

Extending the functionality of Quantum GIS via plugins

Guido Cervone, Mark Coletti
{cervone,mcoletti}@psu.edu

Dept. of Geography and Institute for CyberScience
GeoInformatics and Earth Observation Lab
The Pennsylvania State University

Research Application Laboratory
National Center for Atmospheric Research



Boulder, Colorado, USA
July 24, 2014



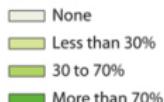
Coastal Hazards

Unprecedented Risk

- 90% of the largest cities lie within few km of the coast.
- Increasing hazards and population.
- Humanitarian Assistance and Disaster Relief (HA/DR)

Coastal population and shoreline degradation

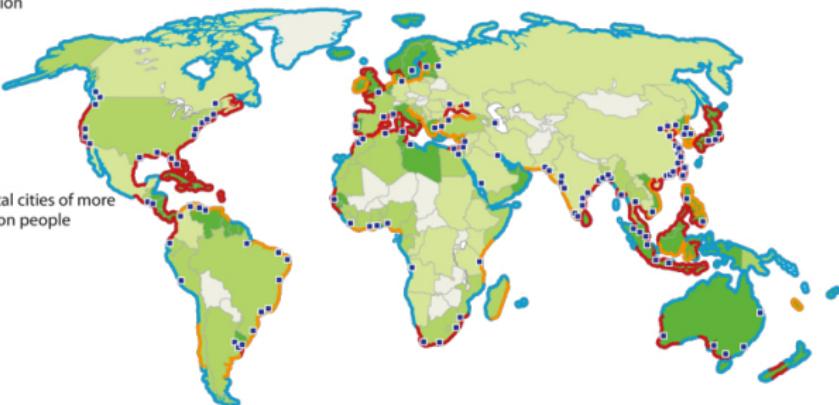
Population living within 100 km of the coast



Shoreline



Source: Adapted from UNEP 2002b, based on Burke and others 2001, Harrison and Pearce 2001



Navies and HA/DR

- New Objective
- Domestic and foreign
- Power projection
- Security



US Navy HA/DR

- ”..the new ships will focus on exercises, port visits, anti-piracy missions, **humanitarian assistance and disaster relief.**” (*March 2013*)



Admiral Jonathan William Greenert, CNO

ONR HA/DR

- Tools and techniques to improve situational awareness with the public, local authorities, first responders, nongovernment agencies and other governments
- Mechanisms for data mining social media in a high-tempo, rapid-onset, massive disaster capable of generating thousands of tweets per hour for first responder purposes and needs
- Improved means to enable first responders to collaborate using inputs from the public via crisis maps and other social media inputs

The screenshot shows a website page with a header containing the ONR logo and navigation links for Technology Locator, Glossary, Careers, Events, and a search bar. Below the header, there's a breadcrumb trail: Home > News and Media Center > Fact Sheets > Humanitarian Assistance/Disaster Relief.

Humanitarian Assistance/Disaster Relief Tools, Maps and Models

About ONR | **Science & Technology Organization** | **Contracts & Grants** | **Education & Outreach** | **News & Media**

News and Media Center

- Fact Sheets** (selected)
- Photo Gallery**
- Media Releases**
- Video Gallery**
- Media Inquiries**

Humanitarian Assistance/Disaster Relief Tools, Maps and Models

What Is It?
The Humanitarian Assistance/Disaster Relief (HA/DR) Tools, Maps and Models Program investigates novel modes of data collection, analysis, and visualization to support decision making by military and nongovernment organizations in crises, including natural disasters, humanitarian assistance and crisis relief operations.

How Does It Work?
Data collection methods provide precise information to military, humanitarian assistance and disaster relief teams. These tools, assist map and analyze data to support decision making. Visualization can be shared with military and nongovernment organizations to facilitate decision making and enhance human security. Through "tool ahead" models, these tools provide timely information to military commanders in crises, improving and saving lives during crisis relief operations abroad and at home.

What Will It Accomplish?
This program will create new technologies and management systems to modularize HA/DR, enable the mission planning and execution of crisis relief operations, and create maps and map-ups that can measure the impact of HA/DR operations from inside, incorporate the capacity of HA/DR modules, develop tools of tool management to enable all parties to work together more effectively, strengthen their information security and improve HA/DR across the services and the agencies.

[Download \(PDF 608.9 KB\)](#)

The HA/DR Program
From Hurricane Katrina to the 2010 Haiti earthquake, the U.S. military has seen an ever-increasing role as broker, coordinator and first responder to a variety of disasters at home and abroad. The HA/DR program combines social science, computational modeling, and data collection and analysis to develop new technologies and tools for improving the execution of humanitarian assistance, civil affairs, human security, and disaster relief operations.

The HA/DR program involves the development of new capabilities that can assist the military in their homeland mission as well as abroad by developing the following tools and capabilities:

- Tools and techniques to improve situational awareness with the public, local authorities, first responders, nongovernment agencies and other governments
- Ability to manage information security across the spectrum – from unclassified to very sensitive systems of trust management that leverage social network management
- Mobile instruments and new techniques for safety and reliability collecting field data through sensors and mobile devices to support decision making
- Mechanisms for data mining social media in a high-tempo, rapid-onset, massive disaster capable of generating thousands of "tweets" per hour for first responder purposes and needs
- Multi-layered maps with shareable and secure layers designed to keep sensitive information secure while allowing broad distribution of less sensitive information to appropriate partners
- Improved means to enable first responders to collaborate using inputs from the public, local authorities, first responders, nongovernment and government organizations to get ahead of the curve in determining what health and human service needs will look like in the future and create a more proactive mission planning stance

Research Challenges and Opportunities

- Development of new models, maps, tools and information mash-ups for HA/DR mission planning and execution that are shareable, secure and easy to use – and relevant to the needs of many kinds of participants
- Development of systems of trust management that meet the needs of all participants, from the military to nongovernment organizations
- Data mining and visualization of massive sets of streaming data, such as an earthquake in Tokyo, in other languages

Point of Contact
Dr. Rebecca Goddard
goddard@onr.navy.mil

ONR Funded Research

Typical Scenario

- A US Navy ship provides HA/DR Operations
- A Chemical, Biological, Radiological, Nuclear, Explosive (CBRNE) atmospheric release is detected

Goal

- Identify the location of the source
- Predict fate of the contaminants
- Generate risk maps
- People reaction / situation awareness

Remote Sensing Disaster Assessment

- De-facto standard in observing the Earth and its environment
- Real time high-resolution data
- Crucial during disasters
- International cooperation (e.g. International Charter for Space and Disasters)

March 2011 Japanese Earthquake

Japan - Tsunami Affected Areas - Tagajyou (Tagajo)



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 22392

MAR 29 2011

Mr. Guido Cervone
Center for Earth Observing and Space Research
George Mason University
4400 University Drive
MS 5C3
Fairfax, Virginia 22044

Dear Mr. Cervone:

The March 10, 2011 earthquake and tsunami was a great tragedy for the nation of Japan. I would like to commend you and your colleagues for your impressive effort and commitment made in response to the demands of the disaster and the request of the Government of Japan. Your hard work and personal sacrifices benefited the Japanese and U.S. agencies assisting in the response effort during a very busy and difficult time.

The efforts you have put forth in collecting and analyzing imagery and creating maps depicting the areas impacted by the disasters, have been recognized and appreciated by many agencies responding to the disaster. As Hiroshi Murakami of the Geospatial and Information Authority of Japan (GSI) indicated in a message:

"the image maps posted by Brenda Jones (all created by U.S. Volunteers) seem to cover most of the important coastal areas of Iwate Prefecture, and will be very helpful for understanding the impact. The weather in the region did not allow us to take air photos today, and these image maps are very helpful. I was impressed that so much information on the damaged areas becomes available on the web immediately after the earthquake by many experts in the world."

On behalf of our Japanese and U.S. agency colleagues, the USGS would like to recognize your contributions to the 2011 Japan Earthquake/Tsunami Response Effort and extend our sincere thanks and appreciation for your immediate action and quick response to the request for assistance. This positive response to the Japanese request for assistance would not have been possible without your help.

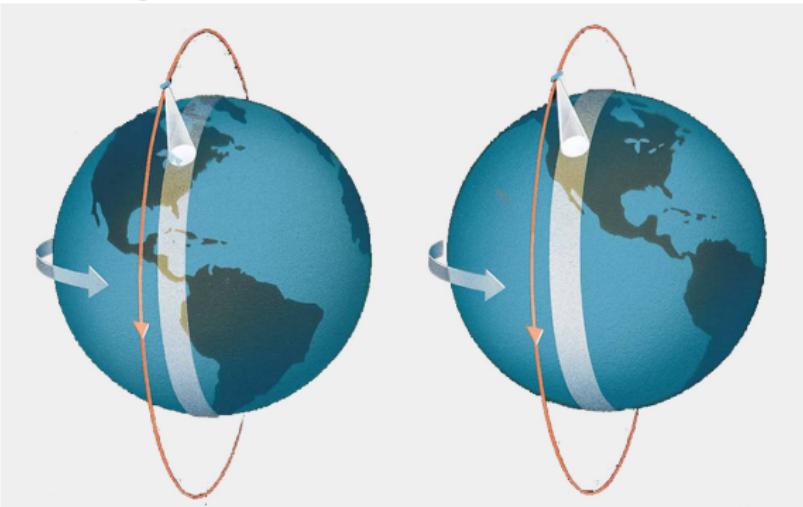
Sincerely,

William S. Leith
Acting Associate Director for
Natural Hazards



Remote Sensing Challenges

- Revisiting Time



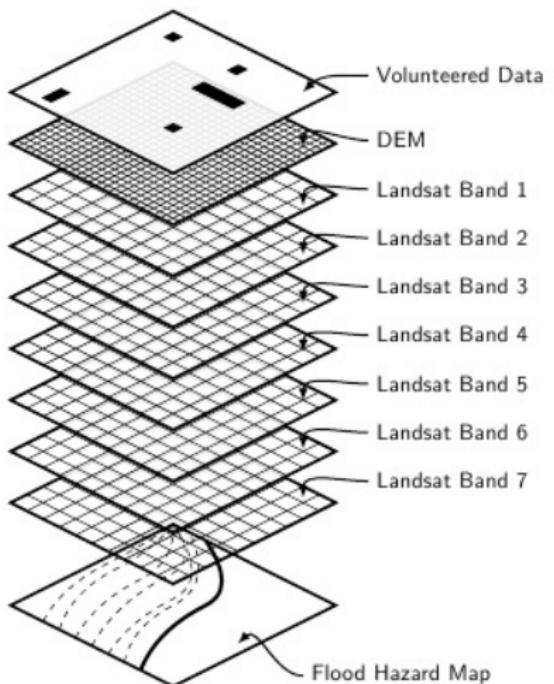
© 2007 Thomson Higher Education

- Atmospheric Transparency

Solution

- Filling the Gaps in Remote Sensing Data Using Social Media
 - Data Fusion Problem
 - Remote Sensing: high spatial resolution, low temporal resolution
 - Social Media: low spatial resolution, high temporal resolution
- Augment initial satellite observations with ground information

GIS Basics



Transportation Assessment after Sandy using Social Media

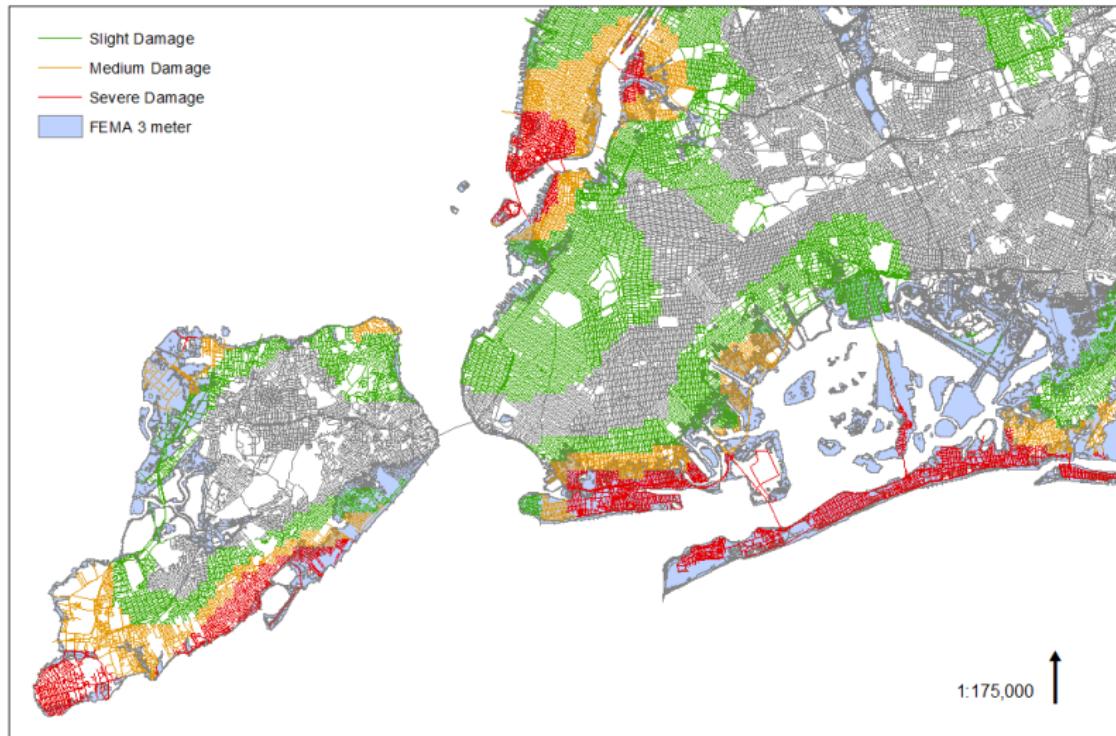
Goal

- Generate flood hazard maps for the 2013 Sandy hurricane
- Tweets, CAP images, USGS water height data
- Performed using ArcGIS
- Funded by DOT

Fema Flood Map



Road Assessment



Fukushima Radioactive Release Estimation

Scenario

- Series of radioactive releases at the Fukushima Nuclear Power Plant
- Source location is known
- The release rate is unknown.
- Radioactive ground measurements are available in several locations

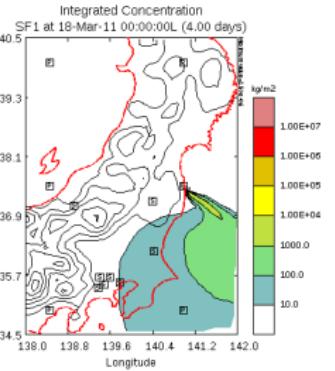
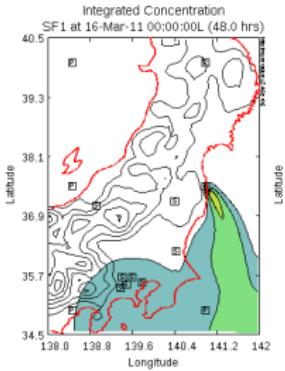
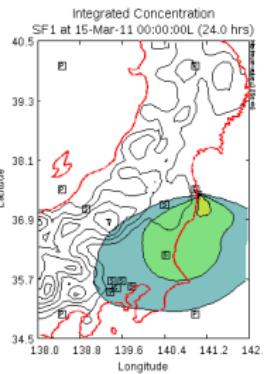
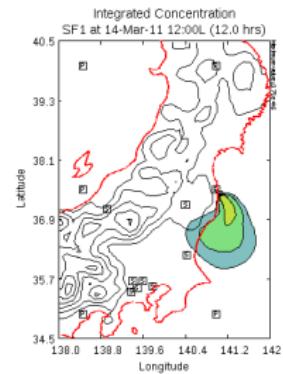
Objective

- Determination of release rate
- Hazard Maps

G. Cervone, P. Franzese, *Reconstruction of the Radiation Release Rate for the 2011 Fukushima Accident*, Chapter in Data Mining for Geoinformatics, 2013

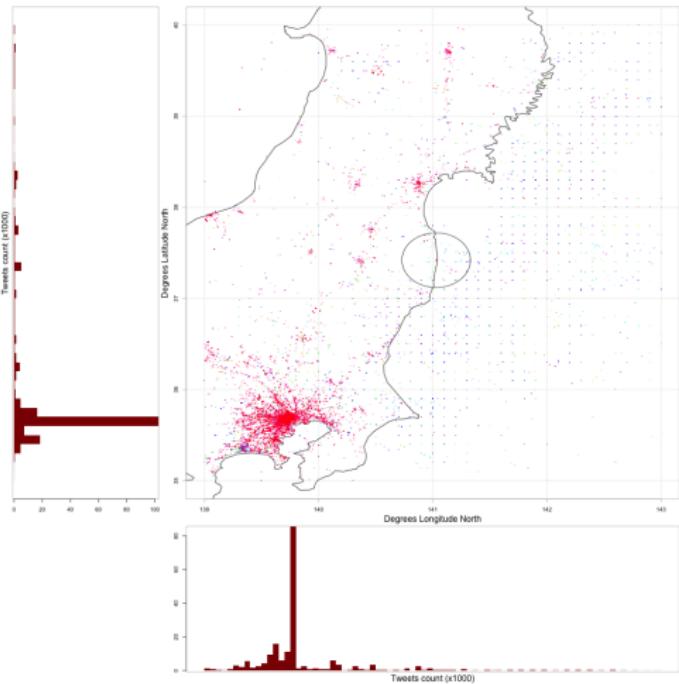
G. Cervone, P. Franzese, *Source Term Estimation for the 2011 Fukushima Nuclear Accident*, NSF Workshop on Methods for Estimating Radiation Release from Fukushima Daiichi, NCAR, Boulder CO, February 2012

Fukushima Power Plant Accident

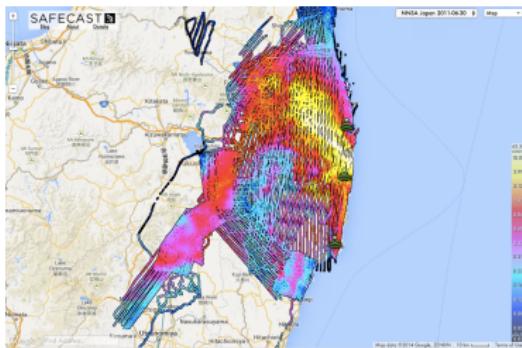
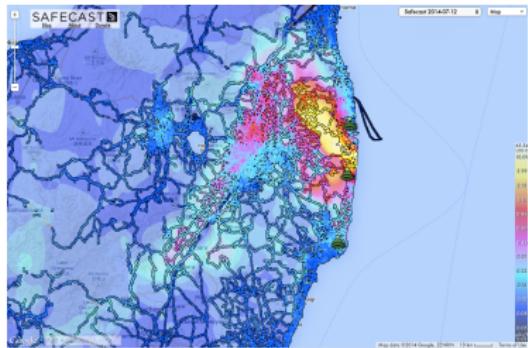


- Nuclear Release
- Millions of tweets available
- Contributed radiological measurements
- Videos, photos
- Rescue operation Data

Tweet Data



Safecast Data



Radiation Exposure



U.S. Navy sailors sue Japan over nuclear accident

By Tom Watkins and Lateef Mungin, CNN
updated 9:20 PM EST, Fri December 28, 2012

STORY HIGHLIGHTS

- 8 sailors from an aircraft carrier allege they were sickened by radiation exposure
- The disaster occurred in 2011 when a massive earthquake was followed by a tsunami
- Officials were "lying through their teeth," plaintiffs' lawyer says

(CNN) -- Eight U.S. Navy sailors who were aboard a U.S. aircraft carrier off Japan after last year's Fukushima nuclear accident have sued the Tokyo Electric Power Company alleging a series of failures, including lying.

The suit, filed December 21 in U.S. District Court Southern District of California, alleges that the sailors -- among some 5,500 who were aboard the USS Ronald Reagan as it was providing aid to the stricken zone -- were themselves sickened as a result of exposure to radiation that escaped from the Fukushima Nuclear Power Plant (FNPP).

"They have physical problems," said Paul C. Garner, the plaintiffs' attorney, in an interview with CNN affiliate KGTV in San Diego, the home port of the ship. "One of them is bleeding from his rectum; already, the others have problems with thyroid glands."

Garner described the illnesses as "major health issues" during a telephone interview with CNN.



"Our best and brightest -- who were hired to perform top service to our Navy -- went there to provide humanitarian tasks and did not want to bargain their health and well being," said Garner. "But the people running the power plant lied to them."

The disaster occurred on March 13, 2011, when a massive earthquake and tsunami struck the area.

The Fukushima Daiichi power plant spewed radiation and displaced

Mark Coletti



- Software Engineer:
 - National Oceanic and Atmospheric Administration: expert system to correct human sourced sea surface meteorological data
 - Federal Highway Administration: road surface wear calculator
 - U. S. Army Materiel Command: expert system for validating purchases
 - U. S. Army Topographic Engineering Center: topographic visualization system
 - U. S. Geological Survey: toolkit for Spatial Data Transfer Standard (SDTS) data conversion and research support

- Education:

- Southern Polytechnic, CS, BSc, 1989
- George Mason University, CS, MSc, 2007
- George Mason University, CS, PhD, 2014

- Graduate Research Assistant:

- evolutionary computation C++ toolkit
- a biologically inspired cognitive model for a DARPA Grand Challenge
- a Joint Improvised Explosive Device Defeat Organization (JIEDDO) related multiagent simulation
- an Office of Naval Research (ONR) Multidisciplinary University Research Initiative (MURI) Office sponsored massive multiagent simulation of pastoral and farming behavior in eastern Africa
- a geospatial extension, GeoMason, for the multi-agent simulation toolkit MASON

Outline

- QuantumGIS: free, open source geospatial information system
- QuantumGIS plugins
- Example plugin: TweetWrangler

What is QuantumGIS?

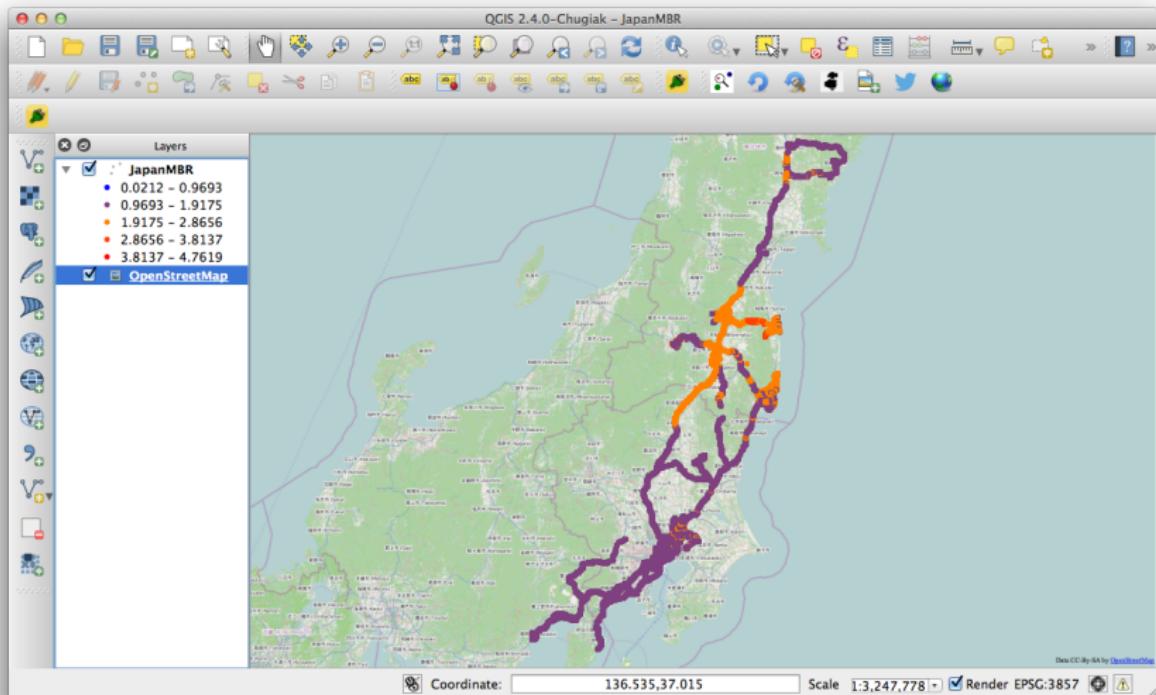
- QuantumGIS (qgis) is a free, open-source GIS (www.qgis.org)
- qgis is cross platform — available on MacOS, Windows, linux, and Android
- qgis offers the functionality of a complete GIS
 - import and export a large variety of geospatial formats
 - fine tuned control over rendering and manipulation of geospatial data
 - supports geospatially aware databases (PostGIS, spatialite, MSSQL)
 - large suite of analytical tools

QuantumGIS Example: Safecast

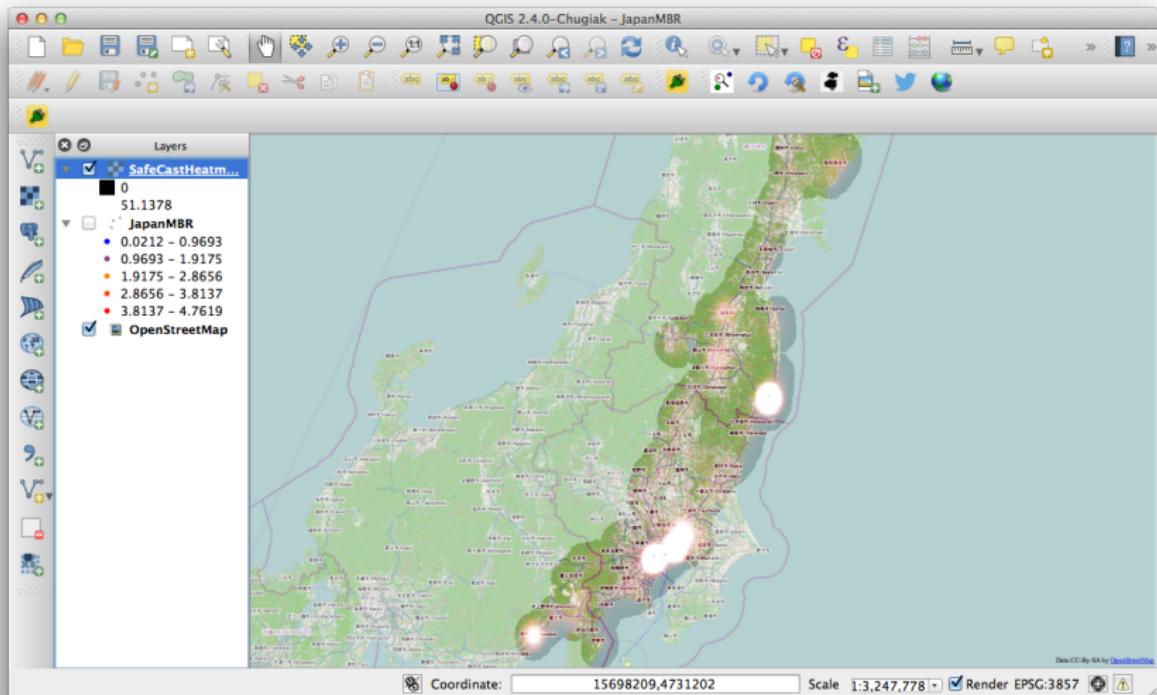
- Safecast is crowd sourced radiation data (<http://blog.safecast.org/>)
- Started one week after 2011 Japanese tsunami
- Uses off the shelf hardware to augment smartphones with radiation sensors
- Data uploaded to central server and freely available
- Has over 17 million records as of May 2014

ID,User ID,Captured Time,Latitude,Longitude,Value,Unit,Device ID
20531829,161,2013-03-02 06:01:27,35.1162266666667,136.1098,43,cpm,
20531832,161,2013-03-02 06:01:32,35.1162266666667,136.1098,50,cpm,
20531835,161,2013-03-02 06:01:37,35.116225,136.109798333333,54,cpm,
20531838,161,2013-03-02 06:01:42,35.116225,136.109798333333,55,cpm,
20531841,161,2013-03-02 06:01:47,35.116225,136.109798333333,55,cpm,
20531844,161,2013-03-02 06:01:52,35.116225,136.109798333333,52,cpm,
20531847,161,2013-03-02 06:01:57,35.116223333333,136.109798333333,51,cpm,
20531850,161,2013-03-02 06:02:03,35.116223333333,136.109798333333,56,cpm,
20531853,161,2013-03-02 06:02:08,35.116223333333,136.109798333333,59,cpm,
...

QuantumGIS Example: Safecast



QuantumGIS Example: Safecast



QuantumGIS Plugins

- users can extend qgis' functionality by developing plugins
- plugins can be written in C++ or python
- many choose python because it is easy to learn and use
- qgis has built-in support for quickly creating python-based plugins

QuantumGIS Plugins

qgis comes stock with over 200 python based plugins

Example plugins:

GEarthView: exports qgis data to Google Earth

GPSTools: imports GPS data

Heatmap: generates a visualization of point layer density

OpenLayers: allows for importing Open Street Map tiles

TimeManager: creates animations of time series geospatial data

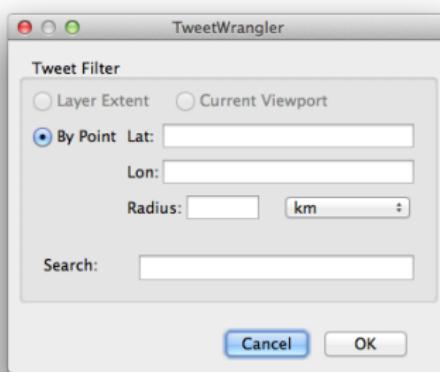
VideoUAVTracker: replay a video in sync with a GPS track

About qgis plugins

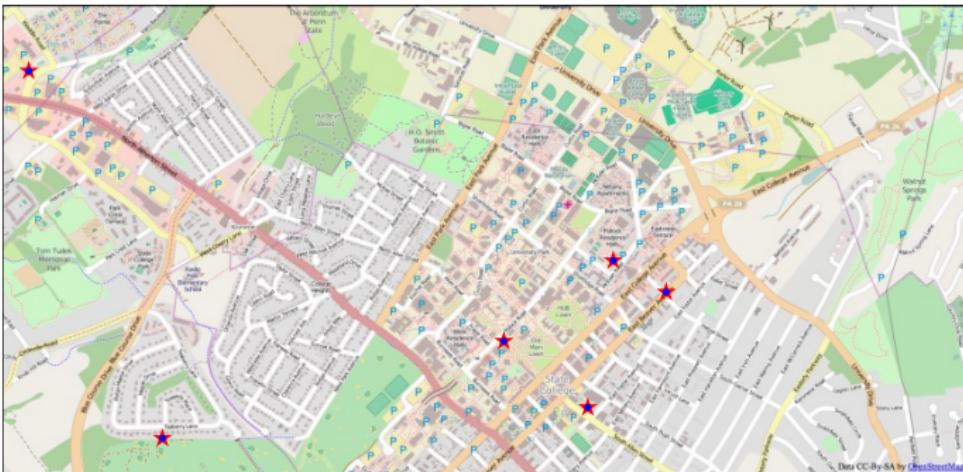
- qgis is built using Qt, which is a crossplatform GUI framework (<http://qt-project.org/>)
- Qt is written in C++, but has python bindings, PyQt
- qgis has a plugin API that allows for plugins to interact with the application

qgis plugin example: TweetWrangler

- Users could load georeferenced tweets into qgis, but this required writing scripts and learning the Twitter API
- Started development of TweetWrangler, a qgis plugin that hides the complexity of loading tweets by area.
- User specifies an area of interest and tweets for that region are loaded into a qgis layer.
- Optionally filter tweets by arbitrary strings such as hashtags or topics.



TweetWrangler Sample Output



Screen Name	Tweet	Tweeted At
lameyhopf	arts fest preparations @ State College Municipal Building http://t.co/26HBFDQGeG	2014-07-08 18:48:06
gpioppi	Currently in charge of 10 14 year olds..... What is my life	2014-07-08 18:45:33
_shoes	@analisa_seader HAHAHAHAH	2014-07-08 18:42:37
Kristinna_Bee	I'd rather get shot in the leg but thanks coach http://t.co/AKfZcWi0t0	2014-07-08 18:40:46
mackslenoo	@azs5238 http://t.co/UECOzgU9KI	2014-07-08 18:40:23
BEChorner	@kaylav_____	2014-07-08 18:35:34

Conclusions

- qgis is a powerful open-source, free GIS
- part of its appeal is adding functionality quickly and easily via plugins
- we rely on qgis for:
 - viewing geospatial data
 - performing analysis
 - extensibility via plugins