WWW.SSAP.EU

SSAP (*slope stability analysis program*) è un codice di calcolo per la verifica della stabilità dei pendii, mediante il metodo dell'equilibrio limite in modalità avanzata…

La versione attuale, SSAP 2010, è la 4.2.2 (Giugno 2013).
SSAP2010 E' caratterizzato da un <u>utilizzo completamente libero</u> per tutti coloro che, per motivi di studio e lavoro, sono interessati a effettuare verifiche di stabilità dei pendii con rigorosi metodi di calcolo all'equilibrio limite su pendii naturali, artificiali e/o con opere di rinforzo quali (terre armate, palificate, tiranti..).

sito ufficiale SSAP: **http://www.ssap.eu**



SSAP 2010 <u>non è un software commerciale</u>

Software Interamente Freeware

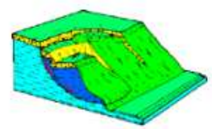
Gratuito e di utilizzo libero

per Privati, Geologi, Ingegneri, Studenti

e Pubbliche Amministrazioni

Vedasi licenza d'uso su:

http://www.ssap.eu/ssap2010licence.pdf



SSAP 2010

"un passo oltre..."

(***SLOPE STABILITY ANALYSIS PROGRAM***)

http://www.ssap.eu

Manuale di Riferimento

Versione 4.2.2 (2013)

by

Dr. Lorenzo Borselli, Geol , Ph.D.*,**

Giugno 2013

* **Docente di Geotecnica e Geologia Applicata**
Facoltà Di Ingegneria
Universitad Autonoma de San Luis Potosì.
San Luis Potosì., Mexico

****Già Ricercatore e Responsabile di Sezione (fino al Luglio 2011)**
C.N.R – IRPI, Istituto di Ricerca per la Protezione Idrogeologica
Via Madonna del Piano 10, 50019 Sesto Fiorentino, Firenze, ITALIA

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http://www.lorenzo-borselli.eu

E-mails:
lborselli@gmail.com
lorenzo.borselli@uaslp.mx

Manuale di 190
Pagine in formato PDF

Caratteristiche base di SSAP 2010

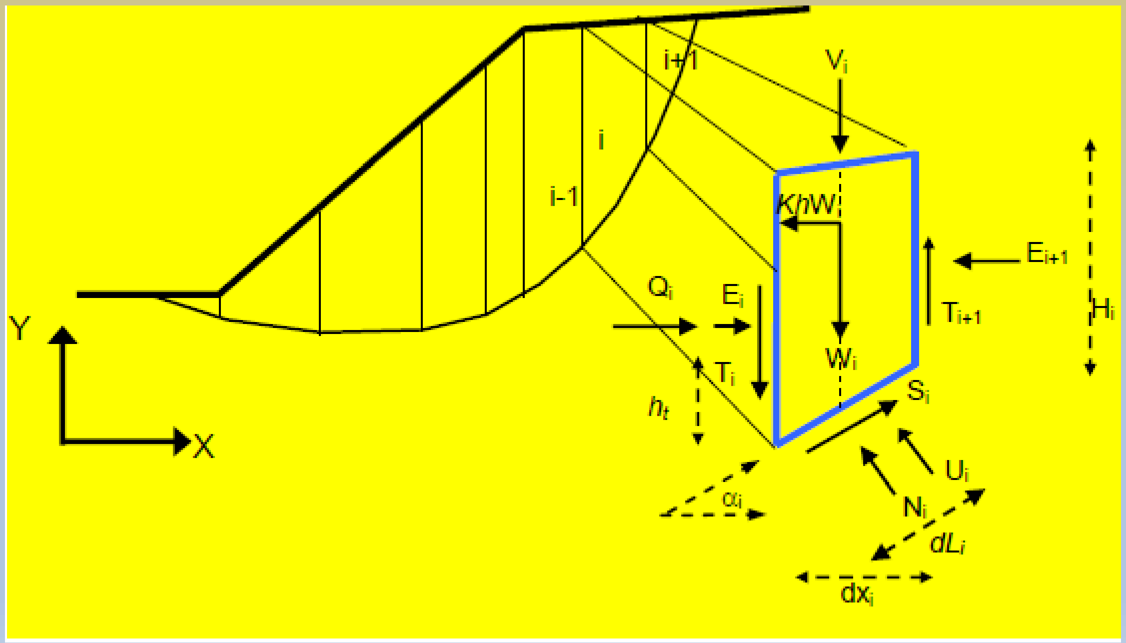
- Verifiche di stabilità dei pendii con il metodo dell'equilibrio limite (Limit Equilibrium Method –LEM)

- Pendii in terreni sciolti e/o con ammassi rocciosi fratturati

- Condizioni sismiche (metodo pseudo statico)

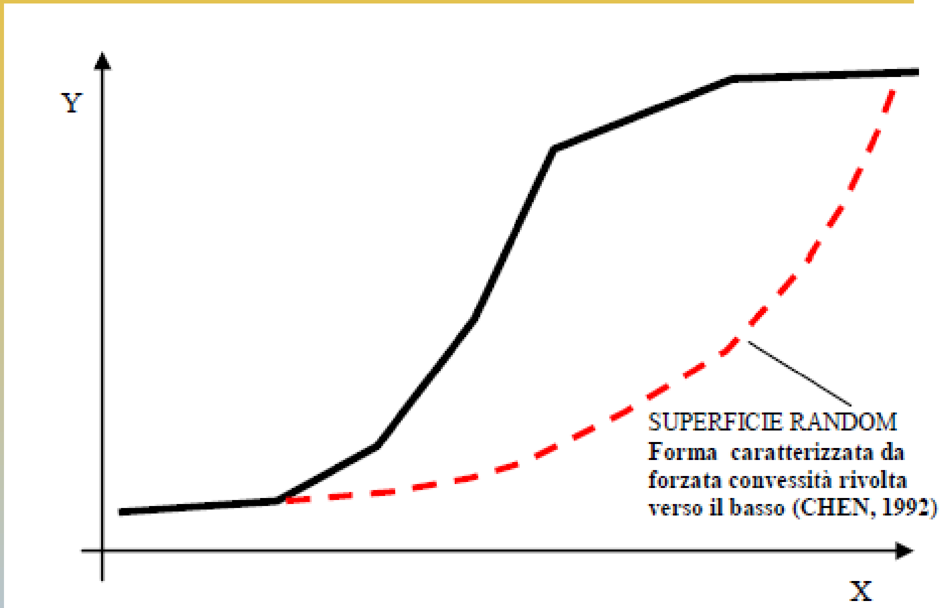
6 metodi di calcolo LEM - RIGOROSI

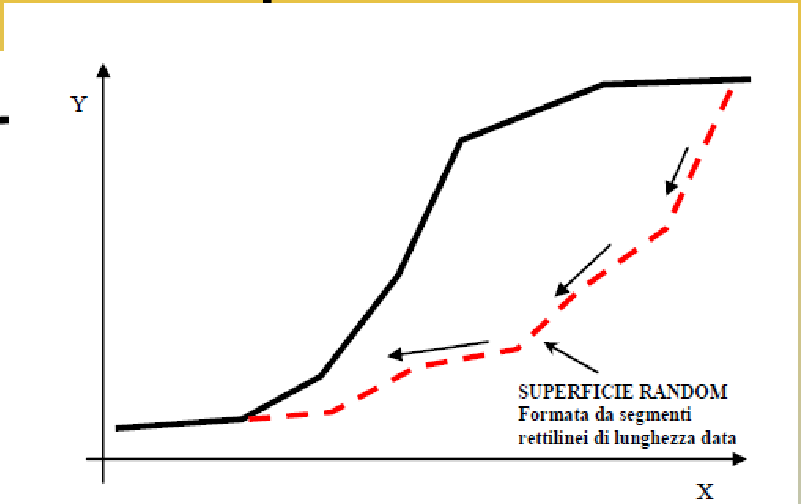
* *Janbu rigoroso(1973);*
* *Spencer (1973)*
* *Sarma I (1973);*
* *Morgenstern & Price (1965);*
* *Correia (1988)*
* *Sarma II (1979)*

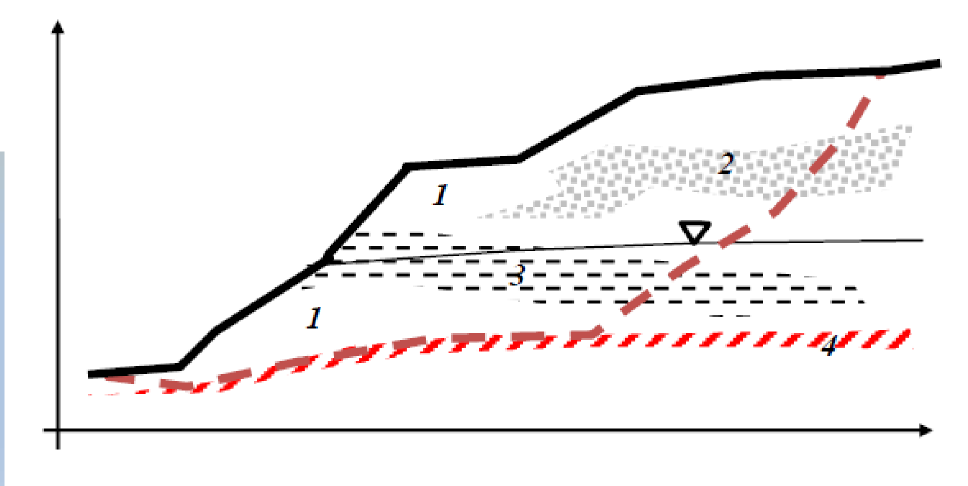


Caratteristiche base di SSAP 2010 … continua

•3 motori di ricerca superfici random (per superfici con Fs minimo) e 3 varianti principali (totale 9 metodologie diverse per generare e ricercare superfici con Fs minimo)

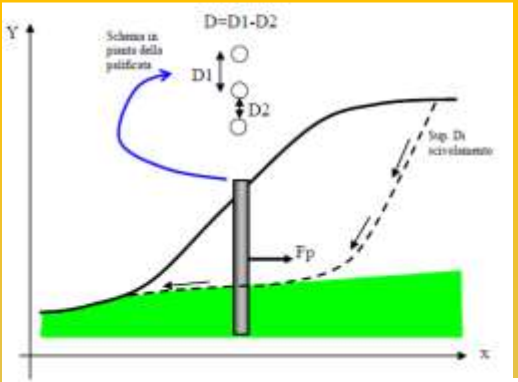


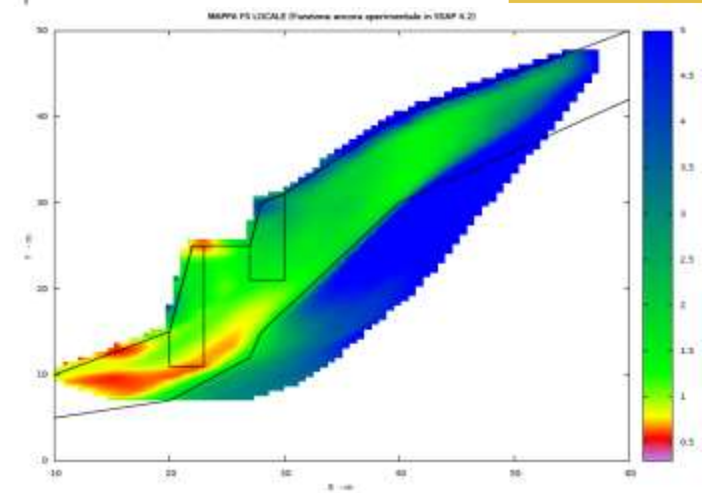


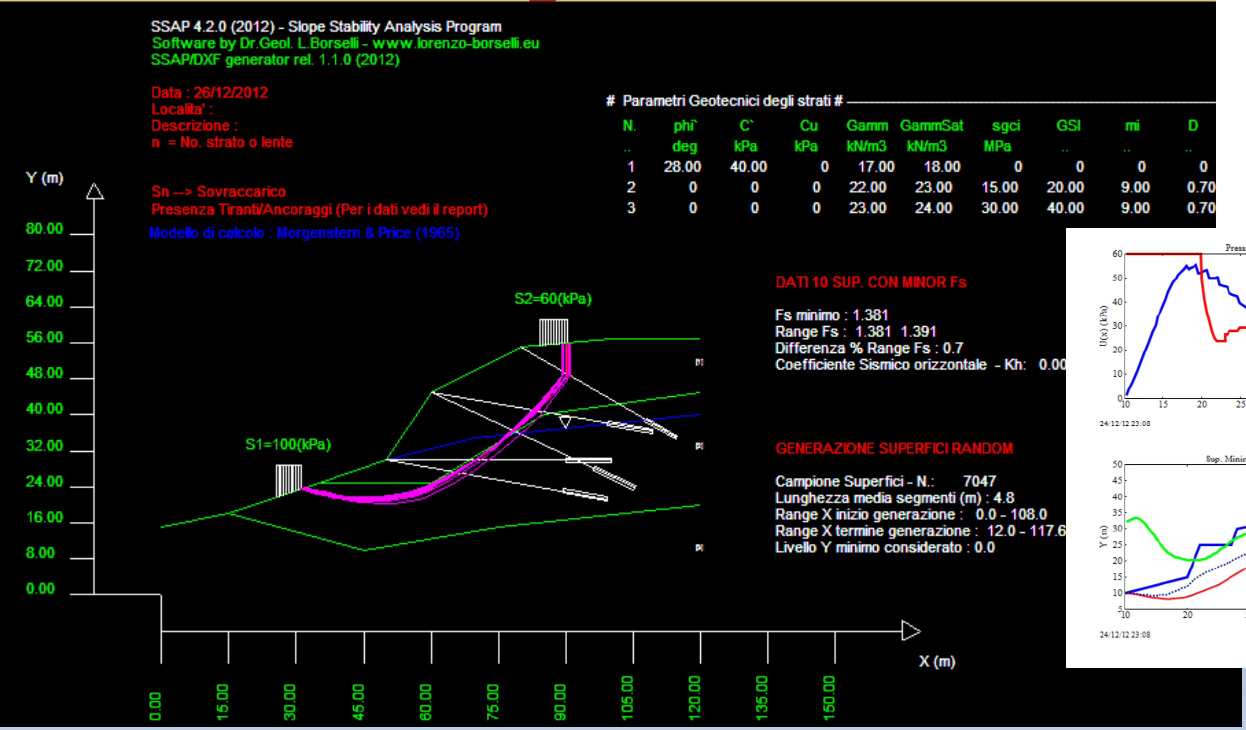


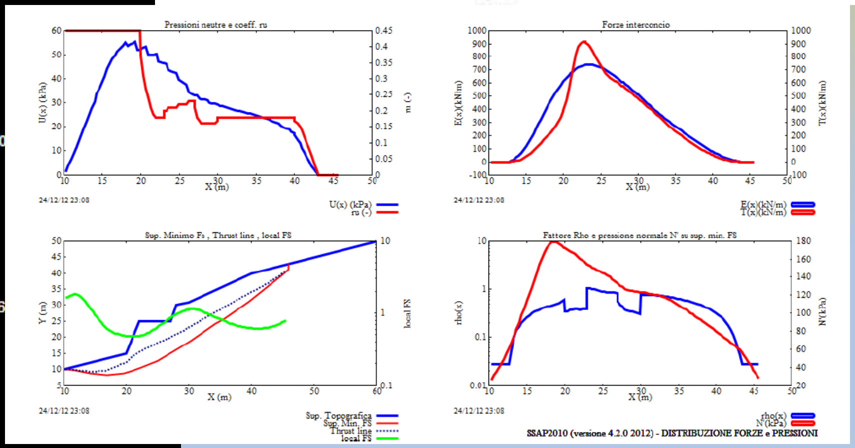
Caratteristiche base di SSAP 2010 … continua

- Strutture di sostegno e rinforzo (muri – tiranti – terre rinforzate con geogriglie/geosintetici – palificate - sovraccarichi)
- Creazione DXF istantanea e visualizzazione grafica









Caratteristiche base di SSAP 2010 … continua

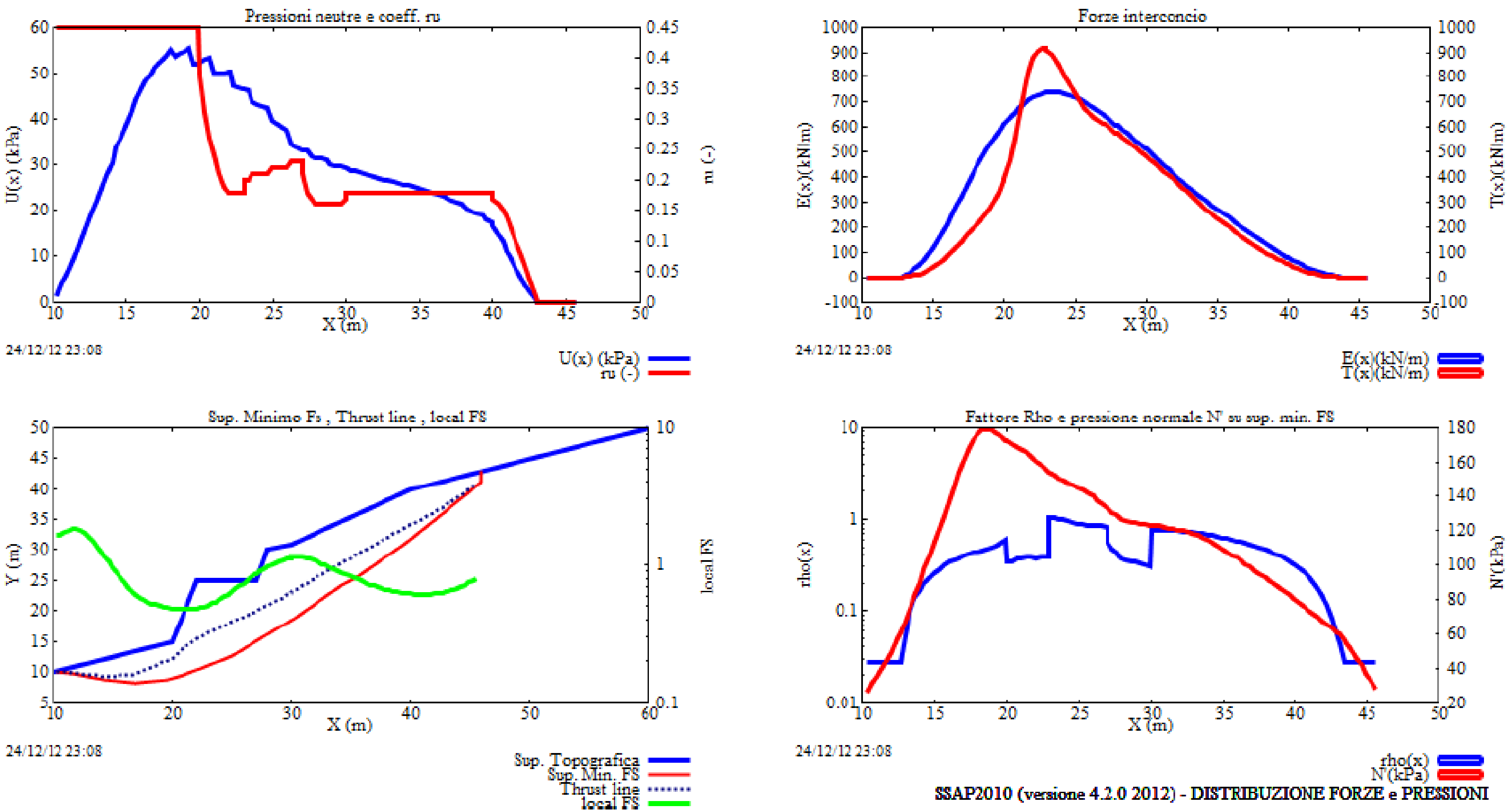
Inoltre:

- finestra con i diagrammi delle pressioni interne, del FS locale, e delle forze interne tangenziali e orizzontali entro la massa in scivolamento soggetta a verifica.(nuovo nella versione 4.0)

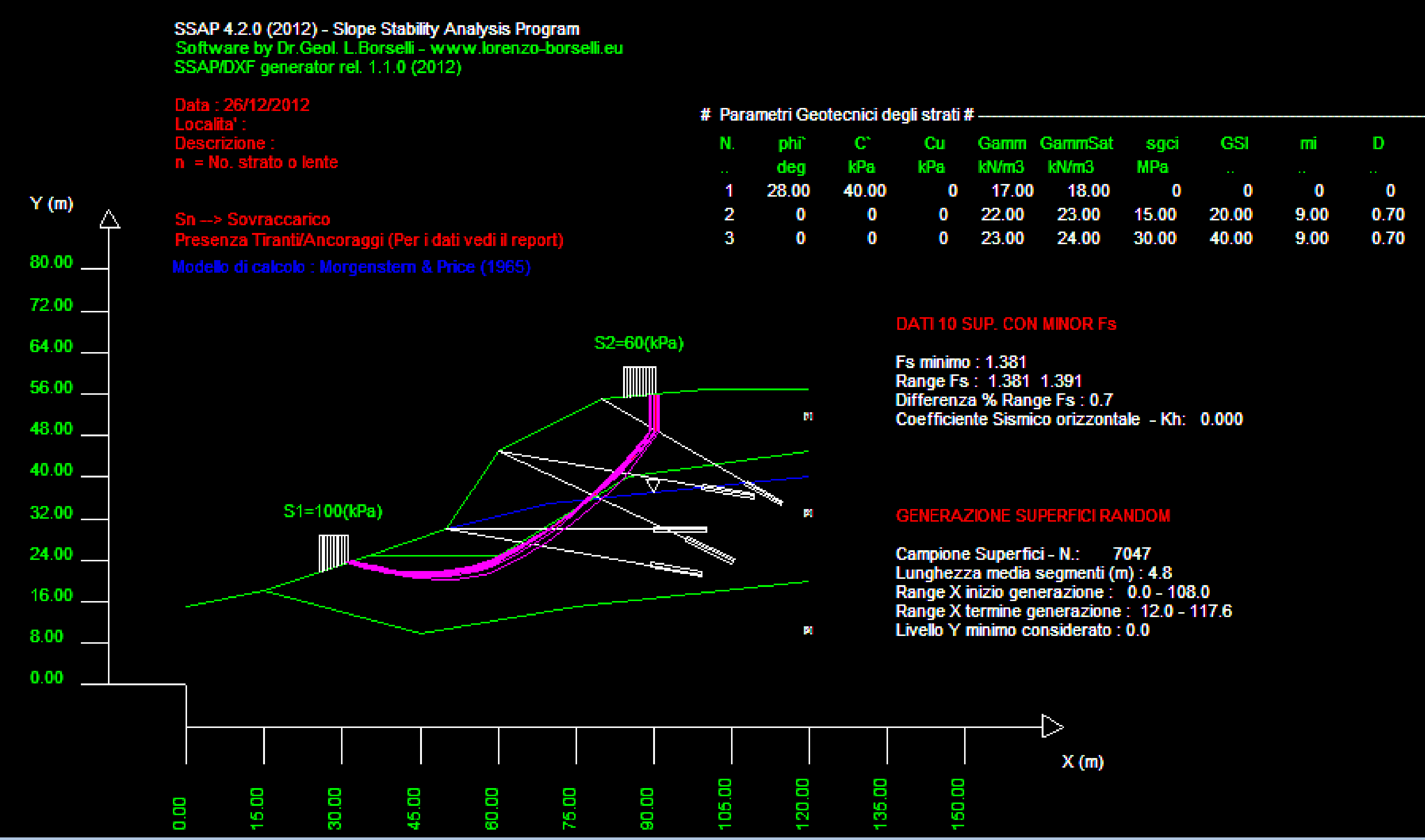
- Utilizzo di nuove strategie computazionali proposte anche da Zhu et al (2003) per eliminare i problemi di convergenza notoriamente esistenti nel metodo di calcolo di Janbu(1973) e negli altri metodi di calcolo rigorosi. Questi algoritmi sono stati ulteriormente sviluppati in modo originale, migliorati, testati e resi più affidabili in SSAP2010.

- Completa verifica di superfici di scivolamento singole definite dall'utente;

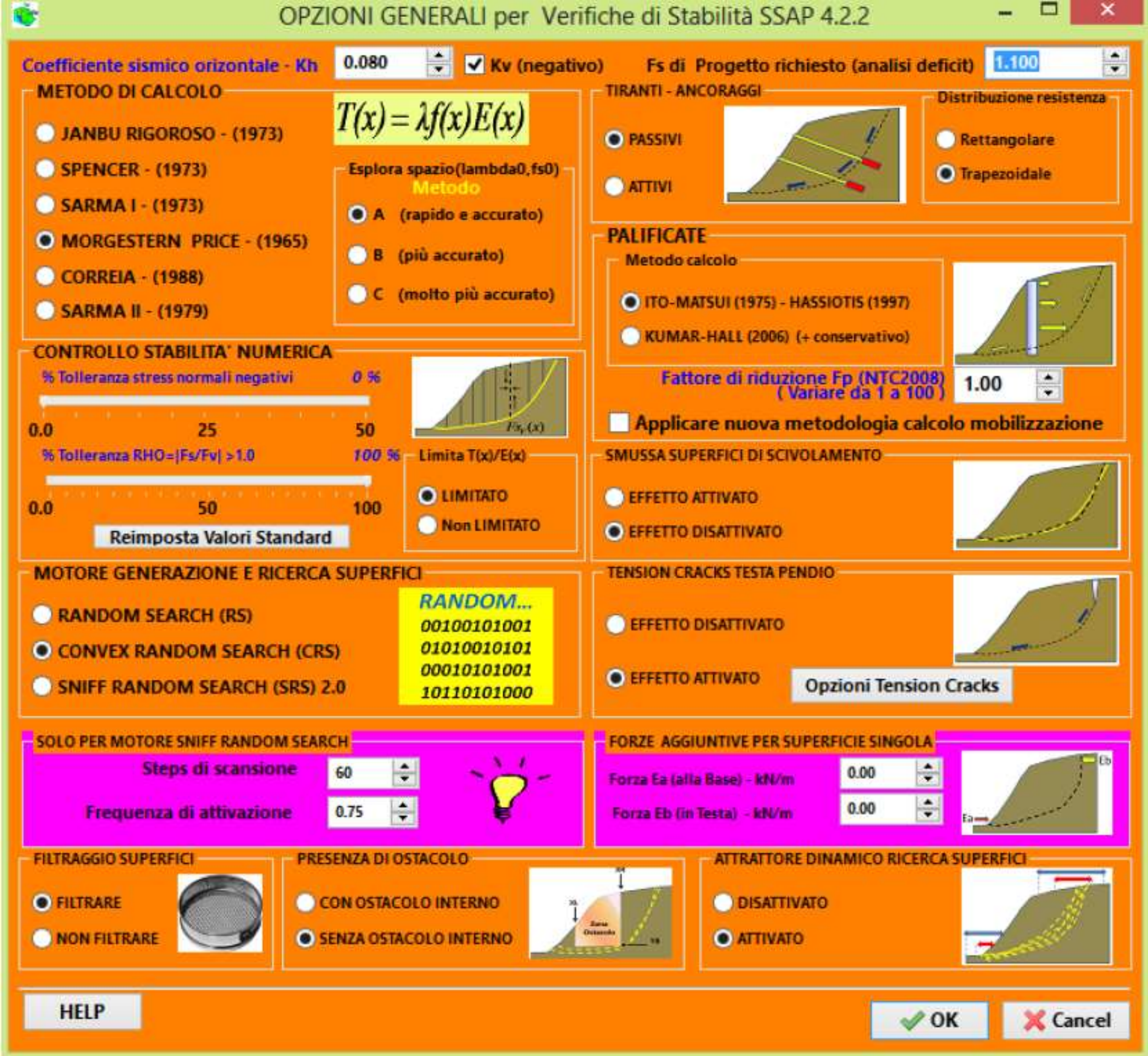
- Reporting in modo testo e grafico (DXF)



Diagrammi distribuzione interna forze e pressioni

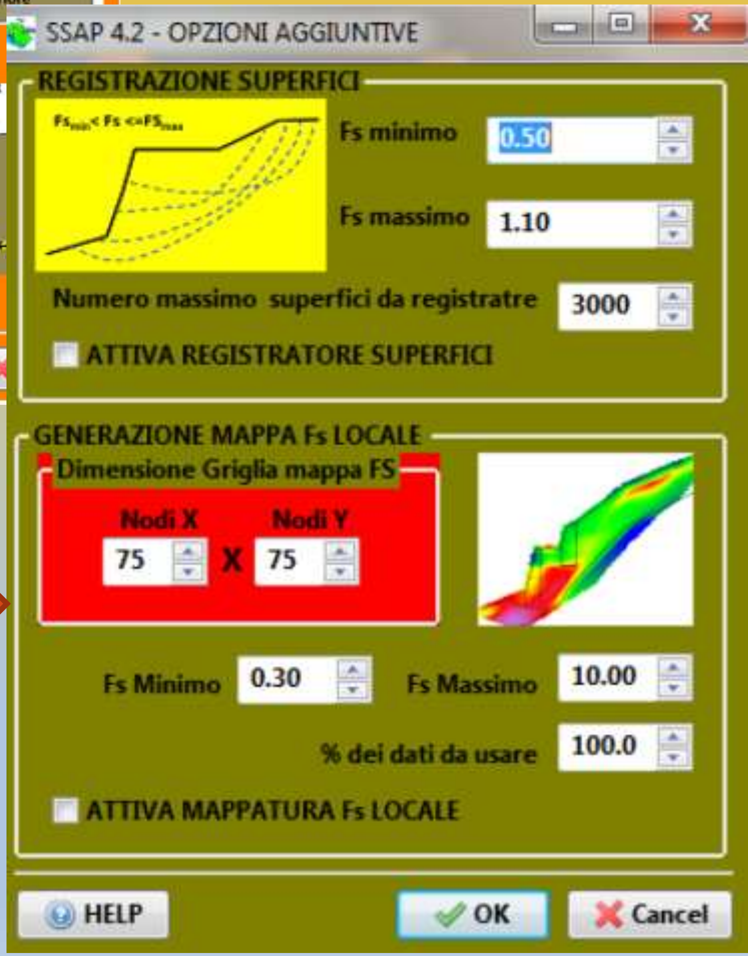


Generazione Grafici in tempo reale in formato DXF esportabili e modificabili.

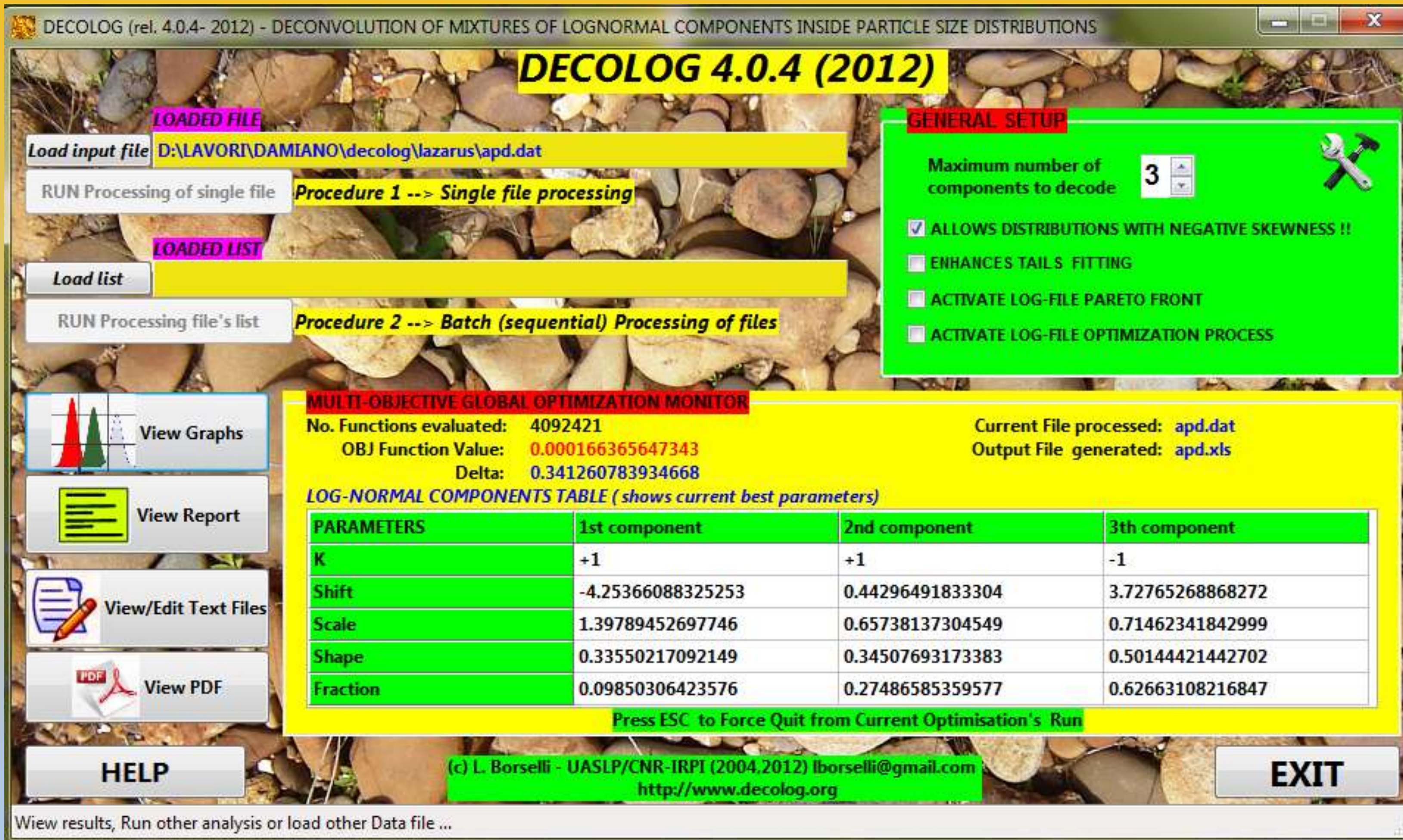


Opzioni per verifica stabilità

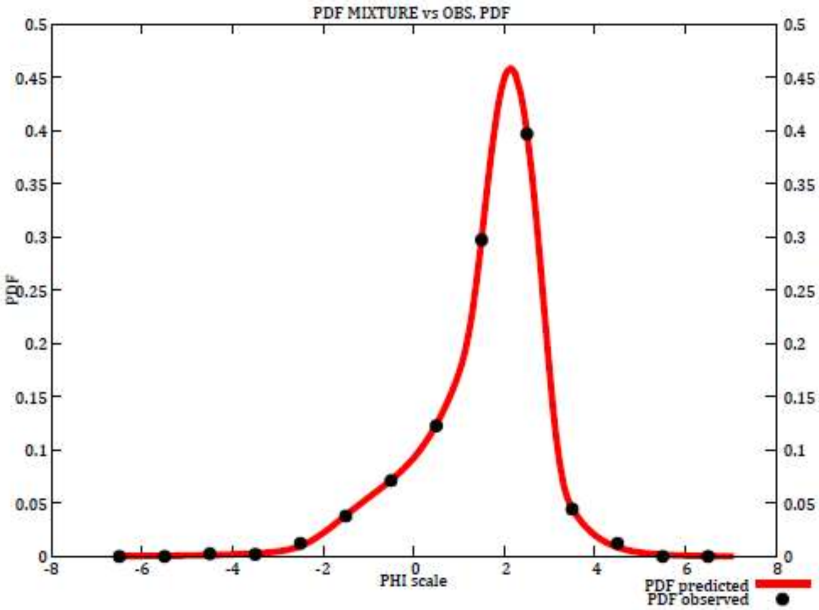
Opzioni aggiuntive e parametri
Modificabili per verifica stabilità

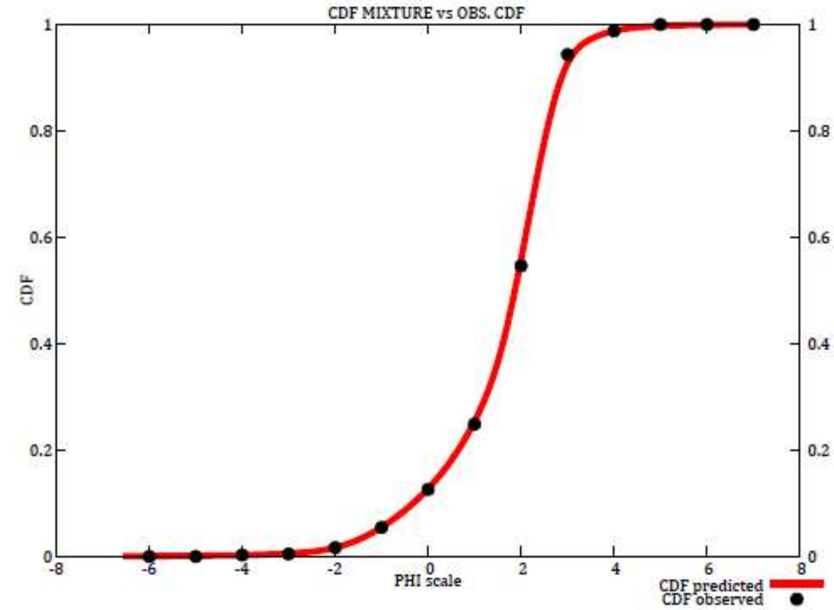


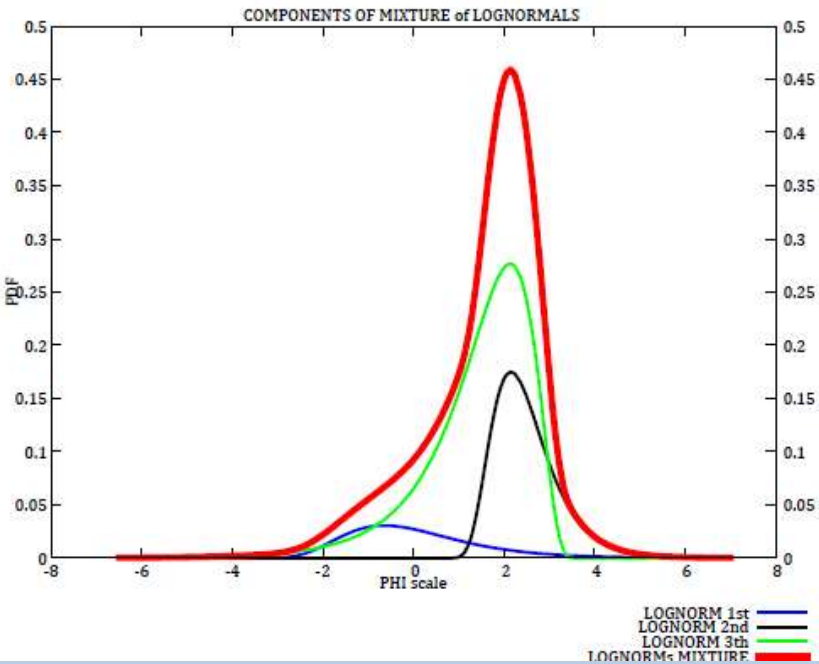
DECONVOLUTION OF MIXTURES
OF LOGNORMAL COMPONENTS
INSIDE PARTICLE SIZE DISTRIBUTIONS (2004,2012)



WWW.DECOLOG.ORG







DECOLOG (rel. 4.0.4 - 2012) - DECONVOLUTION OF MIXTURES OF LOGNORMAL COMPONENTS INSIDE PARTICLE SIZE DISTRIBUTIONS

HTPP://www.decolog.org -By L.Borselli % D.Sarocchi, UASLP(Mexico), lborselli@gmail.com

INPUT DATA FILE: apd.dat

OUTPUT REPORT: apd.xls

Global fitting statistics for CDF:

Model efficiency coefficient EF : 0.9998337

Coefficient of Determination R^2 : 0.9999253

Kolmogorov-Smirnoff difference Ks : 0.0168435

Global fitting statistics for PDF:

Model efficiency coefficient EF : 0.9998336

Coefficient of Determination R^2 : 0.9999327

Statistic from spline resampled Observed CDF (MonteCarlo Method):

Mean	**1.51608**	
Std dev	**1.25764**	**Poorly sorted**
Skewness	**-1.16850**	**Negative skewed**
Kurtosis(normalized)	**2.32304**	**Leptokurtic**

Journal of Volcanology and Geothermal Research 231-232 (2012) 12–23

Contents lists available at SciVerse ScienceDirect

Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

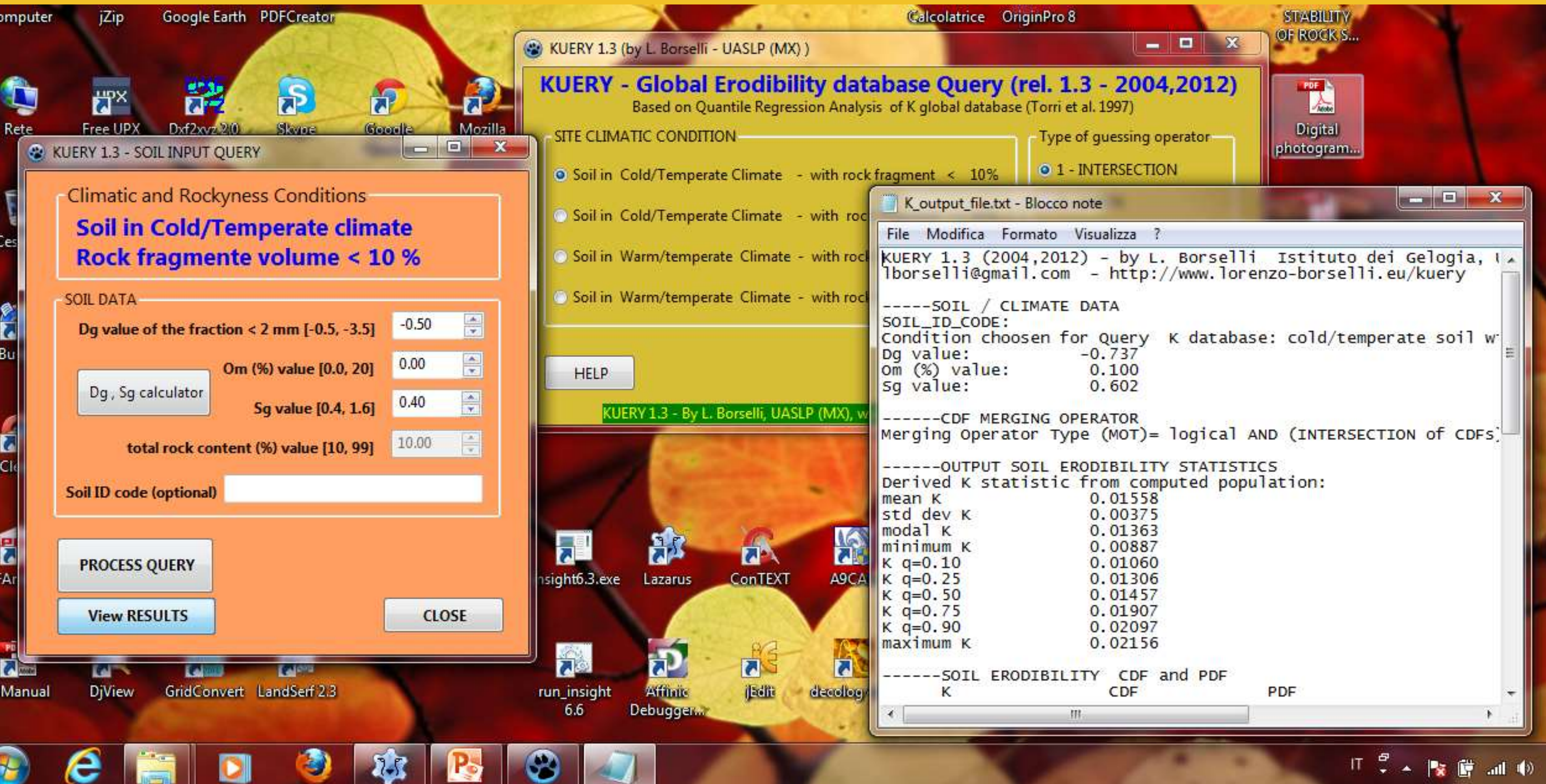
ELSEVIER

Particle interaction inside debris flows: Evidence through experimental data and quantitative clast shape analysis

Lizeth Caballero [a,*], Damiano Sarocchi [b], Lorenzo Borselli [b], Angel I. Cárdenas [c]

[a] *Posgrado en Ciencias de la Tierra, Instituto de Geología, UNAM, Ciudad Universitaria, 04510, Mexico City, Mexico*
[b] *Instituto de Geología/Fac. Ingeniería UASLP, Dr. M. Nava No 5, Zona Universitaria 78240, San Luis Potosí, Mexico*
[c] *Fac. Ingeniería UASLP, Área de Ingeniería Civil, Dr. M. Nava No 8, Zona Universitaria 78240, San Luis Potosí, Mexico*

ERODIBILITA' del SUOLO - KUERY 1.3



www.lorenzo-borselli.eu/kuery

Catena 97 (2012) 85–94

Contents lists available at SciVerse ScienceDirect

Catena

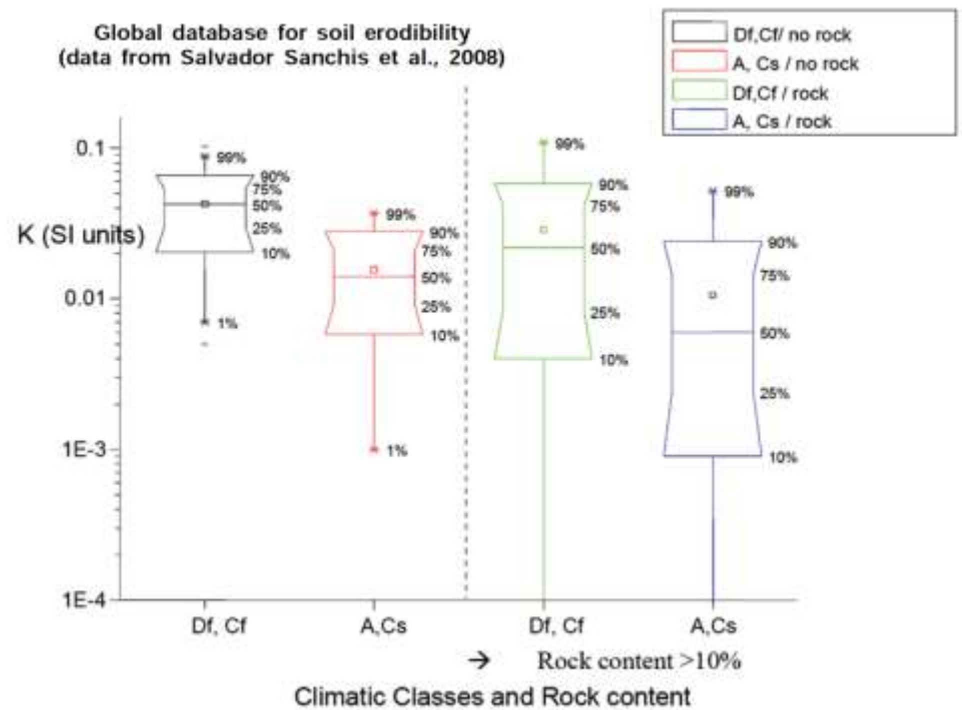
journal homepage: www.elsevier.com/locate/catena

A robust algorithm for estimating soil erodibility in different climates

L. Borselli [a,*], D. Torri [b], J. Poesen [c], P. Iaquinta [d]

[a] Instituto de Geologia/Fac. De Ingenerìa, Universitad Autonoma de San Luis Potosì (UASLP), Av. Dr. Manuel Nava 5, C.P. 78240, San Luis Potosí, SLP, Mexico
[b] CNR-IRPI, Research Institute for Geo-Hydrological Protection, Via Madonna Alta 126, 06128 Perugia, Italy
[c] Division of Geography, KU Leuven, Celestijnenlaan 200E, B-3001 Heverlee, Belgium
[d] CNR-IRPI, Research Institute for Geo-Hydrological Protection, Via Cavour 4-6, 87030 Rende di Cosenza, Italy

Effetto climático sul coefficiente di erodibilita’ del suolo nel database globale



Da Borselli et al. 2009

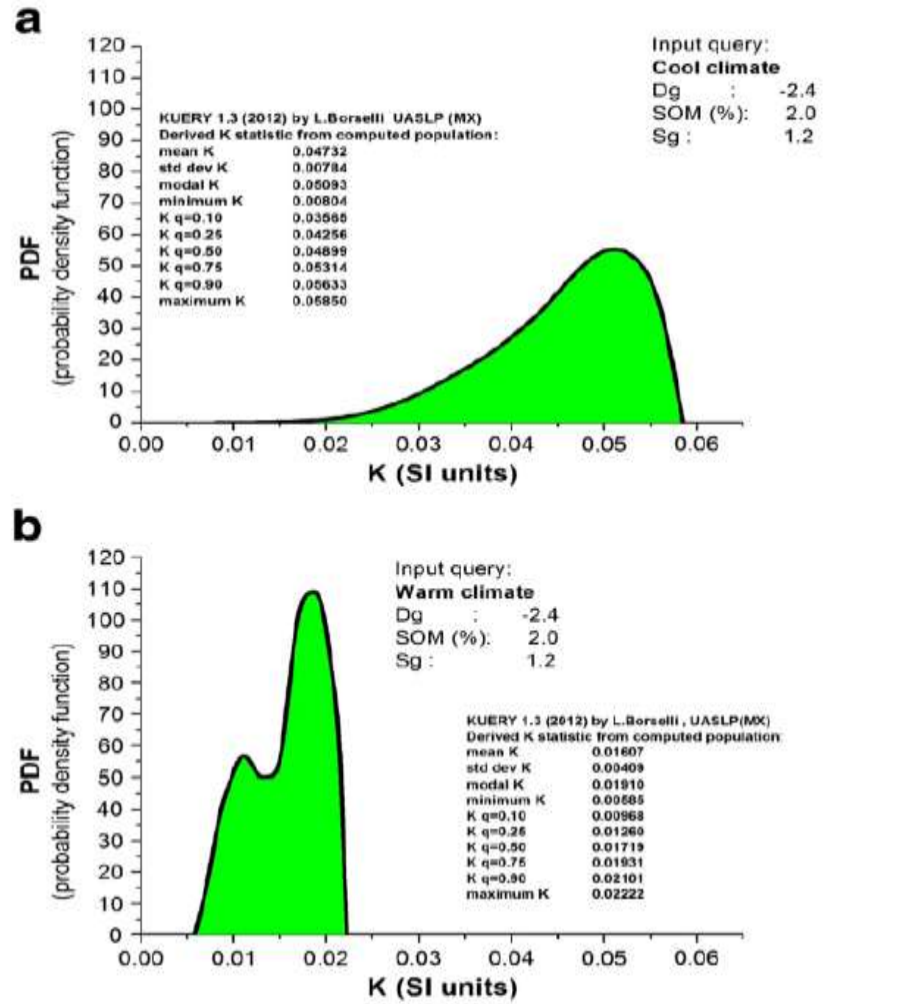
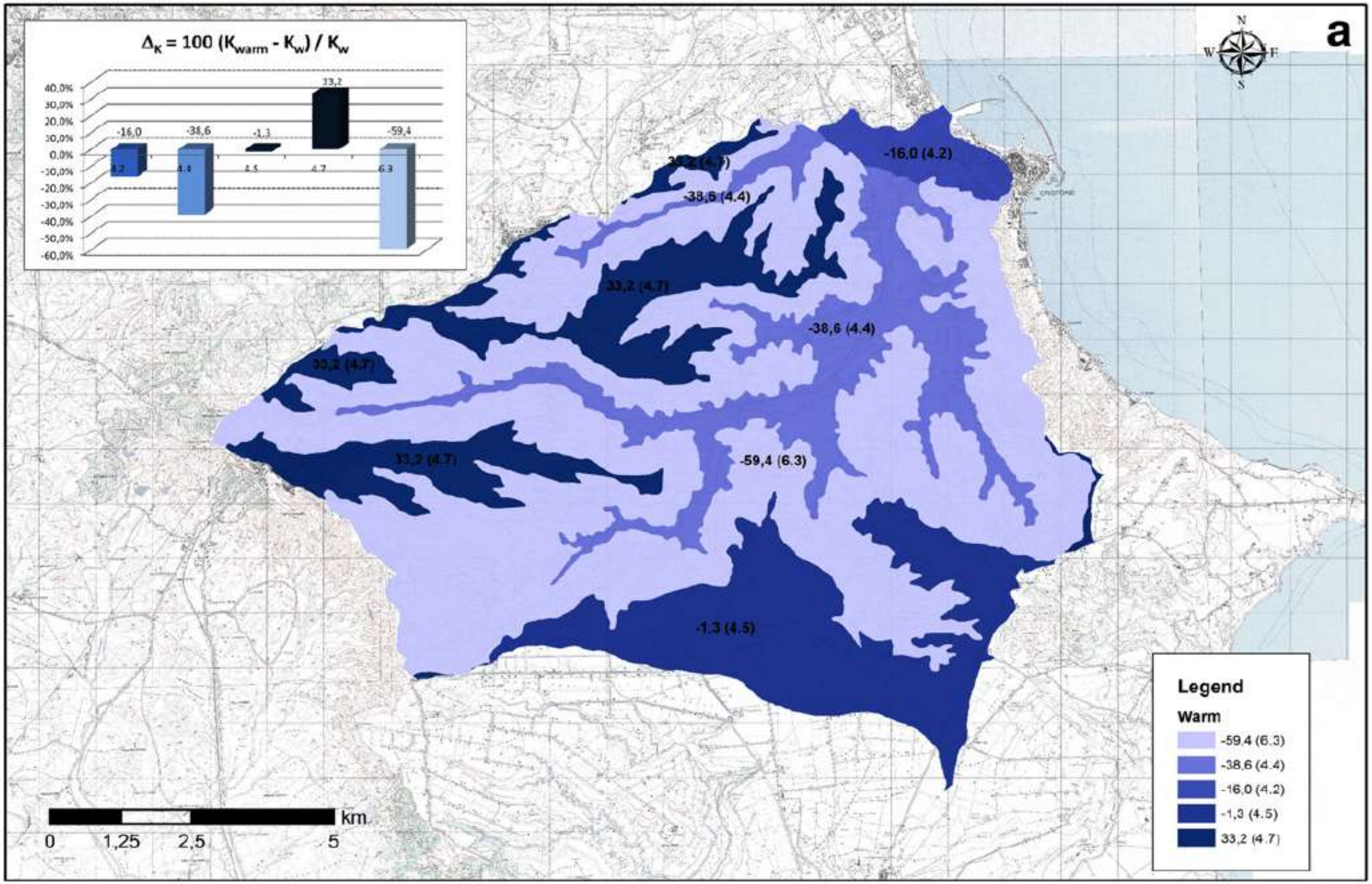


Fig. 3. Probability Density Functions (PDF) produced by KUERY for: a) cool and b) warm climate groups, and rock content < 10%. Input data are identical for both cases. Note the differences in interpolated frequency distributions, despite the fact that input values are the same.

Da Borselli et al. 2012



$\Delta_K = 100 (K_{warm} - K_w) / K_w$
a
N
W
E
S
-16,0 (4.2)
-38,6 (4.4)
33,2 (4.7)
-59,4 (6.3)
-1,3 (4.5)
Legend
Warm
-59,4 (6.3)
-38,6 (4.4)
-16,0 (4.2)
-1,3 (4.5)
33,2 (4.7)
km
0
1,25
2,5
5

DESIRE
A global initiative to combat desertification

Consiglio Nazionale delle Ricerche
irpi

PESERA-L, the shallow landslides contribution to specific sediment yield (SSY), as extensions of the PESERA soil erosion model

L. Borselli(1),
D. Bartolini(1), P. Salvador Sanchis(1),
P. Cassi(1), P. Lollino(2), G. Mitaritonna(2)*
National Research Council (CNR)
Research Institute for Geo-Hydrological Protection (CNR-IRPI)
(1)Via Madonna del Piano 10, 50019, Sesto Fiorentino (Florence), ITALY
(2)CNR-IRPI, viale Amendola 122, 70126 Bari, Italy
borselli@irpi.fi.cnr.it http://www.irpi.fi.cnr.it/borselli.html

Borselli et al. "*PESERA-L, the shallow landslides contribution to specific sediment yield (SSY), as extensions of the PESERA soil erosion model*"
International Conference on Combating Land Degradation in Agricultural Areas (LANDCON 1010) Xi'an China 13-14 oct 2010

Borselli et al. "*PESERA-L, the shallow landslides contribution to specific sediment yield (SSY), as extensions of the PESERA soil erosion model* "
International Conference on Combating Land Degradation in Agricultural Areas (LANDCON 1010) Xi'an China 13-14 oct 2010

The PESERA-L model

shallow landslides (*mudflow, flow slides, Slumps*) can contribute significantly to sediments yield in a watershed (Maquarie and Malet, 2006)

PESERA-L has ben developed as an additional component to PESERA model :

- Assessment of fraction of unstable area inside a land unit (LU)
- Assessment of sediment delivery mass from landslide area to the nearest relevant sink (permanent drainage network , river, road ….).

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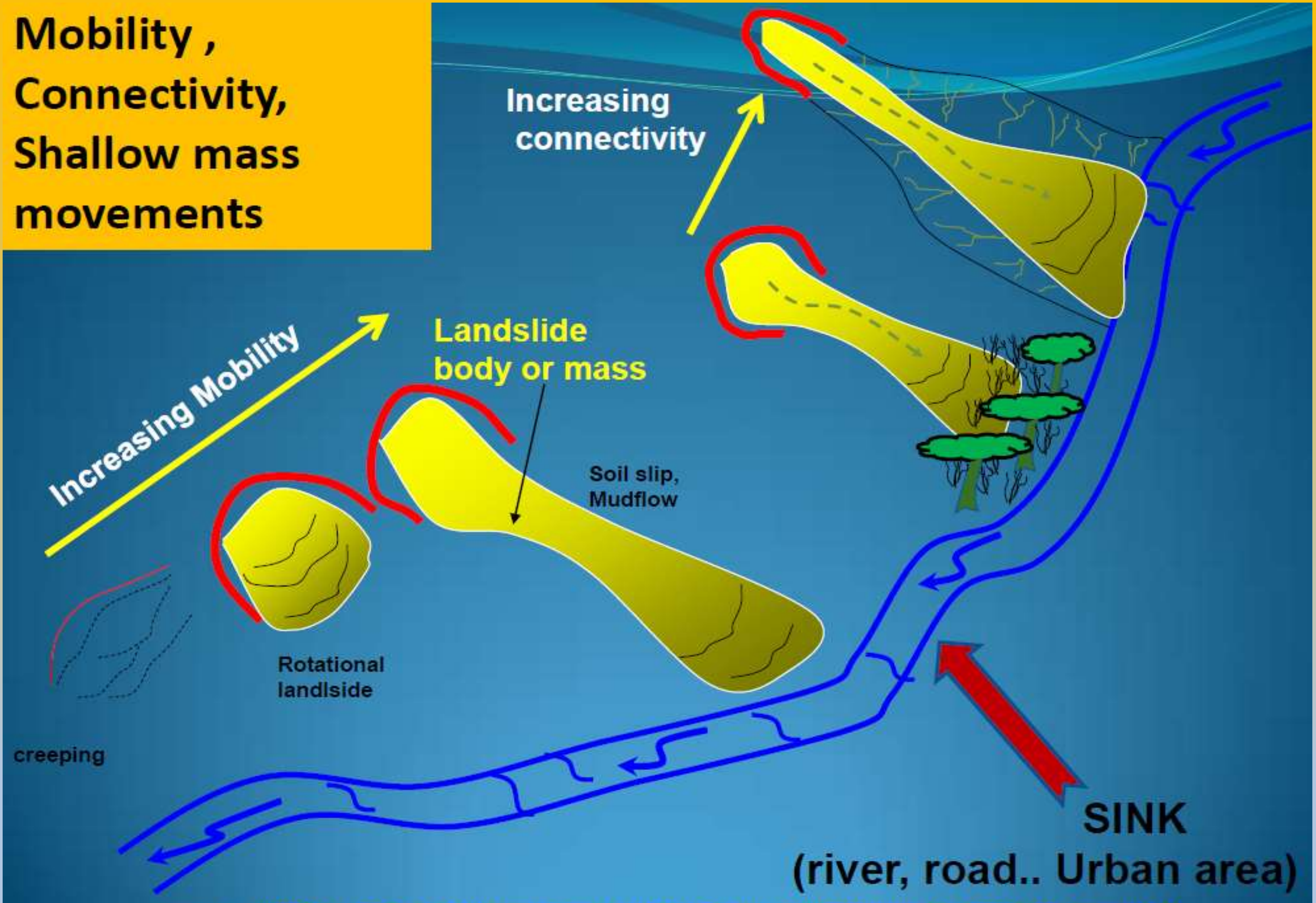
International Conference on Combating Land Degradation in Agricultural Areas (LANDCON 1010) Xi'an China 13-14 oct 2010

Mobility , Connectivity, Shallow mass movements



Borselli et al. "*PESERA-L, the shallow landslides contribution to specific sediment yield (SSY), as extensions of the PESERA soil erosion model* "
International Conference on Combating Land Degradation in Agricultural Areas (LANDCON 1010) Xi'an China 13-14 oct 2010

Exponential distribution model for sediment delivery

Derived by *Miller and Burnett (2008)*

$$SDR_L = e^{-\lambda D_{dn}}$$

$$\lambda = \frac{1}{\overline{L}_R}$$

$$SDR_L = e^{-\frac{D_{dn}}{\overline{L}_R}}$$

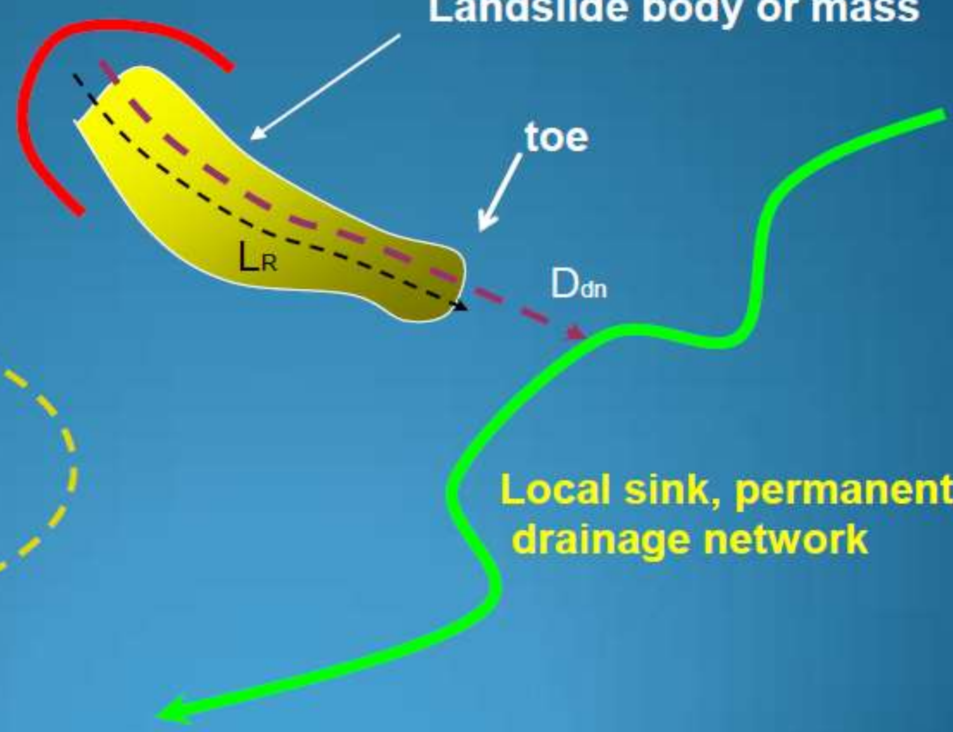
Current form used in model PESERA-L

Where:

L_R = landslide average runout (m)

D_{dn}= Downslope routing weigthed distance (m)

(downslope component IC model Borselli et al. 2008)



Borselli et al. "*PESERA-L, the shallow landslides contribution to specific sediment yield (SSY), as extensions of the PESERA soil erosion model* "
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Mass movement type

Flow slide mudflow

Shallow Translational

Shallow Rotational

creeping

$$\frac{\overline{D_{dn}}}{\overline{L_R}}$$

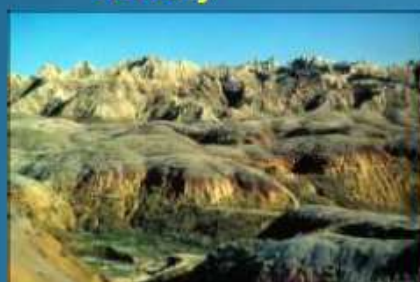
0.1 — 1.0 — 2.0 — 5 — 10 →

Land units landforms

0.1: Badlands, Clay shale, Deposits, High drainage density

2.0: rolling topography, Medium steepness and medium drainage density

10: Rolling to flat topography



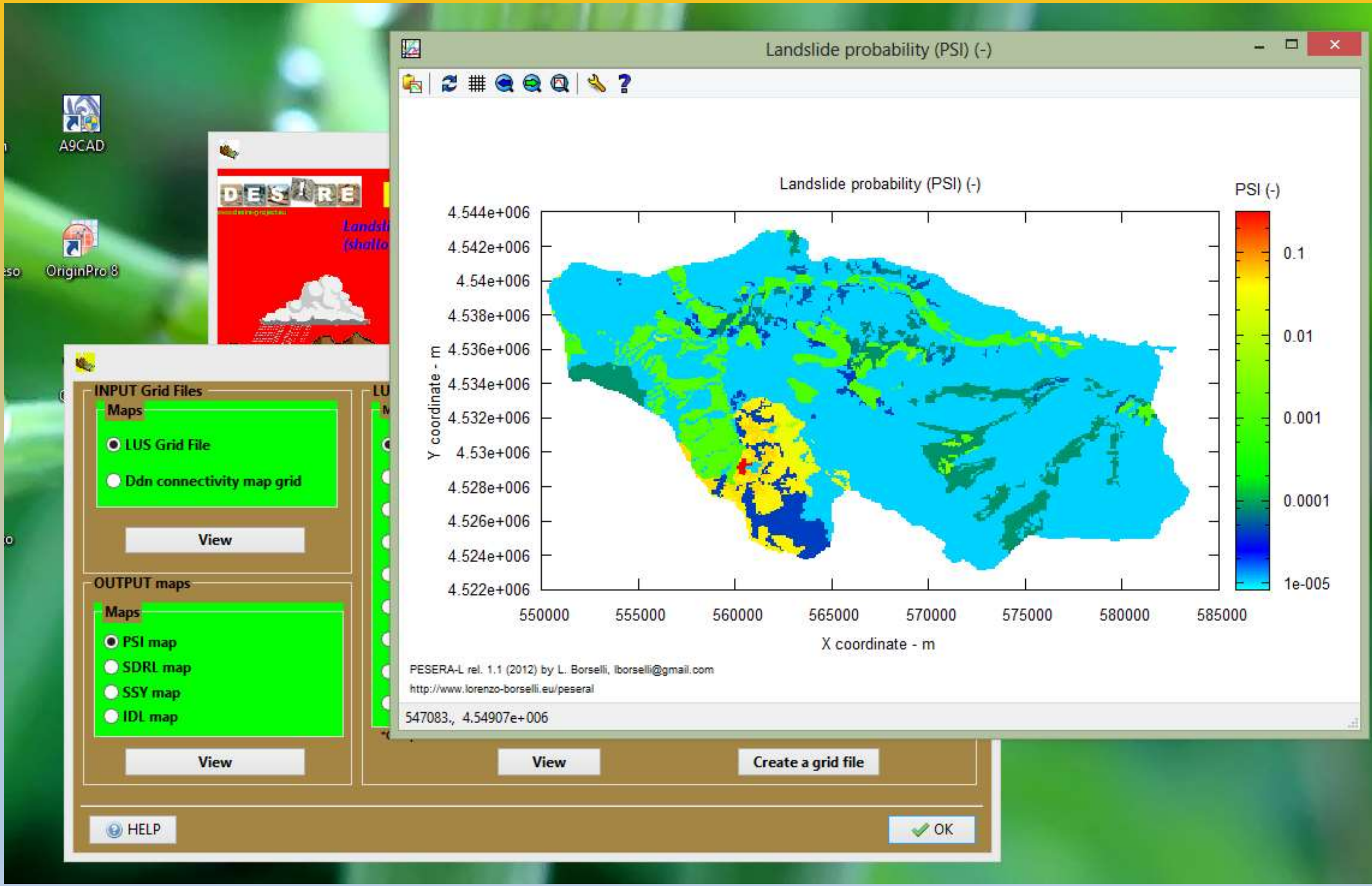
Landslides mobility parameter

And the possible dependence from Processes and landforms

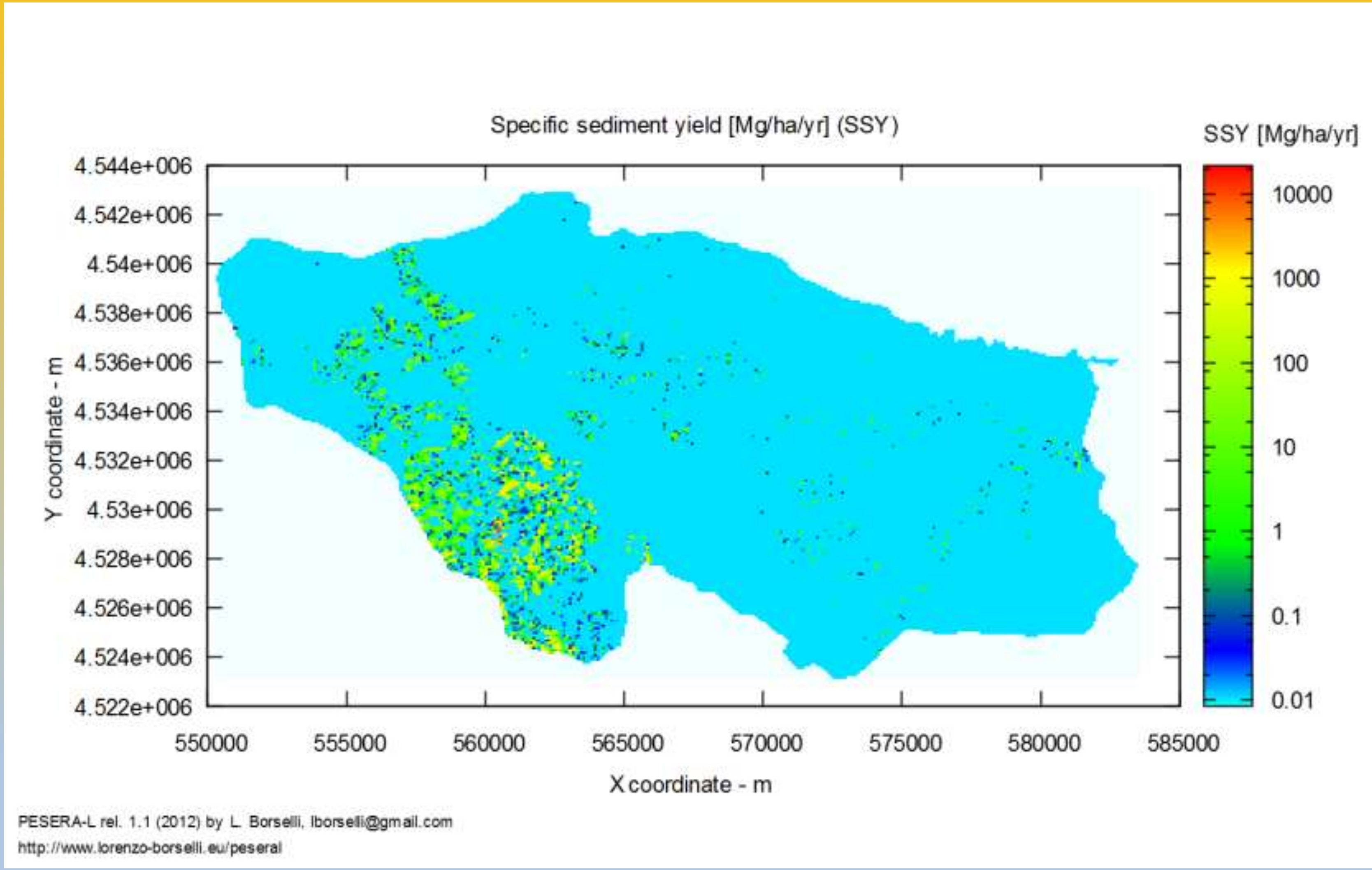
Borselli et al. "*PESERA-L, the shallow landslides contribution to specific sediment yield (SSY), as extensions of the PESERA soil erosion model* "
International Conference on Combating Land Degradation in Agricultural Areas (LANDCON 1010) Xi'an China 13-14 oct 2010

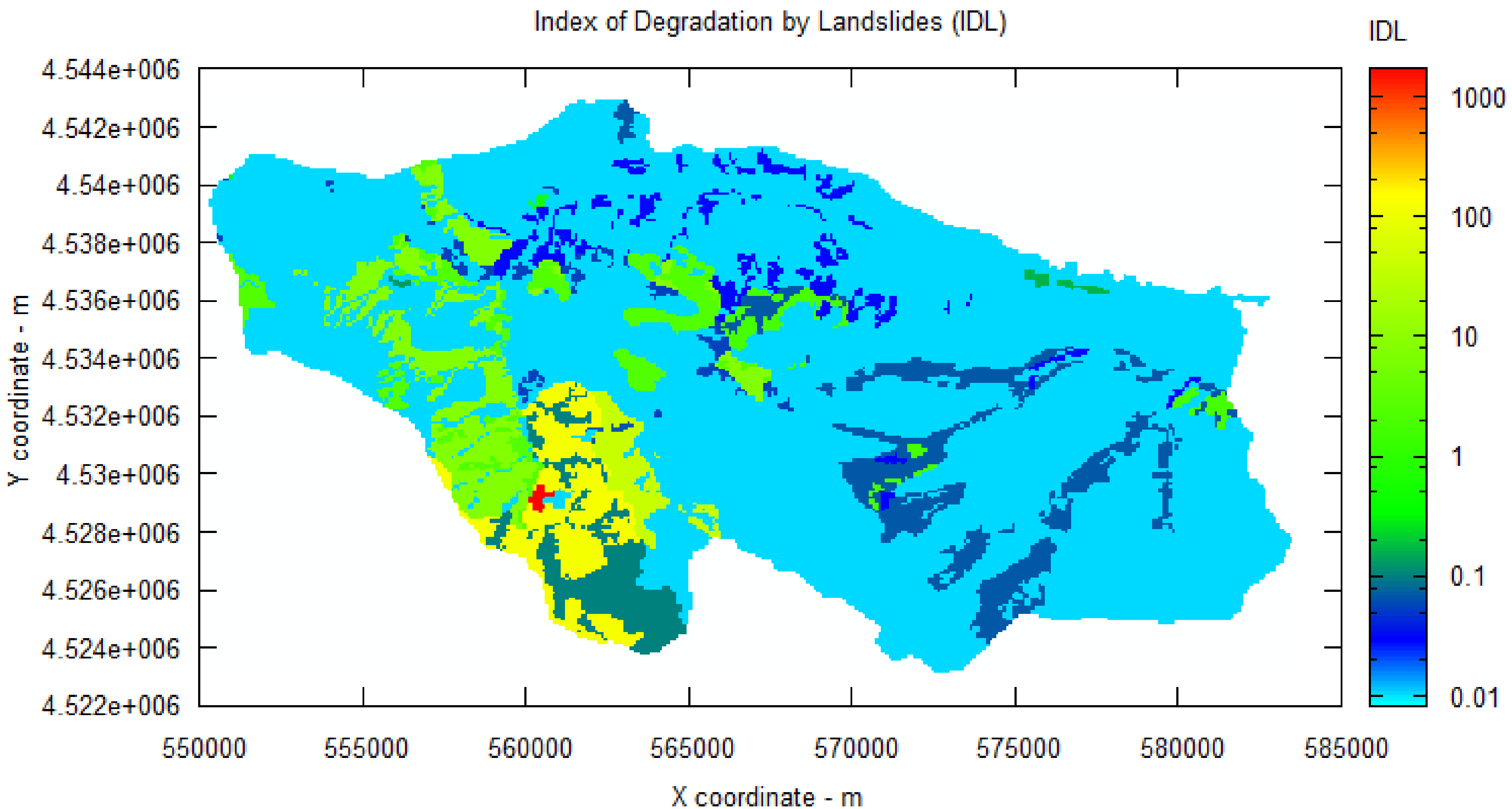

A9CAD
OriginPro 8
QtiPlot
PESERA-L (rel. 1.1 2012)
DESIRE
PESERA-L
Release 1.1- 2012
Landslide addendum to PESERA model
(shallow landslides contribution to SSY)
OPTIONS
LOAD FILES
RUN SIMULATION
VIEW MAPS
Credits
HELP
EXIT
PESERA-L (Release 1.1- 2010-12)
by L.Borselli, UASLP Mexico
lborselli@gmail.com

PESERA -L


A9CAD
OriginPro 8
Landslide probability (PSI) (-)
Landslide probability (PSI) (-)
PSI (-)
0.1
0.01
0.001
0.0001
1e-005
4.544e+006
4.542e+006
4.54e+006
4.538e+006
4.536e+006
4.534e+006
4.532e+006
4.53e+006
4.528e+006
4.526e+006
4.524e+006
4.522e+006
Y coordinate - m
550000
555000
560000
565000
570000
575000
580000
585000
X coordinate - m
PESERA-L rel. 1.1 (2012) by L. Borselli, lborselli@gmail.com
http://www.lorenzo-borselli.eu/peseral
547083., 4.54907e+006
INPUT Grid Files
Maps
LUS Grid File
Ddn connectivity map grid
View
OUTPUT maps
Maps
PSI map
SDRL map
SSY map
IDL map
View
View
Create a grid file
HELP
OK

Applicazione Bacino di rendina (PZ)





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http://www.lorenzo-borselli.eu/peseral


Gracias por su atención !!!