HAZARD, THREAT, VULNERABILITY AND RISK

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- What do hazard, threat, vulnerability and risk mean?
- Differences and similitudes in English and Spanish
- Data collection on eruptive history and monitoring efforts in Latin American volcanoes: preliminary results
- Examples of hazards and risk studies in Latin American countries

BACKGROUND: LANGUAGE ISSUES

- Grammar differences are evident:
  - Two or more words for one expression:
  - i. e. su =her/his
- Scientific writing should be concise but Spanish is different from English
  - Style when writing in Spanish is more proper and educated when using as much synonyms as possible
  - Using synonyms in English is confusing

BACKGROUND: VOLCANOLOGICAL TERMS

- In volcanological terms there are also strong differences:
  - Translation of “welding” into Spanish: soldamiento
  - However, there are two English words for soldamiento, with different meanings: welding and sintering
  - Furthermore, welding in volcanology is applied when there has been collapse of scoriaceous/pumiceous fragments resulting in the formation of “fiames”
  - Latin American volcanologists use “soldamiento” for any degree of bonding of fragments intimately or not, collapsed or not.

BACKGROUND: BEYOND THE LANGUAGE

- Other volcanological terms are matter of discussion in any language:
  - Explosion for instance
  - Different concepts among scientists
  - Physical, geophysical and geological concepts

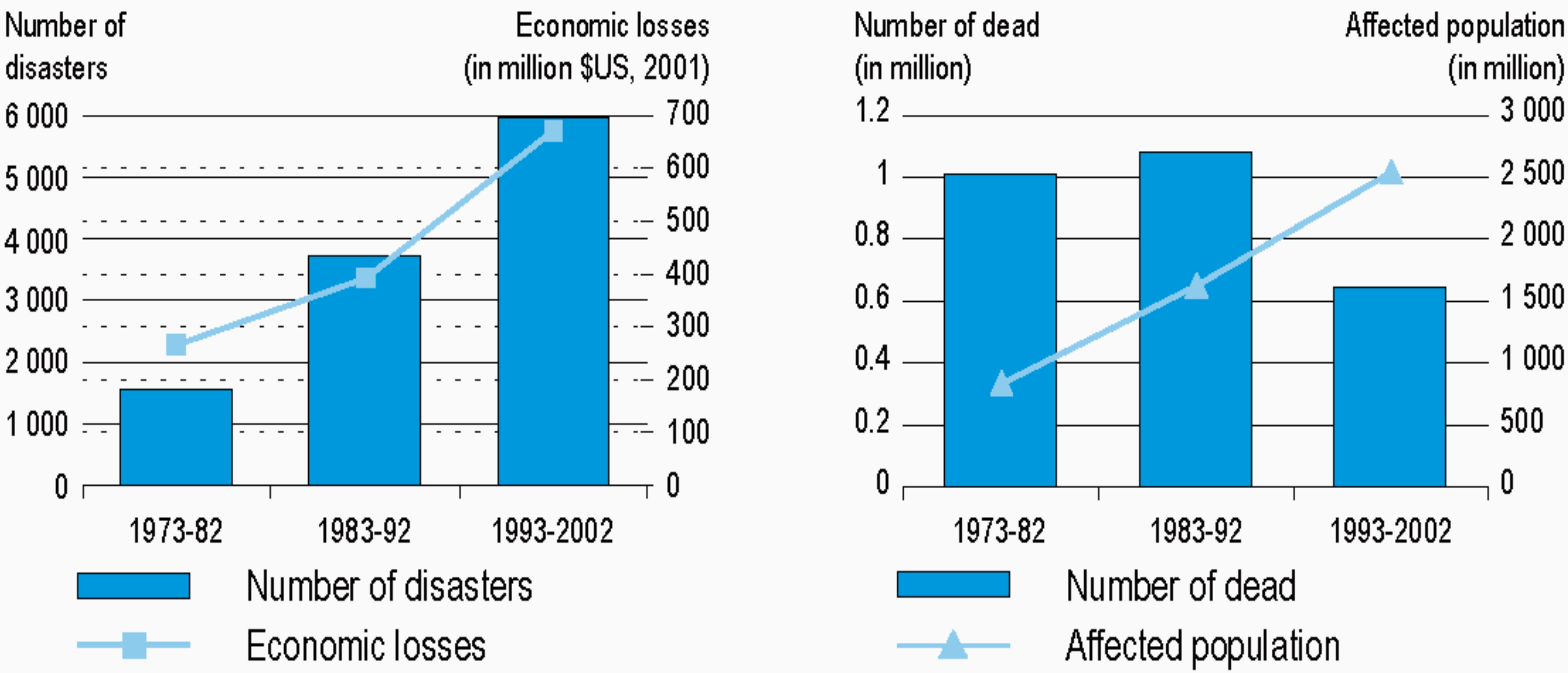
BACKGROUND: SEMANTICS AND CONCEPTS

- Sometimes people don't like to spend time in thinking about concepts and definitions
- However, it is of key importance to communicate concisely
- This is an important issue because finally, when assessing hazards communication is established with people with professional background other than earth science

BACKGROUND

- Alternatives for disaster prevention is a matter concerning to scientists, authorities, media and community
- Understanding of natural processes is a responsibility for scientists

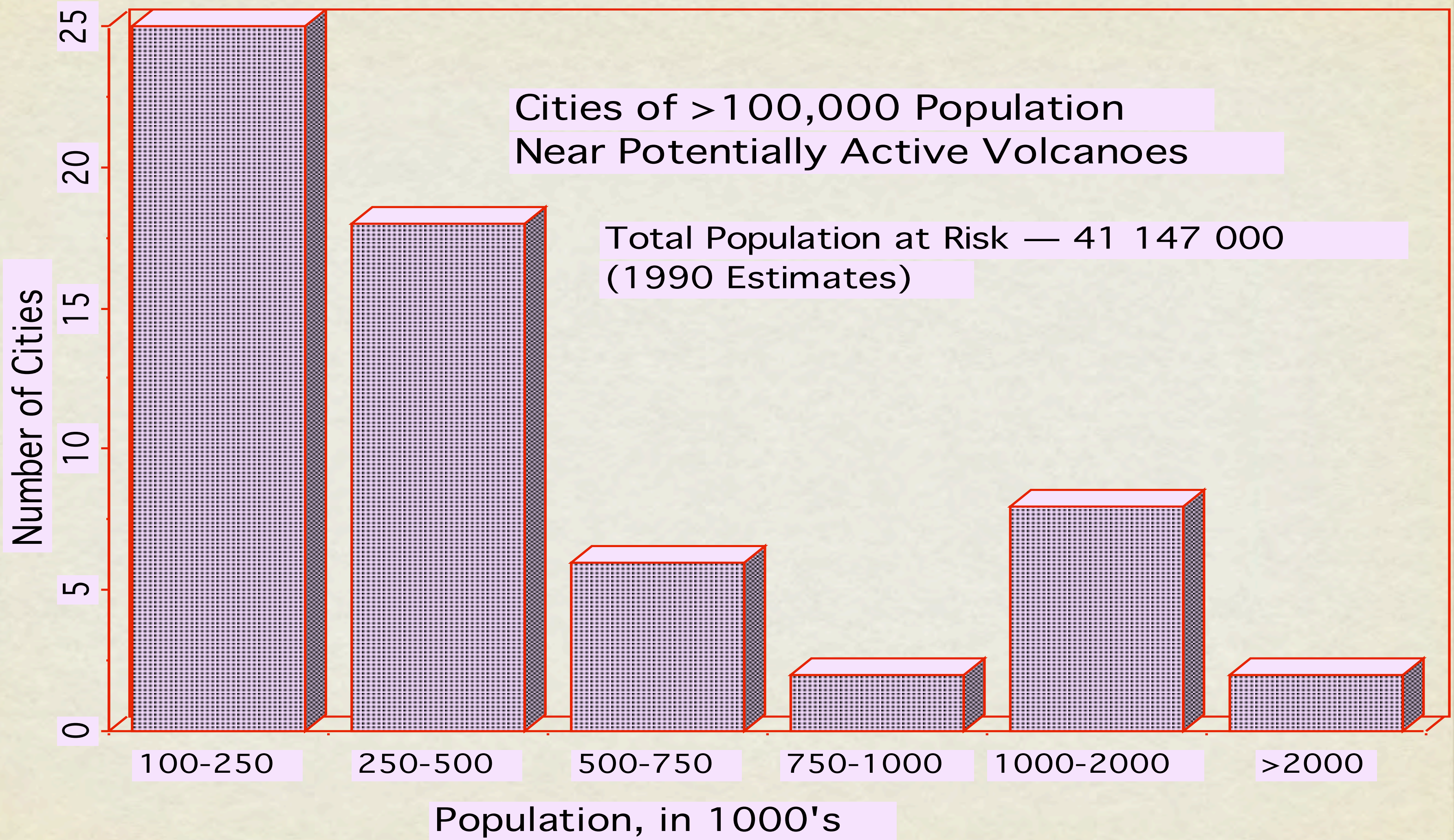
Economic and human impacts of disasters*, 1973-2002



Source: EM-DAT: The OFDA/CRED International Disaster Database - www.em-dat.net - Université Catholique de Louvain - Brussels - Belgium, 2004

*Note: Includes drought, earthquake, epidemic, extreme temperature, famine, flood, industrial accident, insect infestation, miscellaneaous accident, land/debris-slides, transport accident, volcano, wave/surge, wildfire and windstorm.

GLOBAL URBAN POPULATION AT RISK?



Slide courtesy of Grant Heiken

WHAT DO HAZARD, THREAT, VULNERABILITY AND RISK MEAN?

MEANING OF HAZARD, THREAT, VULNERABILITY AND RISK

- According to the Webster dictionary:
  - Hazard - a source of danger
  - Threat - an expression of intention to inflict evil, injury, or damage
  - Vulnerability - open to attack or damage
  - Risk - possibility of loss or injury

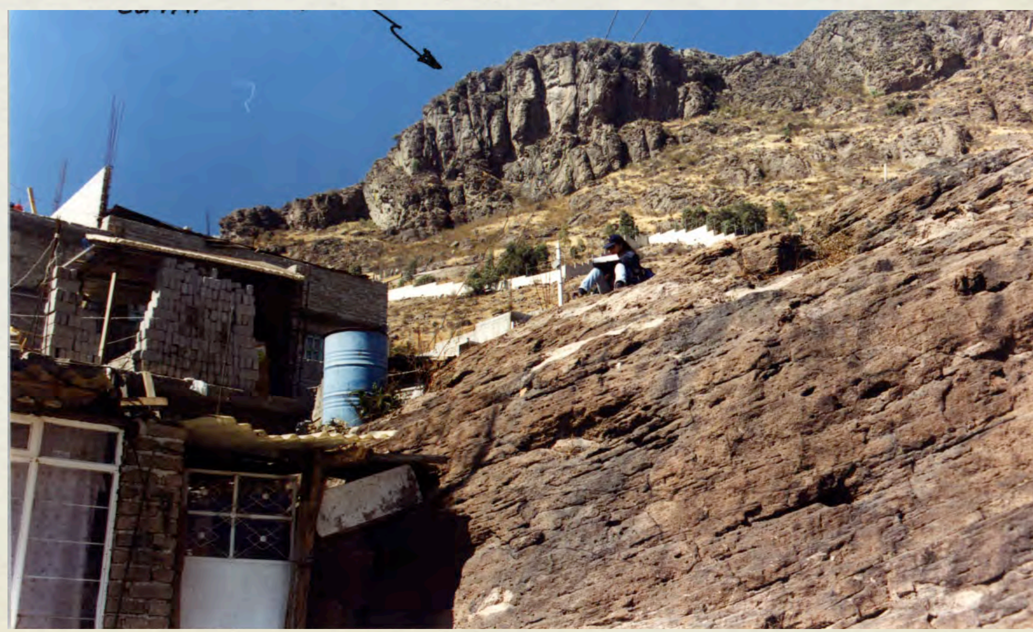
MEANING OF HAZARD, THREAT, VULNERABILITY AND RISK

- Natural hazards include anything that is caused by a natural process, and can include obvious hazards such as volcanoes to smaller scale hazards such as loose rocks on a hillside.
- Threat - an expression of intention to inflict evil, injury, or damage
- Vulnerability - open to attack or damage
- Risk - possibility of loss or injury

BASIC PRINCIPLES

- Hazard-risk concepts are matter of strong discussion among scientific disciplines
- For hazards assessment a basic conceptual framework is needed
- Confusing definitions of hazard and risk will derive in useless confusing tools

- *Initial definition of hazard and risk is crucial*



INTERNATIONAL STRATEGY FOR DISASTER REDUCTION UNESCO, 2004 **HAZARD DEFINITION**

- A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

- Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency and probability.

RISK ASSESSMENT/ANALYSIS

- A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

- *The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.*

The role of science and technology

The idea of launching a decade dedicated to natural disaster reduction came from the scientific community. It was motivated by a desire to expand the scope of scientific and technical abilities in disaster reduction.

Science and technology play key roles in monitoring hazards and vulnerabilities, developing an understanding of their continually changing patterns and in developing tools and methodologies for disaster risk reduction. The dissemination and application of new strategies and measures to protect lives, livelihoods and property within societies experiencing change are key areas of work for the scientific and technical communities.

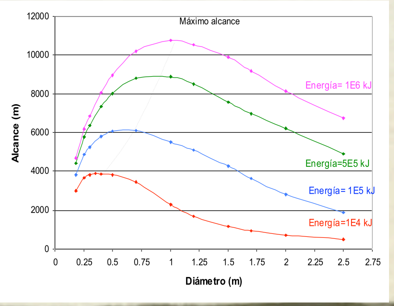
Scientific knowledge and technical expertise have to be shared as an integral part of multidisciplinary technical cooperation. Efficient disaster reduction requires interaction among scientists, decision-makers and informed citizens.

However, the limitations of science and technology in responding to the problems of people and political processes identifying and managing risks need to be carefully considered. An over-concentration on technical abilities at the expense of the human aspects that compose the economic, social and political dimensions of societies will provide disappointing results in sustained commitments to risk reduction. In particular circumstances, science and technology can be misapplied, sometimes provoking or aggravating risks to a society.

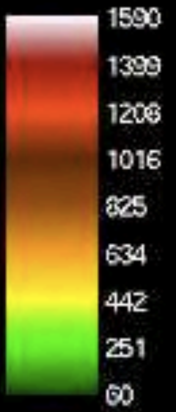
The scientific and technical applications relating to each aspect of disaster risk reduction are addressed extensively throughout this review.

WHEN EVALUATING NATURAL HAZARDS, WE EVALUATE THE PROBABILITY/LIKELIHOOD OF:

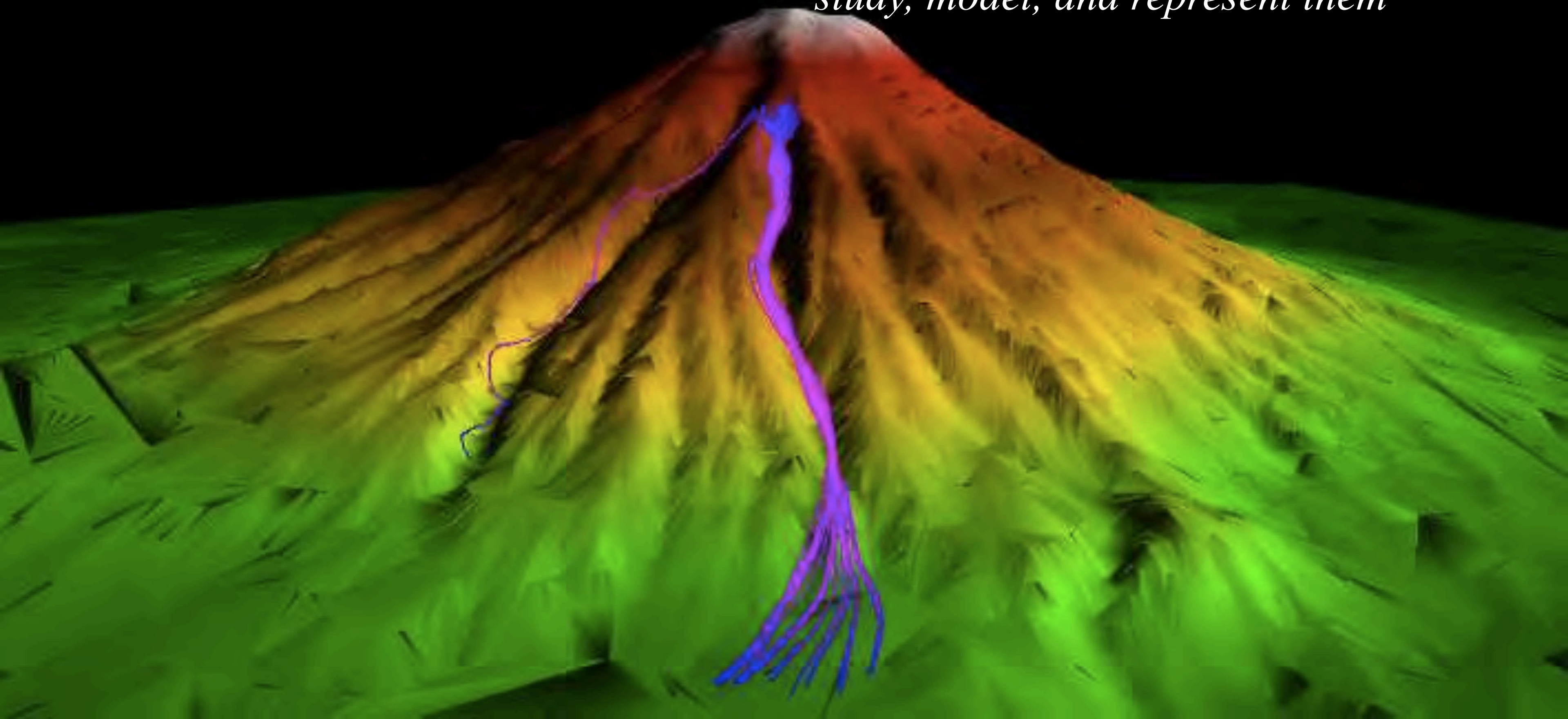
- ...occurrence of a certain process in an area, characterized by certain magnitude
- ...spatial distribution of the related products
- ... maximum range of the products, or maximum influence area of them, during the occurrence of a process of a given magnitude
- ... occurrence of certain process in a given interval of time



Therefore...



- *Study of hazards is a matter of analyzing their physical properties, occurrence modes, emplacement of the associated products, establishing of numerical and physical models, and design of simulation tools*
- *Thus, hazards evaluation should be the realm of scientific and engineering research towards the reconstruction of events, understanding of processes and development of technology to study, model, and represent them*



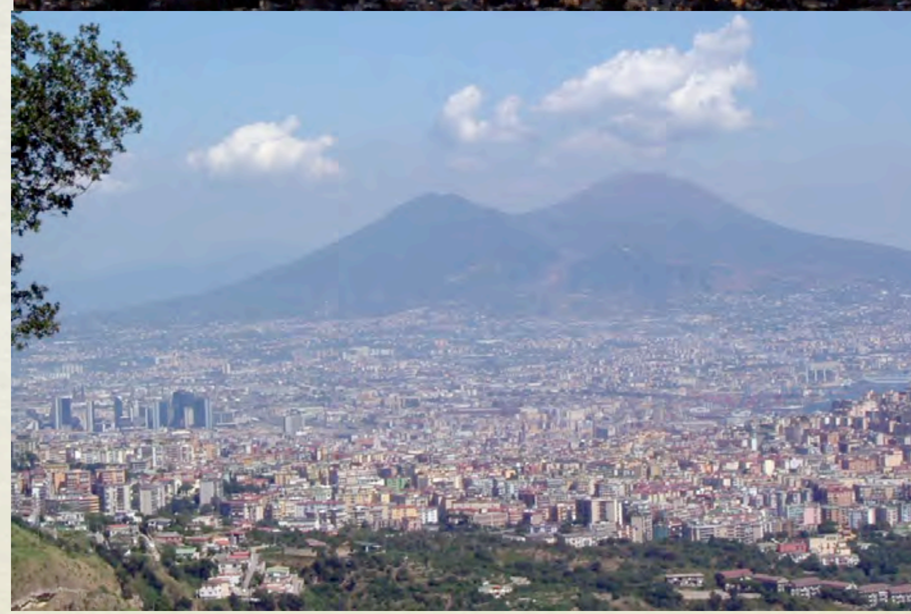
OPERATIVE DEFINITIONS

- Volcanic hazard is the probability or likelihood for a volcanic process characterized by a certain magnitude to occur and/or its related products or effects being distributed spatially or temporally or reach a maximum extent in a determined area

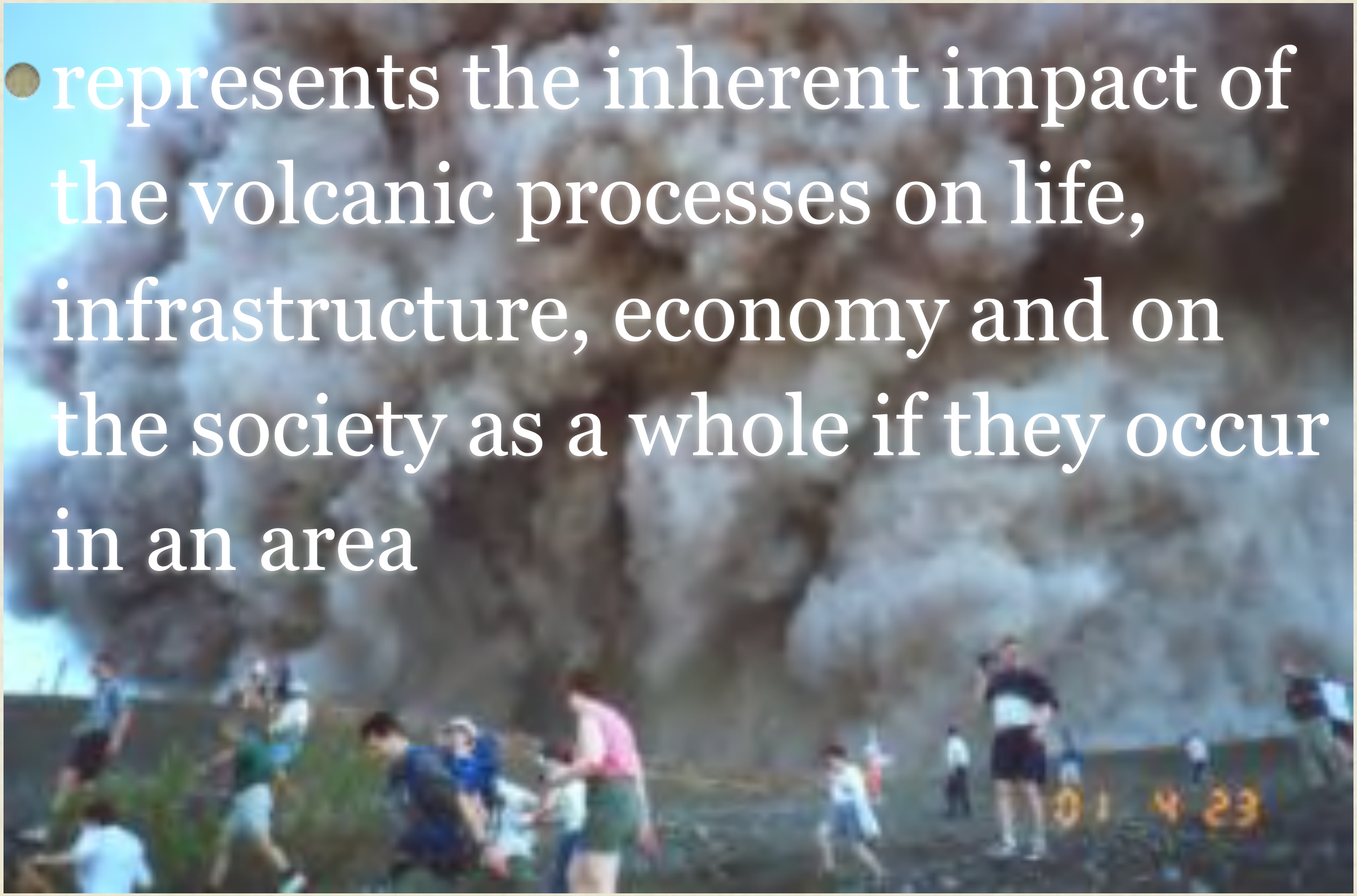
VULNERABILITY

- Humans invade increasingly, areas where regularly landslides, earthquakes, volcanic eruptions, floods, among others, occur

- Daily, more people is exposed to natural processes that may provoke disasters



VOLCANIC RISK...



- represents the inherent impact of the volcanic processes on life, infrastructure, economy and on the society as a whole if they occur in an area

THEREFORE...

- Volcanic risk needs interaction of several specialists
- Volcanic risk is evaluation of the impact of hazards once they occur
- This is the realm of social scientists and authorities because scientific or technical solutions might not be suitable for social, economic or political reasons
- Risk evaluation requires previous hazards evaluation

HAZARDS IN LATIN AMERICA: THE TERMS

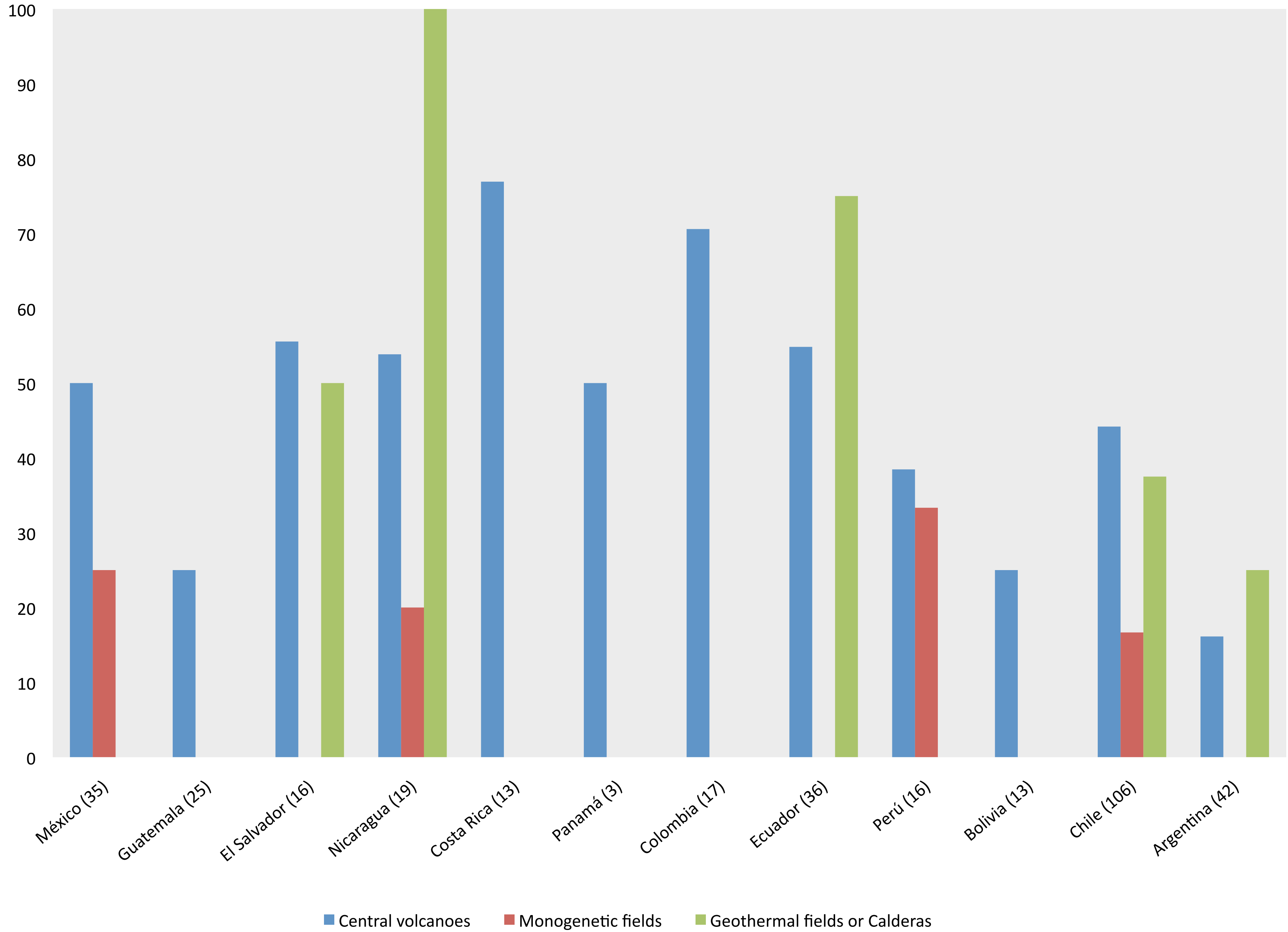
- Hazard can be translated as;
  - Peligro
  - Amenaza
- Some colleagues tried to use the term “Amenaza” as a descriptive term of the natural process and “Peligro” as the probabilistic measure of the “Amenaza” but this resulted to be confusing
- Latin American volcanologists agreed in 2005 to use *Peligro* and *Amenaza* as synonyms

TACKLING HAZARDS AND RISK IN LATIN AMERICA

- How to tackle hazards in a region of the world with the largest number of active volcanoes and the largest population at risk?
- IAVCEI project: Weaknesses and strengths in Latin America facing volcanic crises: A research for the improvement of national capabilities and international cooperation
- Identify weaknesses and strengths in the Latin American regions when facing volcanic crises in order to find the best way to improve national capabilities in the countries of the region and enhance international cooperation

DATA COLLECTION ON ERUPTIVE HISTORY IN LATIN AMERICA

Country	Central Volcanoes			Monogenetic Fields			Calderas and/or Geothermal Fields			Total		
	Total	Monitored		Total	Monitored		Total	Monitored		Total	Monitored	
		No	%		No	%		No	%		No	%
México (35)	18	9	50	12	3	25	5	0	0	35	12	34
Guatemala (25)	16	4	25	7	0	0	2	0	0	25	4	16
El Salvador (16)	9	5	56	5	0	0	2	1	50	16	6	38
Nicaragua (19)	13	7	54	5	1	20	1	1	100	19	9	47
Costa Rica (13)	13	10	77	0	0	0	0	0	0	13	10	77
Panamá (3)	2	1	50	0	0	0	1	0	0	3	1	33
Colombia (17)	17	12	71	0	0	0	0	0	0	17	12	71
Ecuador (36)	31	17	55	1	0	0	4	3	75	36	20	56
Perú (16)	13	5	38	3	1	33	0	0	0	16	6	38
Bolivia (13)	8	2	25	4	0	0	1	0	0	13	2	15
Chile (106)	86	38	44	12	2	17	8	3	38	106	43	41
Argentina (42)	31	5	16	7	0	0	4	1	25	42	6	14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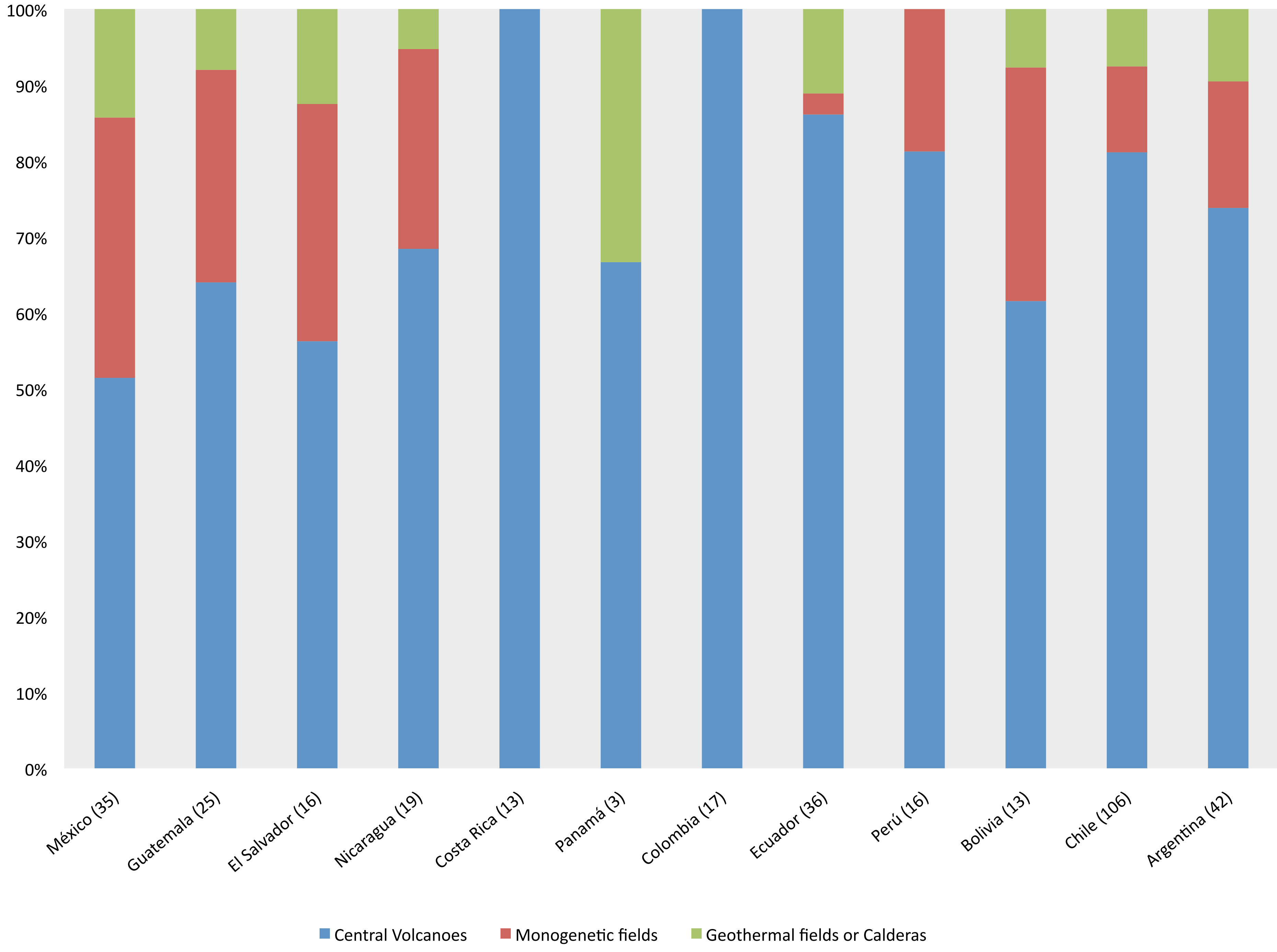
Central volcanoes
Monogenetic fields
Geothermal fields or Calderas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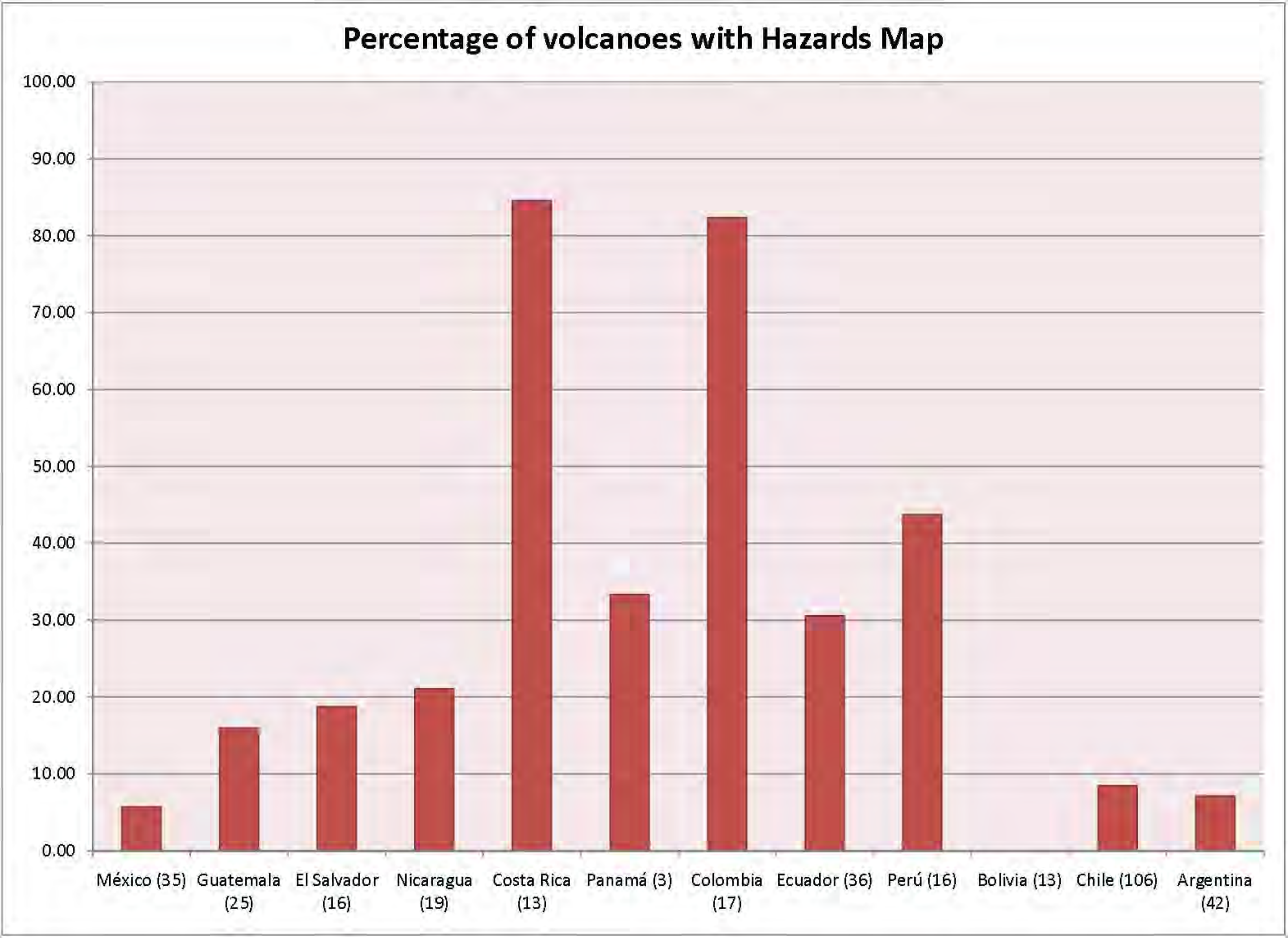
Central Volcanoes
Monogenetic fields
Geothermal fields or Calderas


Percentage of volcanoes with Hazards Map
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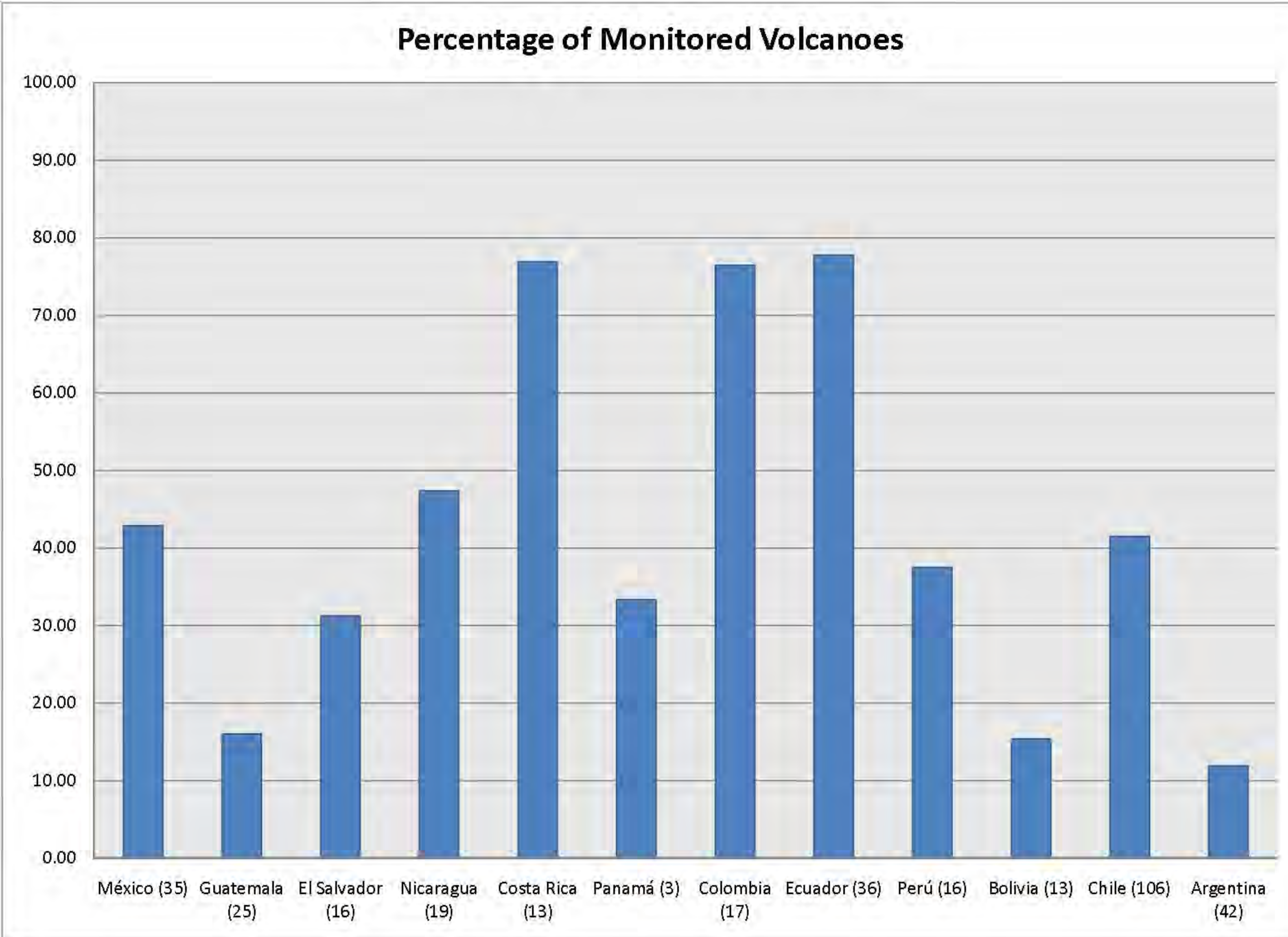
MONITORING EFFORTS IN LATIN AMERICAN VOLCANOES: PRELIMINARY RESULTS

Country	Holocene volcanoes	Volcanoes with Hazards Map		Volcanoes with Seismographs		Volcanoes with periodic gas sampling		Volcanoes with periodic spring-water or fumarole sampling		Volcanoes with Deformation Monitoring		Volcanoes with Remote Sensing		Total percentage of instrumented and monitored volcanoes	
		Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
México	18	2	11	10	56	5	28	8	44	8	44	7	39	15	83
Guatemala	16	4	25	3	19	2	13	1	6	4	25	4	25	4	25
El Salvador	9	3	33	3	33	5	56	5	56	0	0	3	33	5	56
Nicaragua	13	4	31	9	69	4	31	1	8	9	69	1	8	9	69
Costa Rica	13	11	85	8	62	9	69	10	77	2	15	6	46	10	77
Panamá	2	1	50	1	50	0	0	0	0	0	0	0	0	1	50
Colombia	17	14	82	12	71	6	35	6	35	9	53	3	18	13	76
Ecuador	31	11	35	19	61	6	19	7	23	9	29	16	52	28	90
Perú	13	7	54	1	8	1	8	6	46	0	0	5	38	6	46
Bolivia	8	0	0	0	0	0	0	2	25	0	0	0	0	2	25
Chile	86	9	10	40	47	3	3	10	12	29	34	33	38	44	51
Argentina	31	3	10	3	10	3	10	4	13	3	10	0	0	5	16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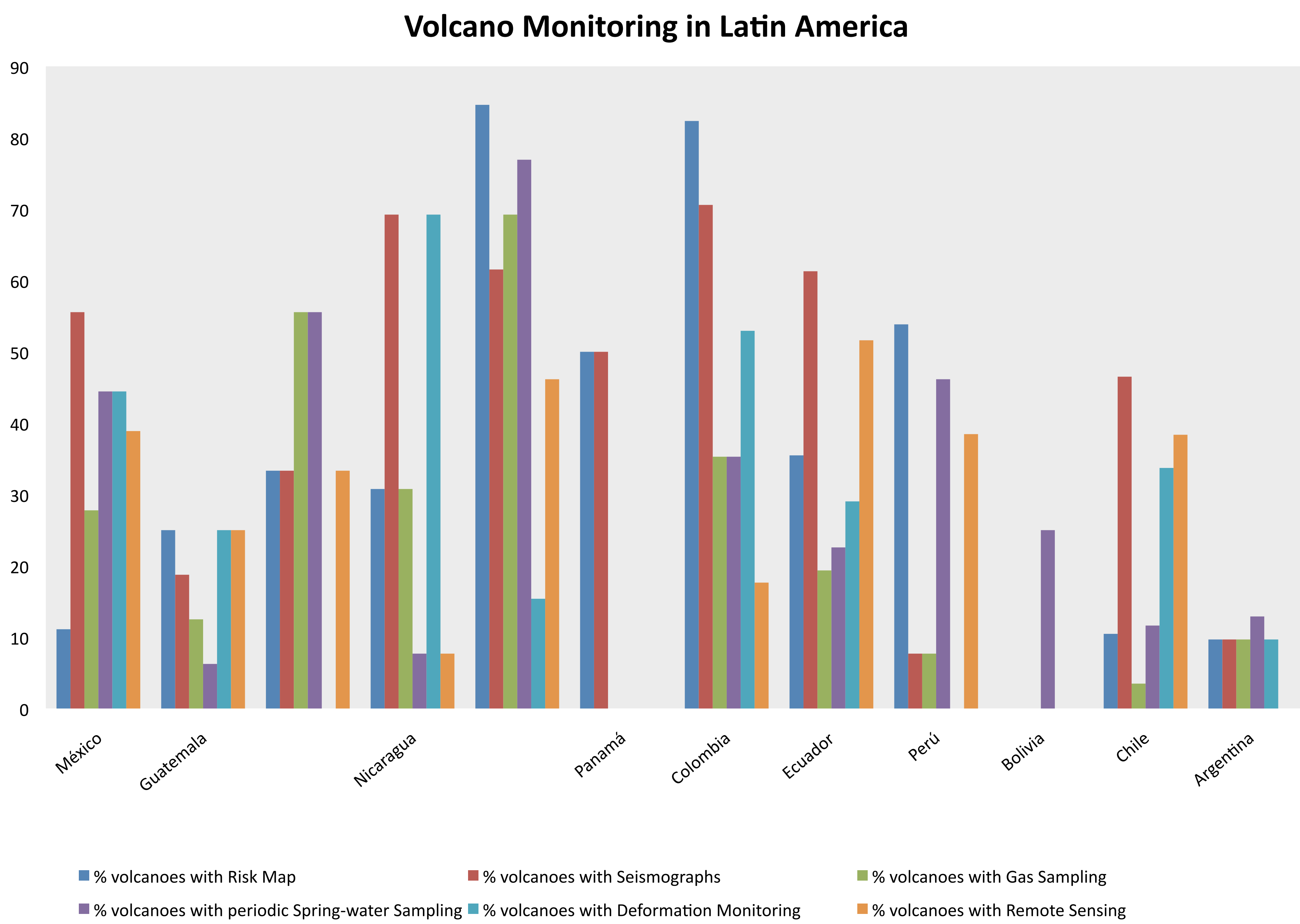

Volcano Monitoring in Latin America
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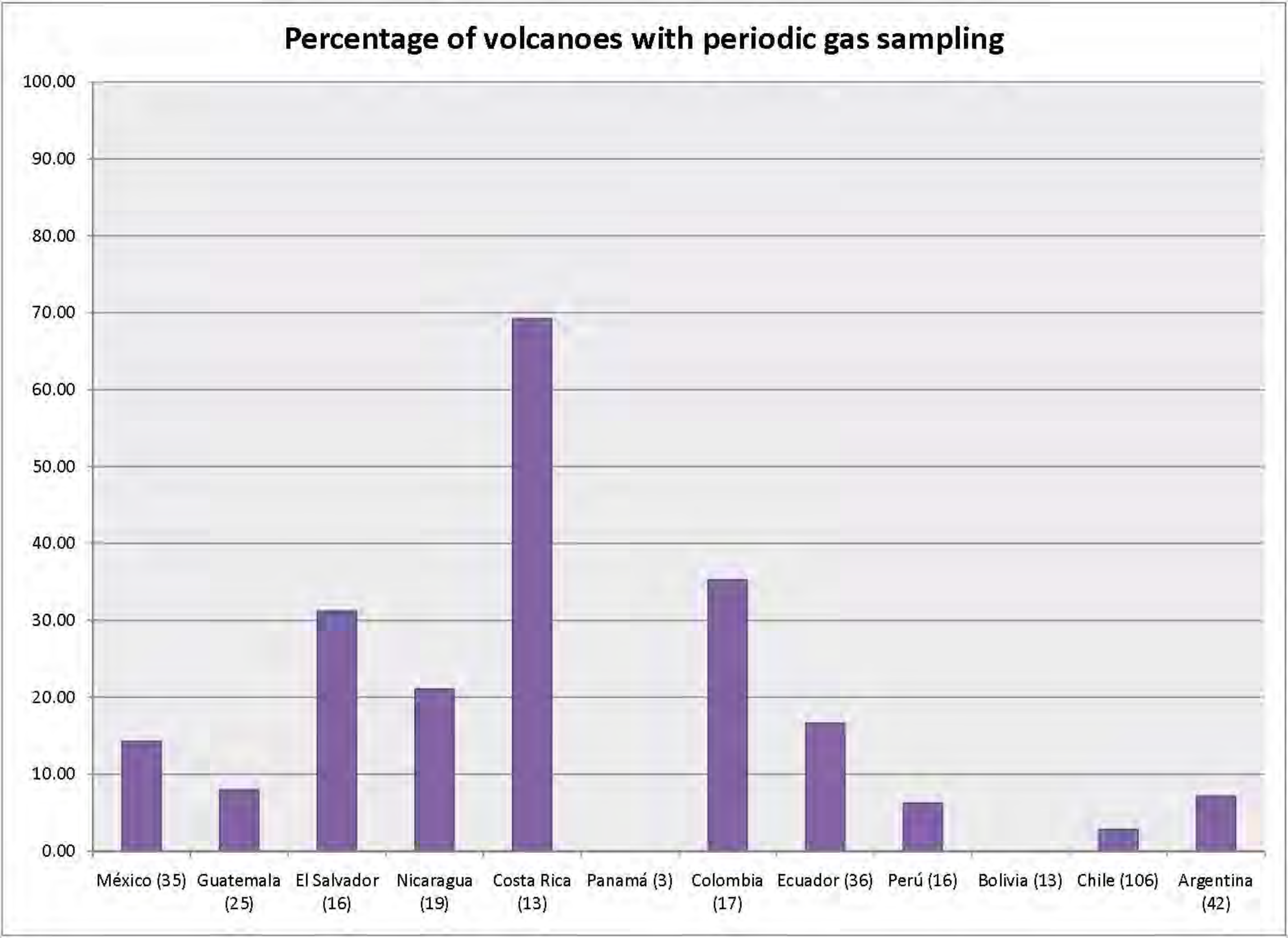
Argentina
% volcanoes with Risk Map
% volcanoes with Seismographs
% volcanoes with Gas Sampling
% volcanoes with periodic Spring-water Sampling
% volcanoes with Deformation Monitoring
% volcanoes with Remote Sensing


Percentage of volcanoes with periodic gas sampling
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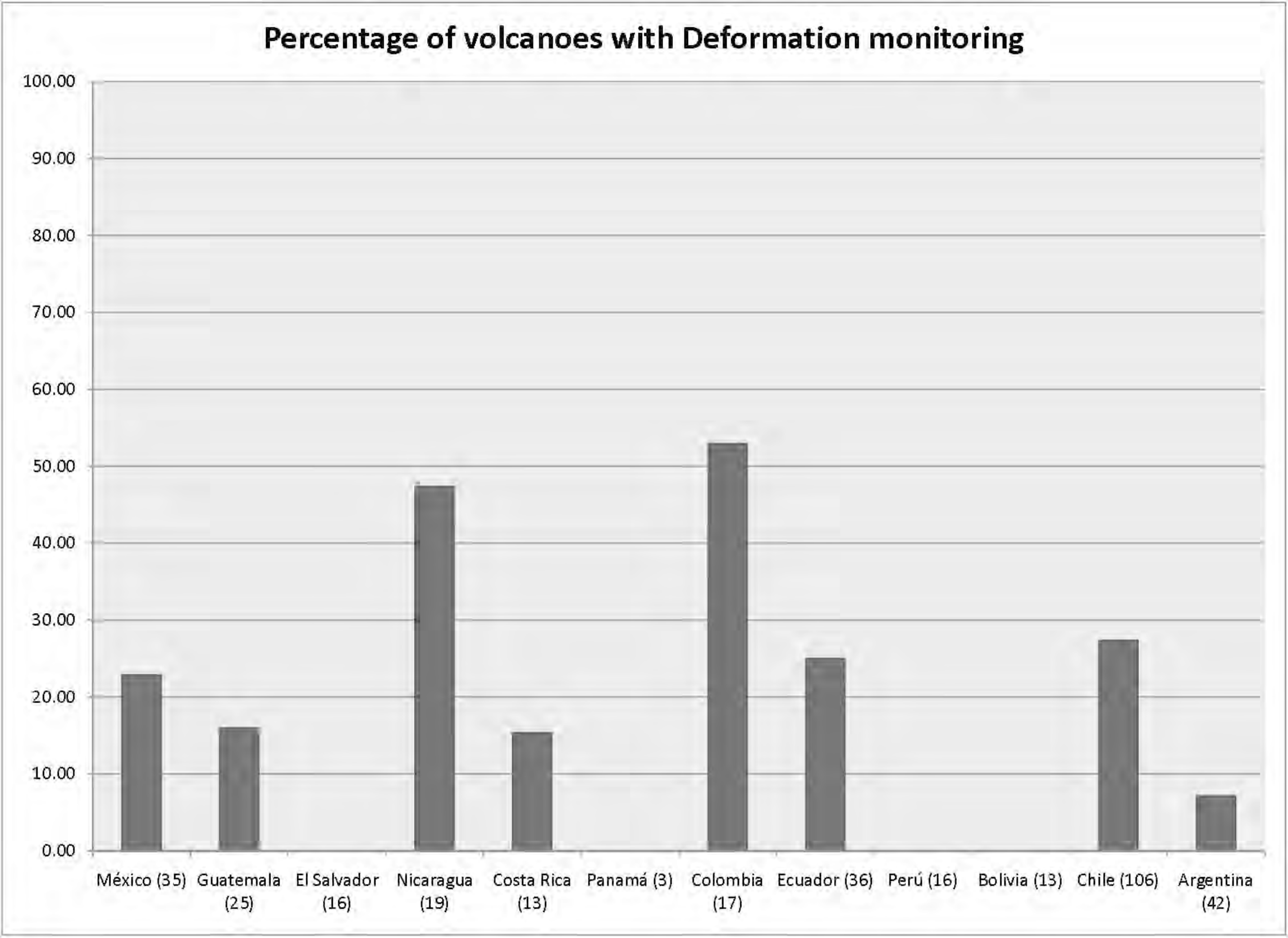

Percentage of volcanoes with Deformation monitoring
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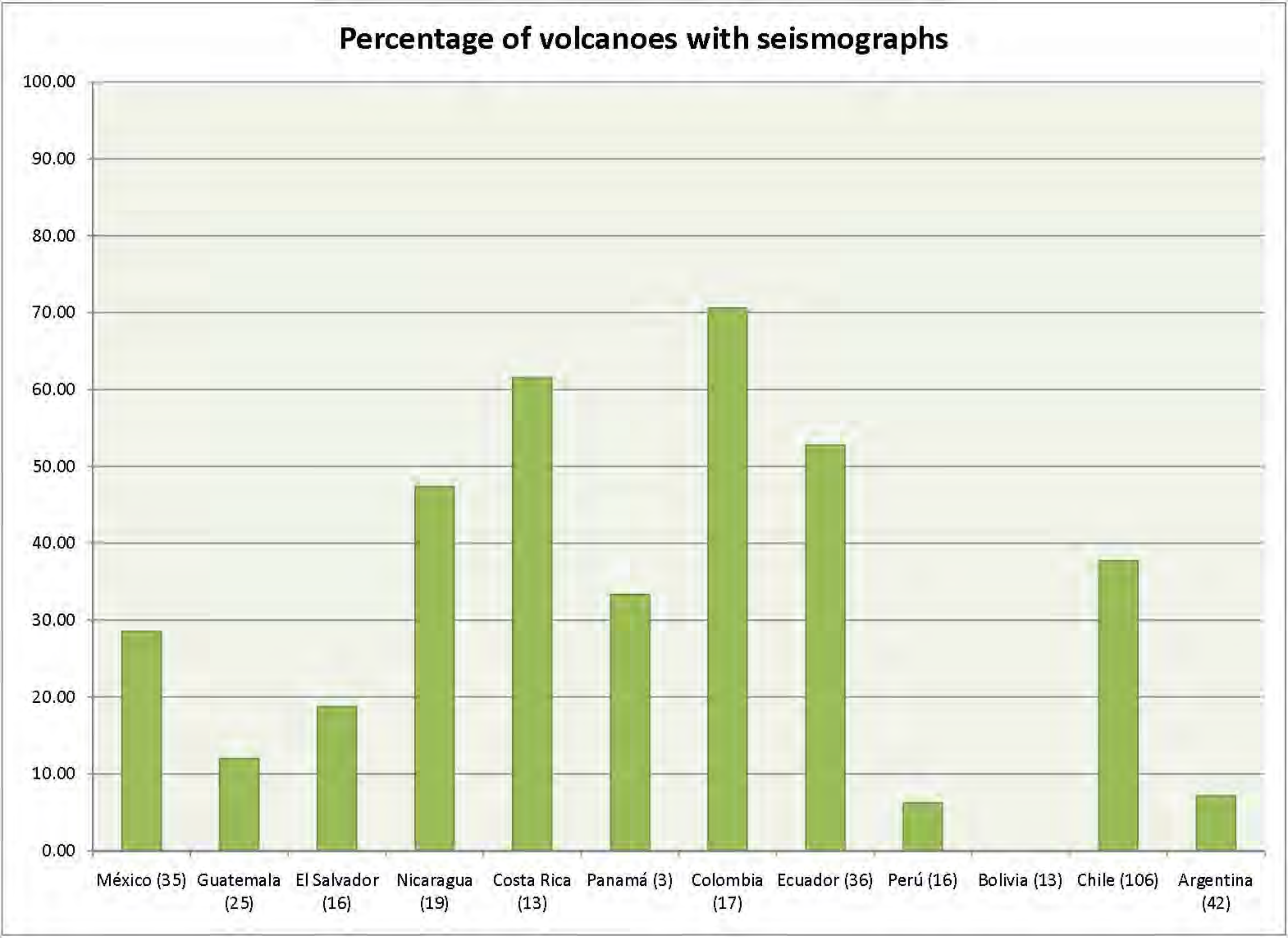

Percentage of volcanoes with seismographs
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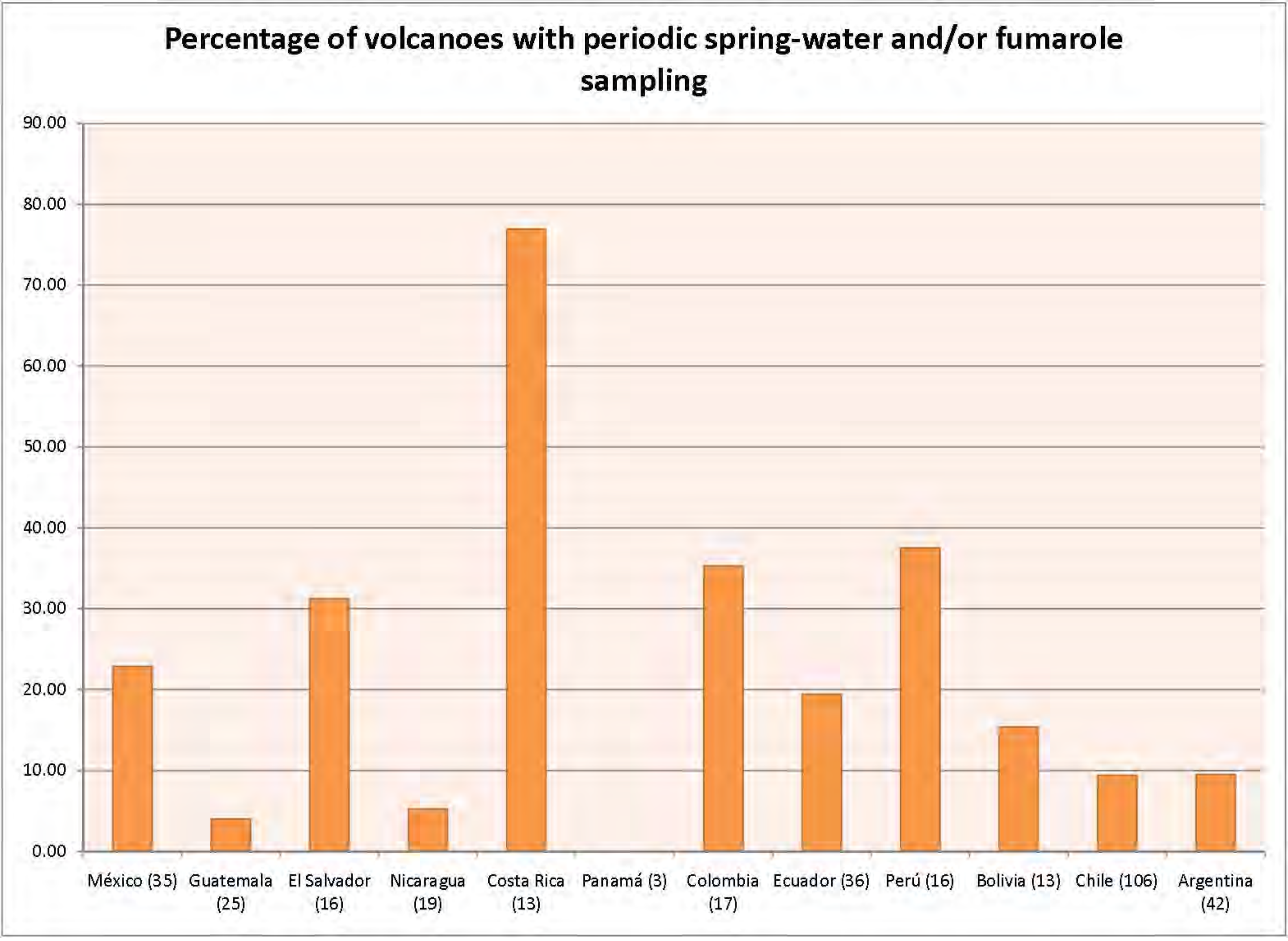
Percentage of volcanoes with periodic spring-water and/or fumarole sampling
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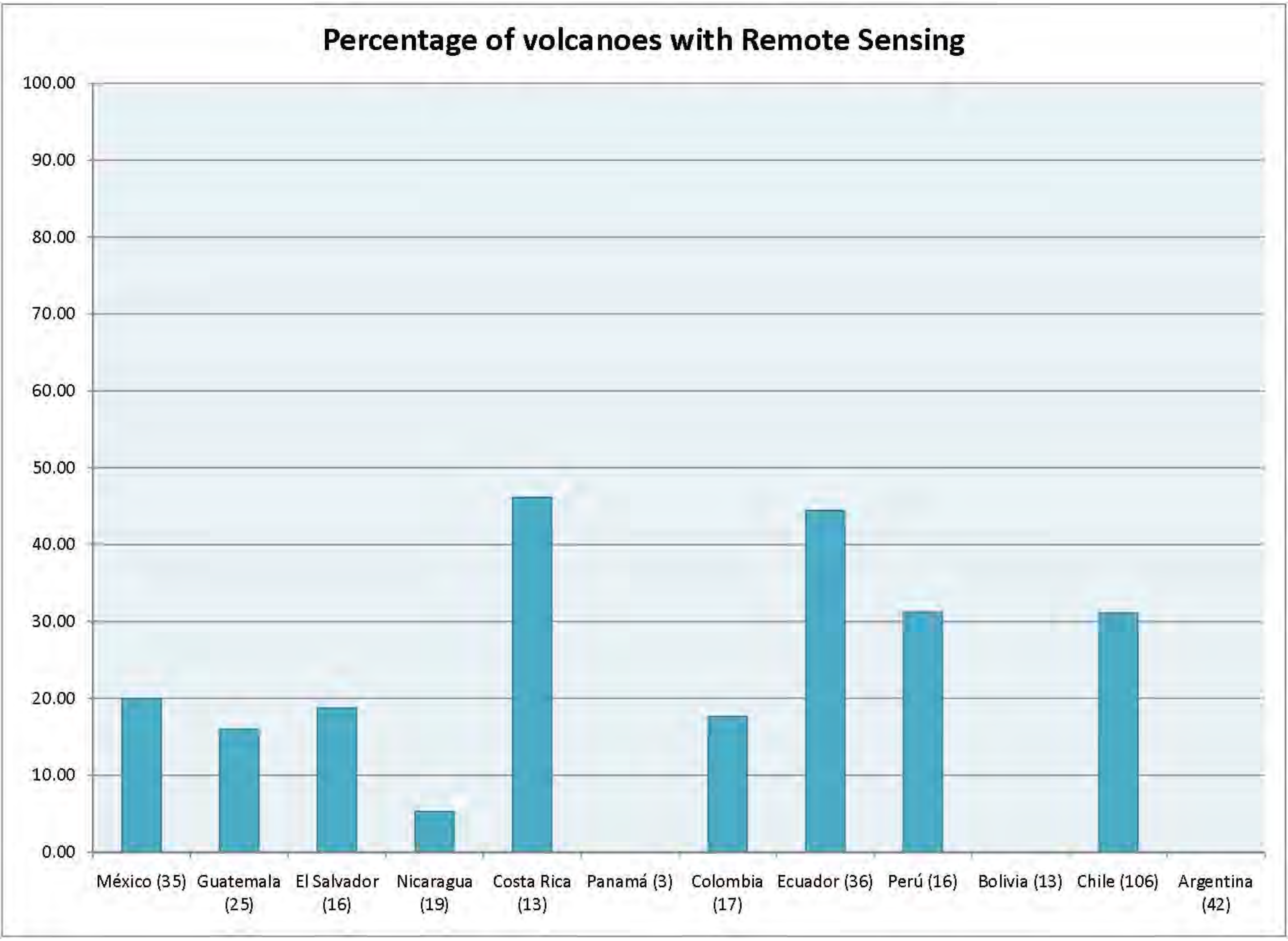
Percentage of volcanoes with Remote Sensing
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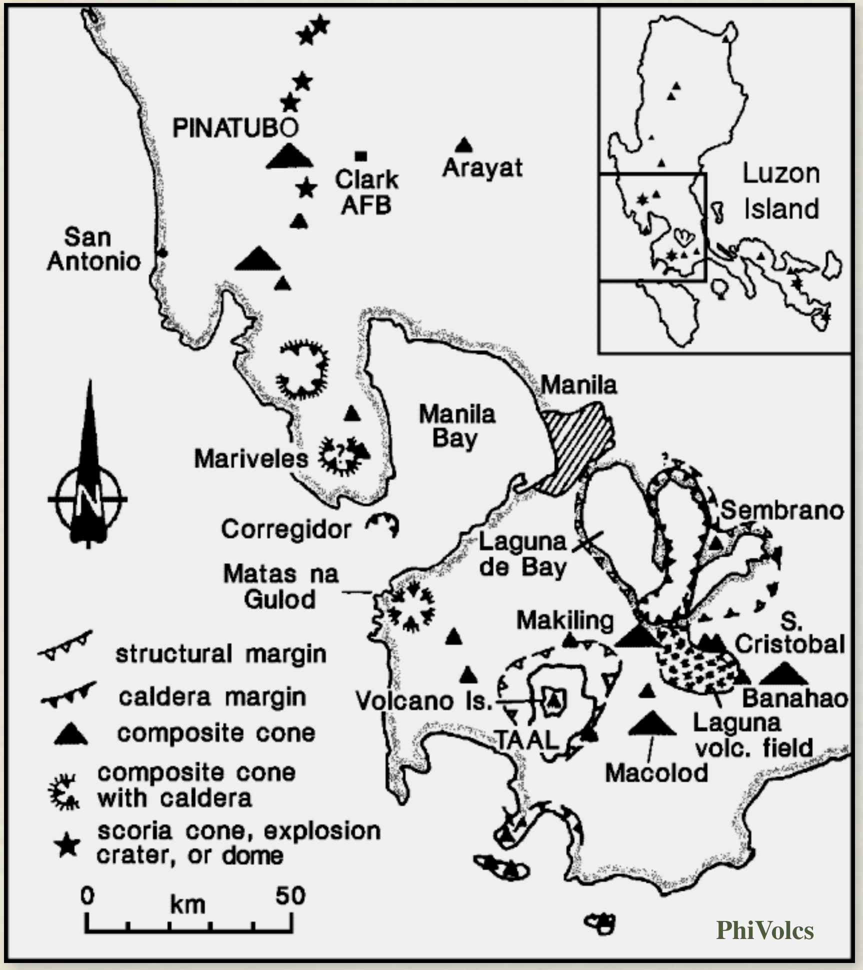
MANILA, PHILIPPINES



- Population, metro area —10 million
- Two caldera complexes, many smaller volcanoes
- Last large-scale eruption —Taal, 5380 years ago
- Last significant eruption in the region—Pinatubo, 1991

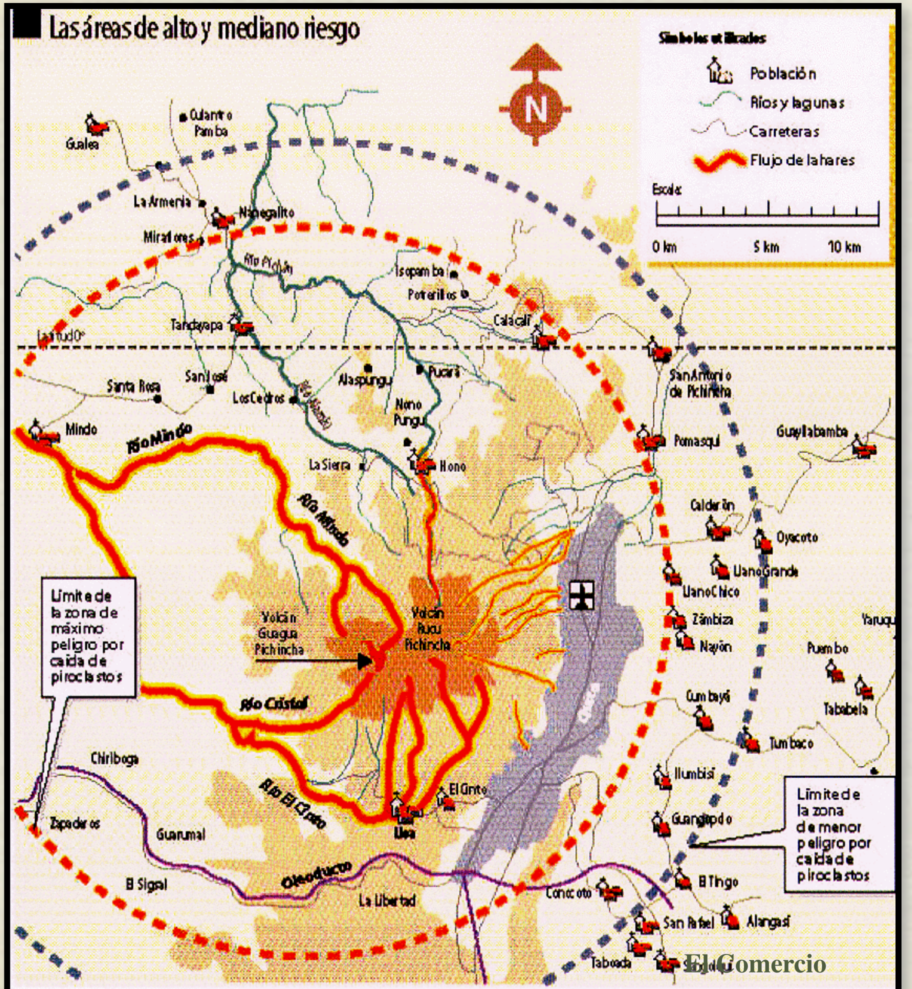
Slide courtesy of Grant Heiken

AUCKLAND, NEW ZEALAND

- Population— ~1 million
- Located in a 360 km^2 volcanic field; scoria cones and tuff rings
- 49 volcanoes erupted during the last 140,000 years
- Last eruption about 1000 years ago

Slide courtesy of Grant Heiken

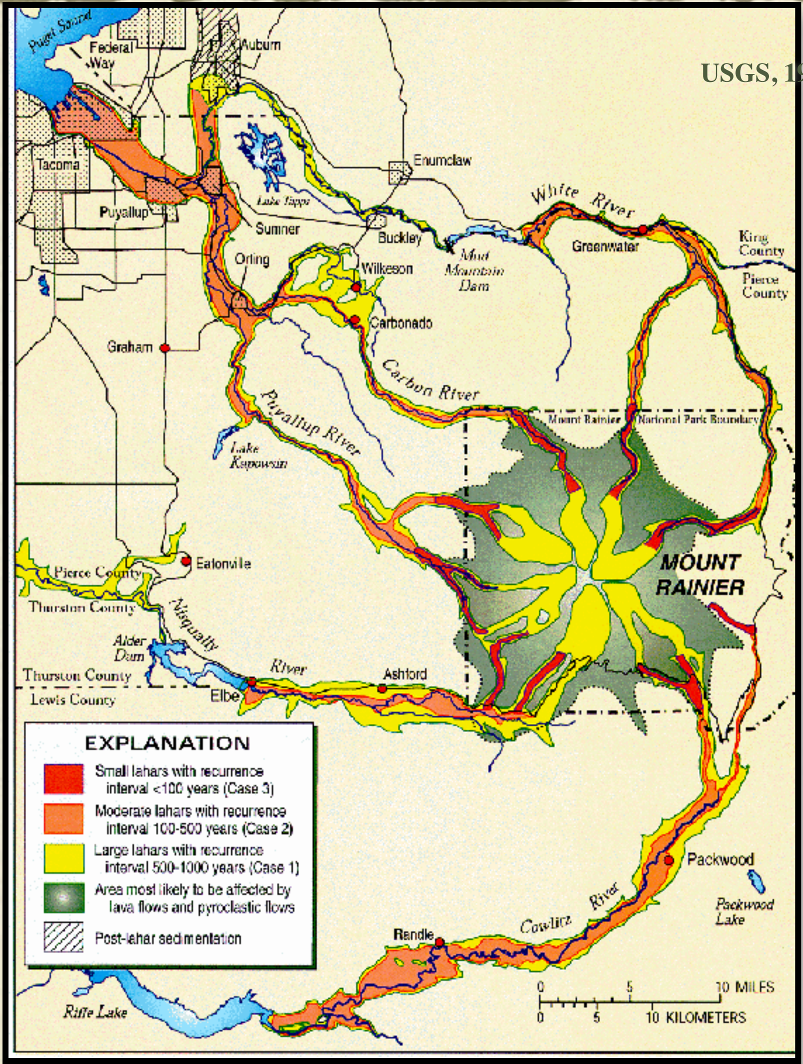
QUITO, ECUADOR



- Population—1.1 million
- Located below Guagua Pichincha, a large composite cone (stratovolcano)
- 12 eruption periods since 1533 AD.

Slide courtesy of Grant Heiken

SEATTLE/TACOMA, WASHINGTON, USA

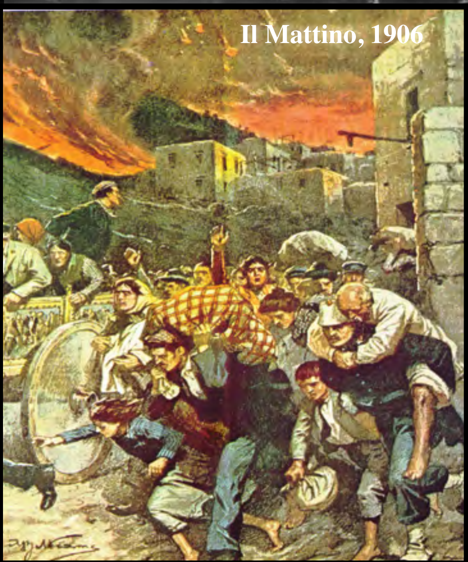


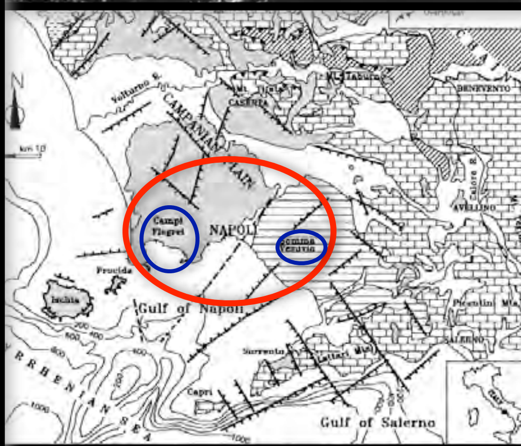
USGS, 1997

- Population, metro Seattle and Tacoma—3.4 million
- Mount Rainier, large composite cone (strato-volcano) east of the cities
- Over the last several thousand years, lahars (mudflows) have reached the lowlands every 500-1000 years
- Minimal risk from Mt. Baker and Glacier Peak volcanoes (northeast of Seattle)

Slide courtesy of Grant Heiken

NAPOLI, ITALY





- Population, metro area— ~3 million
- Vesuvius; frequent historic eruptions; last eruption 1944 AD
- Phlegrean Fields; two calderas (last large eruption 12,000 years ago); multiple smaller scoria cones and tuff rings (last eruption-1538 AD); restless calderas

Slide courtesy of Grant Heiken

Levels of Preparation and Understanding

1

- No analysis of volcanic risk

→

2

- Minimal geo-physical and geological data and maps
- Qualitative, "best guess" idea of volcanic risk

→

3

- Integrated geophysical monitoring
- GIS- and physical process-based hazard maps
- Collaboration with civil defense, city planners, infra-structure authorities
- Public education
- Quantitative risk analysis

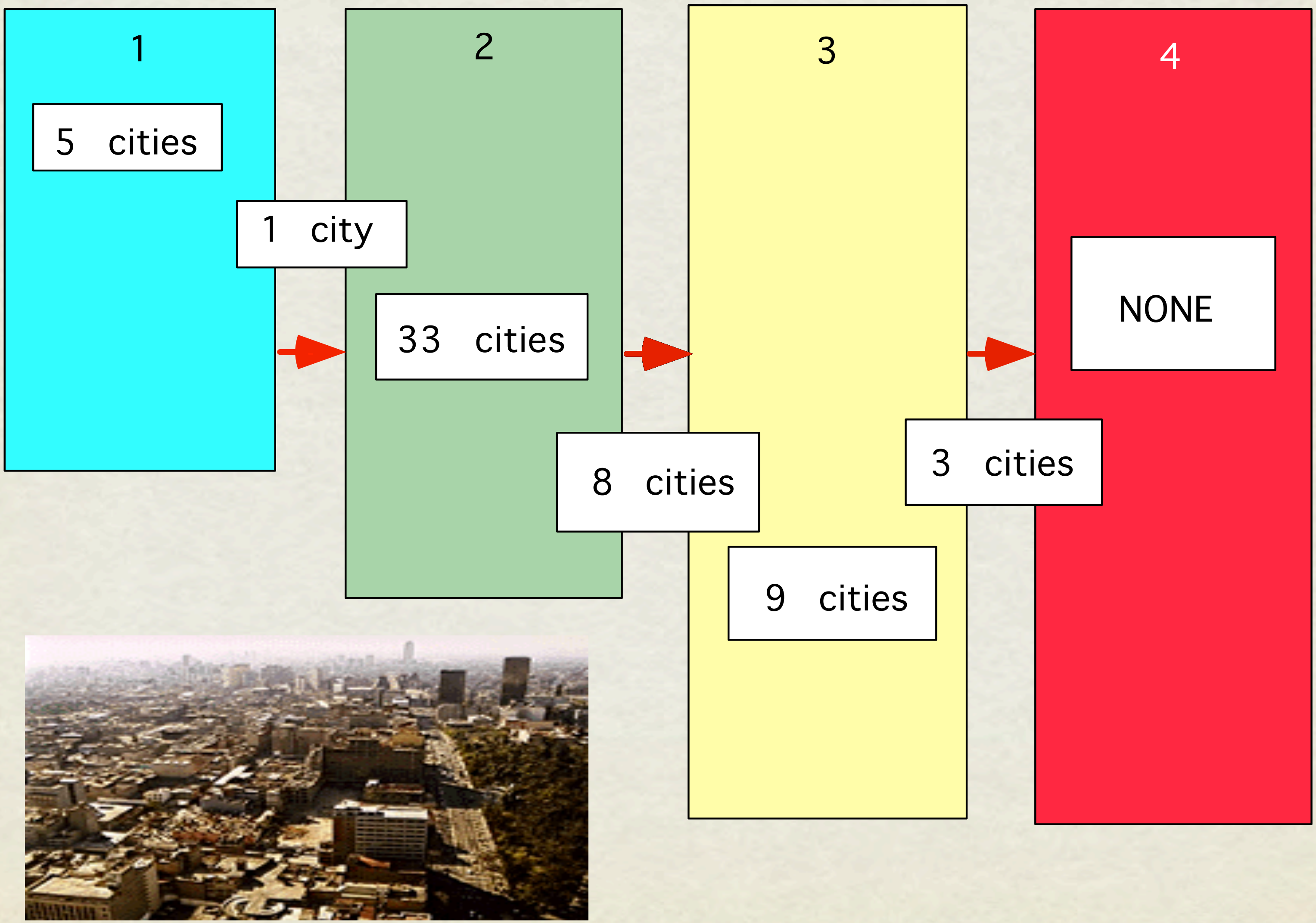
→

4

- Integrated data sets for "real-time" scenario simulations (training, planning, and mitigation) and vulnerability estimates

Slide courtesy of Grant Heiken

Estimated "Levels of Preparation" in 59 "Volcano Cities" Having Populations of >100 000



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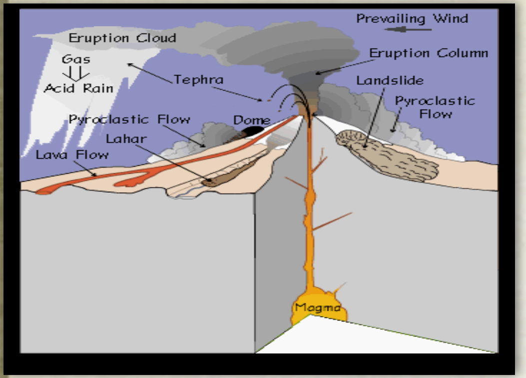


Scientific Research

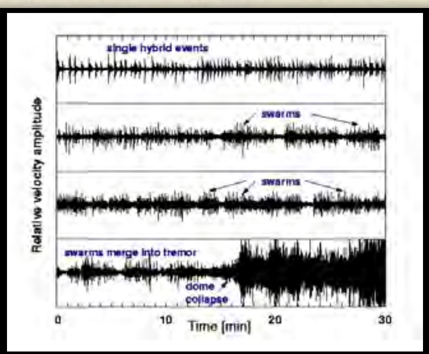
Basic

- Internal structure
- Nature of volcanic tremor
- Existence of shallow magma chamber
- Depth of degassing
- Depth of explosions
- Effusive vs. extrusive activity

Applied

- Remote sensing of volcanic activity
- Forecasting eruptions
- Instrumentation development
- Surveillance of volcanic activity
- Simulation of volcanic processes
- Prediction of volcano birth

Scientific Research



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Scientific Research

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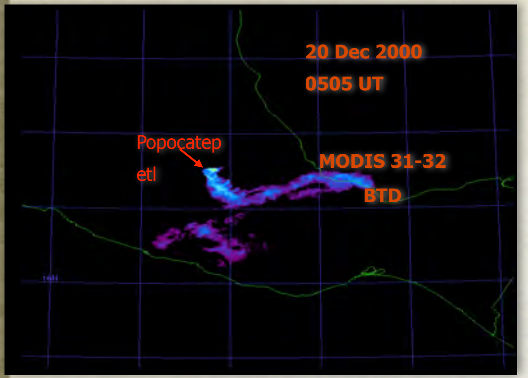
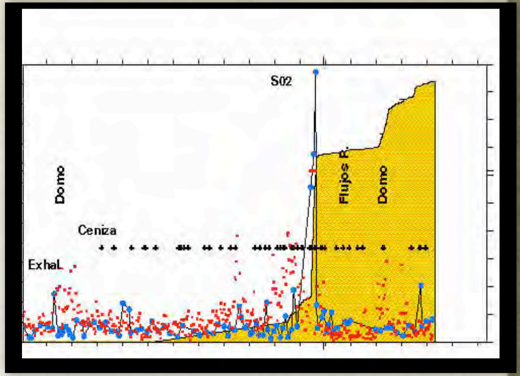
- Effusive vs. extrusive activity

Applied

- Remote sensing of volcanic activity
- Forecasting eruptions
- Instrumentation development
- Surveillance of volcanic activity
- Simulation of volcanic processes
- Prediction of volcano birth



Scientific Research



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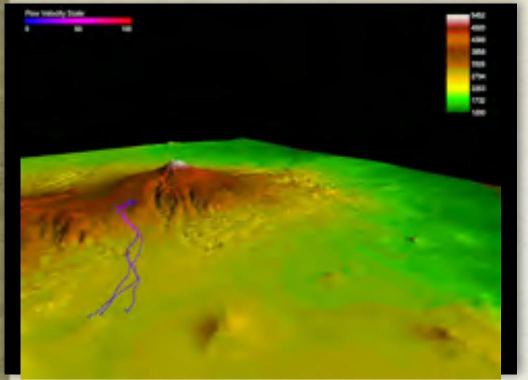

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QUESTIONS?