State of volcanic hazard data access and sharing (local to global): needs, challenges and opportunities

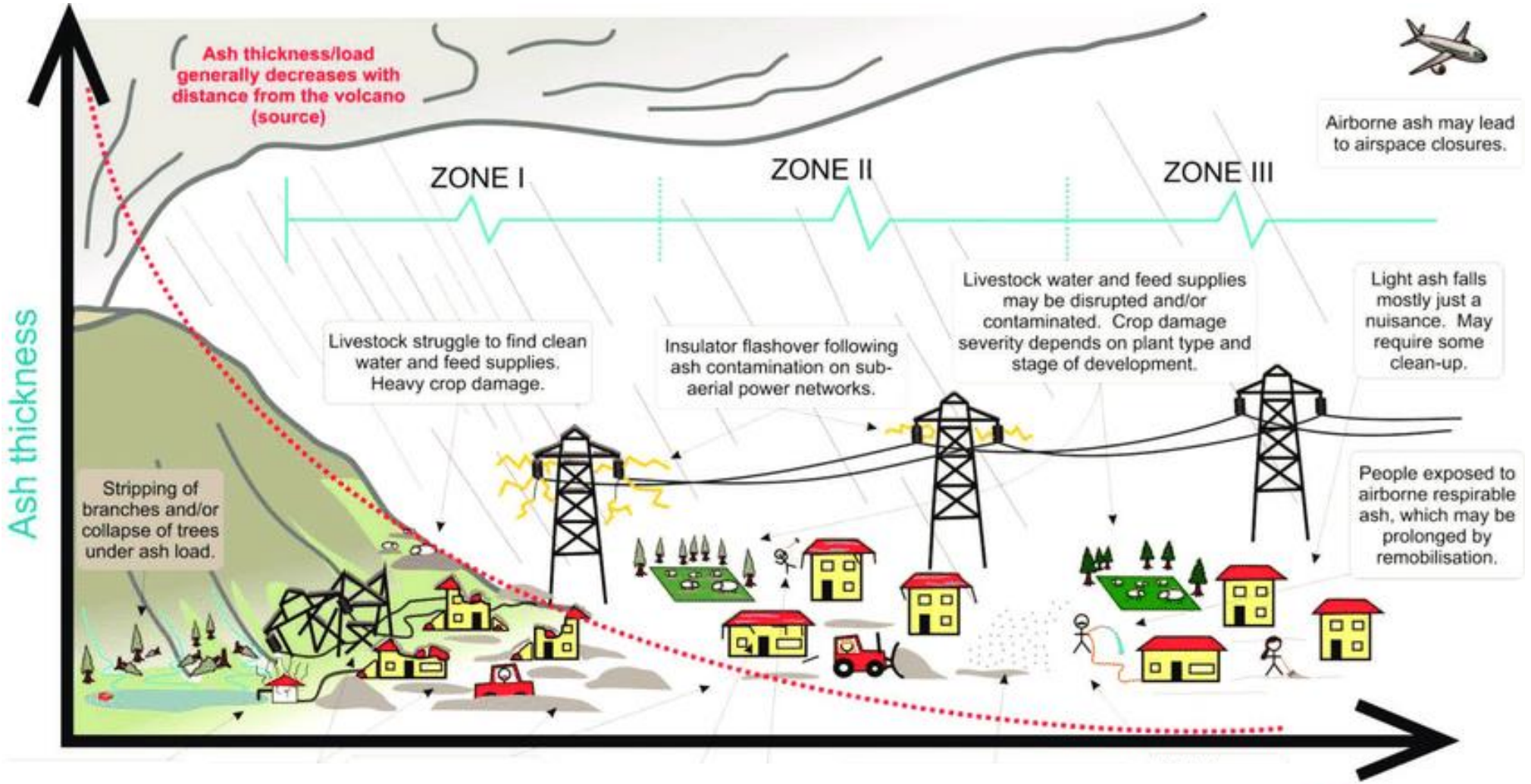
Sarah Ogburn, Danilo Reitano, Benoît Taisne, Christina Widiwijayanti

1. *USGS-Volcano Disaster Assistance Program, USA*
2. *INGV - Catania, Italy*
3. *Asian School of the Environment, NTU, Singapore*
4. *Earth Observatory of Singapore, NTU, Singapore*

EW4All workshop, Geneva, 7-9 July 2025

Volcanic Impacts

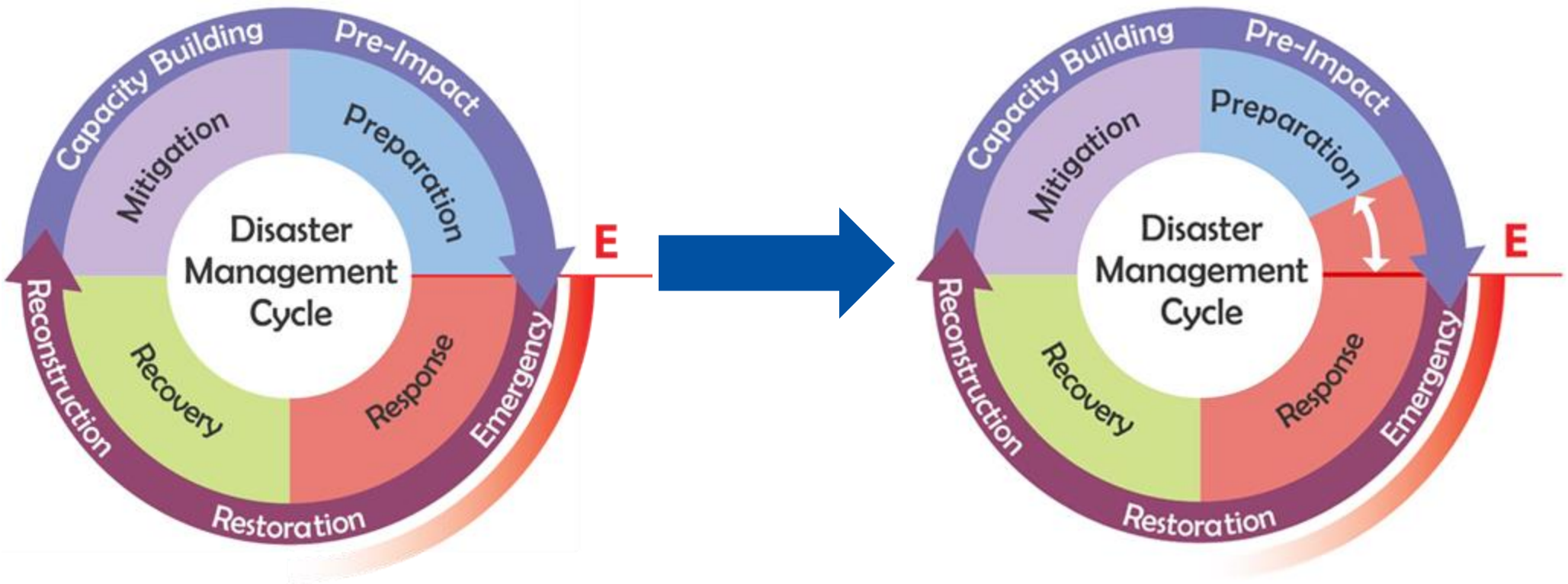
Complex response through time and space



Jenkins et al., 2015

Towards reducing disaster risk

Support decision makers and reduce impacts by increasing response time



Risk reduction approach

Risk reduction through proactive measures:

- More accurate forecasts
- Capacity building between agencies

Challenges in real-time situation

Challenges during management of a crisis:

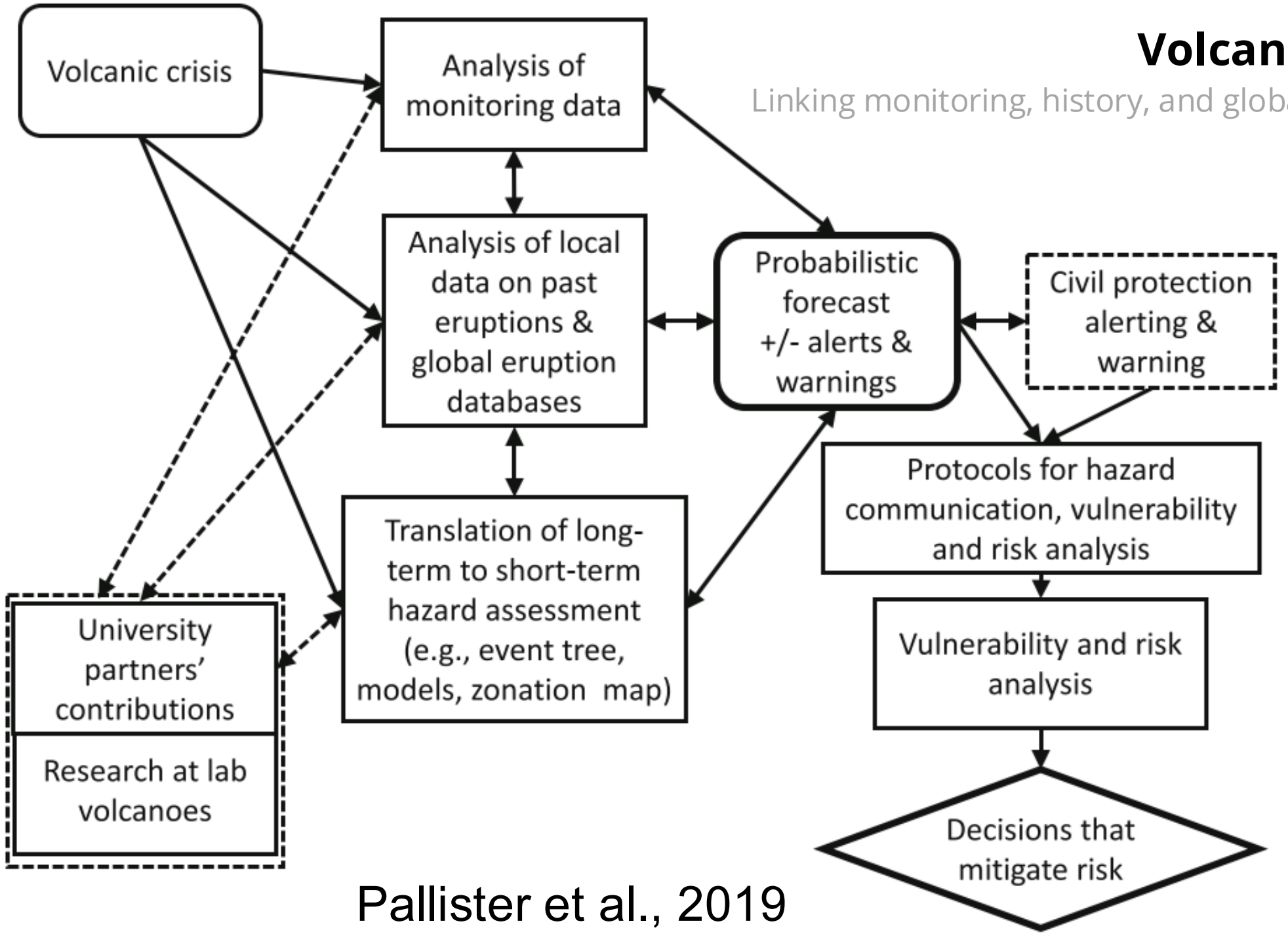
- Difficulty to identify changes in seismic data
- Difficulty to compare with similar volcanoes due to different naming convention
- Too many events to identify in real time

Proposed approach from lessons learned

- To standardise naming convention and analysis
- To improve forecasts by creating a dynamic framework for data processing and assimilation

Volcanic crisis response

Linking monitoring, history, and global data for timely decision



Pallister et al., 2019

From wondering to timely forecasting

Or.. interesting view of ChatGPT on volcanologists

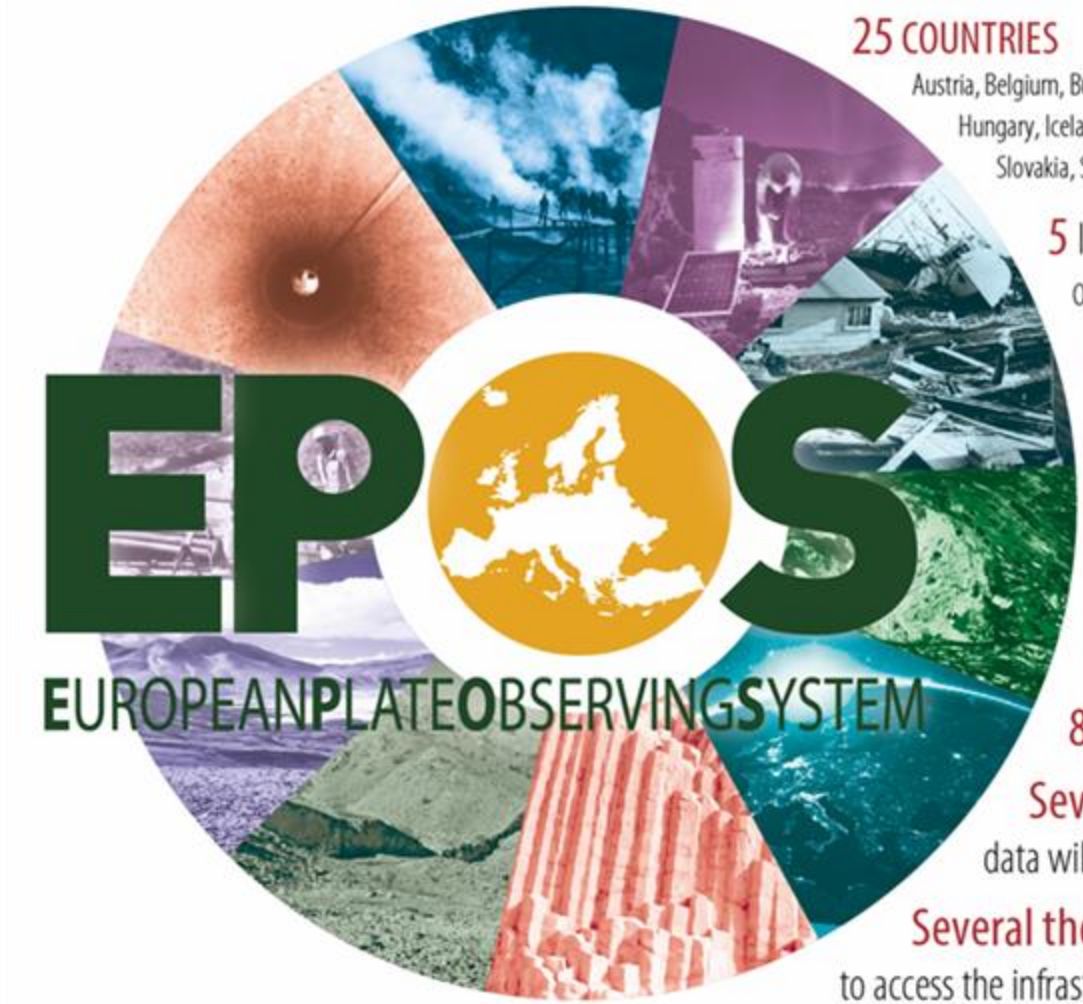
We did not see that coming…

Via sharing and accessibility of knowledge and resources

We told you with enough lead time!!!!

The European Plate Observing system

EPOS integrates the **existing (and future)** advanced European facilities and infrastructures into **a single, distributed, sustainable infrastructure** taking full advantage of new **e-science opportunities**



25 COUNTRIES

Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Grecee, Hungary, Iceland, Ireland, Italy, The Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

5 INTERNATIONAL ORGANIZATIONS

Orfeus, EMSC, EUREF, INTERMAGNET, EuroGeoSurveys

256 NATIONAL RESEARCH INFRASTRUCTURES

4939 SEISMIC STATIONS

2272 GPS RECEIVERS

464 TB SEISMIC DATA

118 LABORATORIES

828 INSTRUMENTS

Several PetaBytes of solid Earth Science data will be available

Several thousands of **users** expected to access the infrastructure

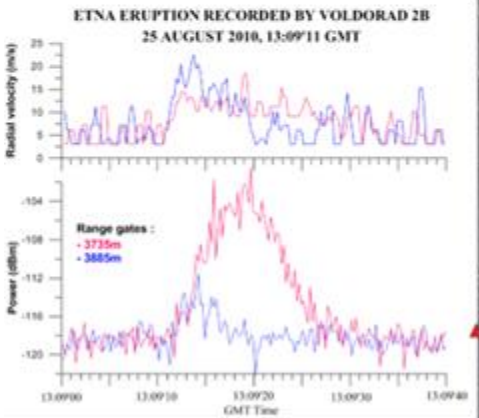
October the **30th 2018**, the European Commission granted the status **ERIC** to EPOS.

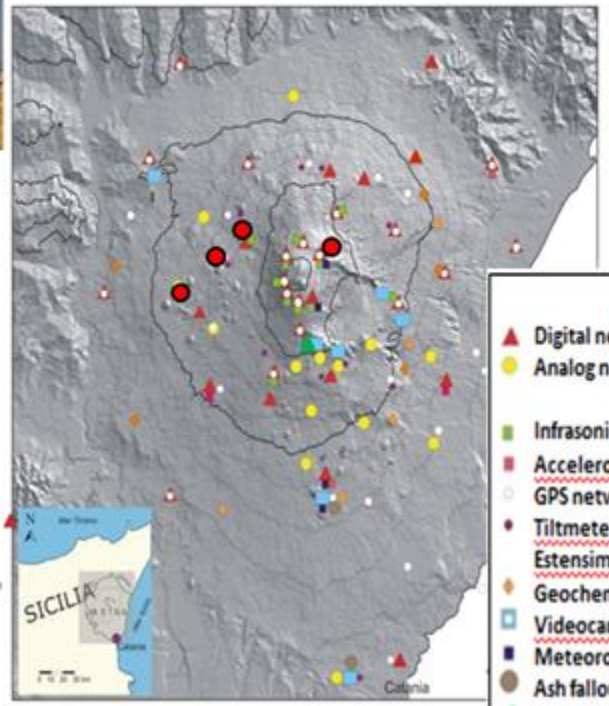
A **E**uropean **R**esearch **I**nfrastructure **C**onsortium (ERIC) is a legal entity created under Union law

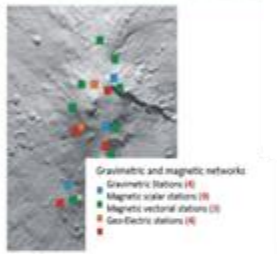
•The **ERIC legal entity** and extensive legal capacity <u>are recognised in all EU Member States</u> without requiring transposition into national law or any national legal instrument

How data access and sharing enables action to reduce risk

The case of Mt. Etna Volcano





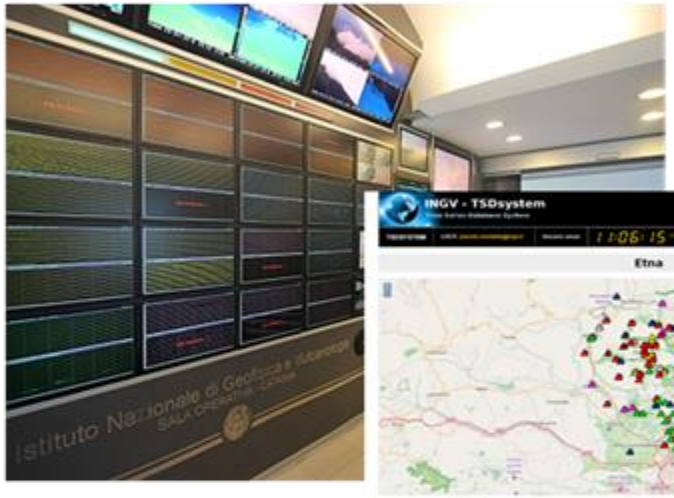


Trasmission lines

Seismic Network (49 stations)
Digital network (Broad-band, 3C)
Analog network (1s , 1C)
Infrasonic network (11 stations)
Accelerometric network (4 stations)
GPS network (36 stations)
Tiltmeter network (11 stations)
Estensimetric network (4 stations)
Geochemical network (9 UV scanner stations)
Videocameras network (11 stations)
Meteorological network (4 stations)
Ash fallout network (2 stations)
Radar (1 station)
Borehole dilatometer

Etna's multiparametric stations

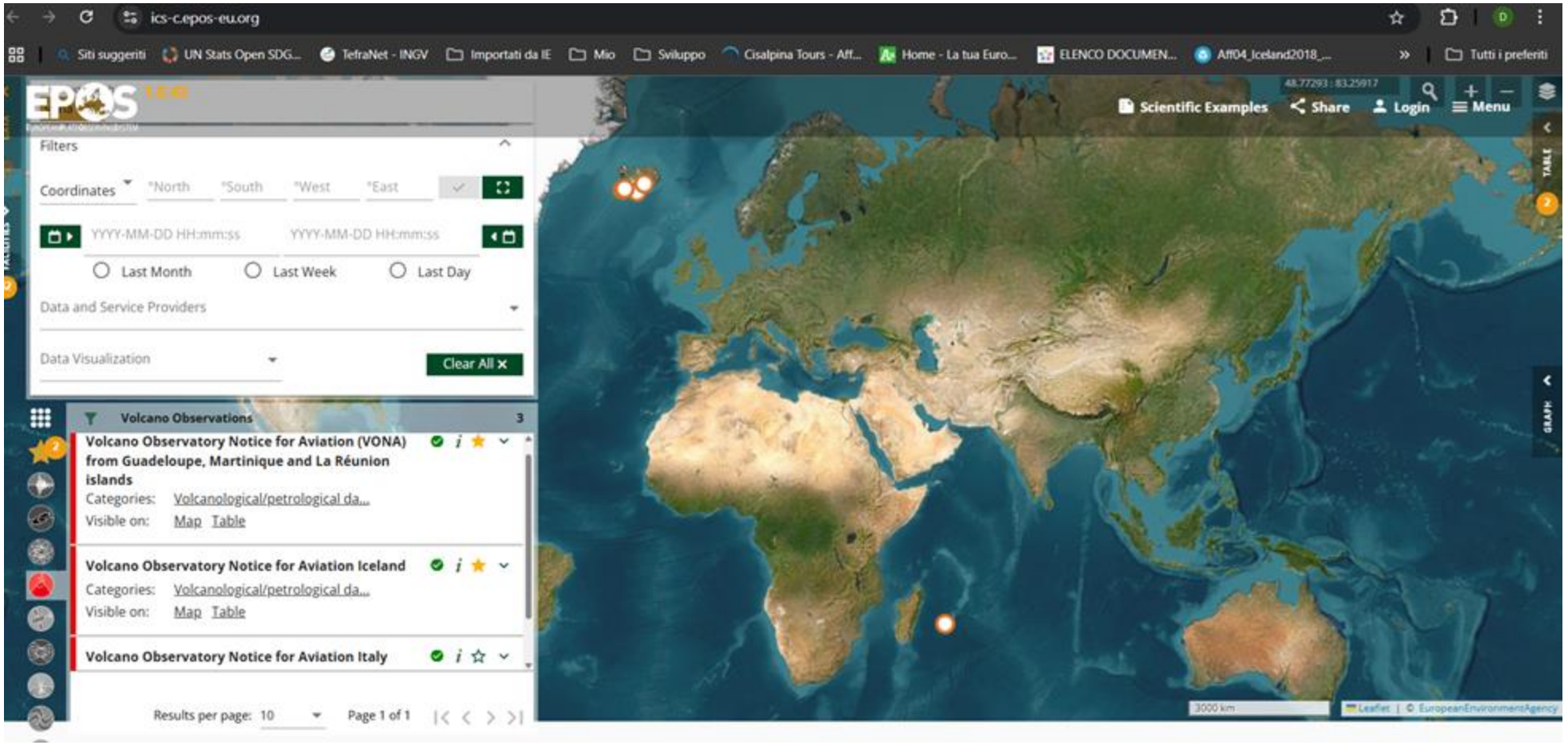
INGV-OE Control room is the node where remote signals are acquired, stored and processed



Alert / Early Warning Systems

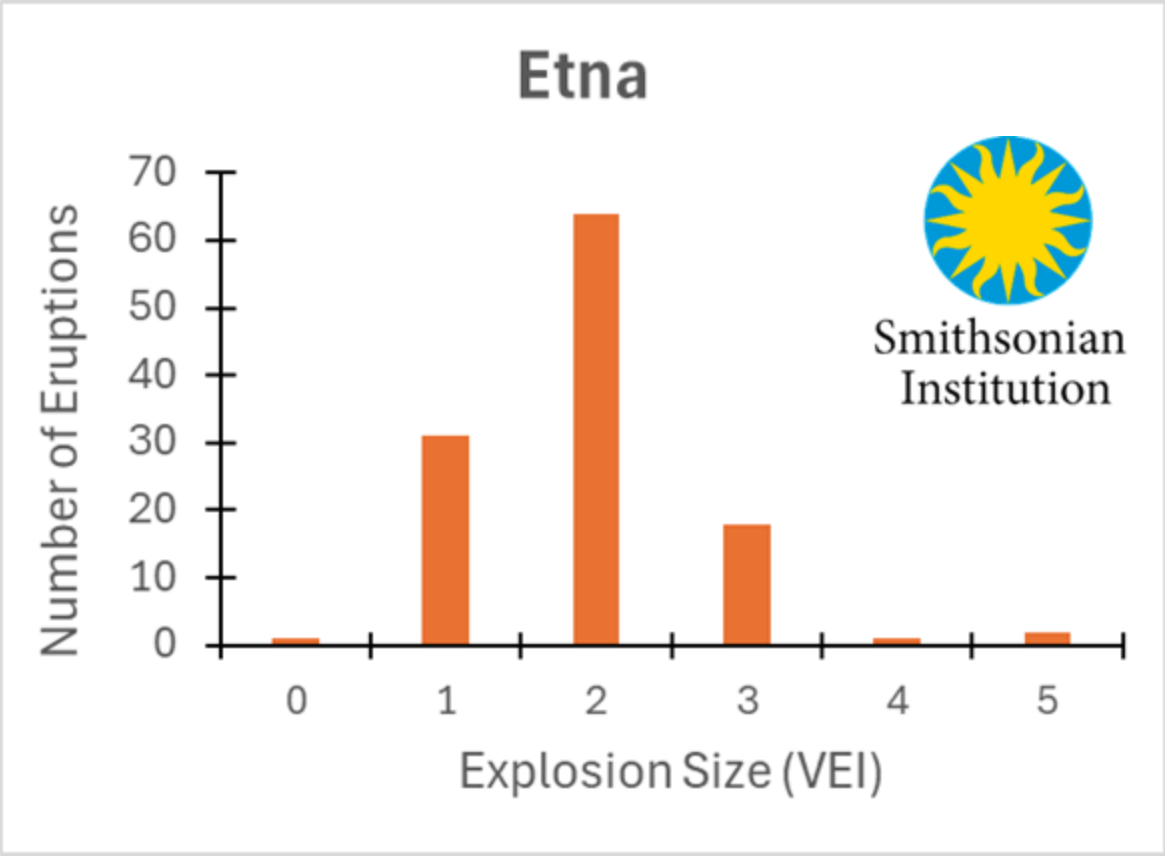
Vona services in EPOS

https://www.ics-c.epos-eu.org/

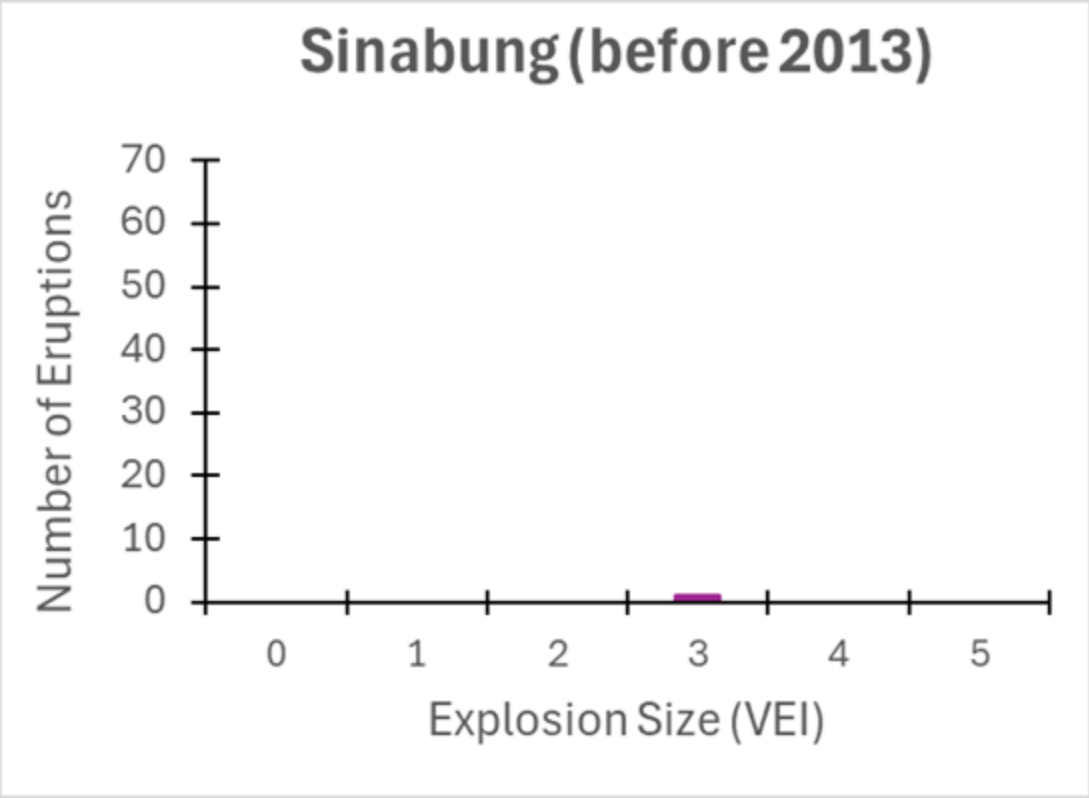


Standardization /Interoperability

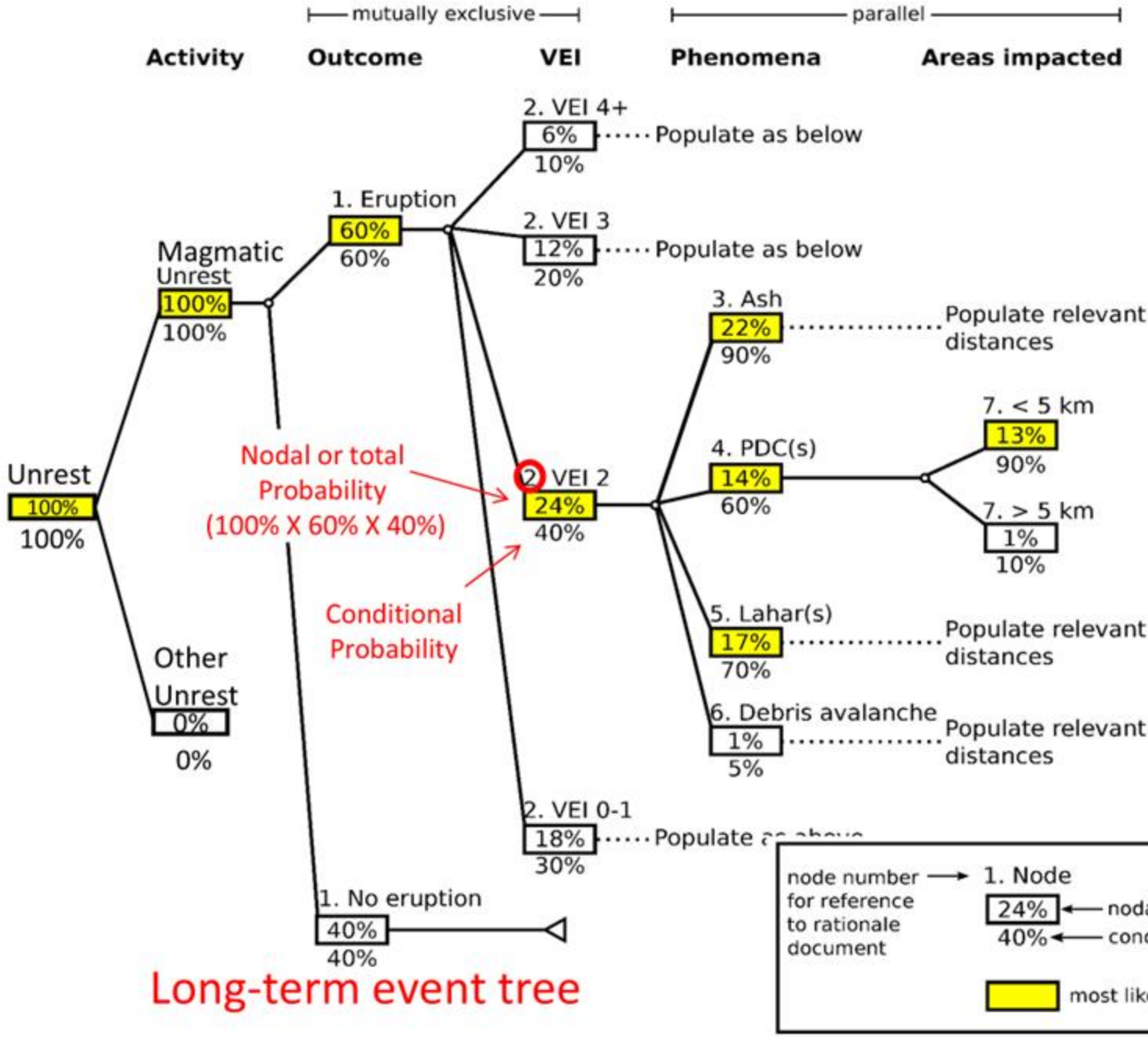
Data-poor volcanoes: a case for global data



~200 eruptions in Global Volcanism Program database



1 eruption in Global Volcanism Program database prior to 2013 unrest



Long-term event tree

What percentage of unrest leads to eruption?

How long after eruption onsets do paroxysmal explosions occur?

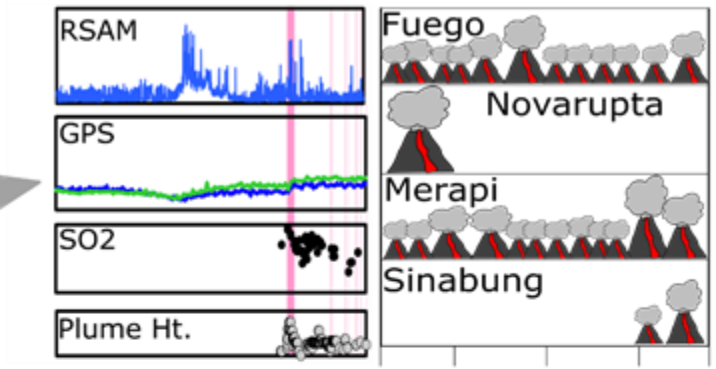
How do we choose model input parameters?

Is this a pause in activity or the end of eruption?

How long might this eruption last?

Eruptive behavior

monitoring data, eruptive history, event chronologies



Data informs models

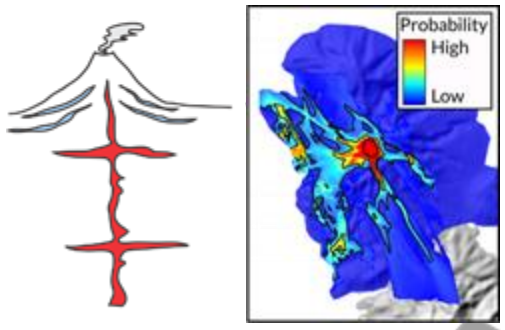
Process-based interpretation of monitoring data

GVP, WOVOdat, E-chron DBs

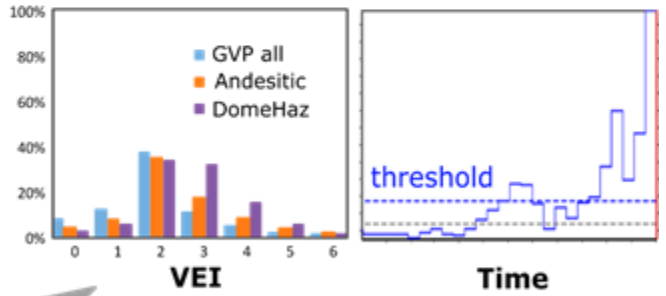
Pattern recognition, thresholds, alarms, data modeling, etc.

Eruption and Hazard Forecasting Data Needs

Conceptual and physical models



Global (and local) statistical analysis

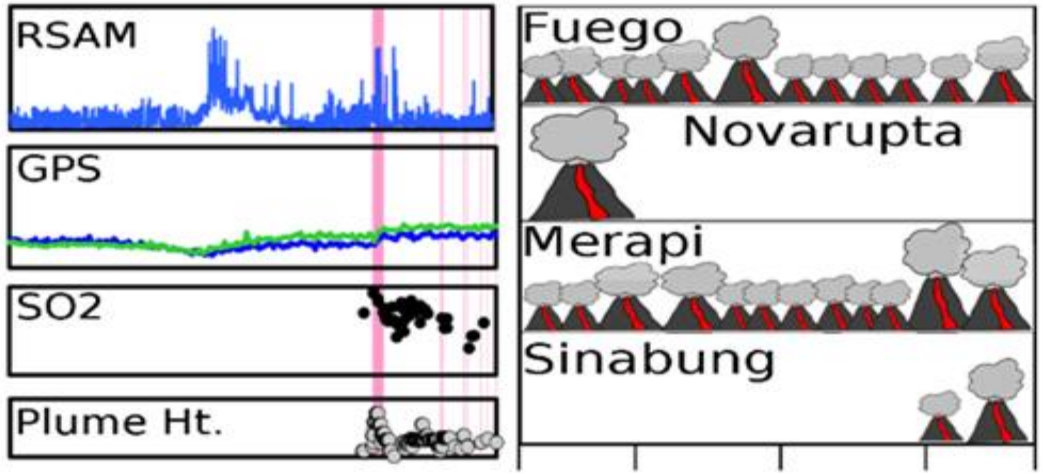


Process-based interpretation of global statistics

Global statistical analysis of analog volcanoes informs models

Eruptive behavior

monitoring data and eruptive history



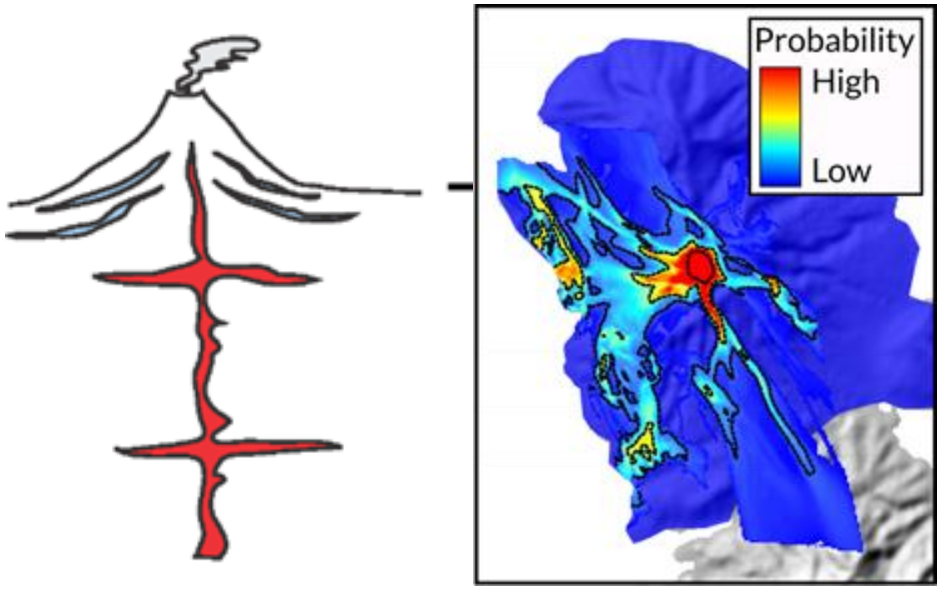
Needs:

- Reliable monitoring networks for continuous records
- Machine-readable event chronologies (not just narrative accounts) of observed events (e.g., explosions, dome growth)

Challenges:

- Network failure can lead to data gaps
- Specialized formats, settings, processing mean data is not always comparable with past local dat or global data
- Many observatories don’t have resources to keep machine-readable event chronologies (only narratives)

Conceptual and physical models



Needs:

- Local and global data for choosing model input parameters
- Computing power for modeling
- Expertise for using data and running models

Challenges:

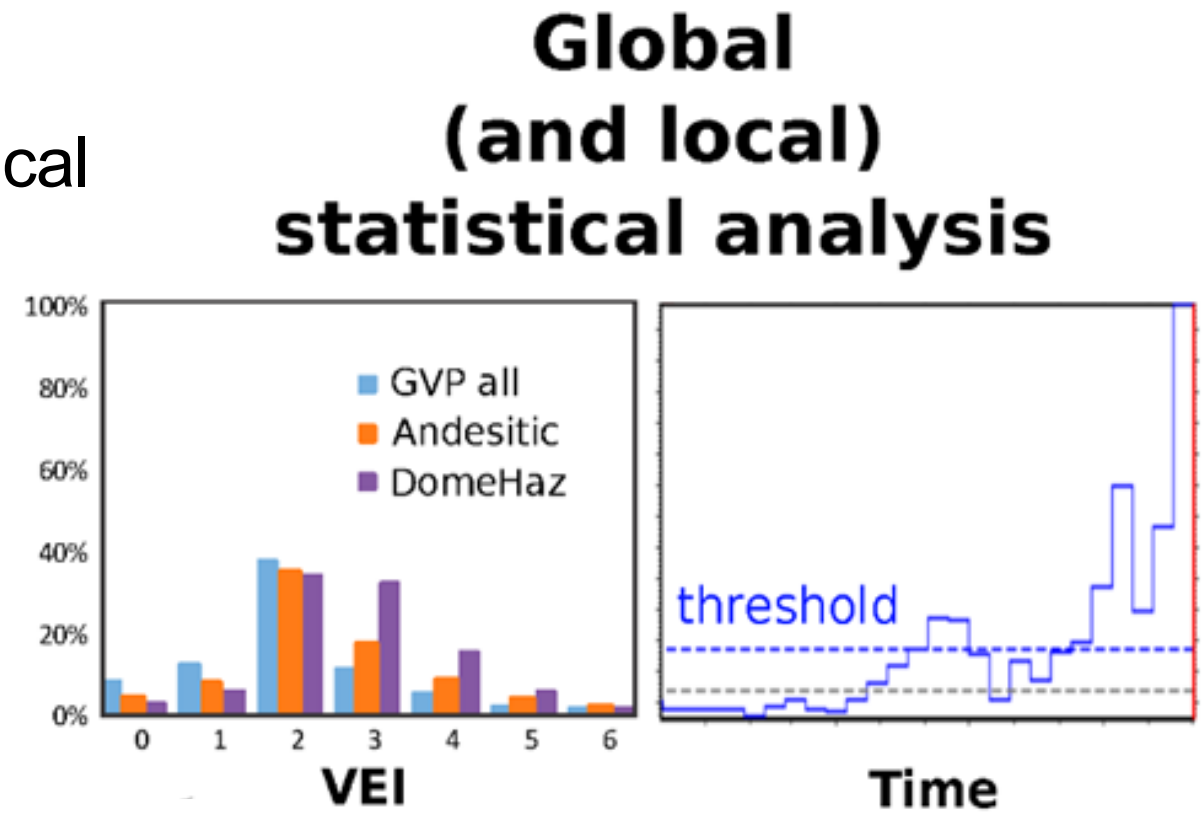
- Data might not exist or might not be easily accessible (e.g., literature only)
- Advanced models are computationally expensive
- Staff turnover leads to loss of expertise

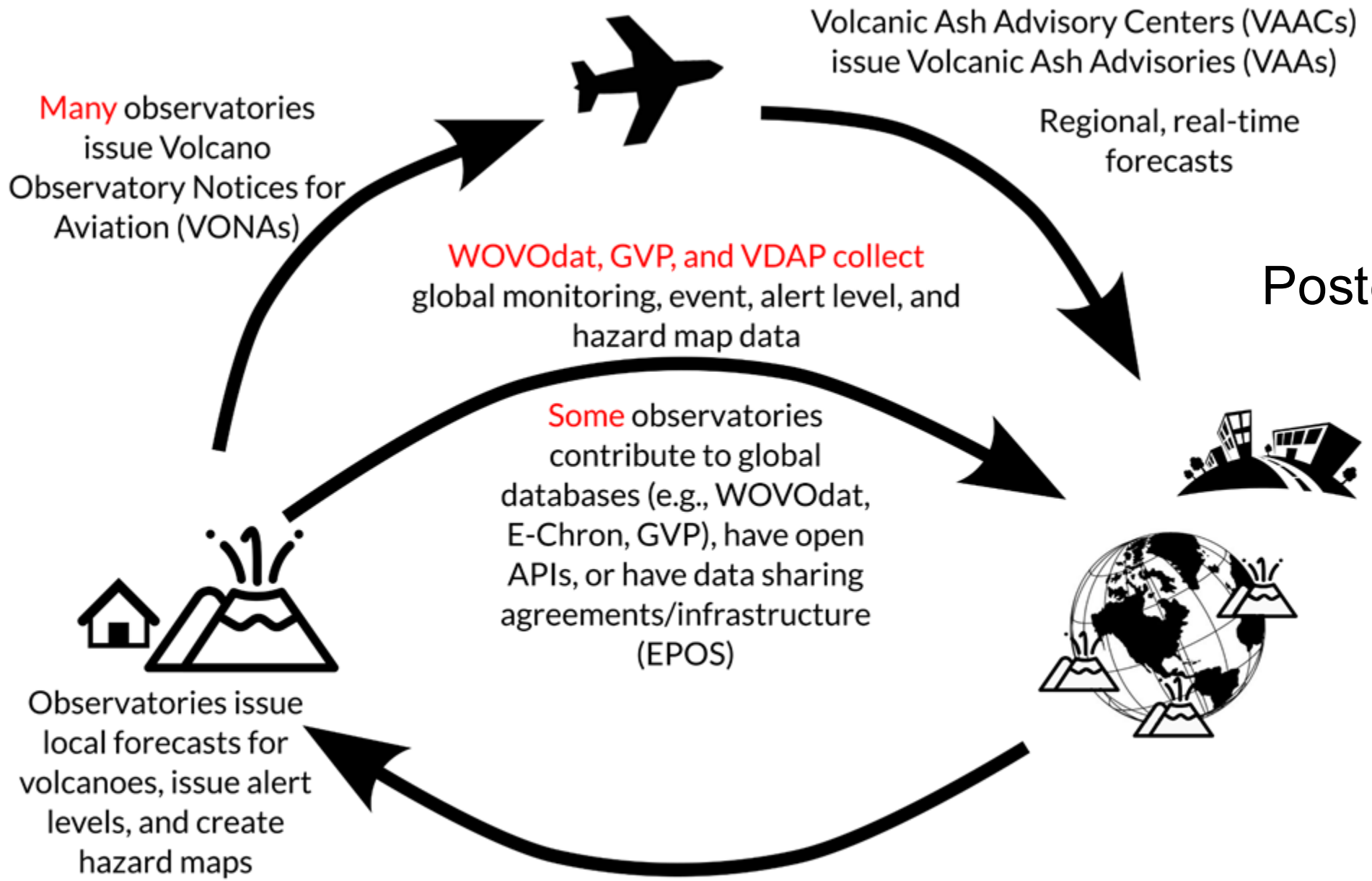
Needs:

- Global databases
- Ability to compare current data to past local and global analog data
  - Comparable, standardized data
  - Derived products for analysis
- Search tools
- Statistical analysis tools

Challenges:

- Observatories have not always seen a return on investment from contributing data
- Many observatories don't have computing resources or staff bandwidth to look beyond their highest priorities: providing hazard information to local communities





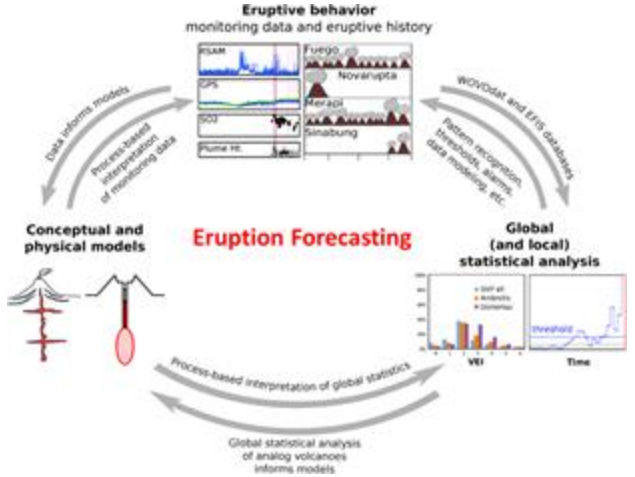
Poster #35

How can the global data community ensure that data and tools help volcano observatories?

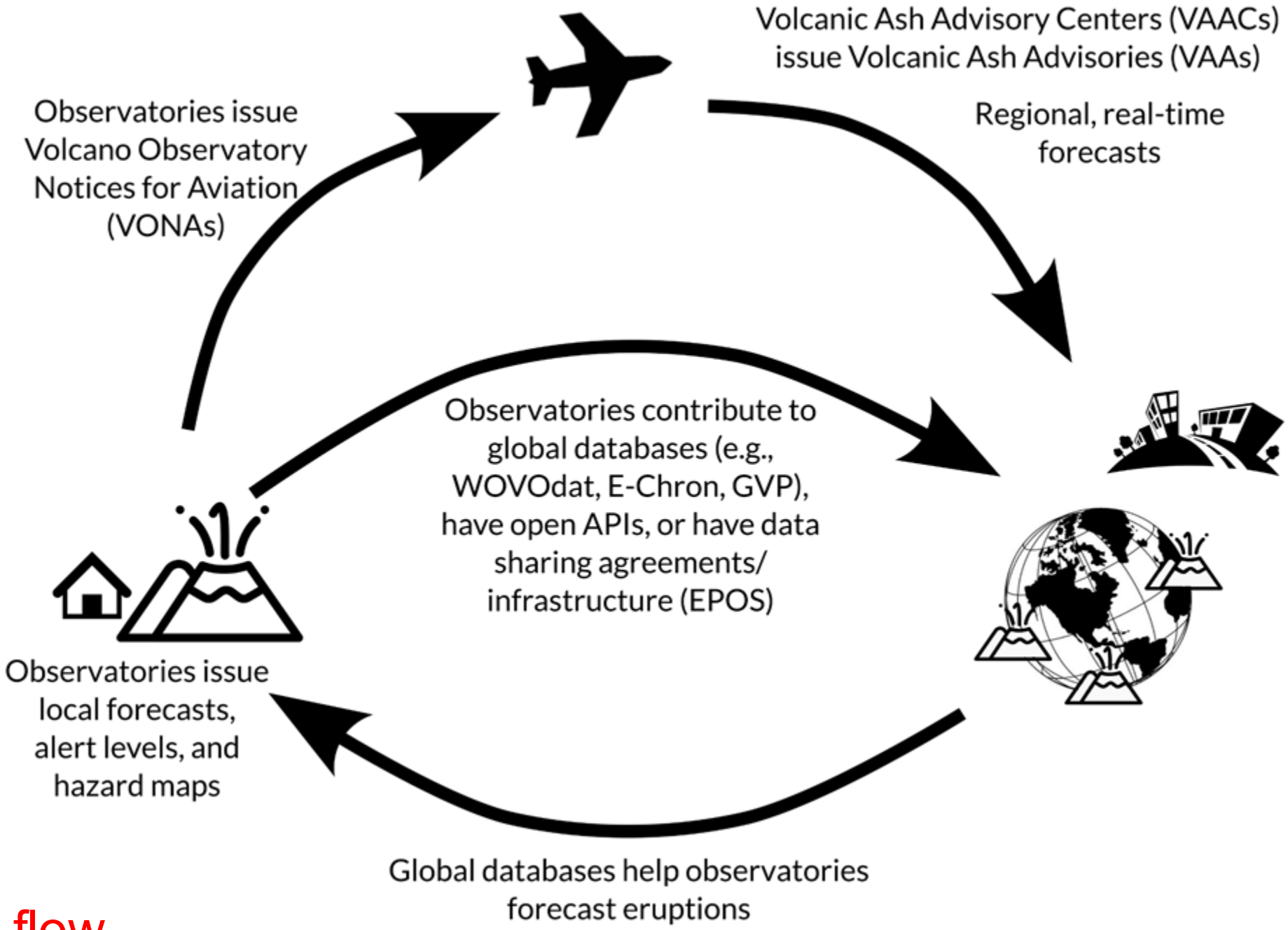
Reality

How can the global data community ensure that data and tools help volcano observatories?

Smithsonian Institution

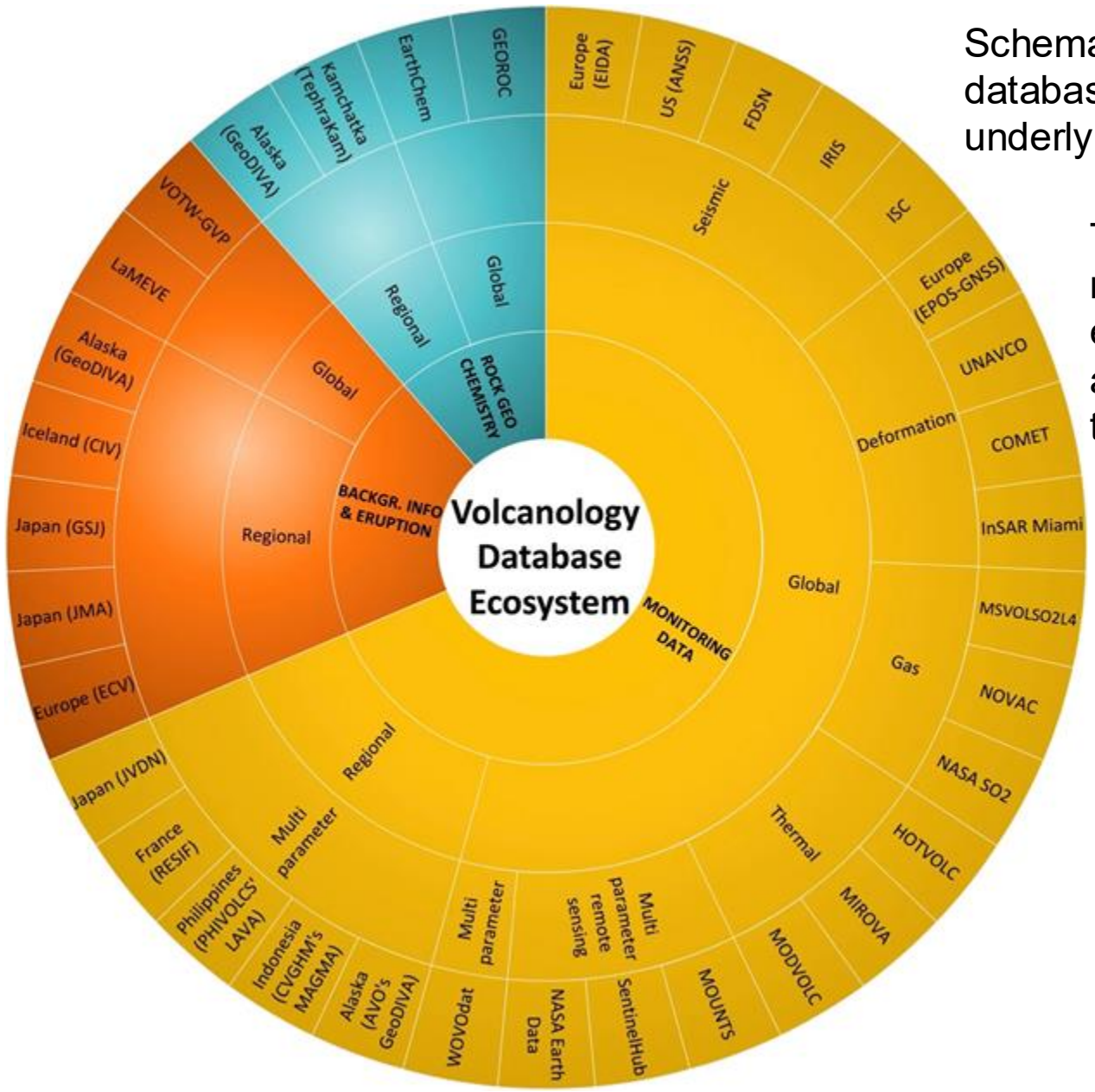


- Cloud computing platforms provide computer power, model education, open source geophysical and statistical models, and linked databases
- Provide tools and standards for easier event chronology-keeping
- Data archives/back-ups
- Search tools for analog data
- Statistical methods for using global data for eruption forecasting
- Direct benefits of data sharing need to be demonstrated
- Need to make things easier for observatories, not harder
- Data may need to be protected so observatories can publish and control narratives about data



Ideal data flow

Volcanology Database Ecosystem



Schematic representation of global volcano database ecosystem, reflecting different underlying data types and resources.

This ecosystem serves as a resource for the volcano community, enabling them to both utilize the available data and actively contribute to it.

Andrews et al. 2022

"There is no one-system-fits-all"

The interoperability between database can be achieved through practice of good data governance:

- Open & accessible, with data policy and terms of use (Creative Common license),
- Can be linked, combine & integrated, e.g. using common IDs,
- Can be contextualised with metadata, time-stamped and georeferenced,
- Using homogenised terms & standardized data formats.

wovodat.org

- **WOVOdat** is an open-access global historical volcano monitoring database, developed by the **World Organization of Volcano Observatories (WOVO)** under IAVCEI and hosted by the Earth Observatory of Singapore.
- It improves understanding of eruptive processes, enhances eruption forecasting, and supports risk reduction through comparative analysis of unrest patterns within and across volcanoes.
- WOVOdat promotes global collaboration, data sharing, and capacity building to enable transparent, timely, and evidence-based decision-making.

Partners, data contributors, and funding support:

About GVMID

Widiwijayanti et al. 2024

Using GVMID

Espinosa-Ortega & Taisne (2024)

- **The Global Volcano Monitoring Infrastructure Database (GVMID)**, is integral part of WOVOdat, documents global ground- and space-based volcano monitoring infrastructure, including techniques, station types, and instrumentation.
- It provides insights to help observatories optimize network design, strengthen detection capabilities, address monitoring gaps, and integrate remote sensing and emerging technologies for improved eruption detection and early warning.

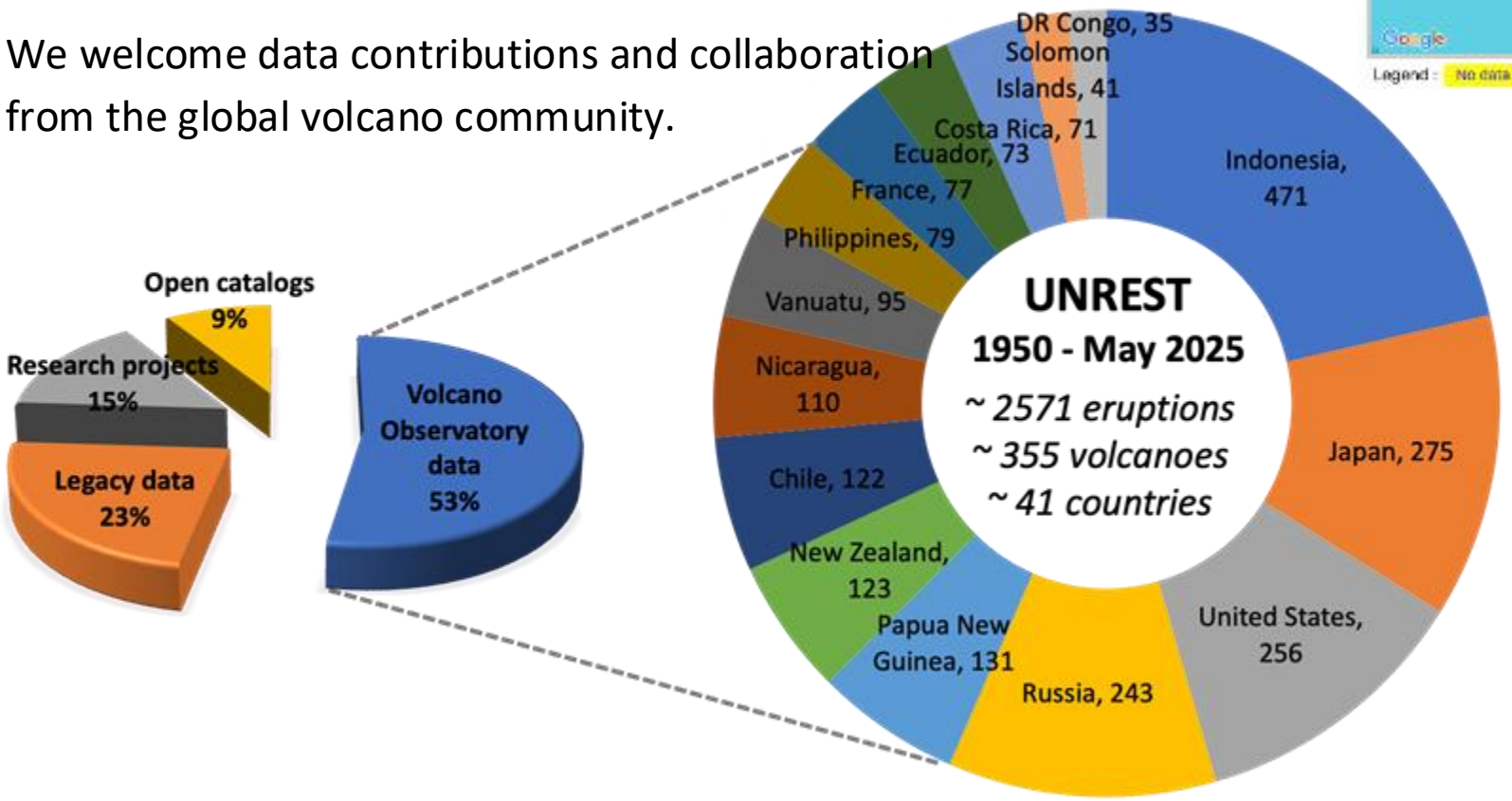
see poster #41

Data sources:

WOVOdat primarily receives data from volcano observatories, with additional inputs from open databases, legacy references, and research projects on volcanic unrest. This collaborative database supports comparative analysis, network design, and eruption forecasting.

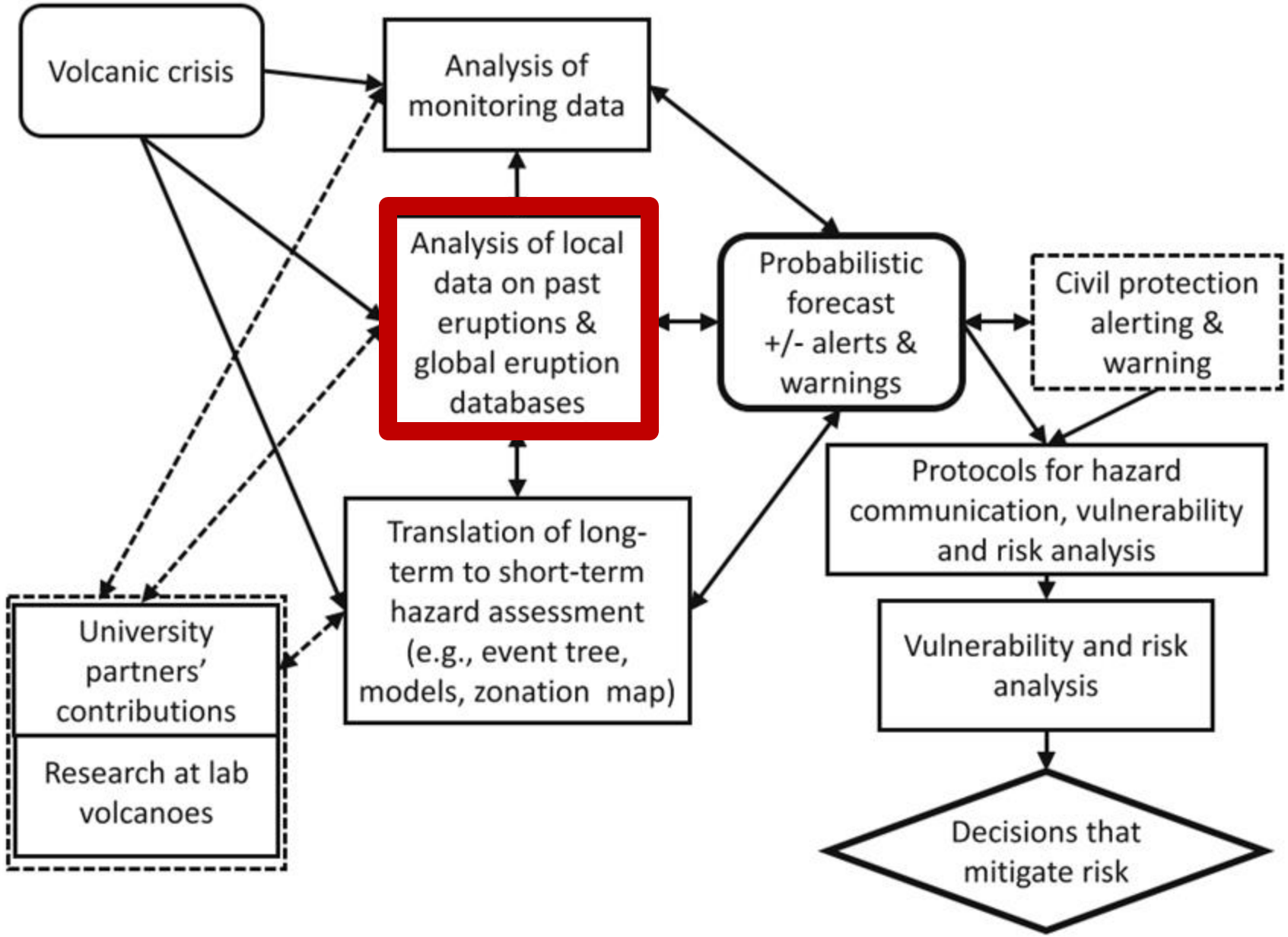
Local WOVOdat systems are operational at observatories such as PHIVOLCS and JVDN-NIED.

We welcome data contributions and collaboration from the global volcano community.



Nang et al., 2025

As of May 2025:
*- **WOVOdat** includes monitoring data from **1,477 volcanoes**, with unrest records for **372 volcanoes** and **2,735 eruptions**.*
*- **GVMID** documents over **13,000 monitoring stations** and **16,000 instruments** across **550+ volcanoes** worldwide.*



- Community-developed standards for interoperability (e.g., terminology, metadata, use of existing volcano and eruption numbers)
- Tools and templates to make data contribution easier
- Data use policies that protect observatories and data producers
- Strategies for sustaining databases through time

Pallister et al., 2019

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