

# Introduction to GEM and Overview of OpenQuake software

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- Paul Henshaw, GEM Foundation



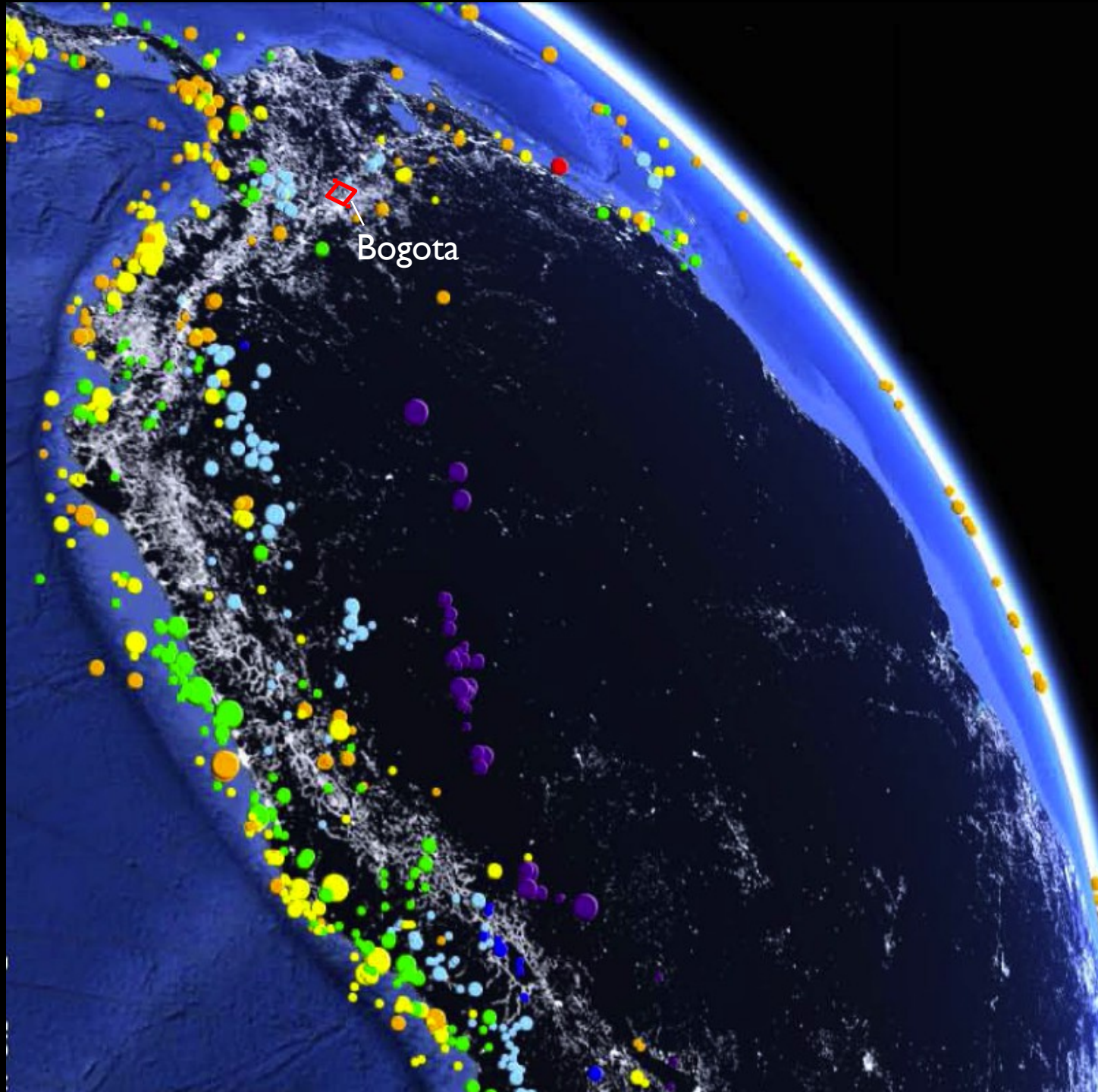
working together to assess risk



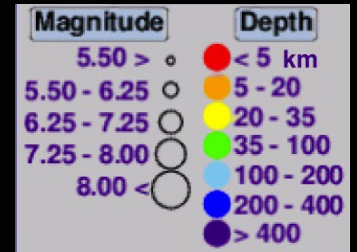
**GLOBAL EARTHQUAKE MODEL**



# 1900-2009 ISC-GEM Earthquake Catalog



Bogota



2011 Landsat  
Population  
density

# Global Earthquake Model

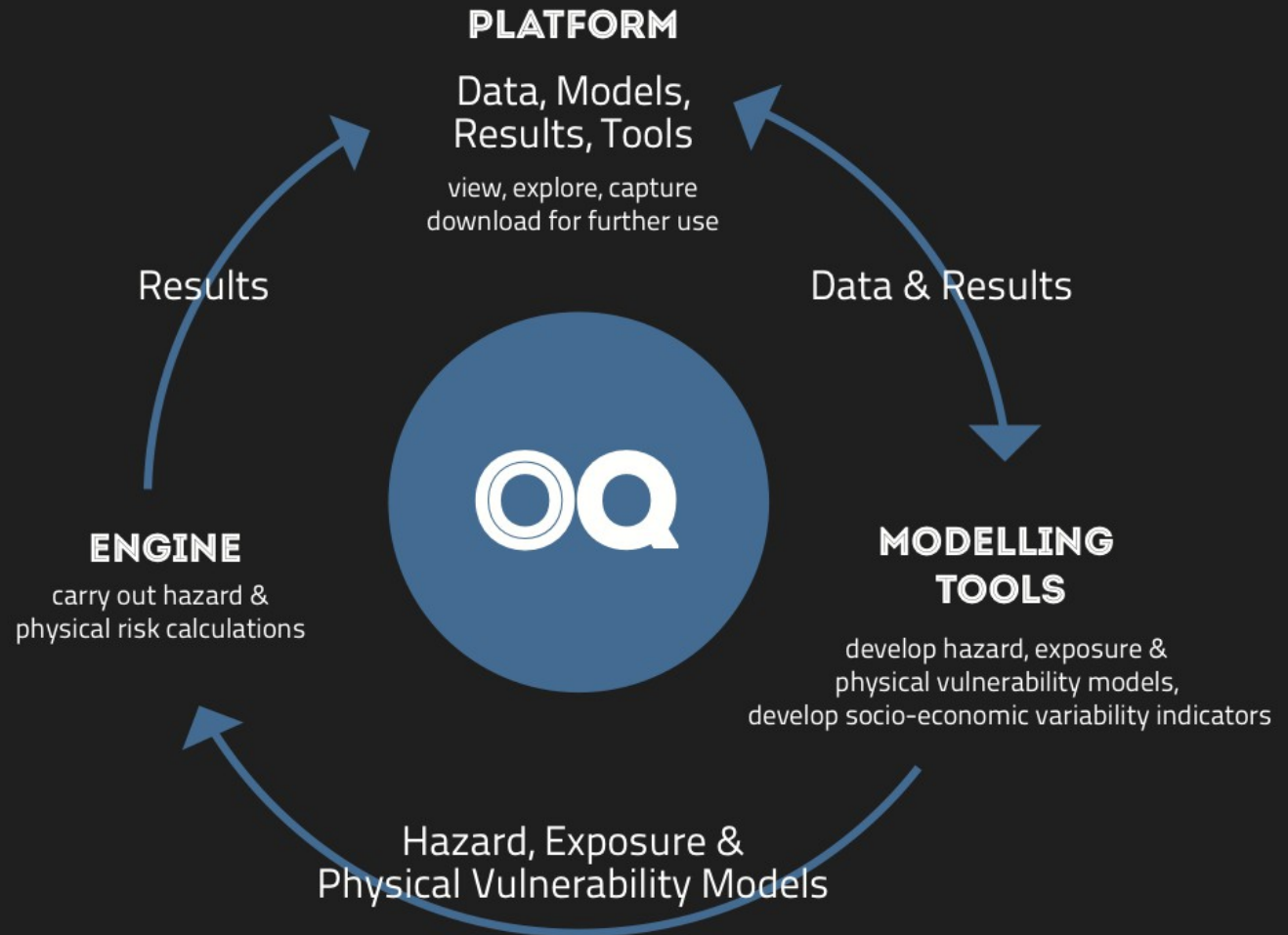
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- Public - Private partnership to provide:
  - global models of earthquakes and their consequences
  - tools and data to advance the science of seismic risk assessment
- International projects with leading experts
- Regional collaboration with local experts
- Open Source software development

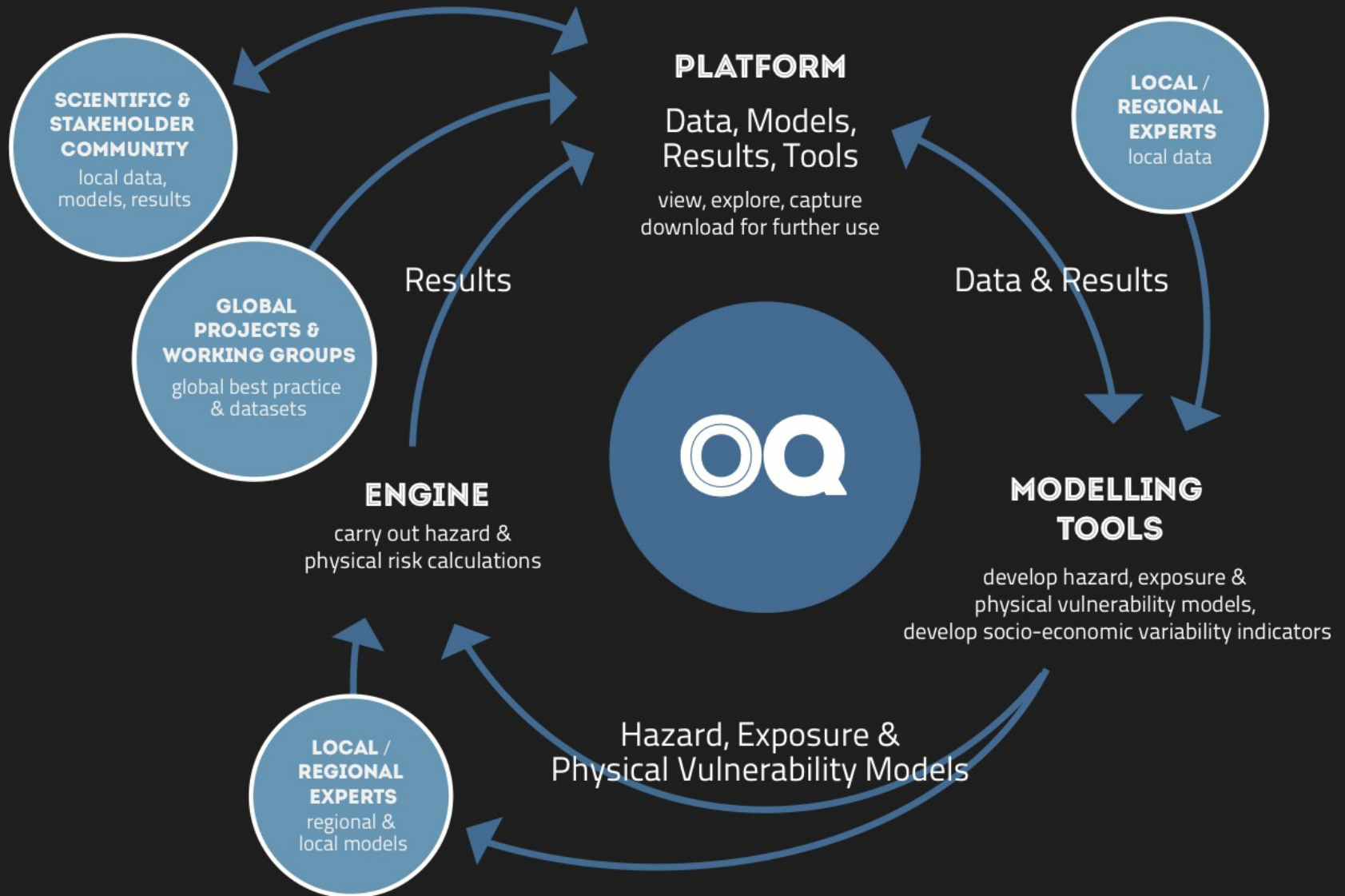
# OpenQuake Components and Status

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- OpenQuake platform
  - Web-based access to data, models and tools
  - Work in progress, v1.0 release end 2014
- OpenQuake engine
  - Calculate seismic hazard and physical risk
  - v1.0 released in June 2013
  - Development continues
- OpenQuake desktop tools
  - Prepare input models for OpenQuake engine
  - Early stages of development, v1.0 release end 2014



# OpenQuake Community Interaction



# OpenQuake Platform Overview

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- Web based, built on GeoNode, PostGIS, Django, TileStream
- Find, explore and visualize existing data and models
- Download data, models, and tools
- Filter, combine and share Maps
- Contribute using online capture tools
- Share results with community
- REST APIs for integration with desktop tools and engine
- Local platforms installations also possible



# Population and Dwelling Fractions

Help

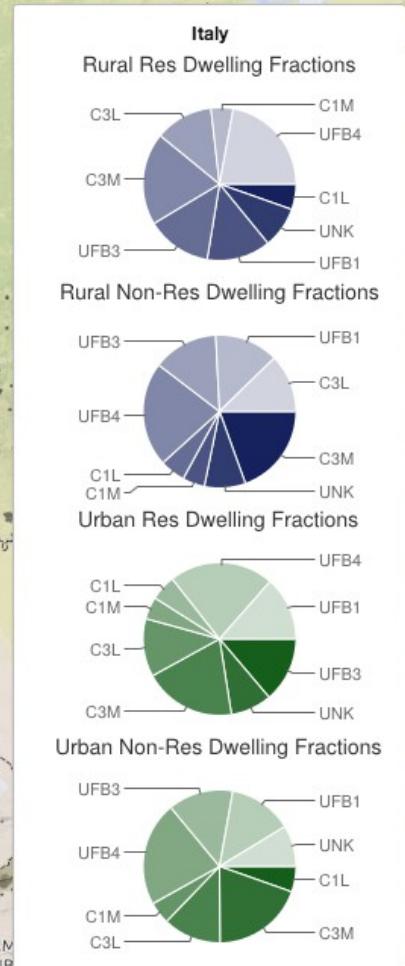


Dwelling\_Types

Legend



Longitude: 12.0410 Latitude: 42.4883



# OpenQuake Platform: Custom Map

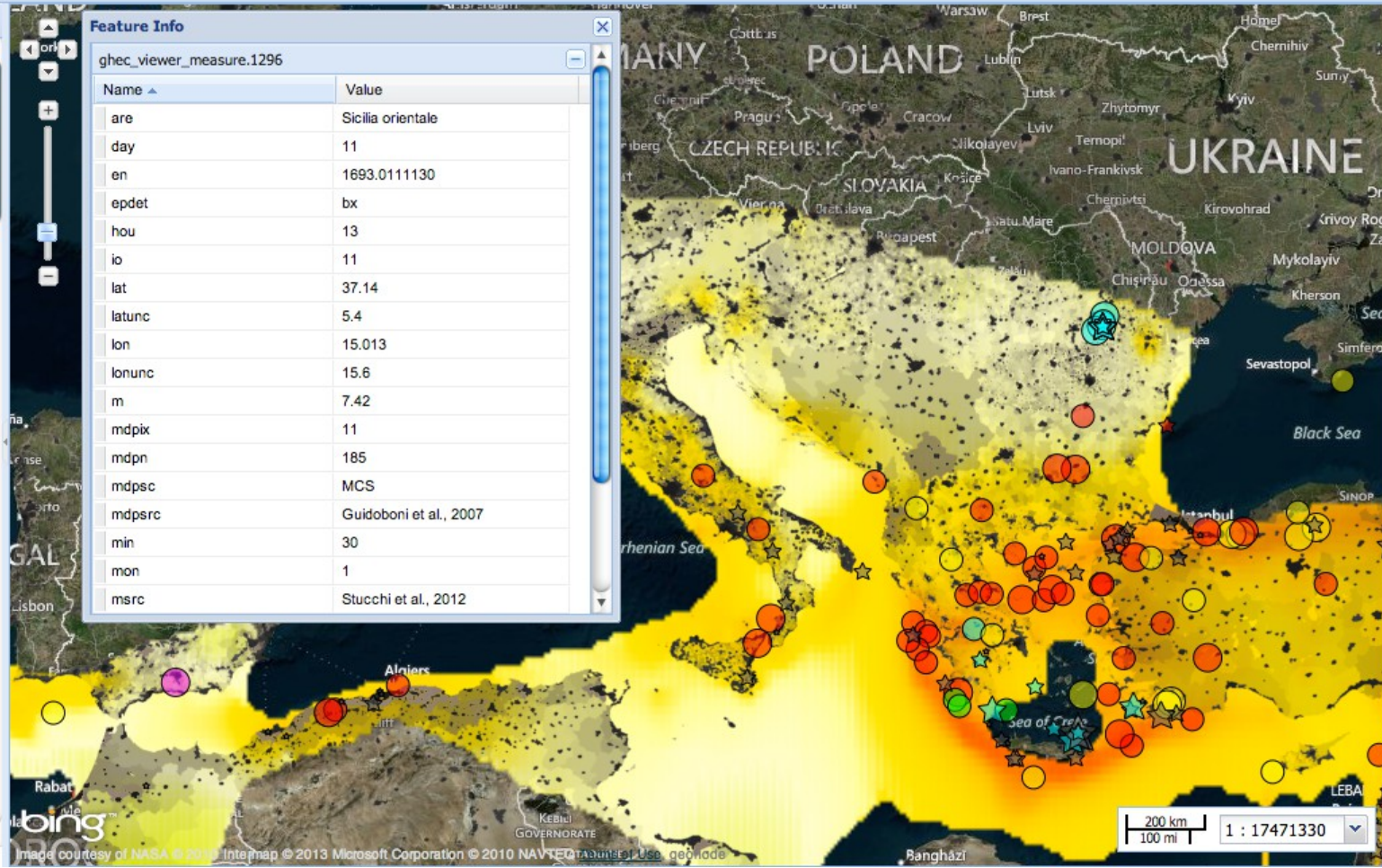


- Overlays
- ghec\_viewer\_measure
    - m < 7 AND depth < 70 km
      - ★ 7 <= m < 7.5 AND depth < 70 km
      - ★ 7.5 <= m < 8 AND depth < 70 km
      - ★ 8 <= m < 8.5 AND depth < 70 km
      - ★ 8.5 <= m AND depth < 70 km
    - m < 7 AND 70km <= depth
      - ★ 7 <= m < 7.5 AND 70km <= depth
      - ★ 7.5 <= m < 8 AND 70km <= depth
      - ★ 8 <= m < 8.5 AND 70km <= depth
      - ★ 8.5 <= m AND 70km <= depth
    - m < 7 AND unknown depth
      - ★ 7 <= m < 7.5 AND unknown depth
      - ★ 7.5 <= m < 8 AND unknown depth
      - ★ 8 <= m < 8.5 AND unknown depth
      - ★ 8.5 <= m AND unknown depth
  - isc\_viewer\_measure
    - unknown mag AND depth <= 15 km
      - mw <= 4 AND depth <= 15 km
      - 4 < mw <= 5 AND depth <= 15 km
      - 5 < mw <= 6 AND depth <= 15 km
      - 6 < mw <= 7 AND depth <= 15 km
      - 7 < mw <= 8 AND depth <= 15 km
      - 8 < mw <= 9 AND depth <= 15 km
      - 9 < mw AND depth <= 15 km
    - unknown mag AND 15km < depth <= 70 km
      - mw <= 4 AND 15km < depth <= 70 km
      - 4 < mw <= 5 AND 15km < depth <= 70 km
      - 5 < mw <= 6 AND 15km < depth <= 70 km

Feature Info

ghec\_viewer\_measure.1296

Name	Value
are	Sicilia orientale
day	11
en	1693.0111130
epdet	bx
hou	13
io	11
lat	37.14
latunc	5.4
lon	15.013
lonunc	15.6
m	7.42
mdpix	11
mdpn	185
mdpsc	MCS
mdpsrc	Guidoboni et al., 2007
min	30
mon	1
msrc	Stucchi et al., 2012



# OpenQuake Platform: Contribute Data



**OPENQUAKE** henshaw (Change password | Log out) English

HOME VIEW CALCULATE CAPTURE EXPLORE Admin

Layers: Observations: Events Form, Observations: Displacement Form, Observations: Slip Rates Form, Observations: Fault Geometry Form, Traces Form, Fault Section Summary Form

Search:

Modify a Neotectonic fault section:  
From the table below press either the Shift or ctrl to select the Sections you would like to Join into a Fault  
Neotectonic Fault Name:   
Join sections:

**Feature Info** observations\_faultsection.3

Name	Value
aseis_com	1
aseis_slip	0.0
compiler	Nicola Litchfield
contrib	Russ Van Dissen
created	2012-04-10
dip_com	1
dip_dir	335
dip_max	90
dip_min	70
dip_pref	80

**observations\_faultsection.3**

Name	Value
Minimum Upper seismogenic depth (*)	0.0
Maximum Upper seismogenic depth (*)	0
Preferred Upper seismogenic depth (*)	0.0
Upper seismogenic depth completeness (*)	1.0
Minimum Lower seismogenic depth (*)	12.0
Maximum Lower seismogenic depth (*)	18.0

Save  Cancel

**Help**

Compulsory  
Reported as 1, 2, 3, or 4  
Should be accompanied by comments or a description of the basis for the choice of factor (free text up to 254 characters long)  
Relative ranking of the completeness of the data constraining the upper seismogenic depth.  
1 = well constrained from field data or high resolution seismic profile data  
2 = moderately constrained from field, seismic profile, or instrumental seismicity data  
3 = poorly constrained from field, seismic profile, or instrumental seismicity data  
4 = inferred

# OpenQuake Engine Overview

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- Seismic Hazard and Physical Risk calculations
  - Classical PSHA, event-based, disaggregation, scenario
  - Model epistemic uncertainty via logic trees
- Continental and global scale calculations (SHARE, GEAR)
- Ubuntu Linux 12.04 on laptop, VM, server, cluster
  - Red Hat / CentOS coming soon
  - 'Engine-lite' for (single machine) Windows & Mac planned
- REST API and Platform Web interface in progress
  - Integration with platform and desktop tools

# OpenQuake Engine Infrastructure

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- Engine and library code written in Python (plus C extensions)
- Using Celery, RabbitMQ to distribute tasks across CPUs/nodes
- Rewrote hazard library to reduce RAM consumption
- Inputs and results stored in PostgreSQL + PostGIS

# Web UI for Calculations (WIP)



oq-engine:8800/v1/calk x Calculate - oq-platform:8000/icebc x refactored loss\_curve\_a x

oq-platform:8000/calculate/

Mail Tools OQ Platform GIT OQ GED4GEM GEM IT Sprint ECD GIS Linux sprint20130205 ... Other Bookmarks

Search... admin

Home Calculate ISC GHEC Geodetic GAF FE Exposure JExplore Hazard Maps

New (Hazard) New (Risk) Open...

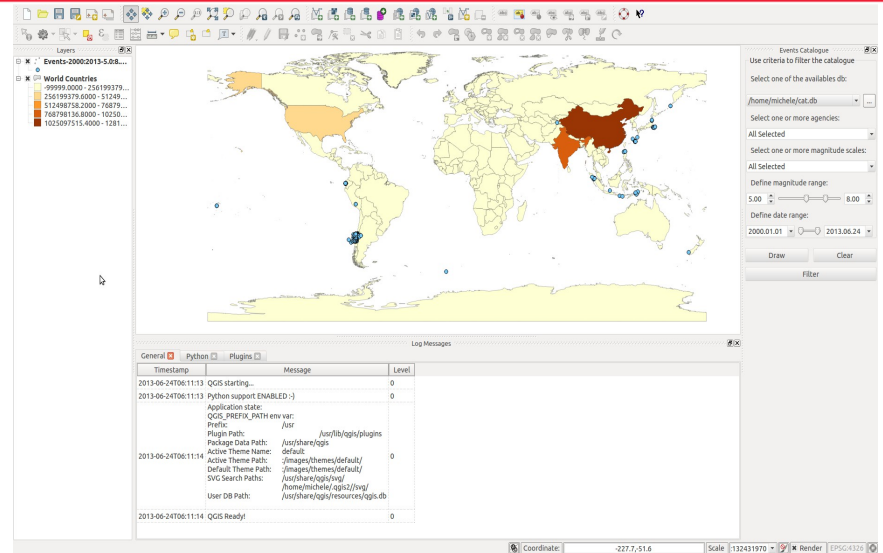
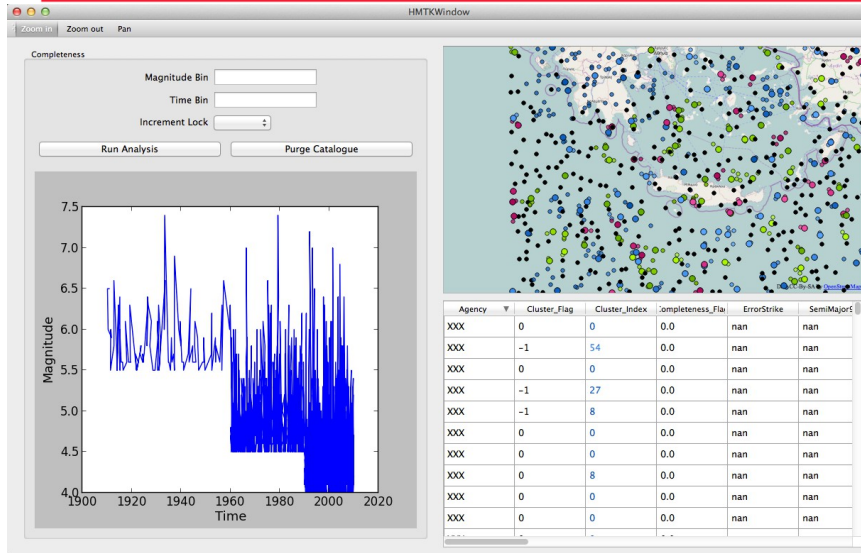
- hazard-map(0.1)-PGA-rlz-3
- hazard-map(0.02)-SA(0.2)-rlz-3
- hazard-map(0.02)-PGA-rlz-3
- hazard-map(0.1)-SA(1.0)-rlz-4
- hazard-map(0.1)-SA(0.5)-rlz-4
- hazard-map(0.02)-SA(1.0)-rlz-4
- hazard-map(0.02)-SA(0.5)-rlz-4
- hazard-map(0.1)-PGA-rlz-4
- hazard-map(0.1)-SA(0.2)-rlz-4
- hazard-map(0.02)-SA(0.2)-rlz-4
- hazard-map(0.02)-PGA-rlz-4
- hazard-map(0.1)-SA(1.0)-mean
- hazard-map(0.1)-SA(0.5)-mean
- hazard-map(0.02)-SA(1.0)-mean
- hazard-map(0.02)-SA(0.5)-mean
- hazard-map(0.1)-PGA-mean
- hazard-map(0.02)-PGA-mean
- hazard-map(0.1)-SA(0.2)-mean
- hazard-map(0.02)-SA(0.2)-mean

# OpenQuake Desktop Tools Overview

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- Python libraries for scientific developers
  - oq-eqcatalogue-tool can be used as independent library
- Graphical User interface (QGIS Plugin / QT application)
  - Connect to platform to download / upload data
  - Load (local) event catalogue, visualize events
  - Exposure import/export, visualize exposure data
  - Vulnerability and Fragility: curve display, match to exposure
  - Connect to engine to run jobs and view results
  - Social Economic Vulnerability and Integrated Risk

# OpenQuake Prototype Desktop Tools

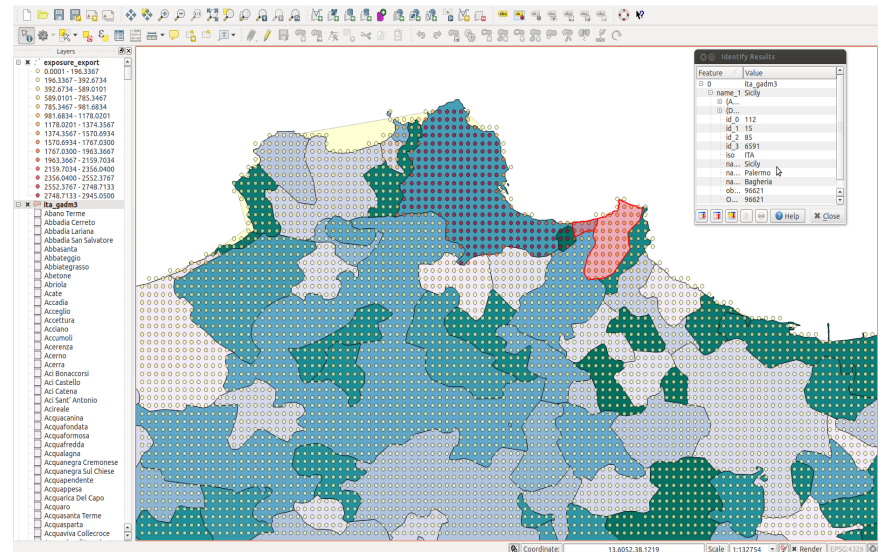


GEM Input tool

Exposure Model Vulnerability Functions Fragility Functions Site Model Rupture Model Config File

Set ID	Asset Category	Loss Category	IMT
1	PAGER	population	fatalities
2	NPAGER	population	fatalities

Fn ID	Prob Dist	MMI	Loss Ratio	Coeff Variation
1	IR LN	5.00	0.00	0.30
2	PK LN	5.50	0.00	0.30
3		6.00	0.00	0.30
4		6.50	0.00	0.30
5		7.00	0.00	0.30
6		7.50	0.01	0.30
7		8.00	0.06	0.30
8		8.50	0.18	0.30
9		9.00	0.36	0.30
10		9.50	0.36	0.30





# OpenQuake Development Philosophy

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- OpenSource is not just a license
  - All contributions visible on github.com and reviewed by at least one other developer
- Collaboration with Scientific Staff
  - Key for requirements gathering, QA testing and code review
- Test-driven
  - Unit tests (nose+mock), QA tests, performance monitoring
  - Continuous integration (Jenkins)
- Agile
  - Daily Scrum developer meetings, 4-6 week Sprints

# OpenQuake Licensing

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- Open Source Software license: AGPL v3.0
  - Transparency a key issue for public and private sector sponsors
  - Facilitates collaboration, defect identification
- Creative-Commons Data license: CC BY-SA-NC v3.0
  - Data re-released without 'NC' clause after 18 months
  - Data licensing subject of much discussion (confusion?)
  - Key issue for data contributors, users and sponsors
  - Many community members not familiar with implications

## More Information

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<http://www.globalquakemodel.org>