

# Mapping and Characterising Volcanic Risk

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# GFDRR Project Outline

- “...a pilot study that aims to establish **science-based evidence** for better integration of volcanic risks in national Disaster Risk Reduction (DRR) programmes in GFDRR’s priority countries, as well as regional cooperation in DRR programmes for all countries supported under GFDRR...”
- Assessment of the **potential volcanic eruption impacts** in the GFDRR priority countries (**hazard**)
- Assessment of **exposure of population and important infrastructure** to various volcano hazards (**exposure**)
- Assessment of **national capacities** to cope with the volcano risk (**vulnerability proxy**)

**Global Facility for Disaster Risk Reduction of the World Bank**

***Use of databases as part of new Global Volcano Model collaboration***

# GFDRR Volcanic Hazard and Risk Assessment



Aspinall, W., Auker, M., Crosweller, S., Hincks, T.K., Mahony, S., Nadim, F., J. Pooley Sparks, R.S.J., Syre, E. (2011) Volcano Hazard and Exposure in Track II Countries and Risk Mitigation Measures - GFDRR Volcano Risk Study. Bristol University Cabot Institute and NGI Norway for the World Bank: NGI Report 20100806; 309pp, 3 May 2011.

**Available on request and will be on Global Volcano Model web site**

# Hazard Score for each volcano

(building on USGS Nviews but different)

- Eight weighted hazard factors scored and summed to get total hazard scores:

Hazard Factor	Scoring Range
Volcano type	0 or 1
Holocene pyroclastic flow hazard	0, 1, or 2
Holocene lahar hazard	0, 1, or 2
Holocene lava flow hazard	0 or 0.2
Crater lake or ice/snow cap presence	0 or 1
Number of sub-features in Smithsonian	0.1 for first 15 subfeatures, then 0.05
Maximum VEI	1, 2, 3, or 4
Eruption frequency	1, 2, 3, or 4
<b>Total hazard score</b>	<b>2 to 14.55</b>

**Data source: Smithsonian GVP database**

# Hazard Uncertainty Index

- Up to four uncertainty options considered for each hazard factor, broadly equated to:
  - Listed with certainty on the Smithsonian website
  - Listed on the Smithsonian website, but with some uncertainty
  - Assumed or inferred, fairly sure
  - Assumed or inferred, fairly unsure

# Hazard Assessment

- Results displayed as a plot of hazard against uncertainty
- Hazard and uncertainty are assigned to levels 1, 2, and 3

## Ethiopia Volcano Facts

65 Holocene Volcanoes on GVP database

No historic record for 49 volcanoes

60% with Uncertainty Index >2

31 classify as effusive and 34 as explosive

7 have produced pyroclastic flows but lavas  
produced on 56

25 have > 100,000 people living within 30 km radius

163 historic casualties (106 at Dubbi in 1861)

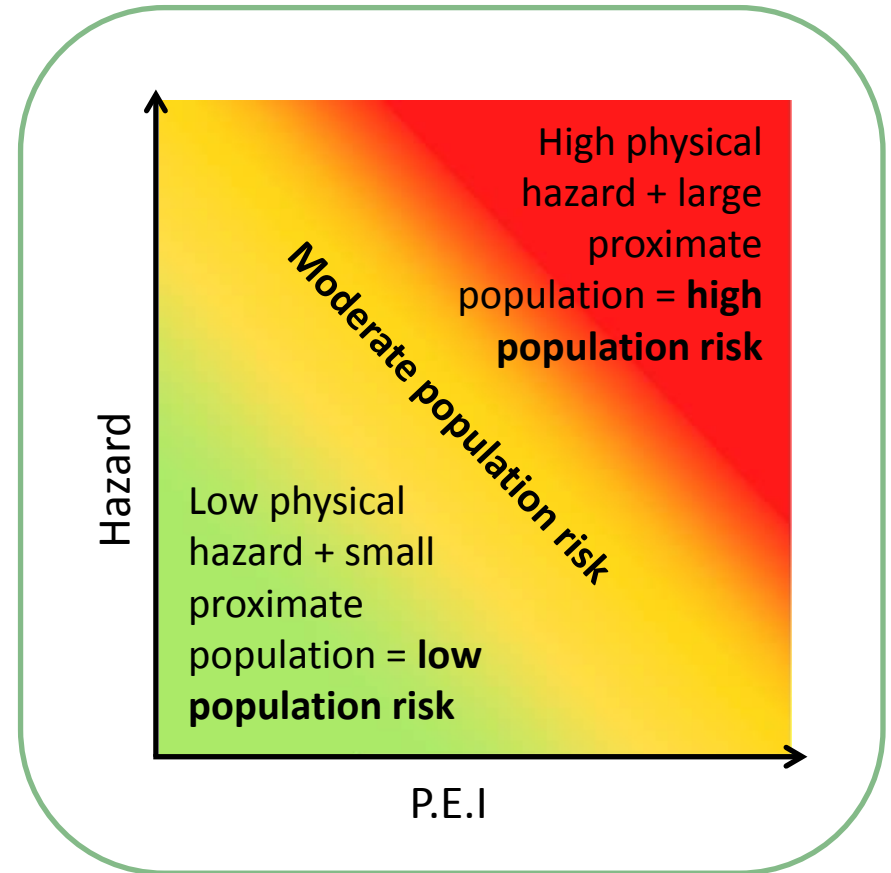
# Population Exposure Index (P.E.I.)

- Quantitative measure of the number of people potentially exposed to volcanic hazards, for each volcano
- Use of Landscan 2009 database
- Weight and sum counts of population within 10 km and 30 km of each volcano according to historical fatality data
- Weighted population =  $0.9375N_{10} + 0.0625N_{30}$

Weighted Summed Population	Population Exposure Index
0	0
<3,000	0.5
3,000 – 9,999	1
10,000 – 29,999	1.5
30,000 – 99,999	2
100,000 – 300,000	2.5
>300,000	3

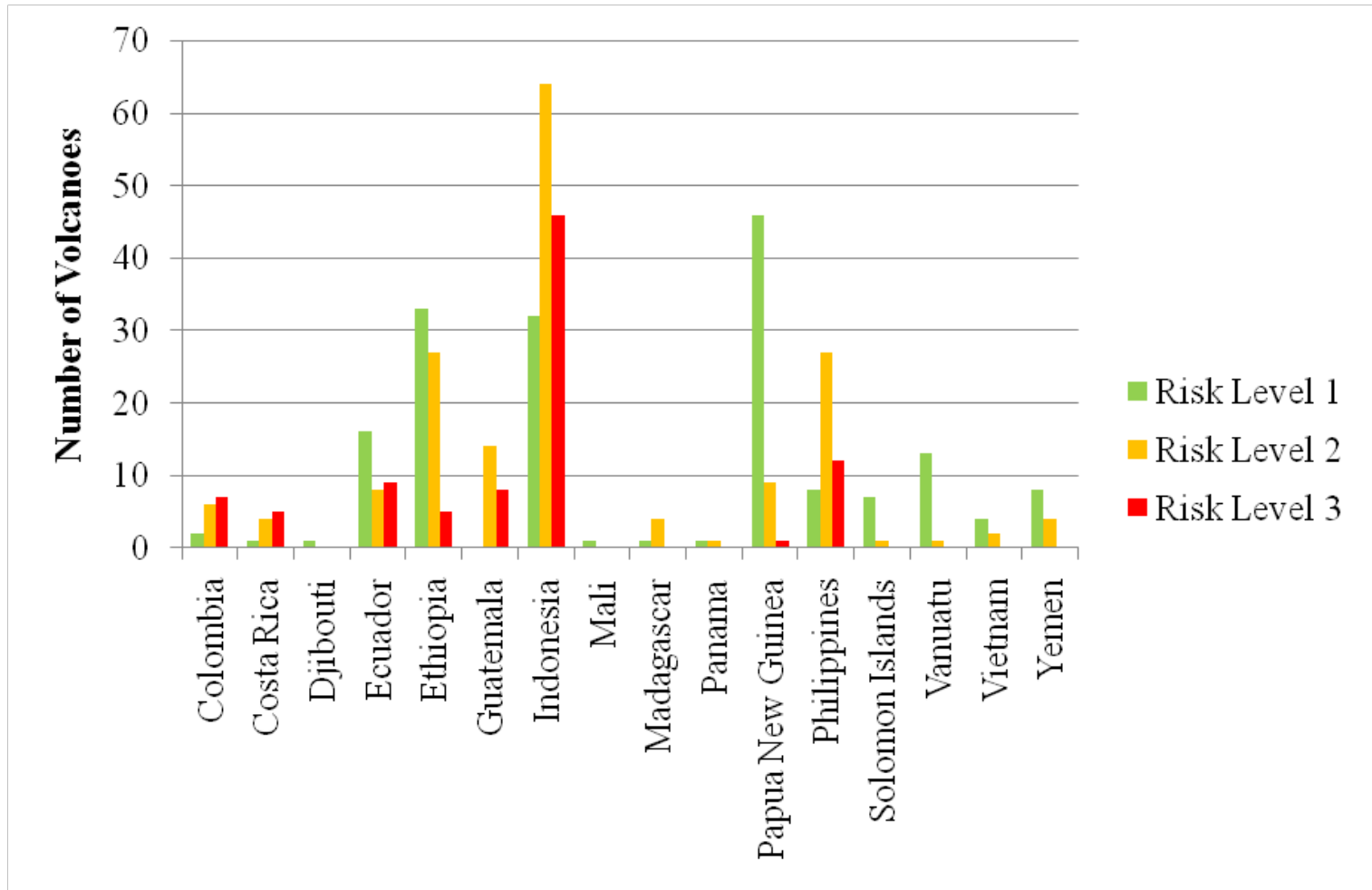
# Risk Assessment

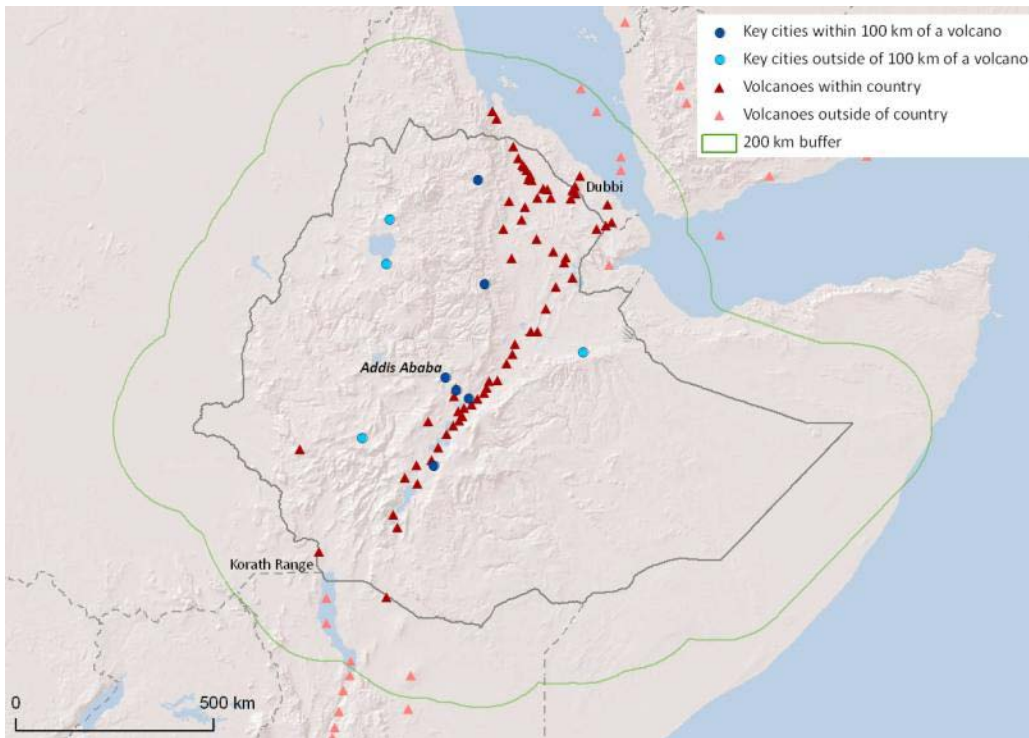
- Results displayed as plots of hazard against P.E.I.
  - Such plots provide insights into population risk
- The product of hazard level and P.E.I. class can be used to quantify population risk





# Number of volcanoes with different Risk Levels in Category A countries

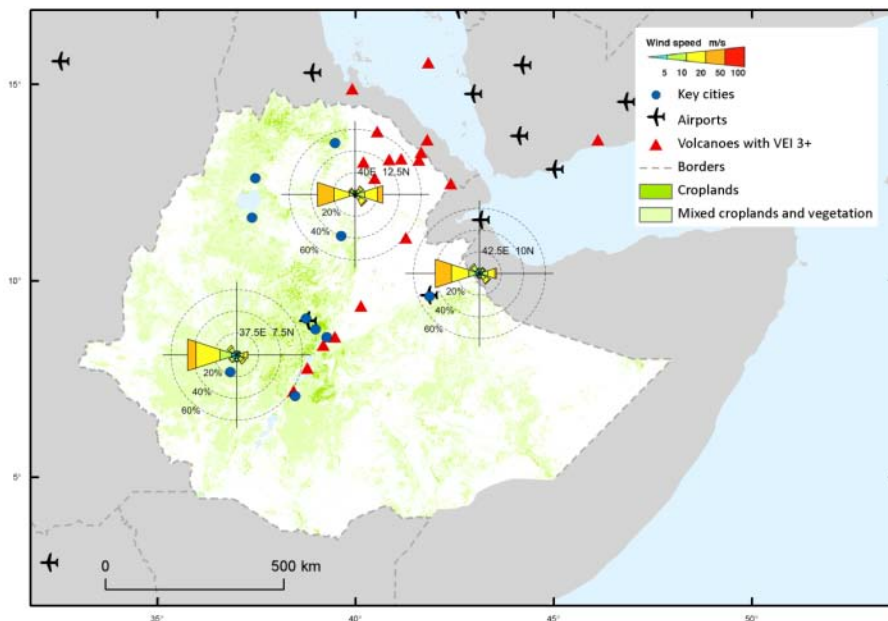




## Distance from volcanoes

10 km	1,300,000 (2%)
30 km	9,500,000 (11%)
100 km	40,000,000 (47%)

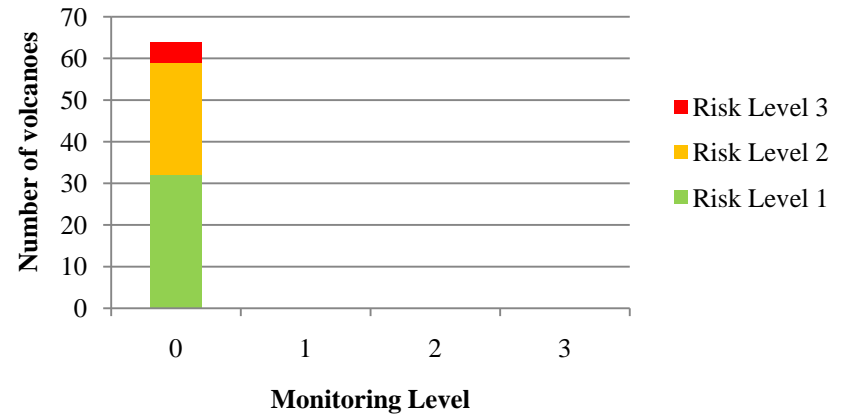
Magnitude	Return Period (years)
3	7.3
3.5	14
4	29
4.5	55
5	100
5.5	250
6	530
6.5	1,400
7	6,200
8	380,000



*LaMEVE global database for GVM  
Large Magnitude Explosive eruptions*

**M = Log mass in kg - 7**

Country-averaged monitoring level uncertainty: LOW



## HIGH RISK LIST

Alutu\*

*Bilate River Field*

*Bishoftu Volcanic Field*

Boset-Bericha

*Butajira-Silti Field*

*Corbetti Caldera*

Gebdamsa

*Hobicha caldera*

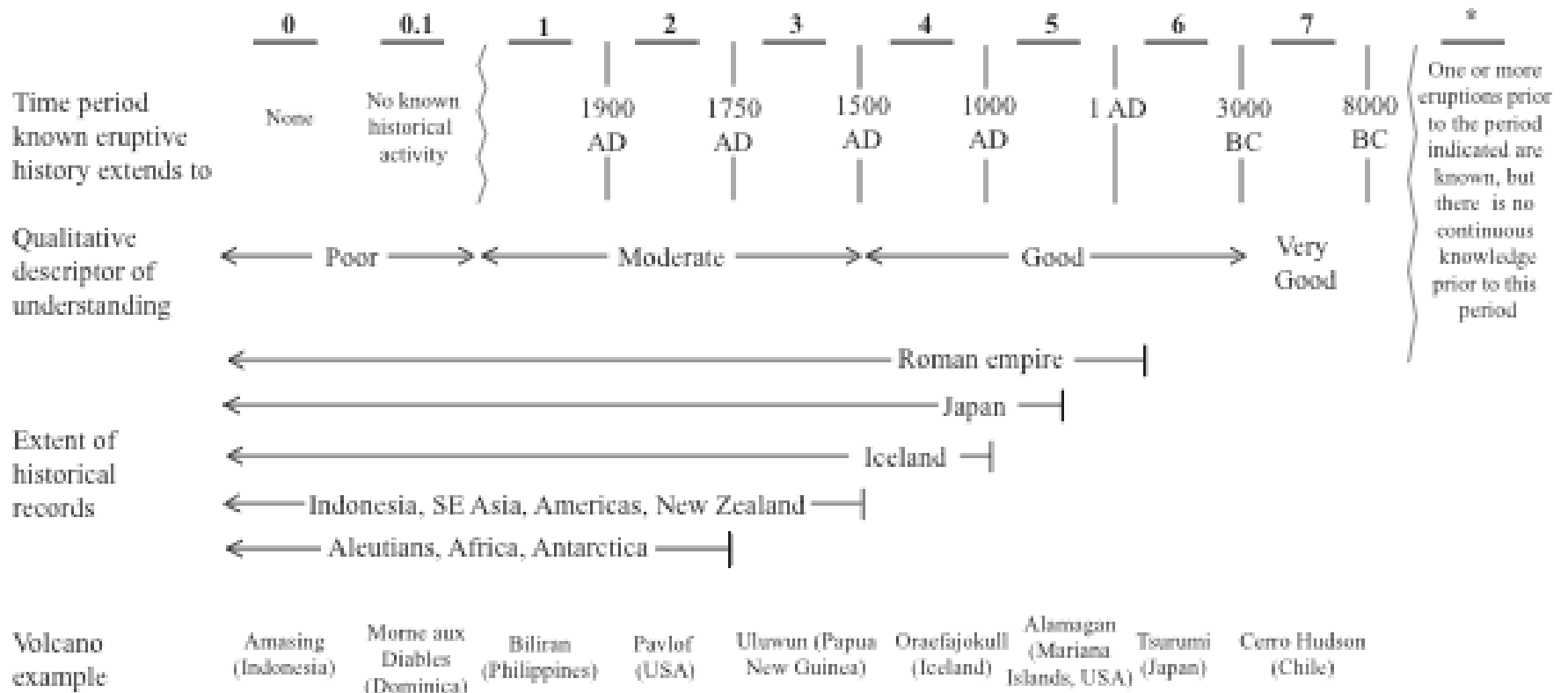
Kone

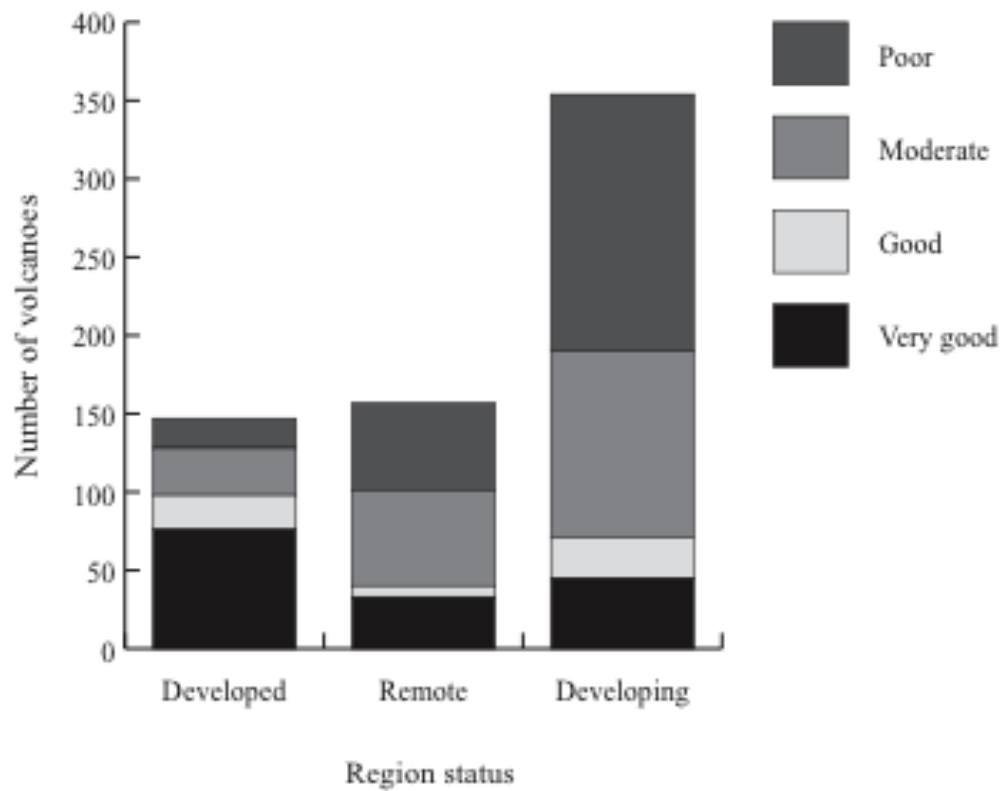
O'a caldera

## Update for GAR2013 and Global Volcano Model country profiles

Thanks to Atalay Ayele, Lorraine Field and Elias Lewi (AAU) for information during the GFDRR study

# Volcanic Record Index (VRI)





**Distribution of knowledge**

**<20% of Holocene explosives eruption with  $M > 4$  are recorded**

LaMEVE database

**Global time series of Holocene large magnitude explosive eruptions**

Deligne, N.I., Coles, S.G. and Sparks, R.S.J. Recurrence Rates of Large Explosive Volcanic Eruptions. *Journal of Geophysical Research* 115, B06203, doi:10.1029/2009JB006554.

# Conclusions

- Lack of hazards data on many of World's volcanoes
- Very little is known about most of Ethiopia's volcanoes
- None appear to be permanently monitored even with 1 dedicated seismometer
- > 9 million people live within 30 km of an active volcano
- 5-10 volcanoes classify as High Risk in the GDFRR study
- Large uncertainties (lack of basic information) means volcanoes might move into High Risk category
- Need for more in depth analysis and capacity

*What can be done? Tomorrows Hazard workshop to discuss*

***GLOBAL VOLCANO MODEL***