Assessing the Volcanic Threat in Latin America

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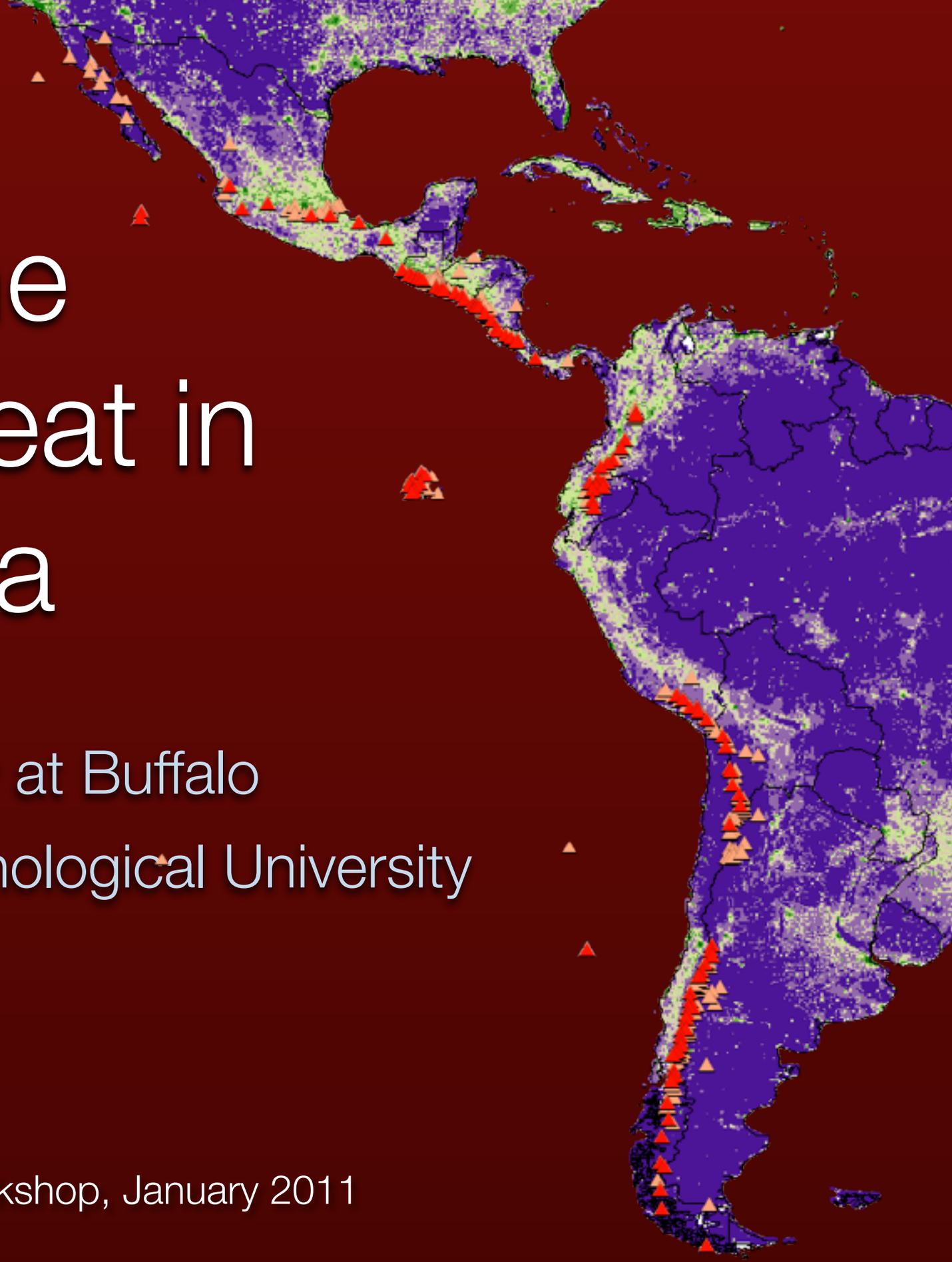
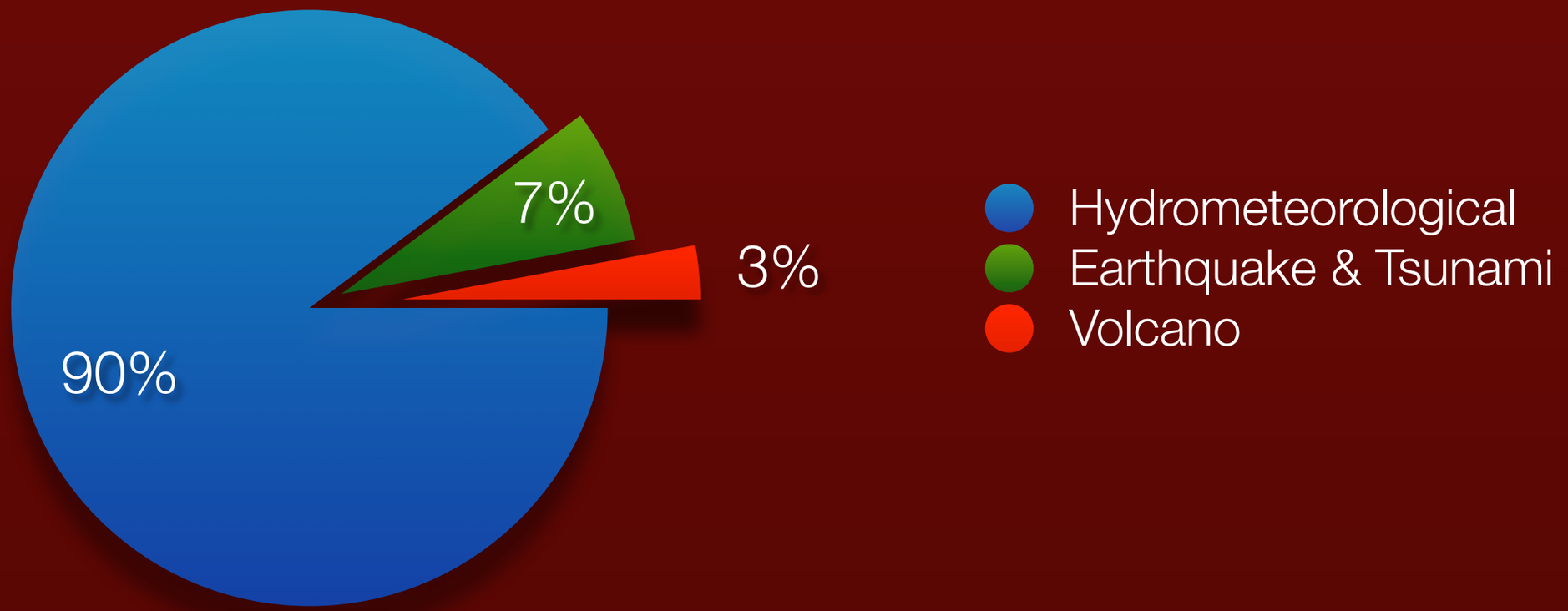
PASI Workshop, January 2011



Natural Disasters by Type, 1991-2005



	Hydrometeorological disasters							Geological disasters			Biological disasters			
	Drought	Extreme Temperature	Flood	Slide	Wild Fire	Wind Storm	**Total**	Earthquake & Tsunami	Volcano	**Total**	Epidemic	Insect Infestation	**Total**	**Total**
Americas														
Carribean	6		44	2	2	95	**149**	5	4	**9**	6		**6**	**164**
Central America	20	13	82	12	7	76	**210**	31	19	**50**	30		**30**	**290**
North America	8	11	90	1	56	236	**402**	10	1	**11**	9		**9**	**422**
South America	23	21	165	46	20	36	**311**	34	10	**44**	28	3	**31**	**386**
Sub-total	**57**	**45**	**381**	**61**	**85**	**443**	**1 072**	**80**	**34**	**114**	**73**	**3**	**76**	**1 262**

Source: ISDR- International Strategy for Disaster Reduction

Awareness

Among all natural hazards, volcanoes are not the one that is in most peoples minds (Hurricanes, Earthquakes, Landslides…)

In many places in Latin America, poverty, health and other social issues are huge and compelling, and they are simply more important issues for most people.

Eruption of Chaitén volcano, 2008

Satellite image Formosat, May 19 2008

Nevado del Ruiz, 1985

EL MUNDO

TRAGEDIA

Medellín-Colombia. Viernes 15 de Noviembre de 1985


Dolor


Horror


Muerte

Dijeron que no había peligro

La catástrofe ocurrida ayer con la erupción del volcán Nevado del Ruiz, que dejó un saldo inicial de más de 25 mil muertos, es el resultado de una de las mayores improvisaciones y negligencias que se hayan podido tener en la historia nacional, toda vez que desde diciembre del año pasado, cuando se inició la actividad del volcán, ya se alzaban muchas voces de alarma para que se tomaran las precauciones que hubieran podido evitar la espantosa tragedia. El municipio de Armero quedó prácticamente borrado del mapa y buen número de poblados cercanos sintieron los efectos de la devastación.

Hace apenas dos meses se reunieron en Manizales los más conocidos vulcanólogos de Estados Unidos, Japón y Colombia, a quienes se encargó la tarea de evaluar los peligros potenciales que podría representar la reactivación ya manifiesta del Nevado del Ruiz. Estos, desestimando las voces de alerta aseguraron a la nación que nada iba a ocurrir.

Sin embargo, otros estudios, como el realizado por Ingeominas, insistían en los riesgos inminentes a que estaba expuesta la zona de influencia, y los que, infortunadamente para el país, han derivado en la mayor desgracia de la historia colombiana.

Aparte del elevado número de víctimas y damnificados, cuantiosas pérdidas materiales, imposibles de determinar a corto plazo, afectan una importante zona agroindustrial y compromete seriamente la economía nacional, por la destrucción de cosechas de diferentes productos, especialmente café y la desaparición de una vasta zona ganadera; asimismo una de las más importantes redes viales del centro del país quedó inhabilitada, como consecuencia del deshielo del Nevado que produjo una serie de avalanchas de piedra y lodo arrastradas por la creciente de los ríos. Arrasaron todo lo que encontraron a su paso.

La mayor parte de la zona afectada quedó aislada, por lo que han sido

Líbano, Ambalema, Lérida, Casabianca, Villahermosa, Galán, Carmelo, Santuario, Pindalito e incluso Manizales, se acostaron en aparente calma.

Cuando la explo
tando enormes
piedras, cayó so
dos (parte de Tol
y Risaralda), la n
te se encontraba
en que el número
tal magnitud. El
des del Nevado
las altas tempera
extrusión del ma
taron el caudal
Guali, Azufrad
quebradas men
dieron su desboc
poblados ribereñ
sepultaron la ma
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"Sentí un ruido
una poderosa
marcha y luego
cuello... Después
unas personas qu
tera y me encon
uno de los
Chinchiná. Mien
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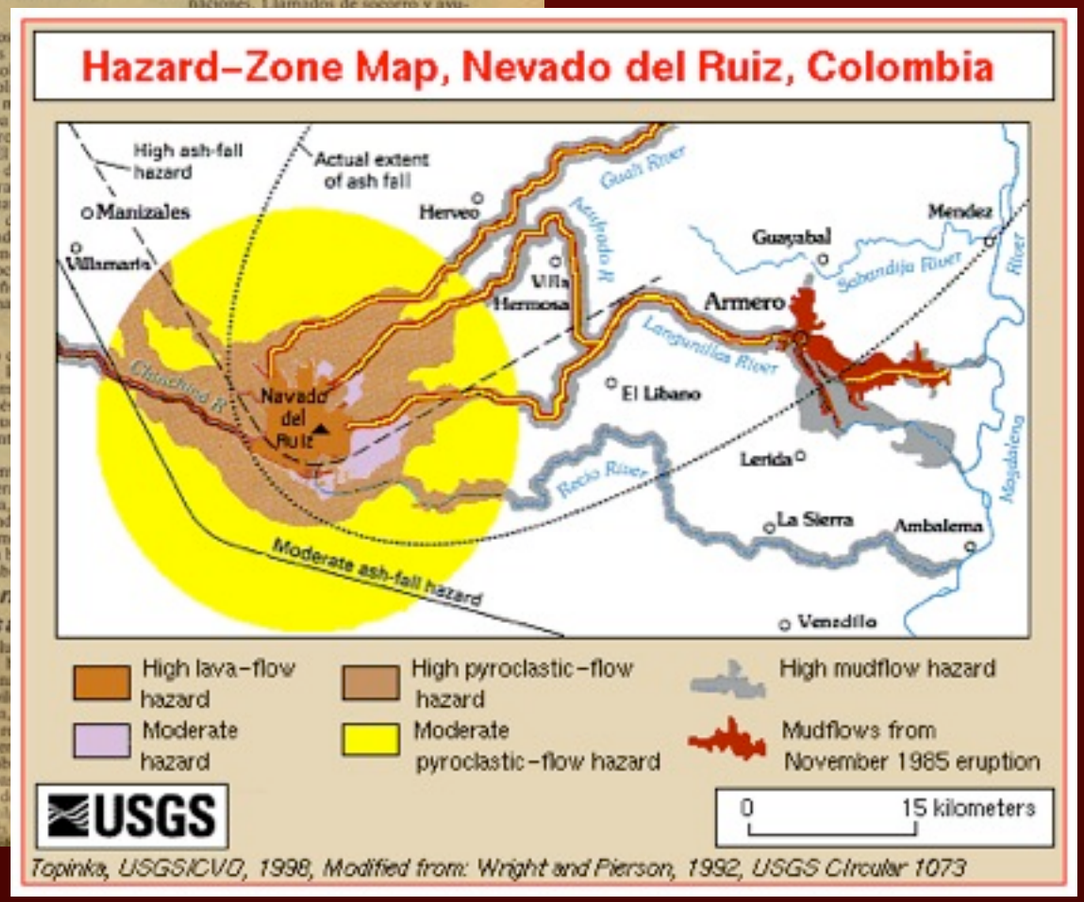
toda su familia,
gustada: "Dond
ahora hay solam
quedó enterrada
La catástrofe hab

Zon
des

Con las primera
ayer empezó a
magnitud de un
imprecisa. Un pi
Fernando Rivera,
área de desastre,
mática que Arme
do. "Algunos sob
subirse a las copa
años, a techos d
contaron a ser civ

grupo guerrillero y la posterior y violenta respuesta de las Fuerzas Armadas. Nuevamente el país volvía a centrar la atención de casi todas las naciones. Llamados de socorro y ayu-



Mt. Pelée, Martinique, 1902

Erution of Mt. Tambora in 1815, VEI 7

Tambora volcano on Indonesia's Sumbawa Island. Images downloaded from Wikipedia.

Volcanic Disasters in 20th Century

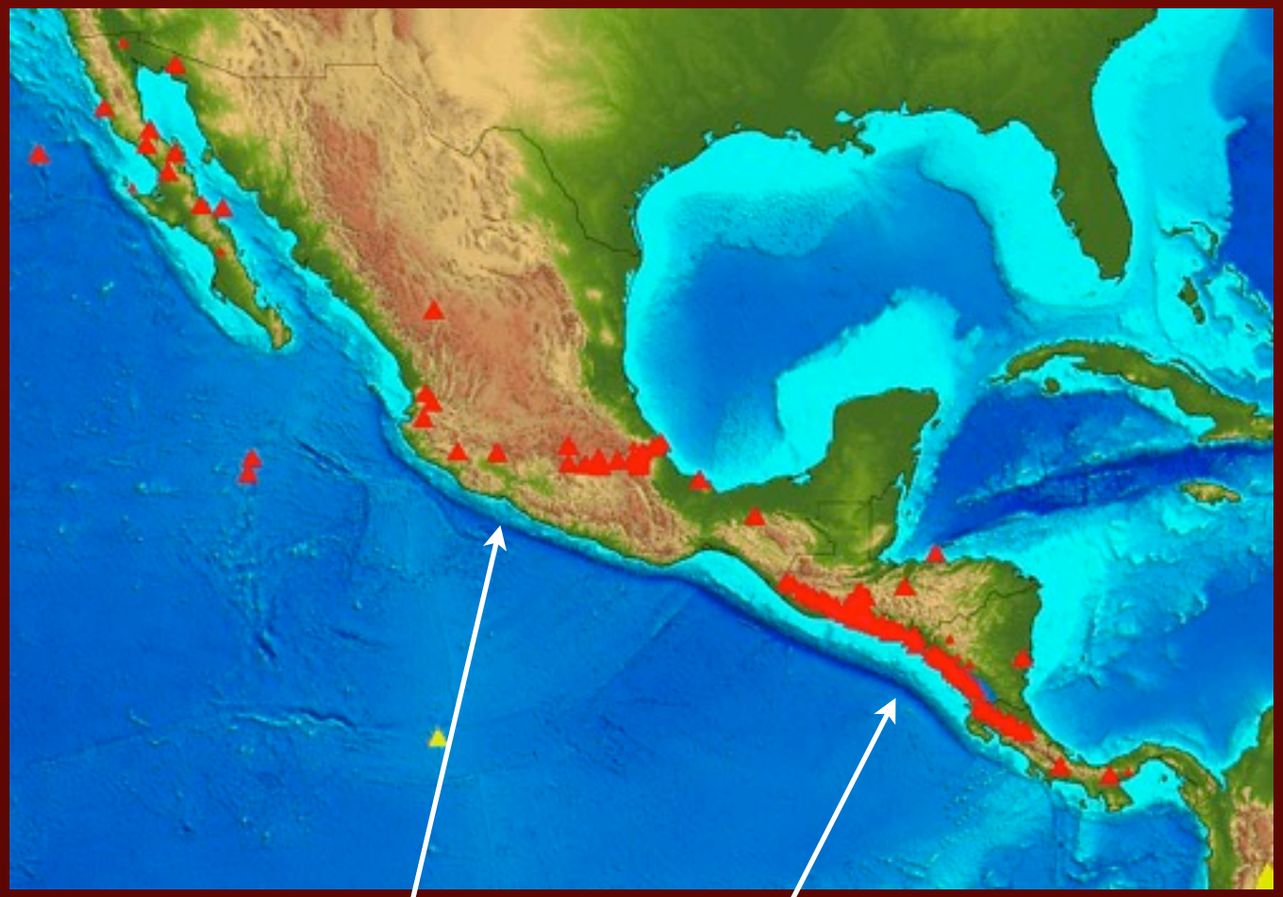
Top 10 events by impact

Rank	Killed		Injured		Homeless		Evacuated/affected	
	Event	People	Event	People	Event	People	Event	People
1	Pelée, 1902	29 000	Nevado del Ruiz, 1985	4470	Pinatubo, 1991	53 000	Guagua Pichincha, 1999	1 200 400
2	Nevado del Ruiz, 1985	23 080	Awu, 1966	2000	Kelut, 1919	45 000	Pinatubo, 1991	967 443
3	Santa Maria, 1902	8750	Ambrym, 1979	1000	Galunggung, 1982	22 000	Pinatubo, 1992	787 042
4	Kelut, 1919	5110	Dieng, 1979	1000	Pinatubo, 1992	15 700	Agung, 1963	332 234
5	Santa Maria, 1929	5000	Lake Nyos, 1986	845	Tokachi, 1926	15 000	Vesuvius, 1906	100 000
6	Lamington, 1951	2942	Taal, 1965	785	El Chichón, 1982	15 000	Popocatépetl, 1994	75 000
7	El Chichón, 1982	2000	El Chichón, 1982	500	Merapi, 1930	13 000	Soufrière Guadeloupe, 1976	73 500
8	Lake Nyos, 1986	1746	Merapi, 1994	500	Merapi, 1961	8000	Mayon, 1984	73 000
9	Soufriere St. Vincent, 1902	1565	Merapi, 1998	314	Soufrière Hills, 1995	7500	Arenal, 1976	70 000
10	Merapi, 1930	1369	Vesuvius, 1906	300	Colo (Una Una), 1983	7101	Galunggung, 1982	62 755
Sum (% of total)		80 562 (87.8)		11 714 (73.2)		201 301 (69.1)		3 741 374 (70.8)

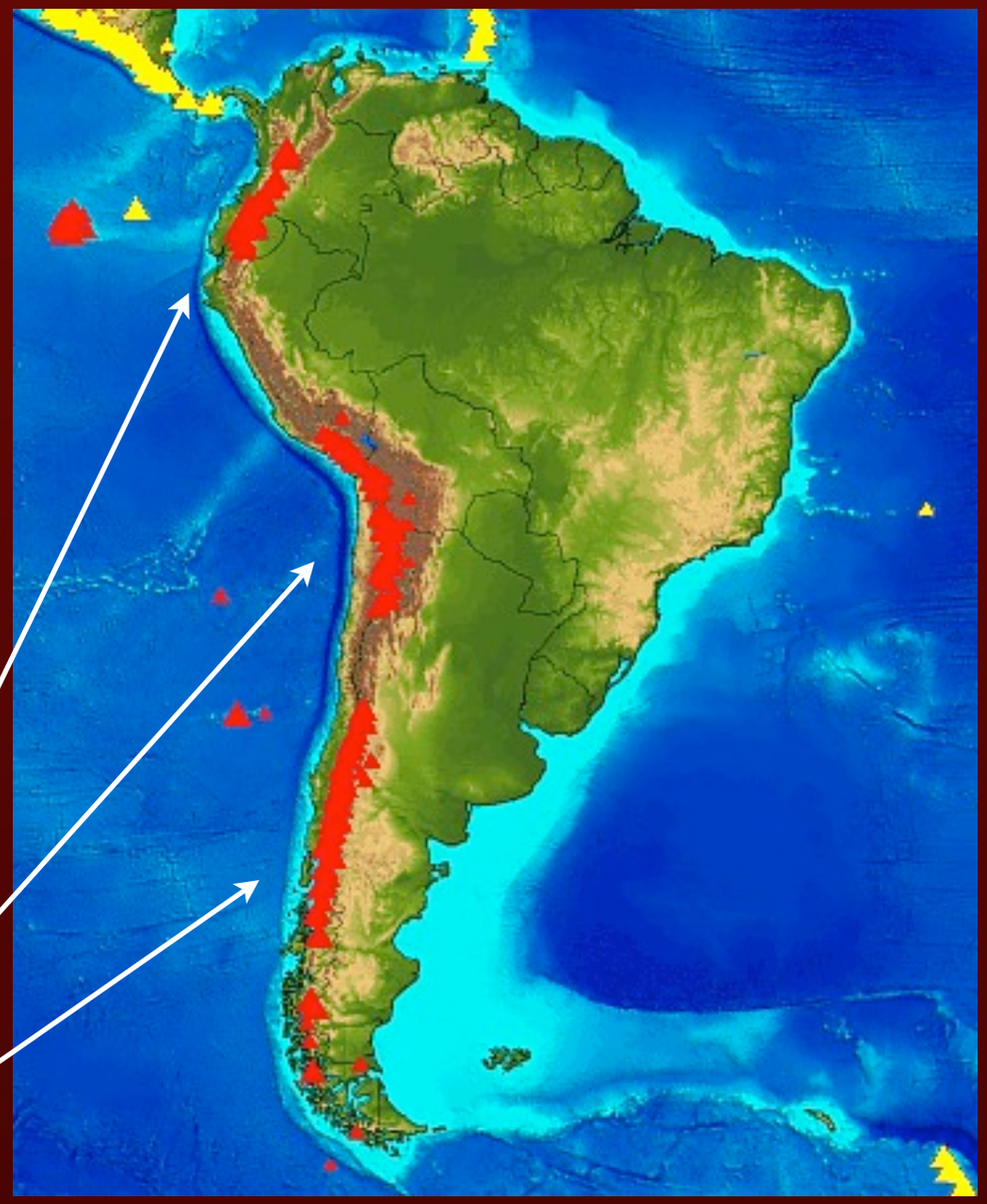
Table 6 in Witham, 2005, JVGR 148, p.191.

Total: Killed 91,724; Injured 16,013; Homeless 291, 457; Evacuated/affected 5,281,906.

Volcanic Segments in Latin America

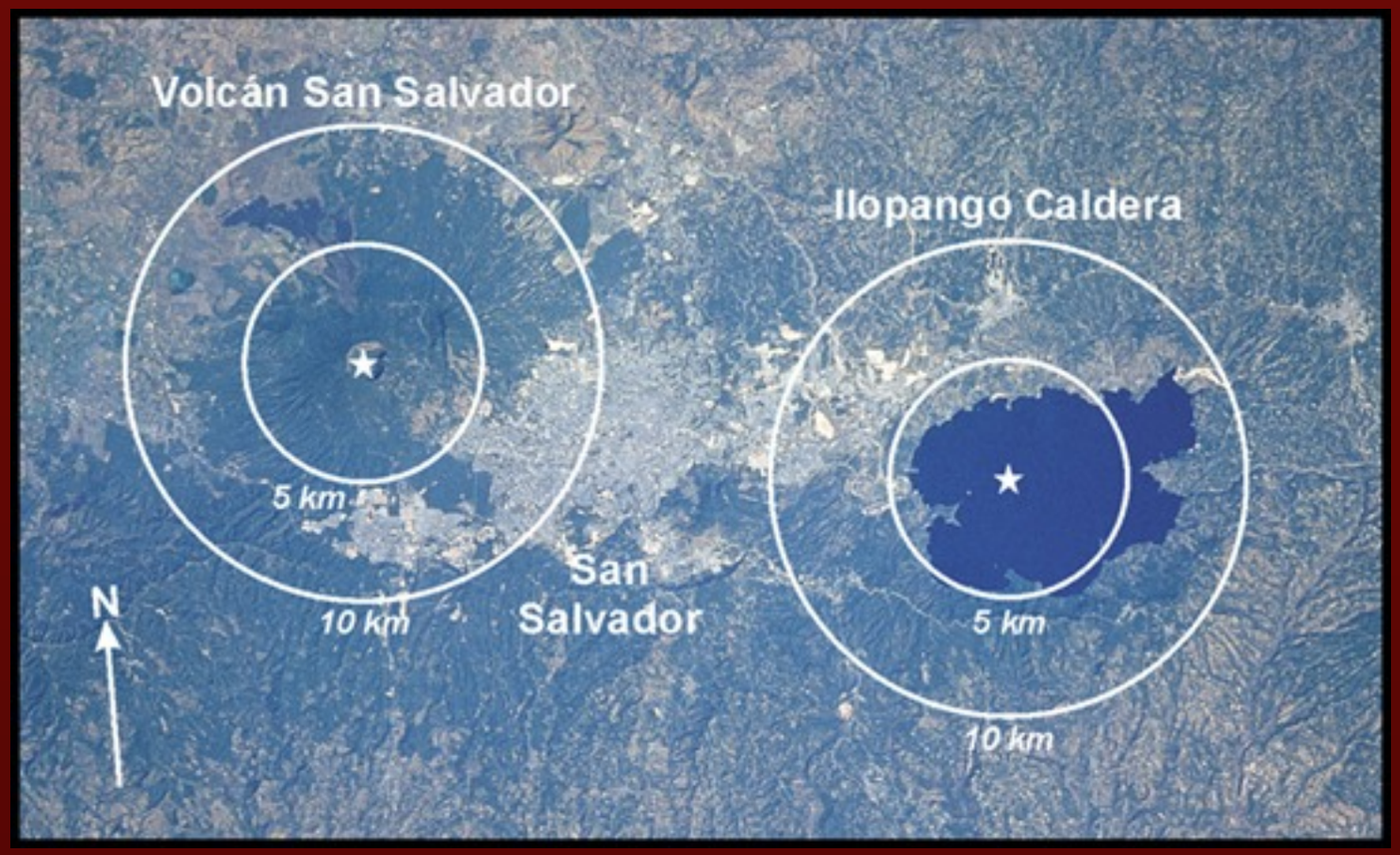


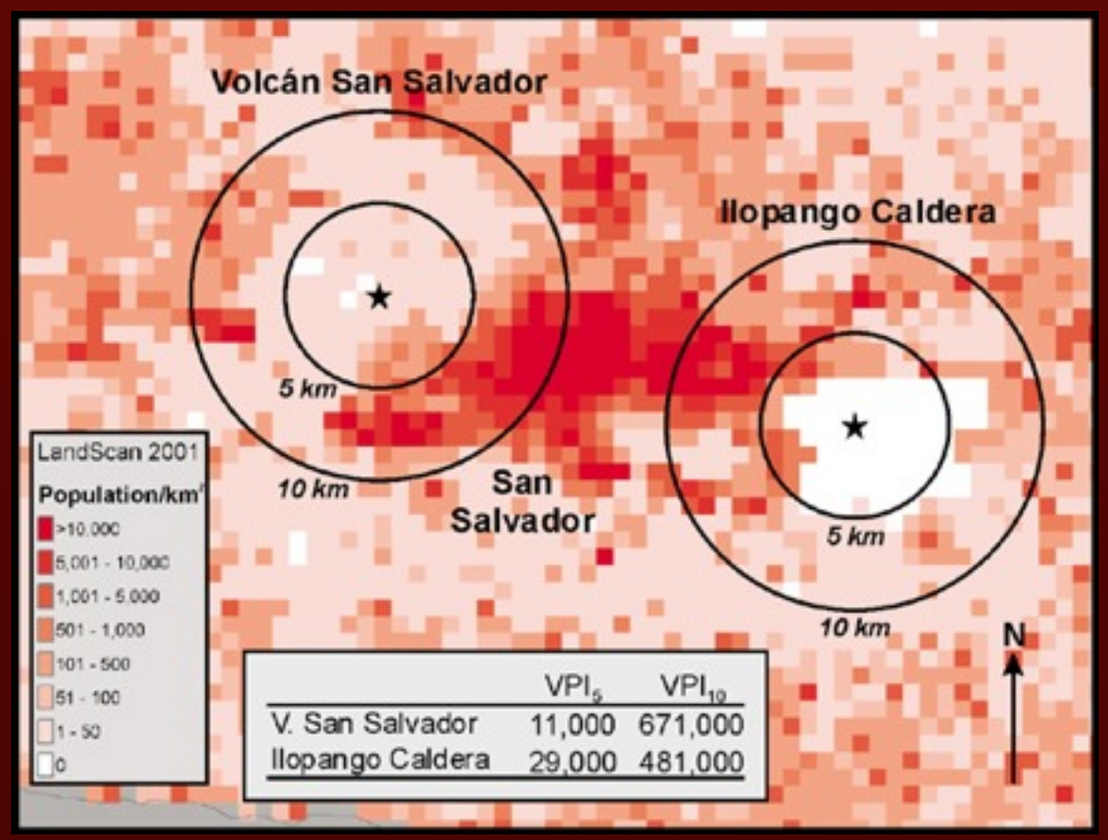
North A.
Central A.



N-South A.
C-South A.
S-South A.

Volcano Population Index (VPI)





Ewert, J.W. and Harpel, C.J. (2004) In Harm's Way: Population and Volcanic Risk. Geotimes. http://www.agiweb.org/geotimes/apr04/feature_VPI.html

Ewert, J.W. and Harpel, C.J. (2003) A Volcano Population Index for Estimating Relative Risk with Example Data from Central America. AGU Fall Meeting, abstract #U22C-03

Volcanoes in Central America

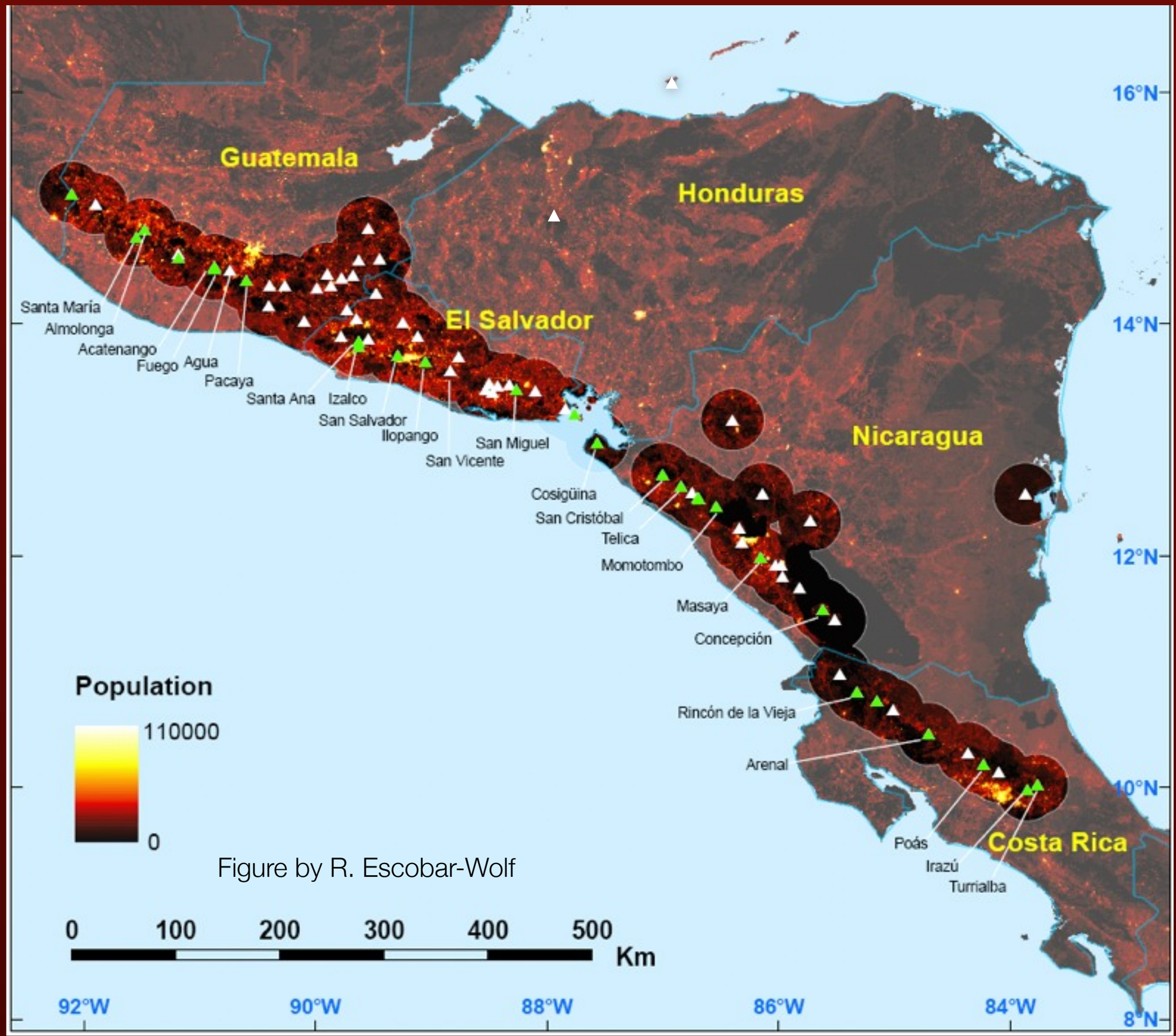
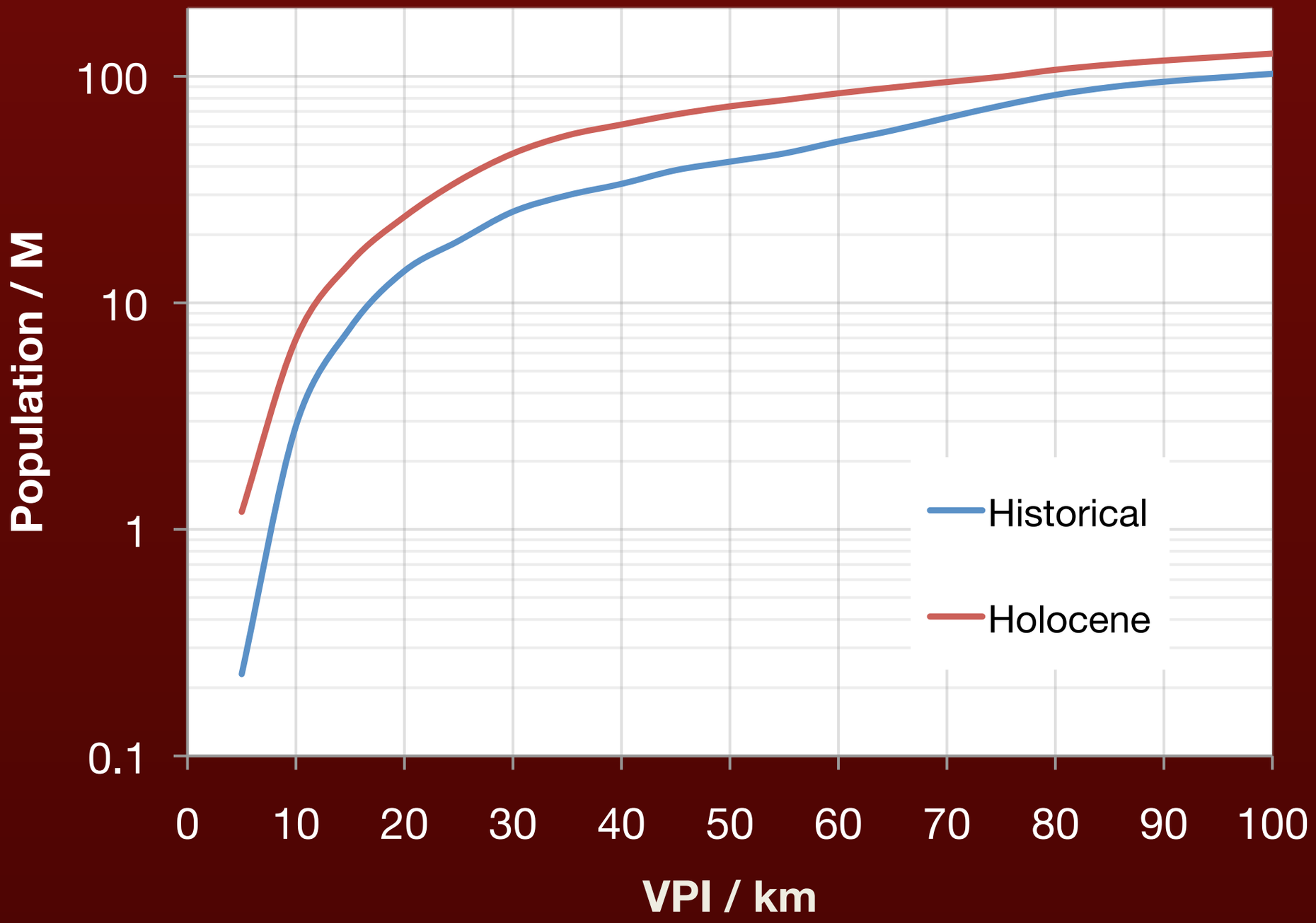
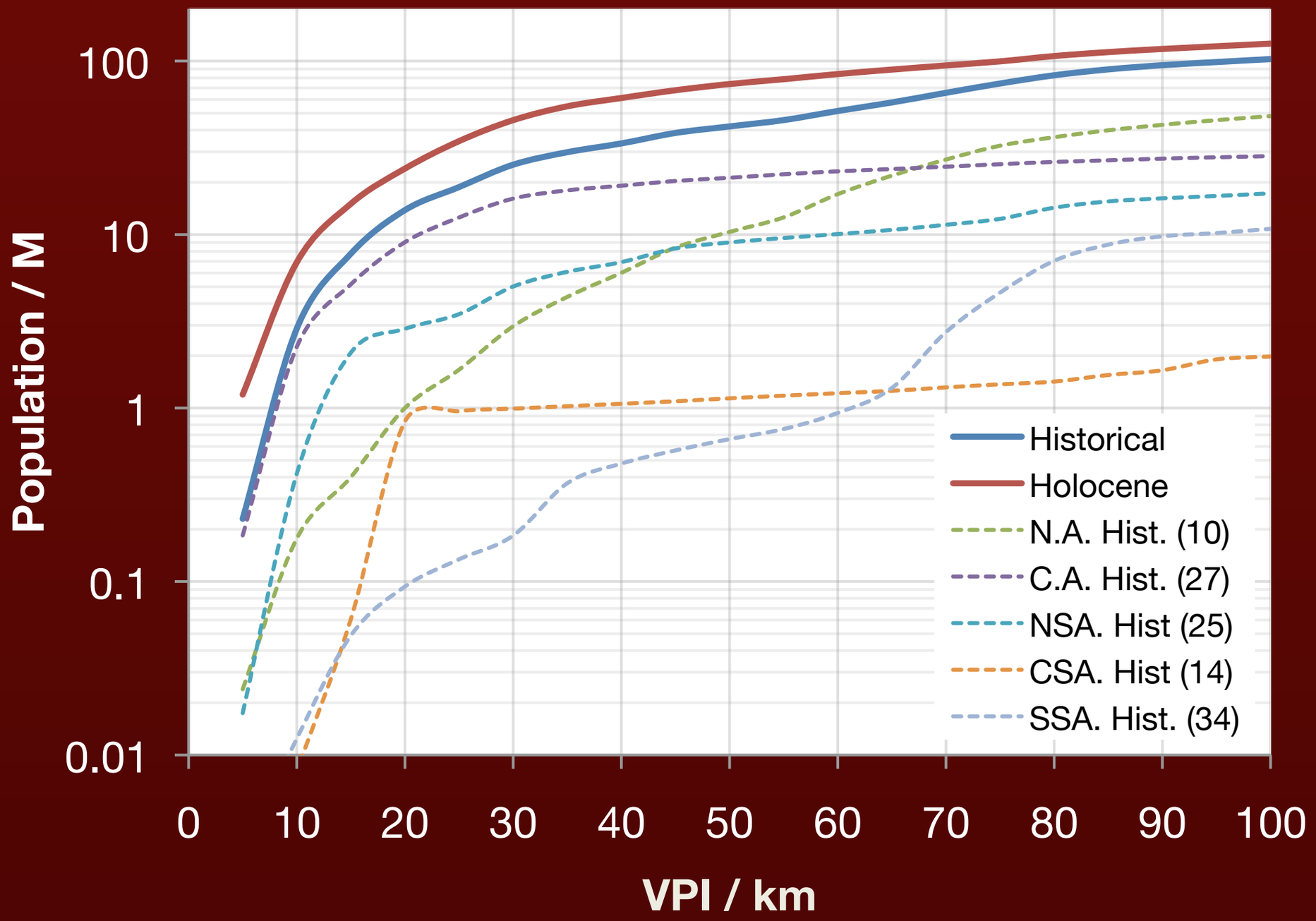


Figure by R. Escobar-Wolf

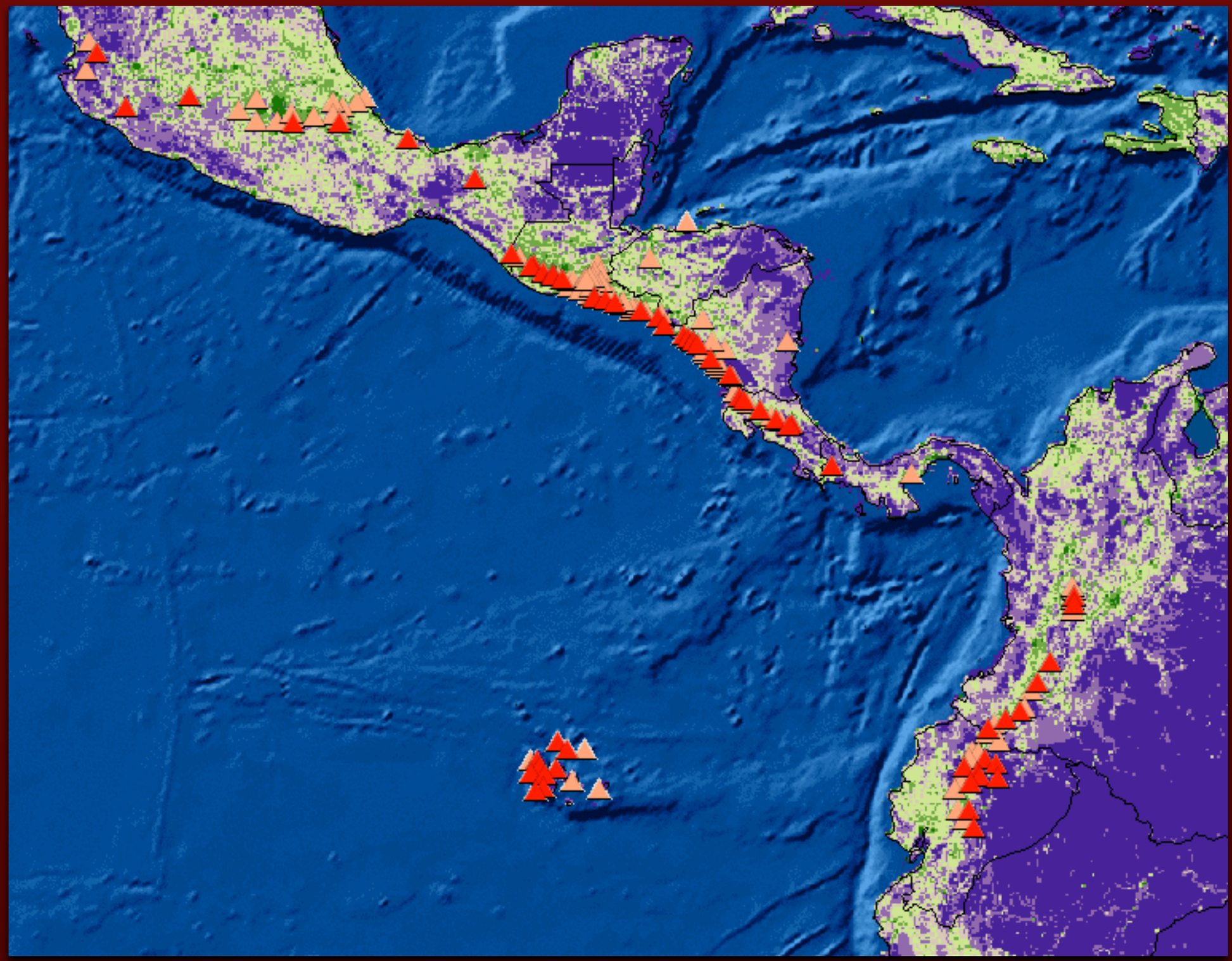
Total Population Around Volcanoes



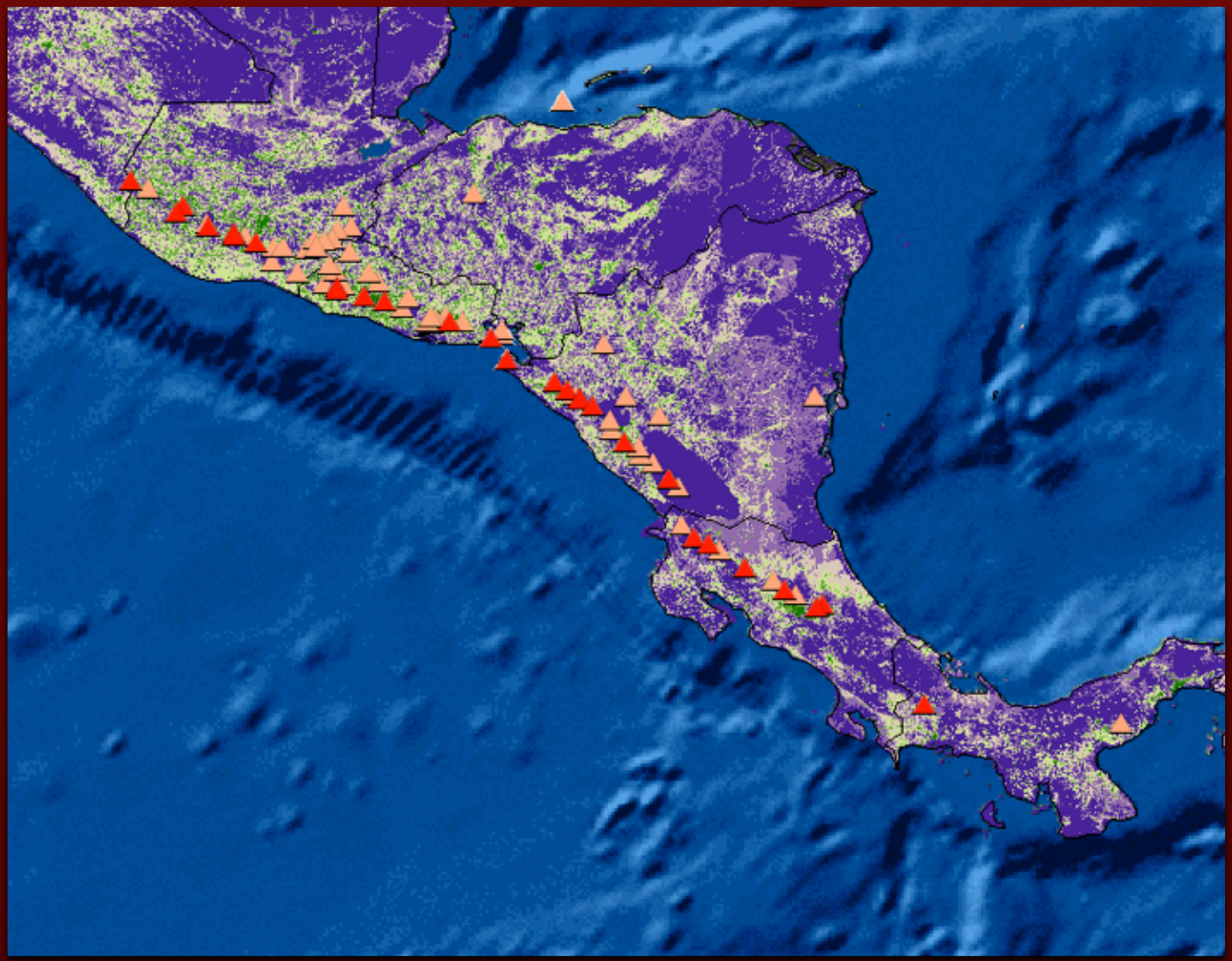
Total Population Around Volcanoes



Population Around Volcanoes

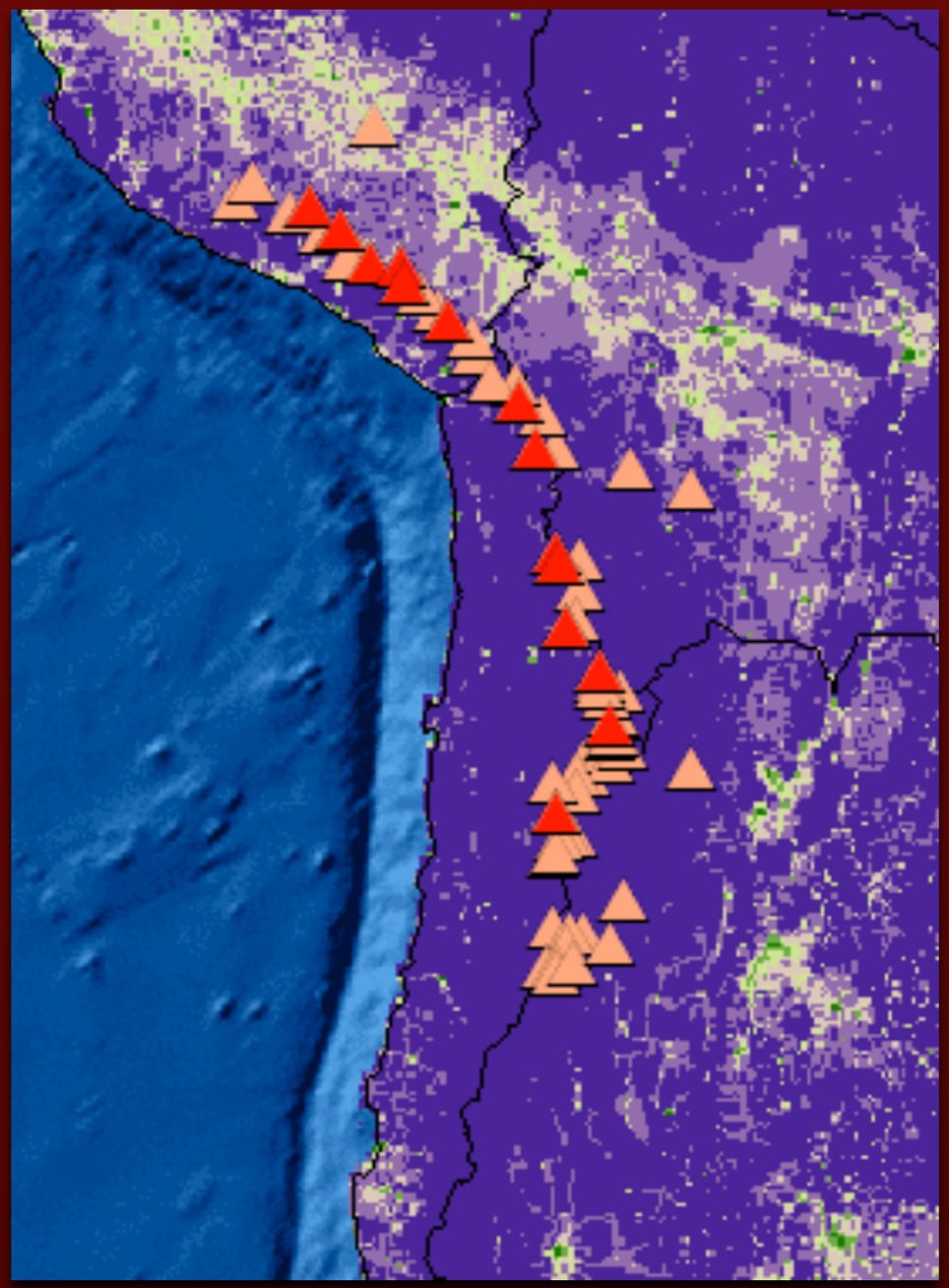


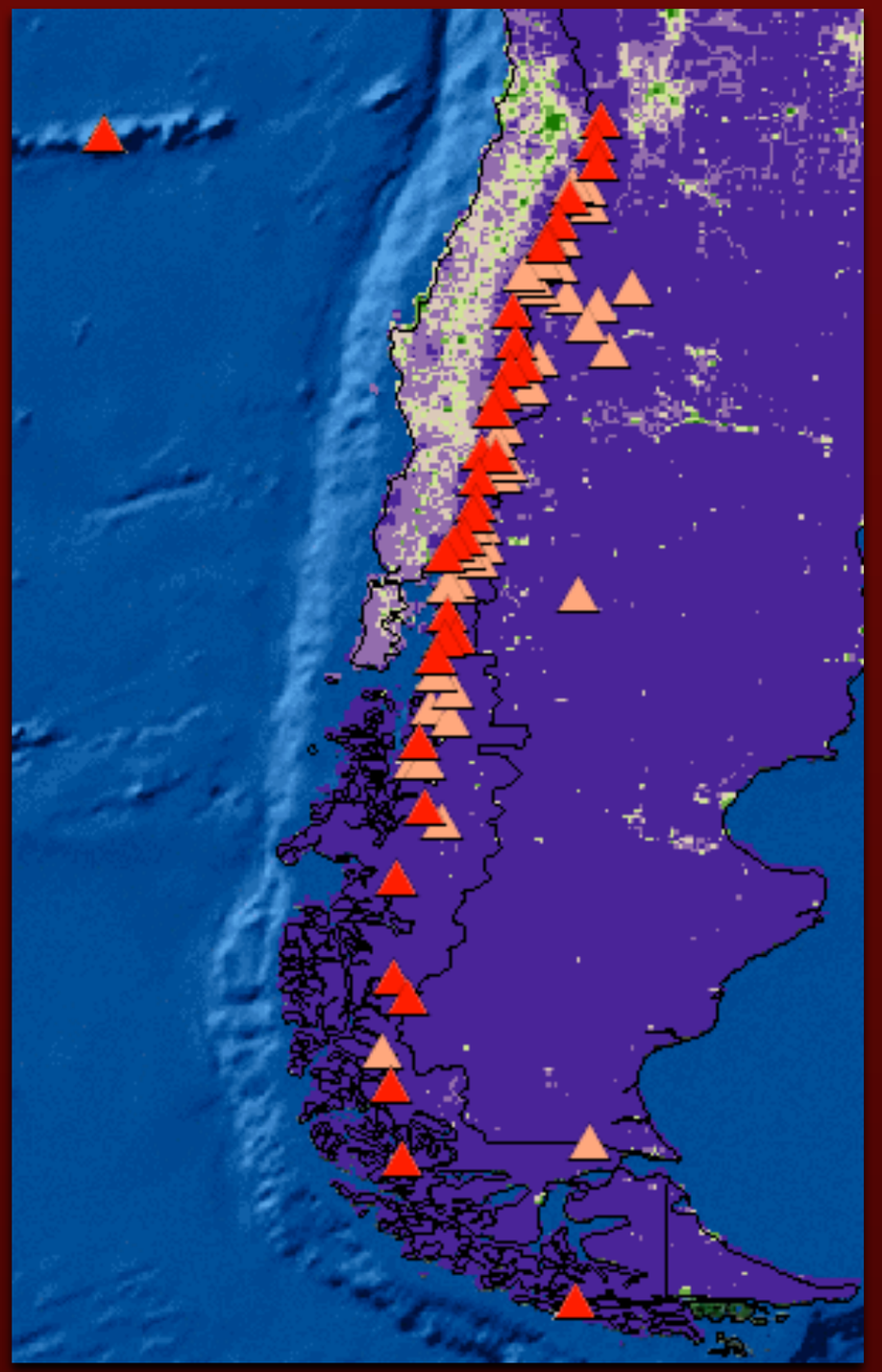
Population Around Volcanoes



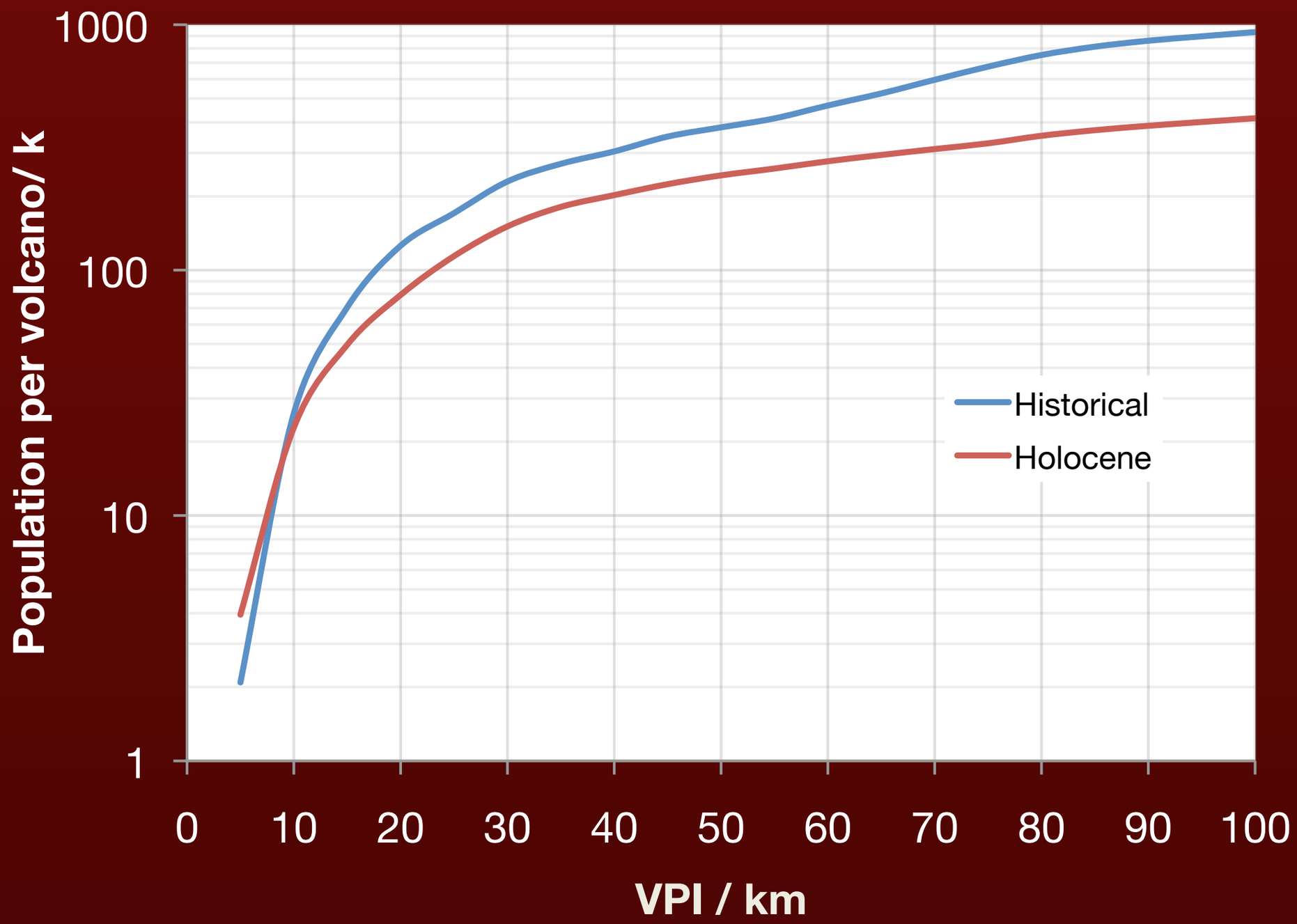
Local population often live on volcano slopes, where the land is cheaper and the soils are fertile.

Population Around Volcanoes

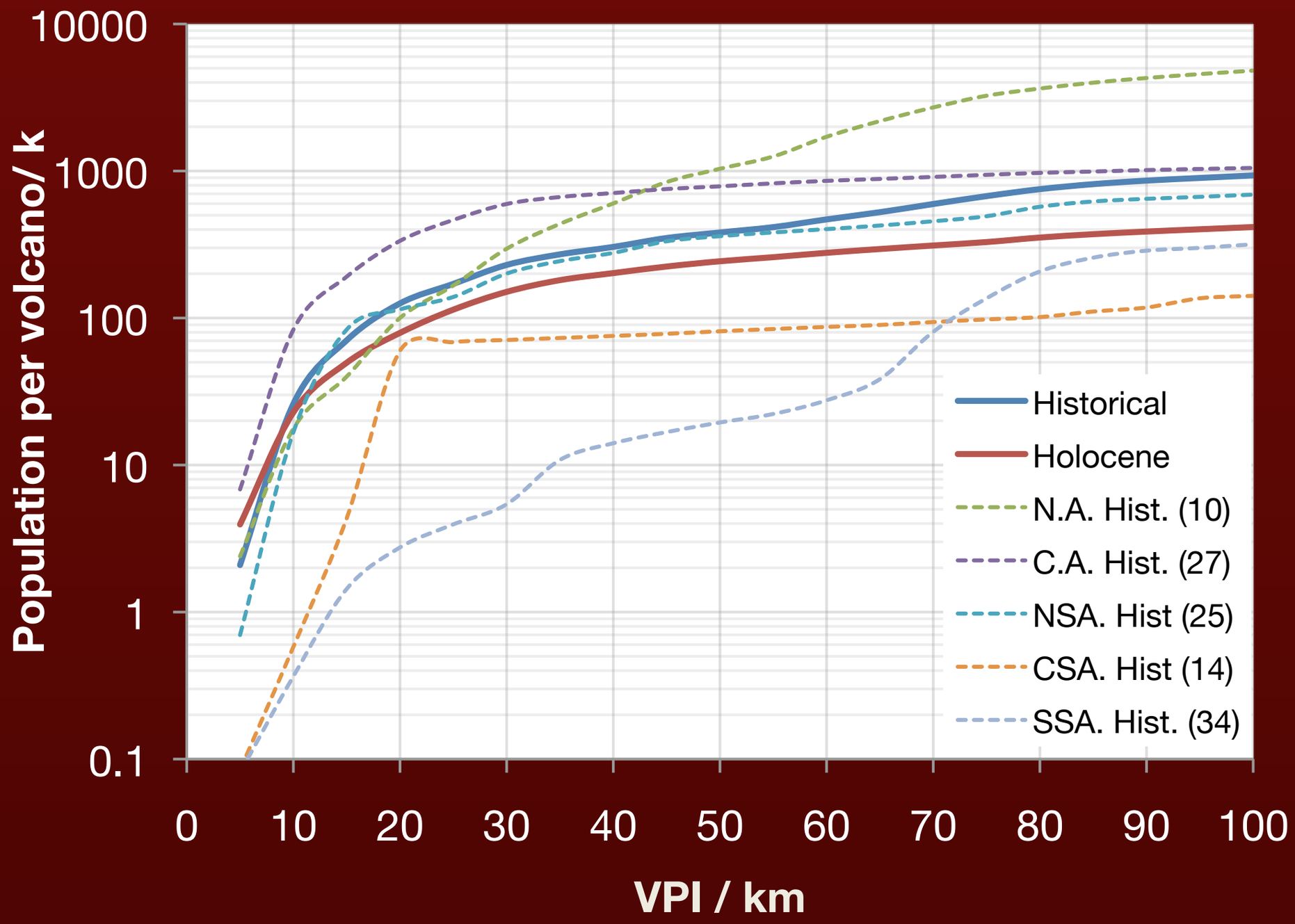




Average Population Around Volcanoes



Average Population Around Volcanoes



Quantifying Volcanic Threat- NVEWS

The volcanic threat is quantified using the ranking system developed by Ewert et al. (2005, 2007) as part of the Framework for a **N**ational **V**olcano **E**arly **W**arning **S**ystem in the United States.


USGS
science for a changing world

OPEN-FILE REPORT 2005-1164

An Assessment of Volcanic Threat and Monitoring Capabilities in the United States:
Framework for a National Volcano Early Warning System

NVEWS

John W. Ewert, Marianne Guffanti, and Thomas L. Murray
U.S. Geological Survey

April 2005

Ewert et al. 2005. An Assessment of Volcanic Threat and Monitoring Capabilities in the United States: Framework for a National Volcano Early Warning System.USGS open-file report 2005-1164.

Ewert 2007. System for Ranking Relative Threats of U.S. Volcanoes. Natural Hazards Review v.8 p.112-124.

Hazard, Exposure and Threat Scores

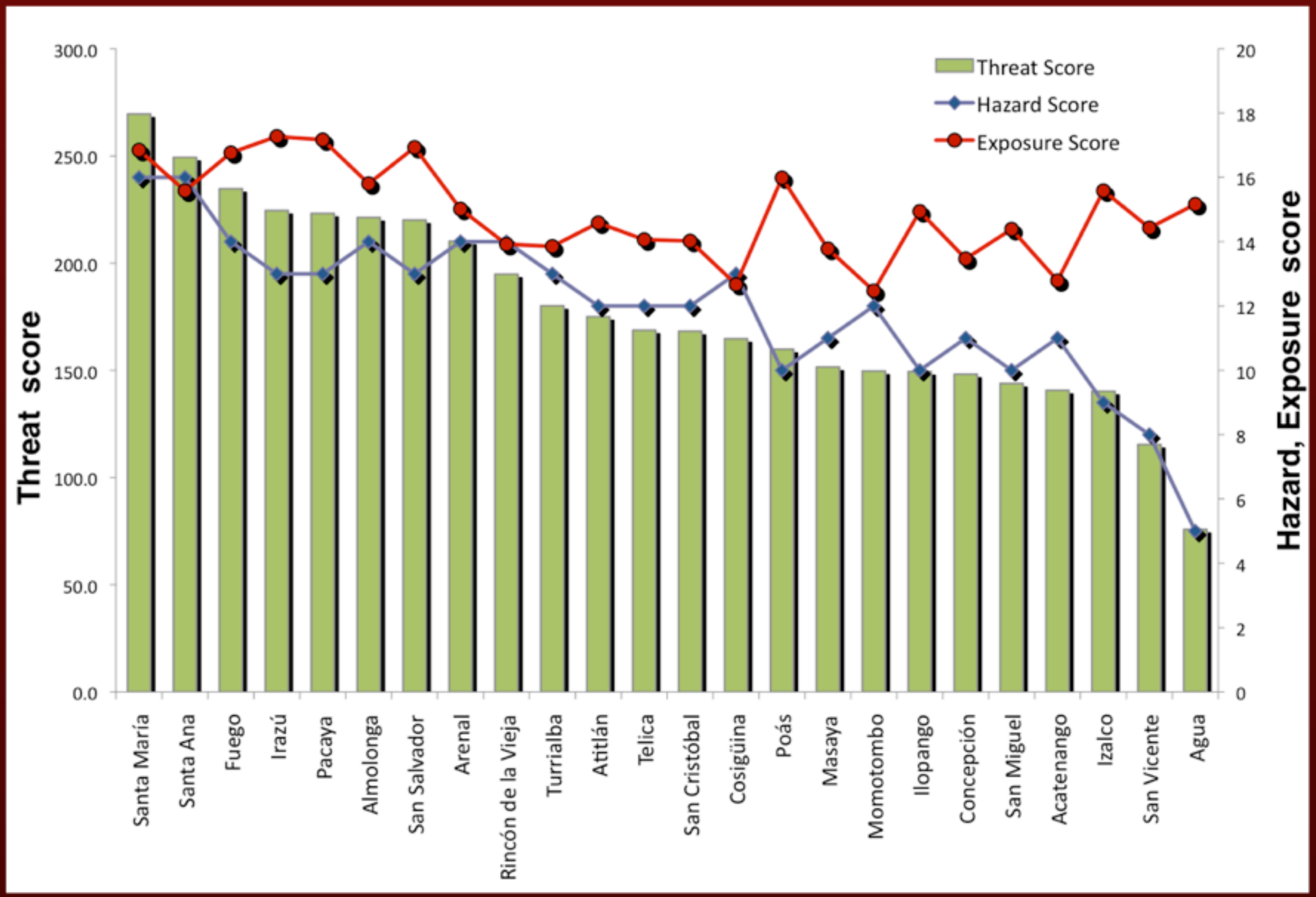
	HAZARDS			EXPOSURE	
Past Eruptions	Type code	0-1	0-x	Log VPI (30km)	Historical Ground Impact Populat
	Max VEI code	0-3	0-x	Log population downslope	
	VEI>2 in last 500 yrs?	0-1	0-1	>25% of populated island?	
	VEI>3 in last 5000 yrs?	0-1	0-1	Historical fatalities?	
	Eruption Recurrence code	0-4	0-1	Historical Evacuations?	
Holocene Flows	Holocene PFs?	0-1	0-2	Local Aviation Exposure?	
	Holocene Lava Flows?	0-1	0-x	Regional Aviation exp?	
	Holocene Lahars?	0-1	0-1	Power infrastructure?	Develop ment
	Holocene Tsunami?	0-1	0-1	Transportation infrastr.?	
Potential Hazards	Hydrothermal Explosion P.?	0-1	0-1	Major development?	
	Sector Collapse P.?	0-1			
	Primary Lahar P?	0-1			
Historical Unrest	Seismc Source?	0-1			
	Ground Deformation?	0-1			
	Fumaroles/Degassing?	0-1			
	TOTAL HAZARD SCORE	HS	ES	TOTAL EXPOSURE SCORE	
	THREAT SCORE = HS x ES				

NVEWS-Volcanic Threat in Central America

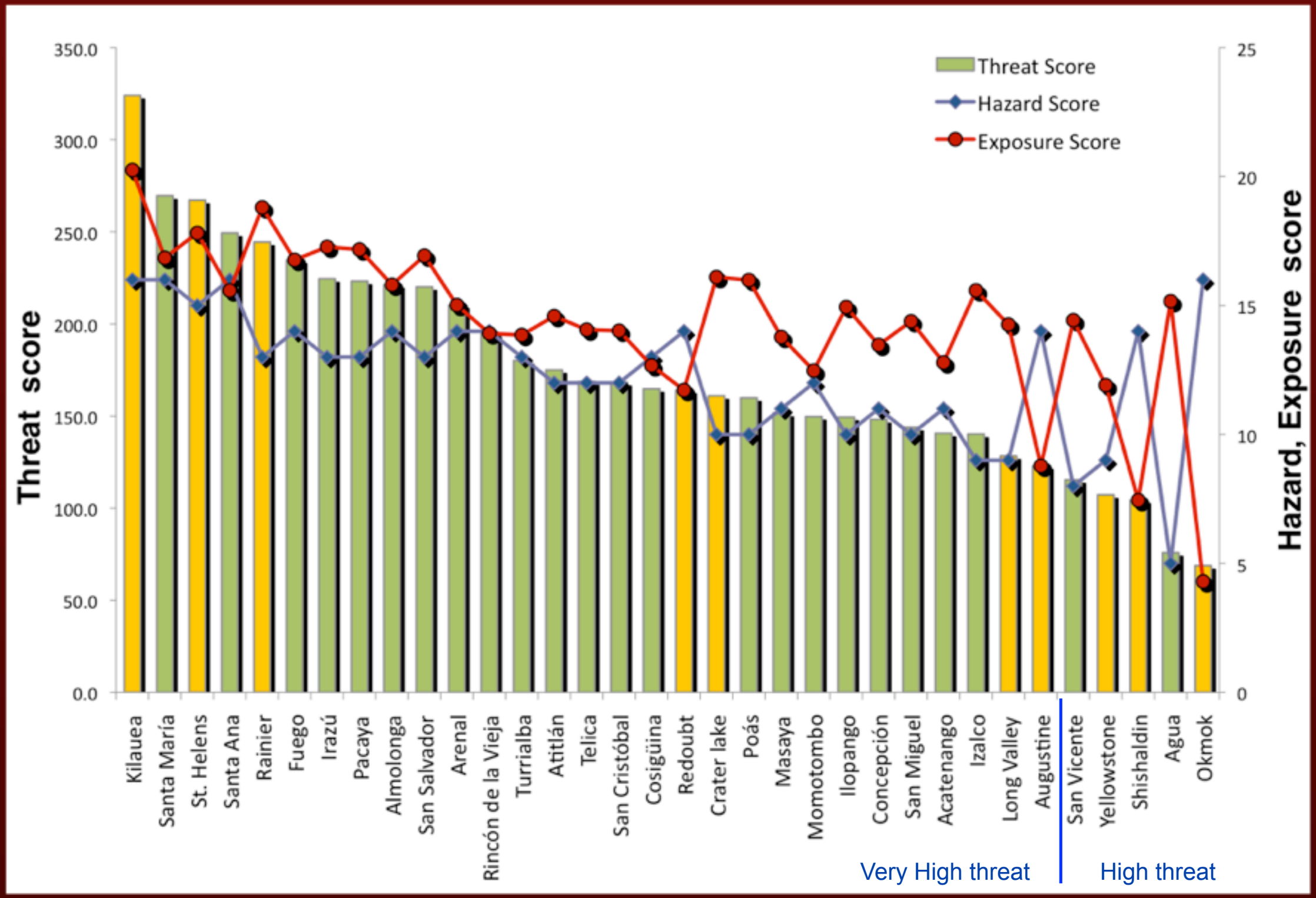
Name	Status	Type	Past Eruptions	Holocene flows	Potential Hazards	Historical Unrest	HAZARD SCORE	Ground-based population	Historical Impact	Development	EXPOSURE SCORE	THREAT SCORE
Santa María	Historical	Stratovolcano	9	3	1	3	16	6.1	2	8.78	16.8	269.5
Santa Ana	Historical	Stratovolcano	7	3	3	3	16	6.1	2	7.5	15.6	249.3
Fuego	Historical	Stratovolcano	8	3	1	2	14	6.0	2	8.78	16.8	234.7
Irazú	Historical	Stratovolcano	7	2	2	2	13	6.2	2	9.04	17.3	224.5
Pacaya	Historical	Complex volcano	7	2	1	3	13	6.4	2	8.78	17.2	223.2
Almolonga	Historical	Stratovolcano	8	3	2	1	14	6.0	1	8.78	15.8	221.2
San Salvador	Historical	Stratovolcano	8	2	1	2	13	6.4	2	8.5	16.9	220.1
Arenal	Historical	Stratovolcano	8	2	1	3	14	5.0	2	8.04	15.0	210.2
Rincón de la Vieja	Historical	Complex volcano	8	2	2	2	14	4.9	1	8.04	13.9	194.9
Turrialba	Historical	Stratovolcano	8	2	1	2	13	5.8	0	8.04	13.9	180.1
Atitlán	Historical	Stratovolcano	7	3	1	1	12	5.8	1	7.78	14.6	175.0
Telica	Historical	Stratovolcanoes	8	1	1	2	12	5.6	1	7.5	14.1	168.7
San Cristóbal	Historical	Stratovolcano	7	1	2	2	12	5.5	1	7.5	14.0	168.2
Cosigüina	Historical	Stratovolcano	8	2	1	2	13	4.2	2	6.5	12.7	164.7
Poás	Historical	Stratovolcano	5	1	2	2	10	5.9	1	9.04	16.0	159.9
Masaya	Historical	Caldera	8	0	1	2	11	6.3	0	7.5	13.8	151.5
Momotombo	Historical	Stratovolcano	8	2	0	2	12	5.0	0	7.5	12.5	149.7
Ilopango	Historical	Caldera	8	1	0	1	10	6.4	0	8.5	14.9	149.4
Concepción	Historical	Stratovolcano	6	2	1	2	11	6.0	1	6.5	13.5	148.2
San Miguel	Historical	Stratovolcano	5	1	2	2	10	5.9	1	7.5	14.4	143.9
Acatenango	Historical	Stratovolcano	5	3	2	1	11	6.0	0	6.78	12.8	140.7
Izalco	Historical	Stratovolcano	7	2	0	0	9	6.1	2	7.5	15.6	140.3
San Vicente	Holocene	Stratovolcano	3	2	2	1	8	5.9	1	7.5	14.4	115.4
Agua	Holocene	Stratovolcano	2	1	2	0	5	6.4	0	8.78	15.2	75.8

?? Conchaguita (El Sal), Tacana (G-M), Cerro Negro & Las Pilas (Nicaragua), Miravalles (Costa Rica), Barú (Panamá) ??

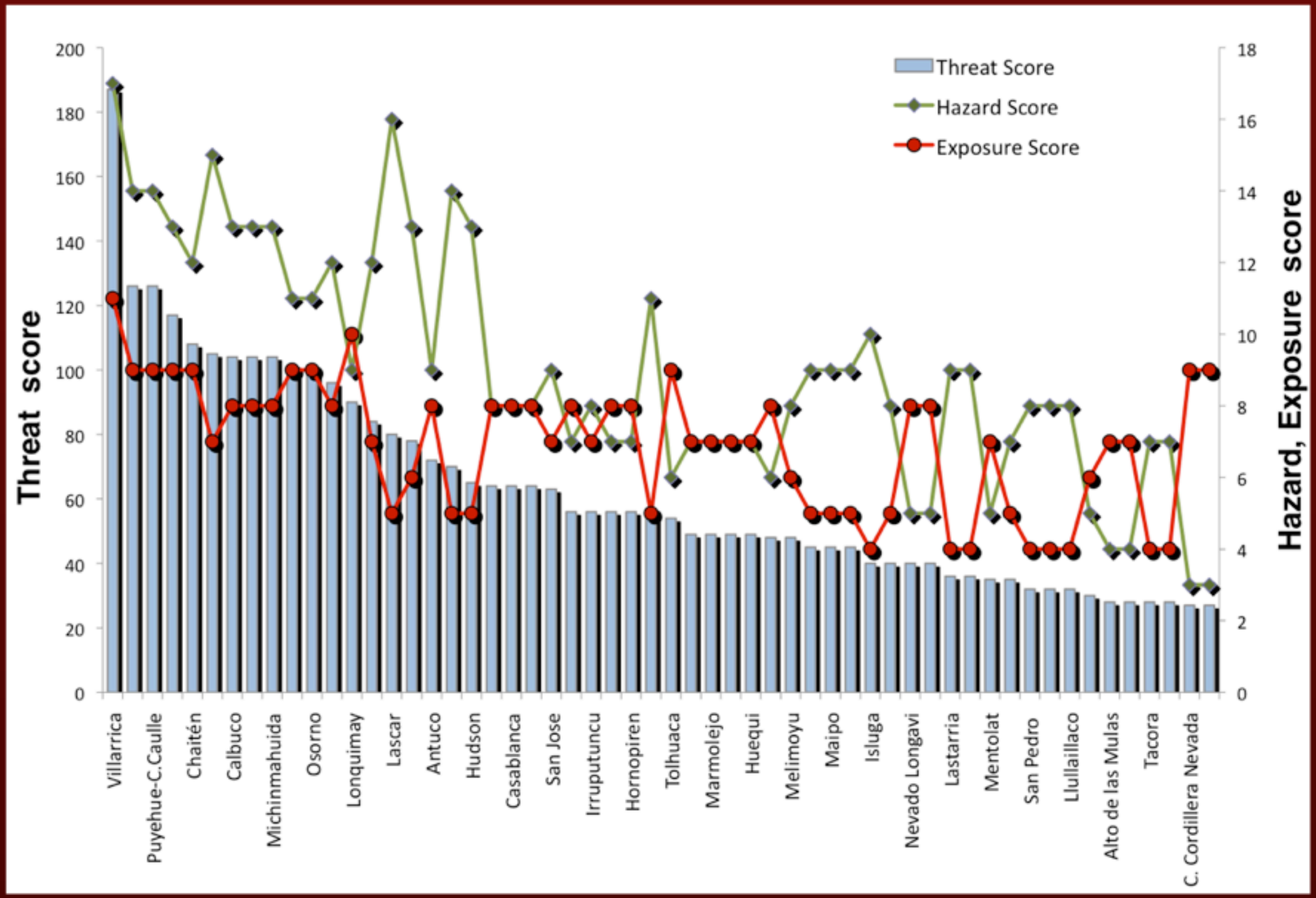
NVEWS-Volcanic Threat in Central America



NVEWS-Volcanic Threat in Central America

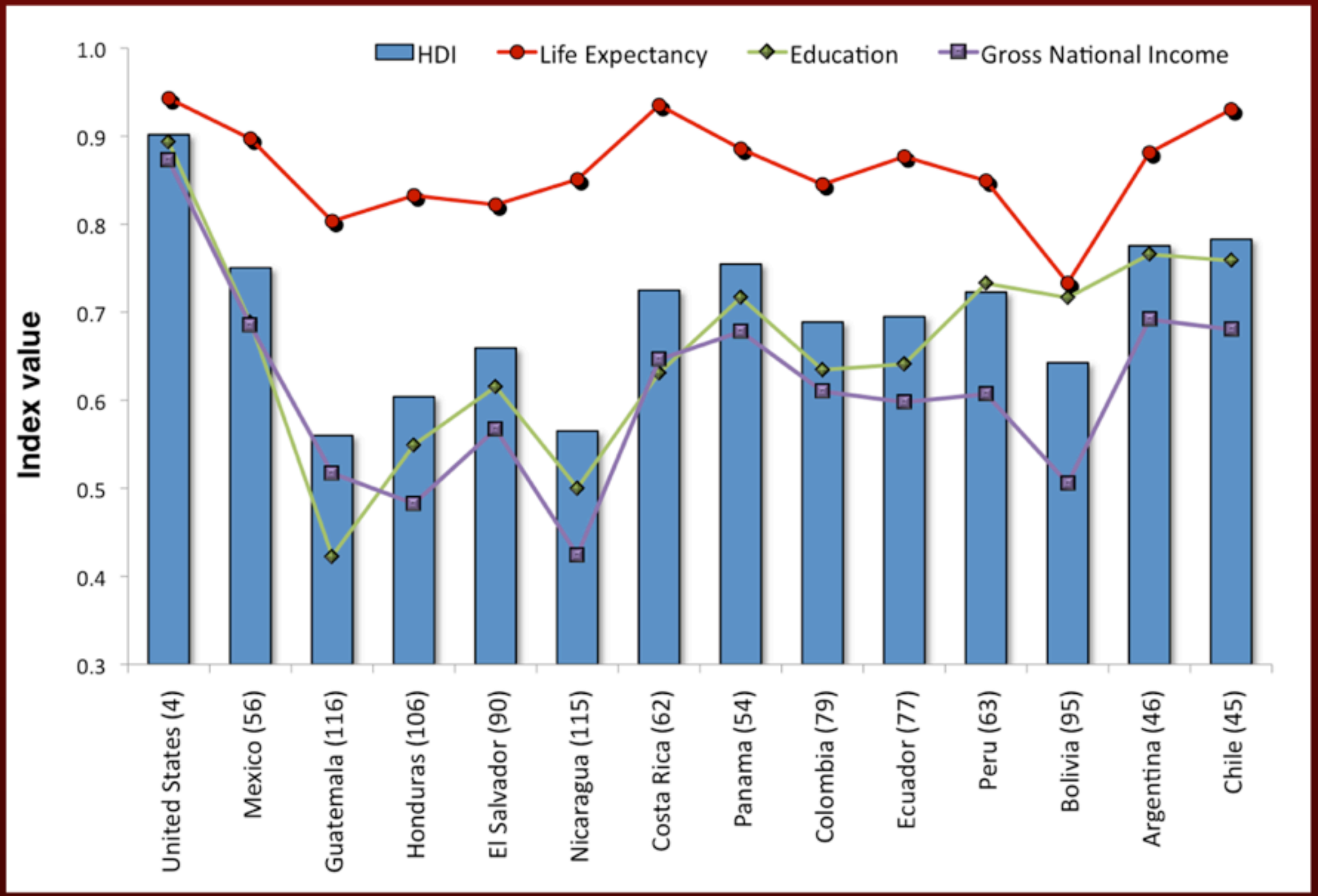


NVEWS-Volcanic Threat in Chile



Lara et al. (2006), NVEWS-Chile. XI Congreso Geológico Chileno, Antofagasta. Data courtesy of L. Lara.

Human Development Index- HDI



Pros and Cons of NVEWS method

- Ranking volcanoes based on a measure of threat or risk.
- Identify gaps in data/information
- No difference between explosive and effusive eruptions
- It doesn’t take into account wind direction to assess likely scenarios of ash fall
- No separation between exposure of population and infrastructure

Summary and Discussion

- Long return periods of catastrophic eruptive activity affects awareness and lowers risk perception.
- High population density in active volcanic areas, particularly at < 20 km from summit and/or downstream. Increase awareness and mitigation efforts.
- Fundamental field studies and monitoring efforts limited by insufficient resources or poor realization of the threat.
- Volcanic risk increases as population and infrastructure grows around volcanoes, accentuated by an increase in their vulnerability.
- Eruption can have local, regional and even global impact, with large economic effects.