VGI and formal data

EEO / AGI (Scotland) seminar

David Fairbairn

Newcastle University

School of Civil Engineering & Geosciences

Newcastle University

Civil Engineering and Geosciences

VGI and formal data

- Investigating the possible interaction between informal and formal data
  - Informal Volunteer Geographic Information
  - Formal official spatial data
- Examples of VGI data collection
  - Flickr
  - Panoramio
  - commercial satellite imagery
  - OpenStreetMap

Flickr sets

nls

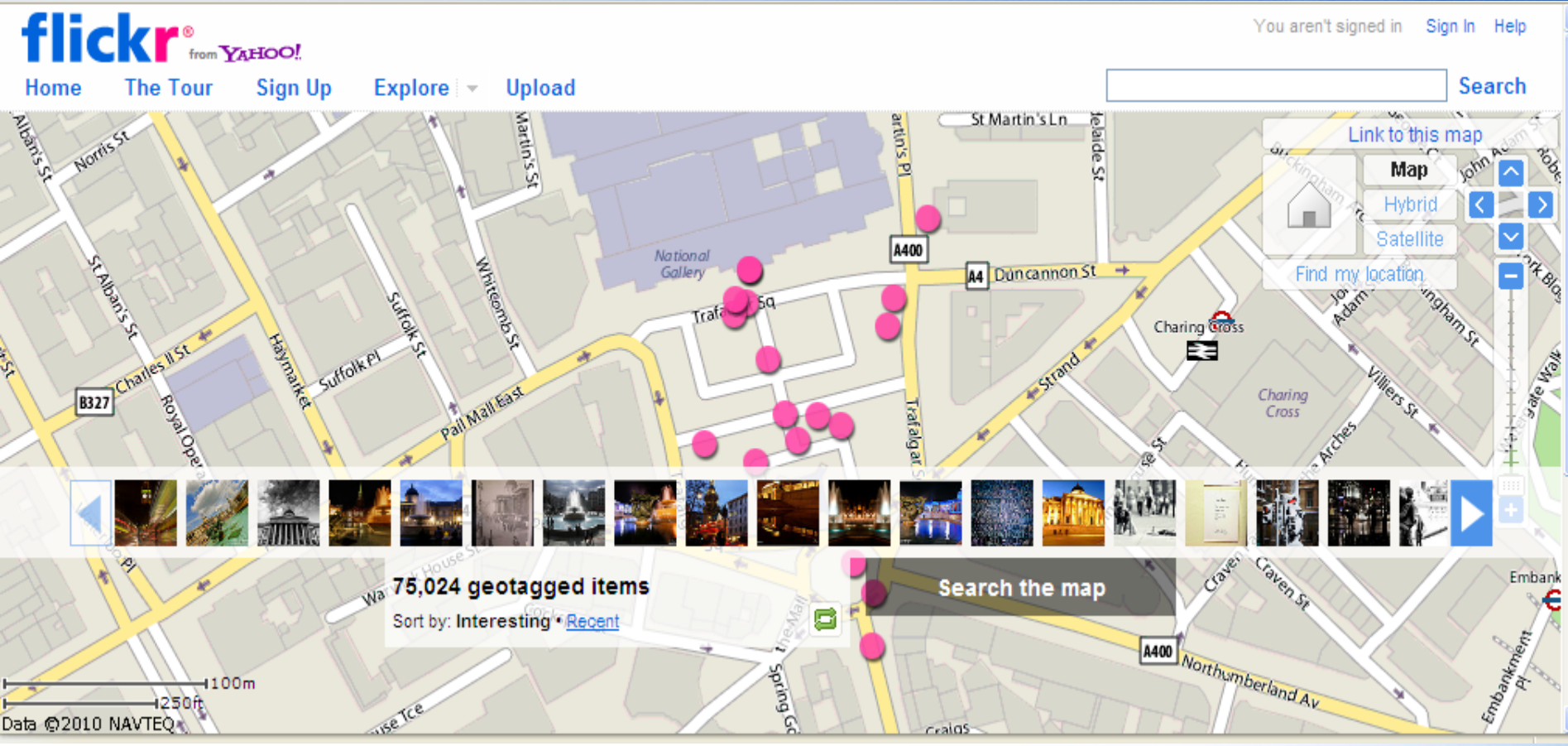
Photographs of the South Side of Edinburgh

Slideshow Share

Thumbnails Detail Map 3 comments

137 black-and-white photographs taken in 1929 taken by **Alfred Henry Rushbrook** on behalf of the City of Edinburgh Improvement Trust. Show tenements and shops around St Leonards before buildings were pulled down for slum clearance. Half-plate gelatin silver

Flickr images



Panoramio images

Panoramio

Forum | Blog | Sign in | Help

Sign up | Upload | Groups | Contest | Places | Tags

Search place

Popular | Recent

Also show photos not selected for Google Earth

Swing Bridge built 1876, River Tyne, Newcastle upon Tyne, 6/2005

Map | Satellite | Hybrid

Quayside

Scott G

Chambers

BRIDGE

A167

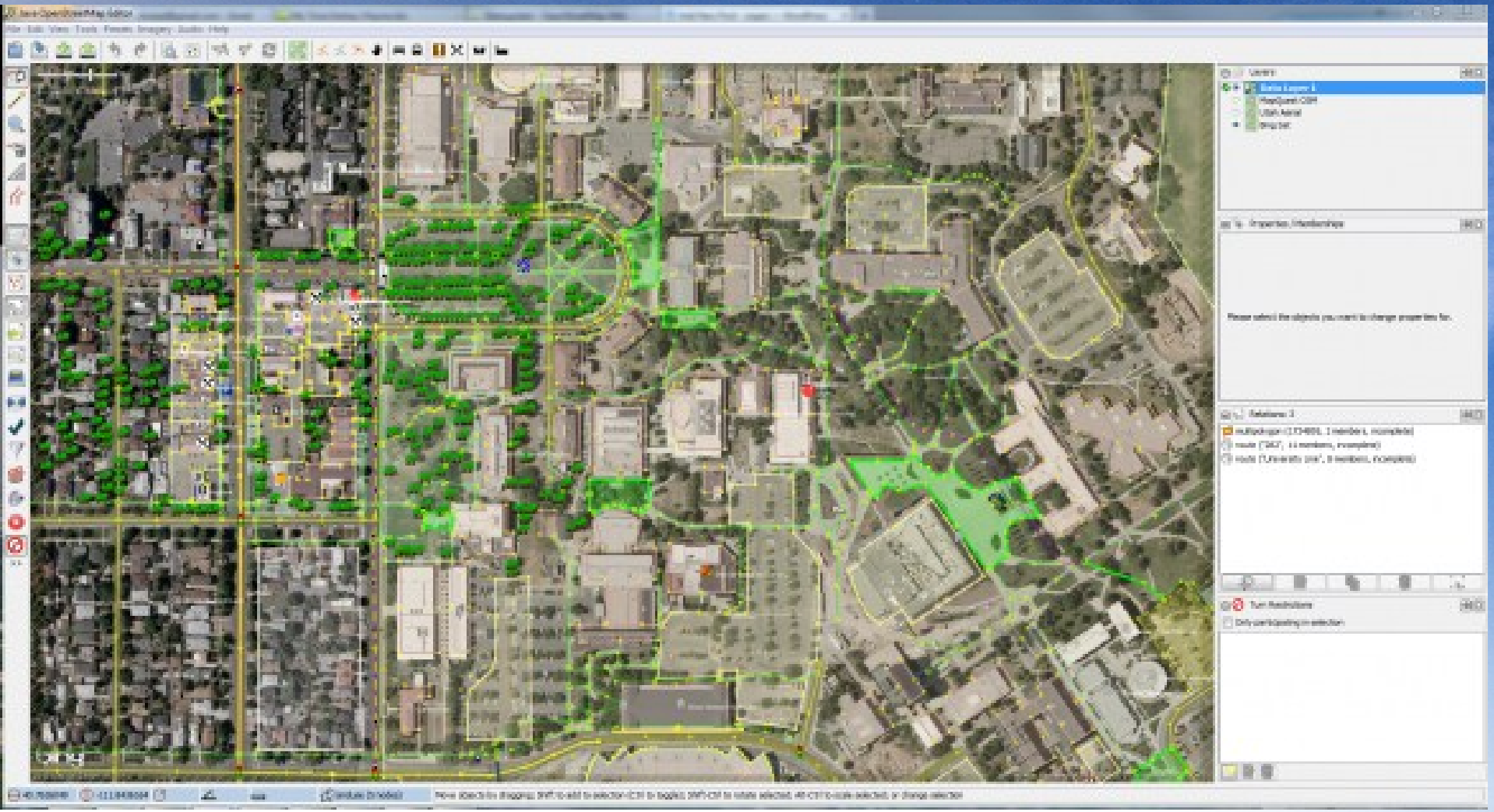
Hillgate

54° 58' 4.27" N 1° 36' 20.17" W ©2011 Google - Imagery ©2011 , Map data ©2011 - Terms of Use

Popular photos in Google Earth

« Previous | Next »

Using satellite imagery to update spatial databases



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OpenStreetMap

OpenStreetMap

The Free Wiki World Map

Search Where am I?

Go

examples: 'Alkmaar', 'Regent Street, Cambridge', 'CB2 5AQ', or 'post offices near Lünen' more examples...

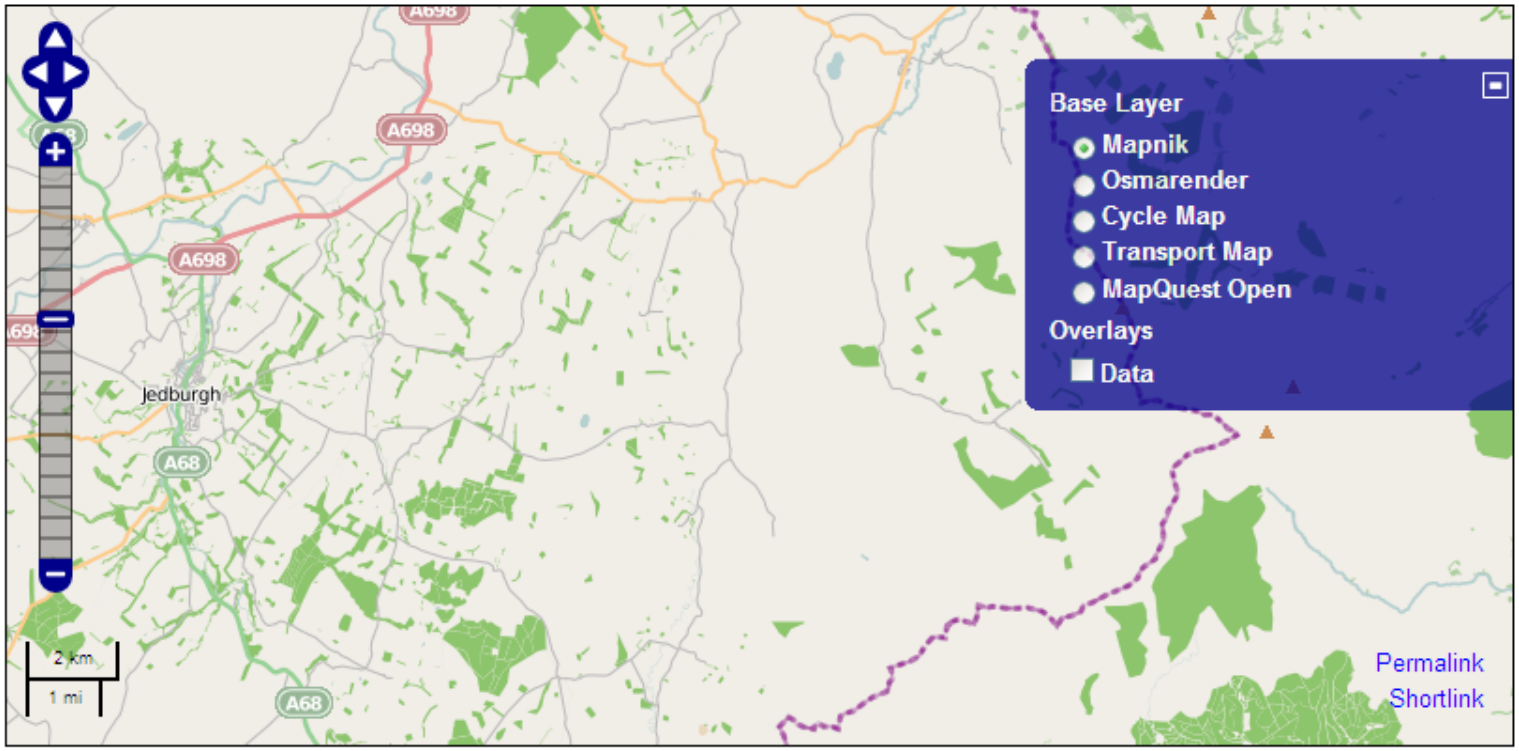
OpenStreetMap is a free editable map of the whole world. It is made by people like you.

OpenStreetMap allows you to view, edit and use geographical data in a collaborative way from anywhere on Earth.

OpenStreetMap's hosting is kindly supported by the UCL VR Centre, Imperial College London

View | Edit | History | Export | GPS Traces | User Diaries

log in | sign up



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OpenStreetMap's hosting is kindly supported by the UCL VR Centre, Imperial College London

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Roxburghshire

Jedburgh

2 km

1 mi

Base Layer

- Mapnik
- Osmarender
- Cycle Map
- Transport Map
- MapQuest Open

Overlays

- Data

Permalink

Shortlink

OSM data

View | Edit ▾ | History | Export | GPS Traces | User Diaries | log in | sign up

Data Close

Manually select a different area
Hide areas

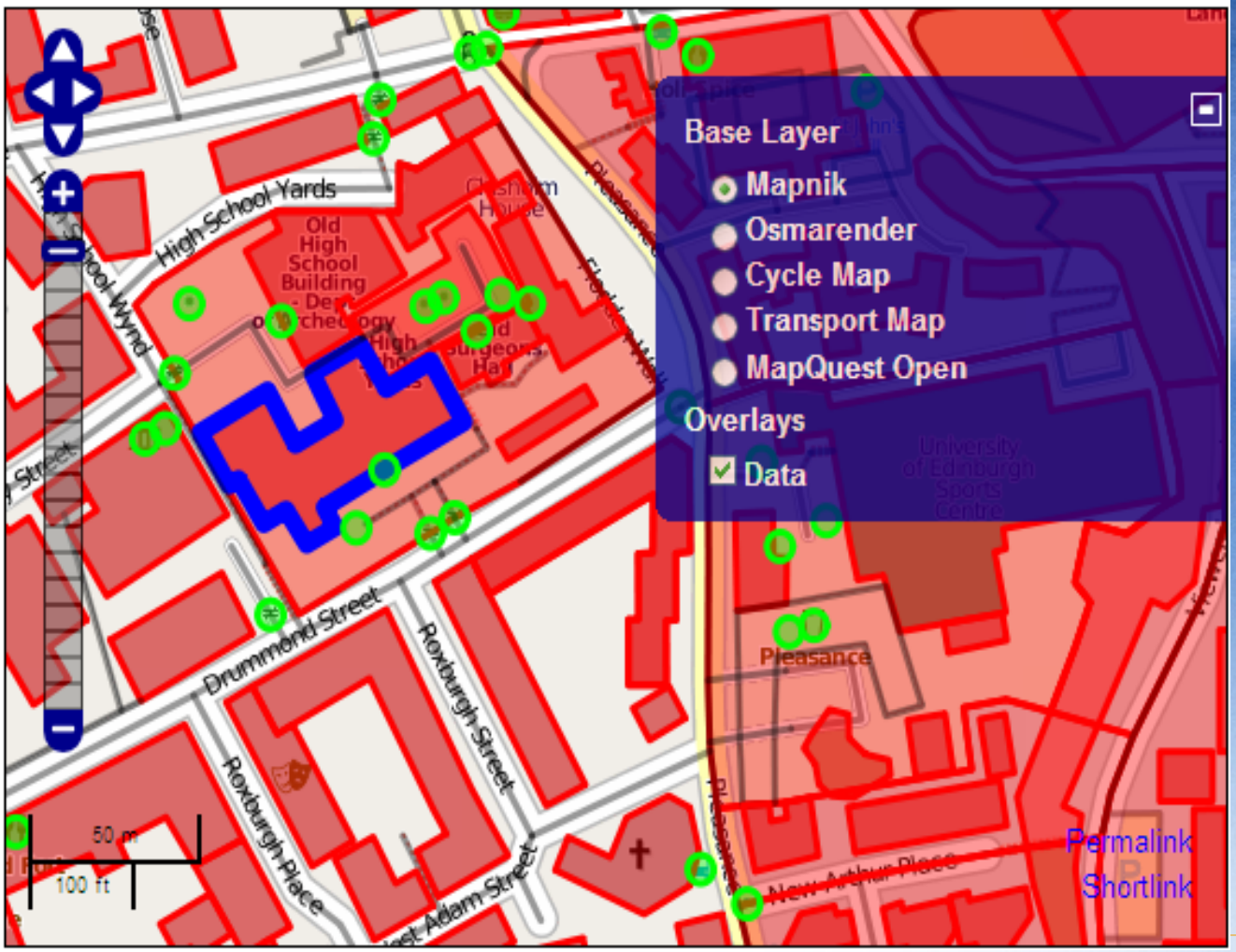
Display object list

Insitute of Geography (New Surgical Hospital Building) Details

- **amenity**: university
- **building**: yes
- **name**: Insitute of Geography (New Surgical Hospital Building)

History for Insitute of Geography (New Surgical Hospital Building) Details

- Edited by jamesks at 2010-09-29T10:51:58Z
- Edited by jamesks at 2010-09-28T14:26:45Z



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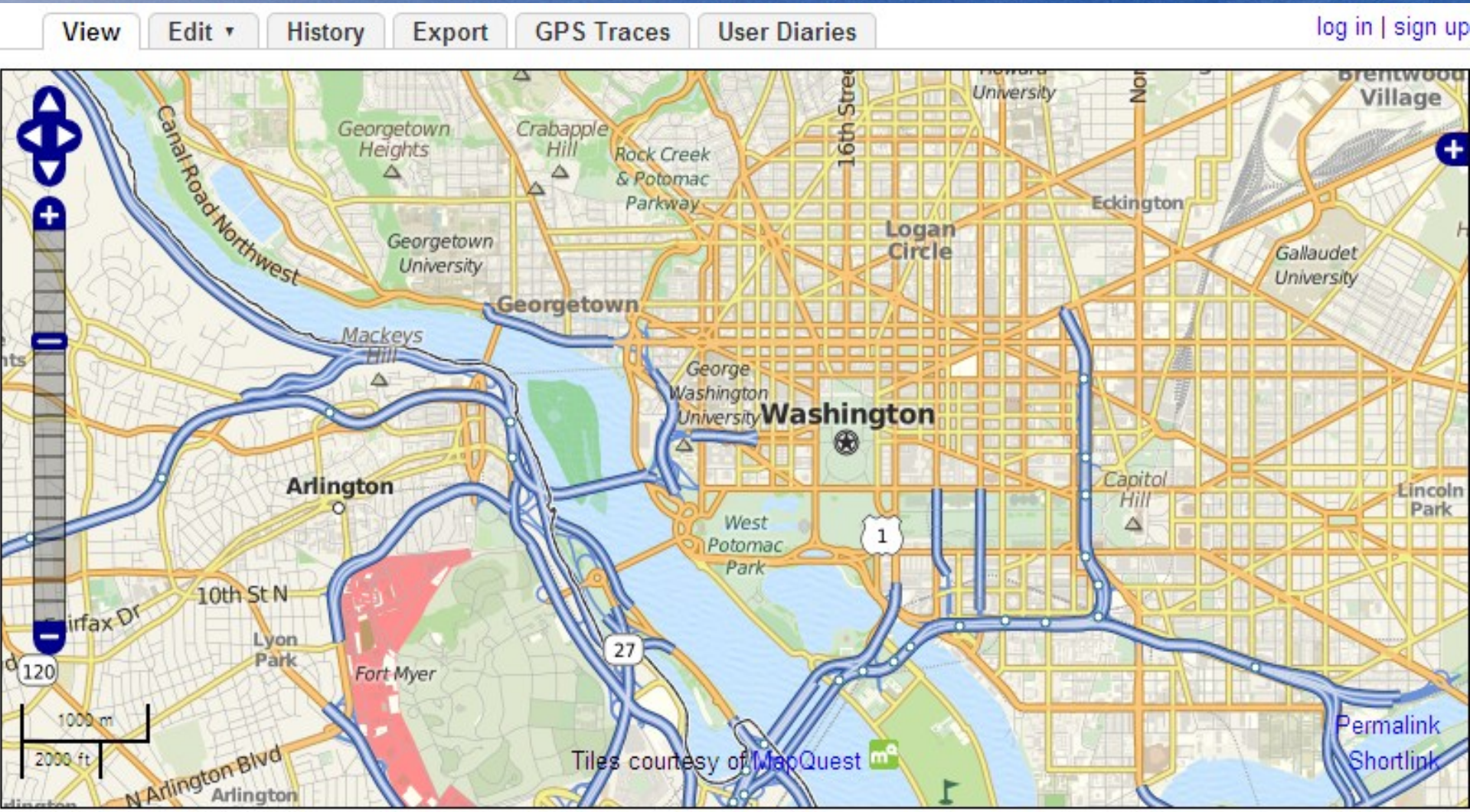
OSM data



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OSM data

View | Edit | History | Export | GPS Traces | User Diaries | log in | sign up

Data Close

Hide areas

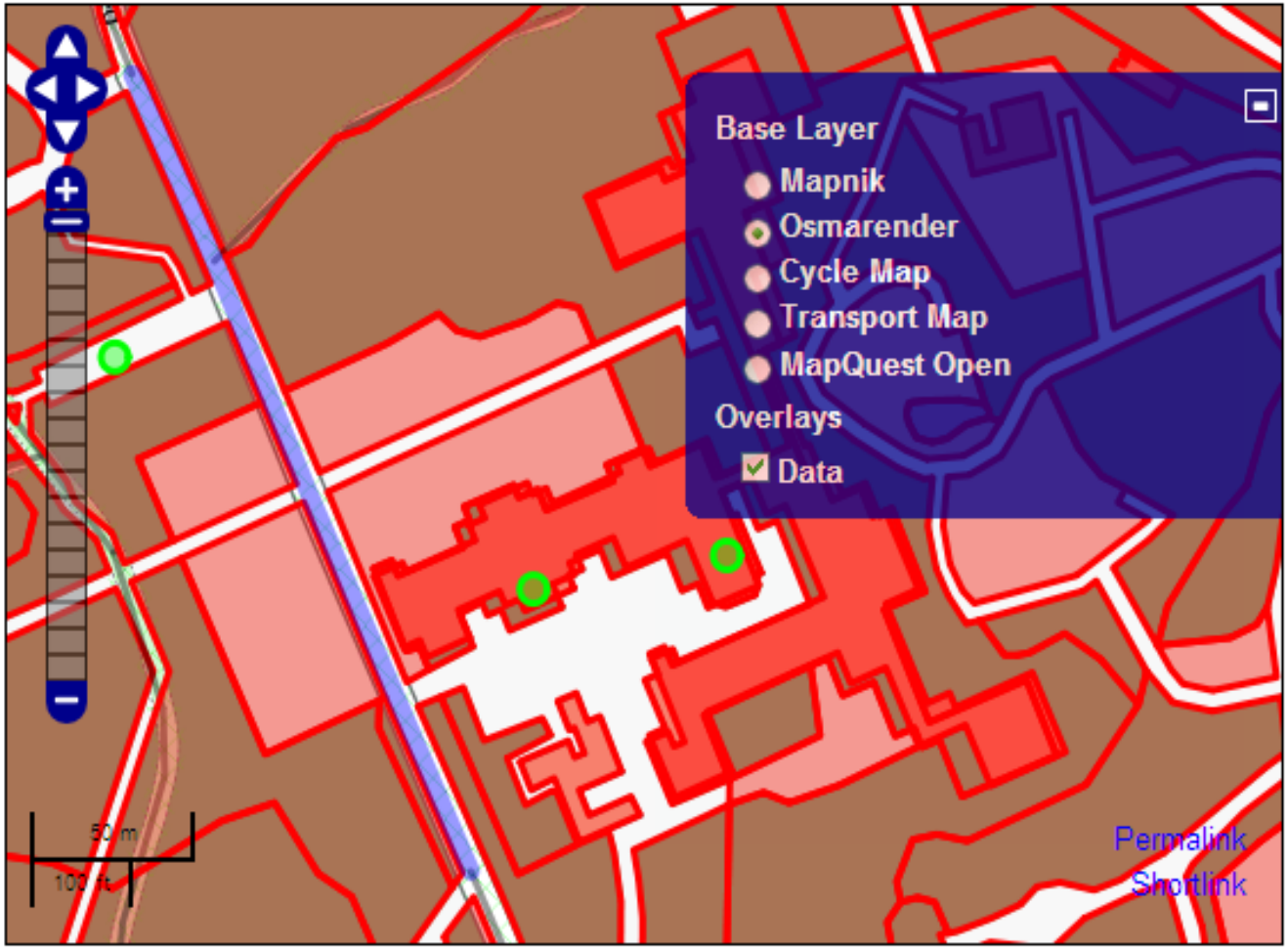
Display object list

Wildbaanweg Details

- **access**: permissive
- **AND:importance_level**: 5
- **AND_nosr_r**: 15632878
- **highway**: unclassified
- **name**: Wildbaanweg
- **toll**: yes

History for Wildbaanweg Details

- Edited by polderrunner at 2011-10-09T20:35:23Z
- Edited by Reinout at 2009-12-25T16:31:56Z
- Edited by Lambertus at 2009-09-03T18:03:09Z
- Edited by AND at 2007-09-18T09:55:59Z



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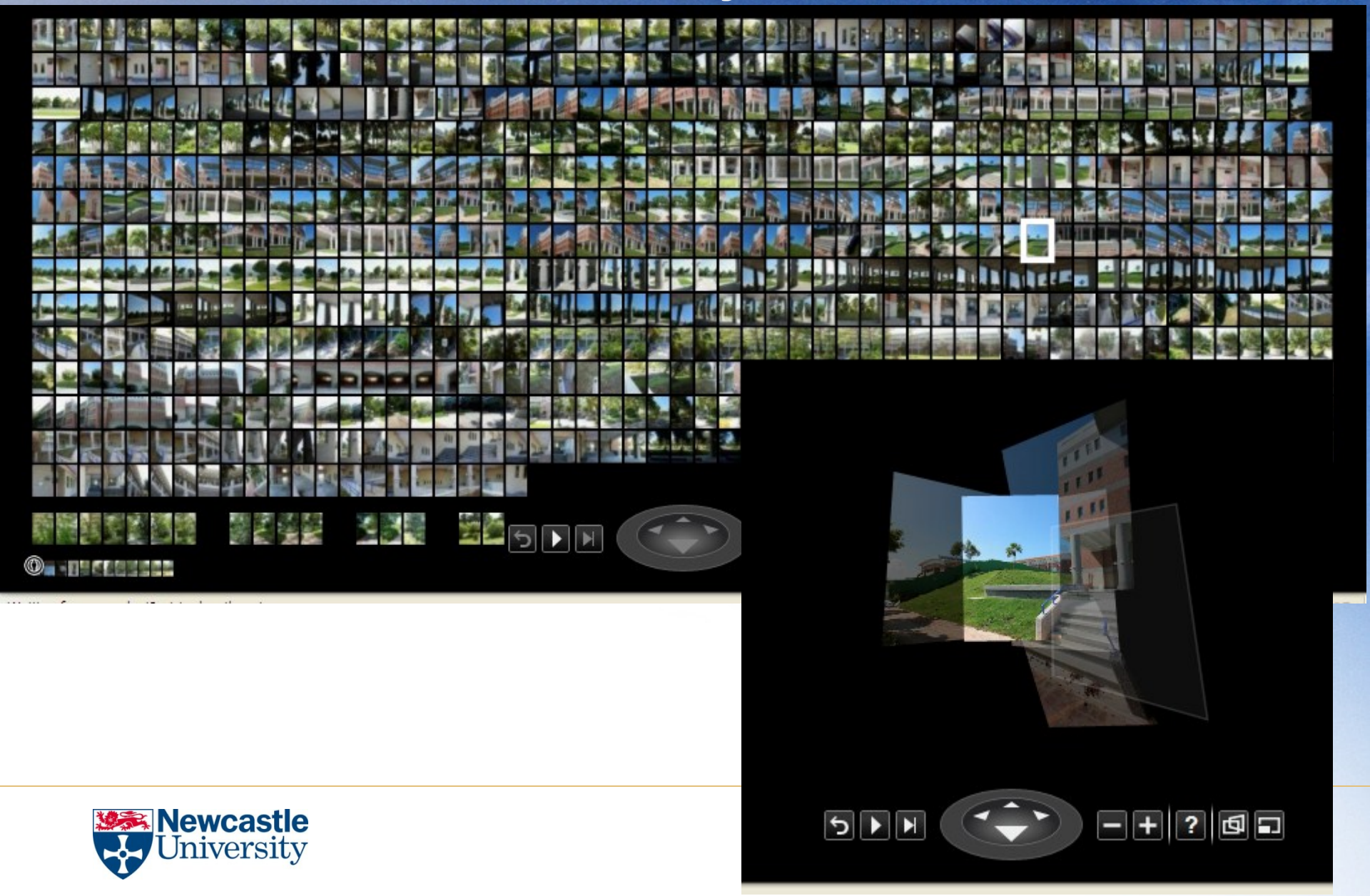
Applications for data interaction

- Photosynth
- SatNav
  - TomTom
- Hazard and disaster mapping
  - Sri Lanka
  - Haiti
- SDI
  - INSPIRE
- ….

Photosynth



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Photosynth pointcloud

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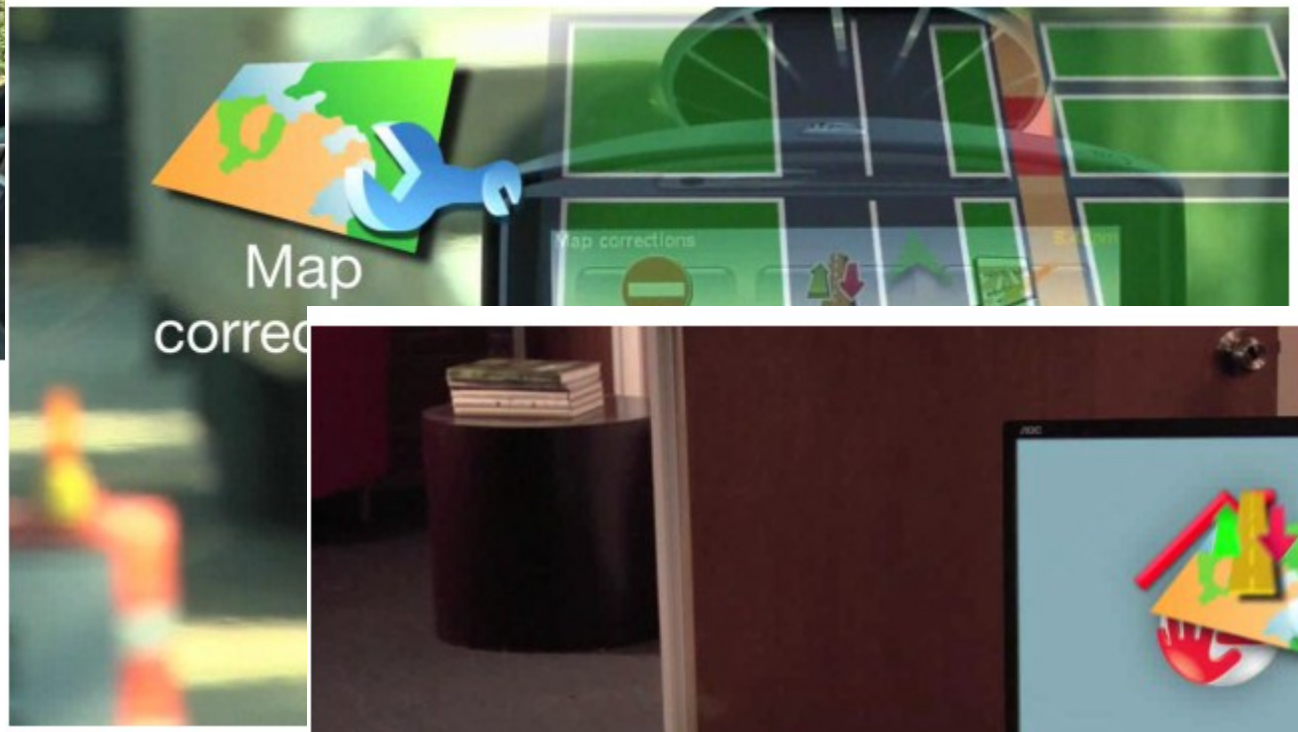
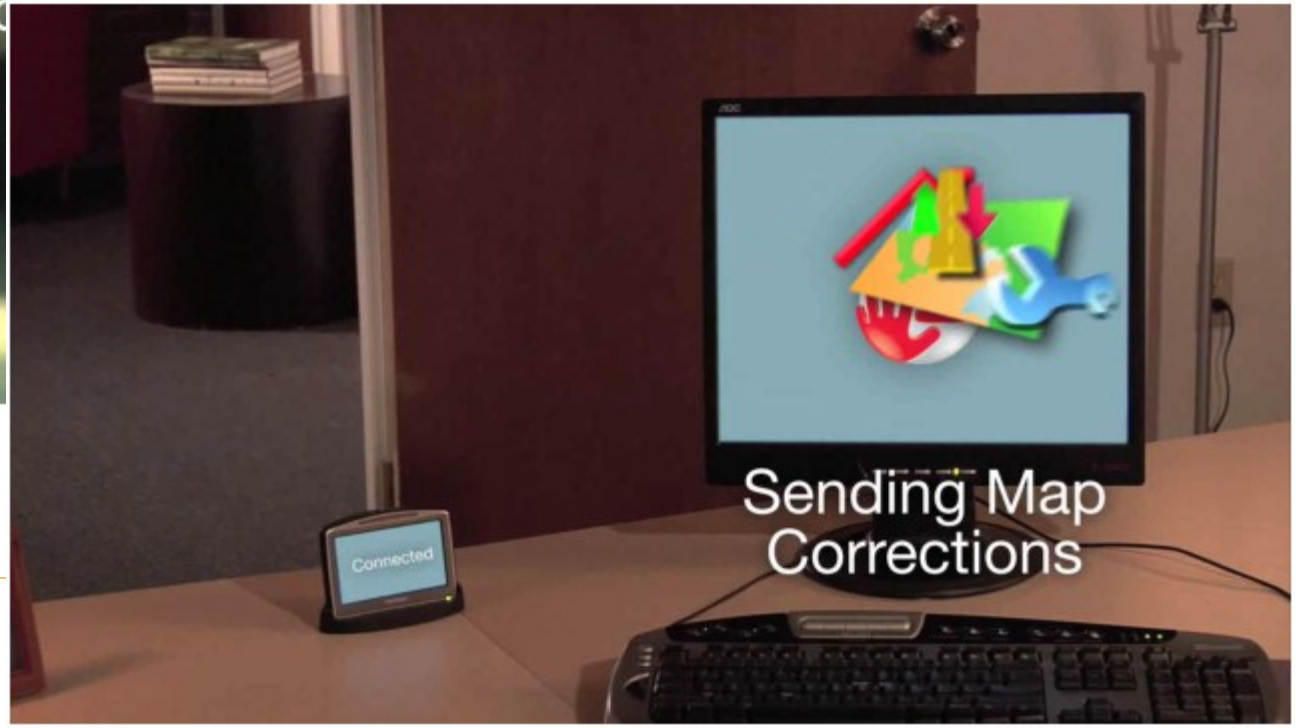
TomTom Map Share





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Sri Lanka 2005

Sri Lanka South East Coast
East of Palatupana

Before and after disaster map

Disaster type : Tsunami
Disaster date : 26 December 2004

Datum : WGS 84
Projection : UTM 44

Data sources :
Reference image : SPOT 2 natural colour (10 m)
08 February 2002
© CNES 2002 : distribution Spot Image
Crisis image : SPOT 4 natural colour (10 m)
13 January 2005
© CNES 2005 : distribution Spot Image

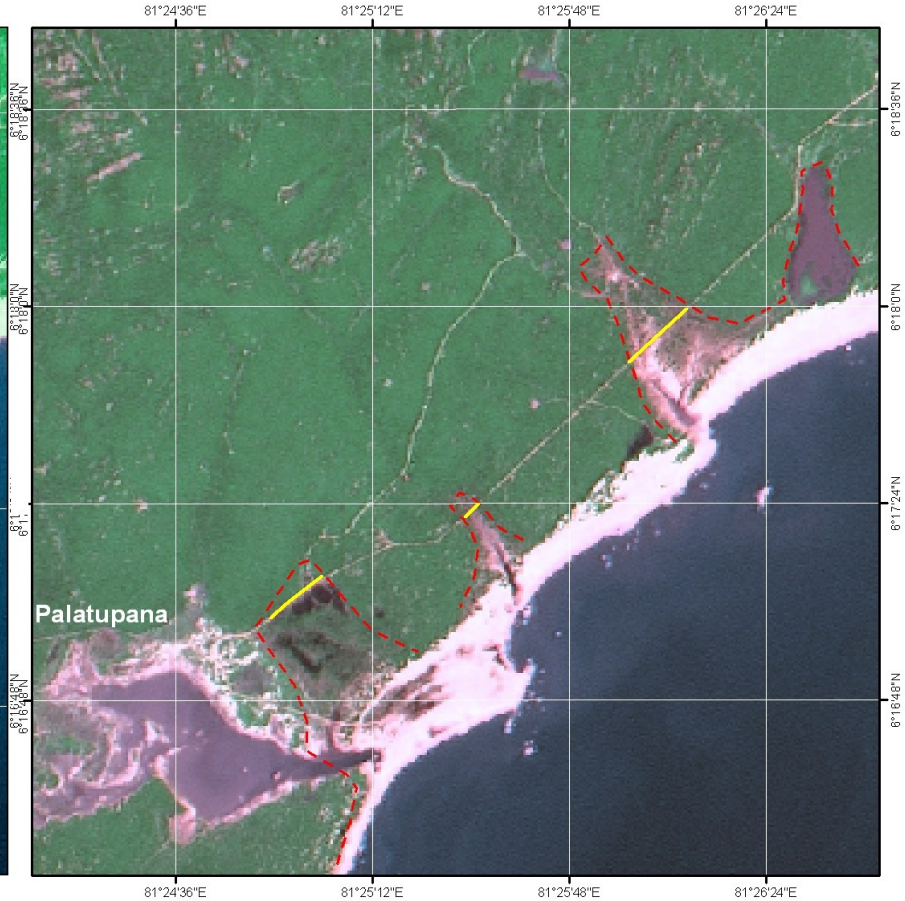
Scale : 1/25 000 for A3 prints

Map created 13 January 2005 by SERTIT.
© SERTIT 2005

sertit@sertit.u-strasbg.fr
http://sertit.u-strasbg.fr/

SPOT 2 - 08 February 2002

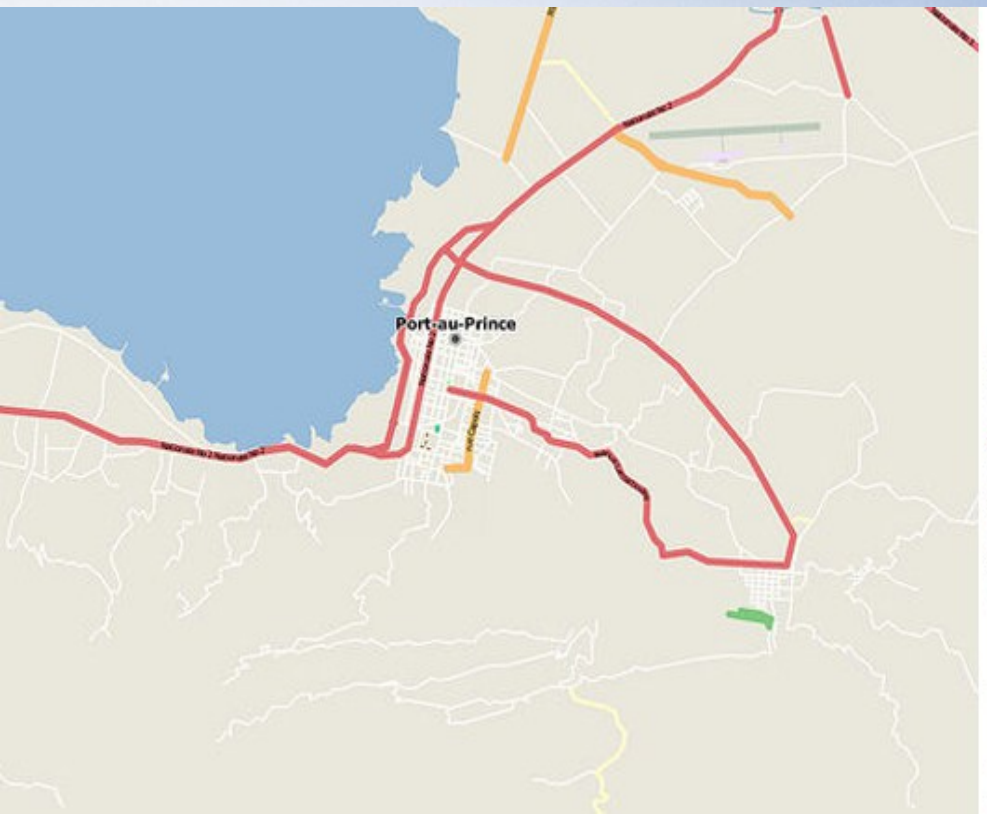
SPOT 4 - 13 January 2005

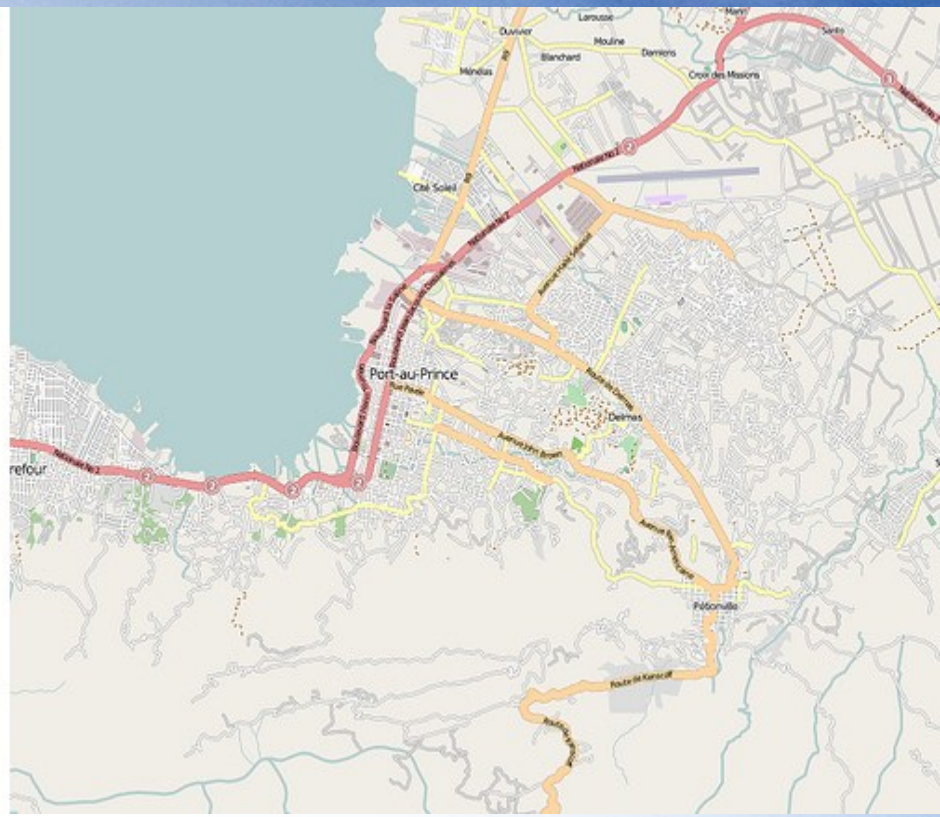


0 0.5 1
km

Probably highly affected areas
Possibly affected roads

Haiti OpenStreetMap 2010





INSPIRE

- 2007/2 EU Directive does not mention citizen input
- BUT can existing structures and short-term finances meet statutory needs?
- Whether / how to use ‘citizen-sourced’ data

Applications for data interaction

- Photosynth
- SatNav
  - TomTom
- Hazard and disaster mapping
  - Sri Lanka
  - Haiti
- SDI
  - INSPIRE

- … more mapping examples later

Mapping anew or combining with existing sources?

- Can VGI initiate new projects?
- VGI contributing to existing projects
  - updating
  - enhancing / extending
  - integrating
- Investigating integration

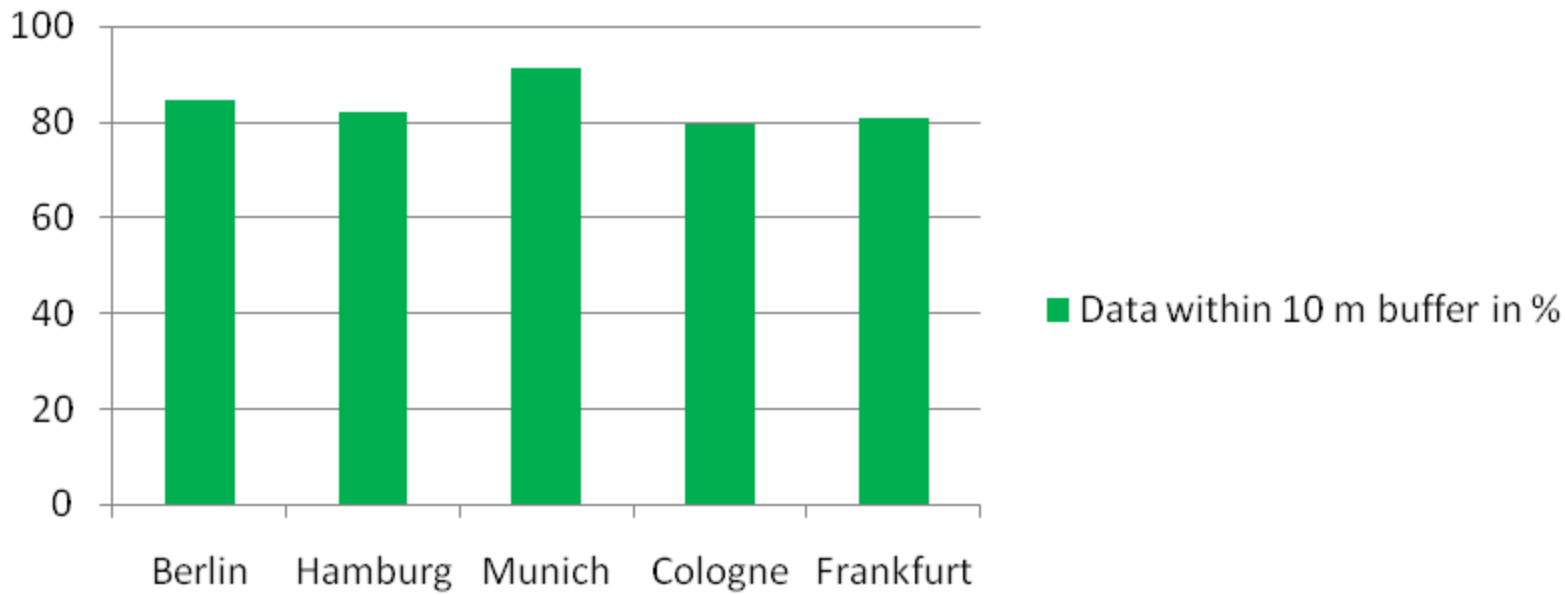
Interaction => integration?

- Need to standardise?
- Parameters to consider
  - geometry
  - semantics
  - currency
  - completeness
  - collection method
  - nature of collecting organisation
- Role of metadata

Experimental approaches

- Zielstra and Zipf (2010) Germany – accuracy
- Girres and Touya (2010) France – semantics (and other parameters)
- Haklay (2010) UK – completeness

Positional Accuracy of OpenStreetMap Data in Comparisson to Tele Atlas in Five Major Cities in Germany



Experimental approaches

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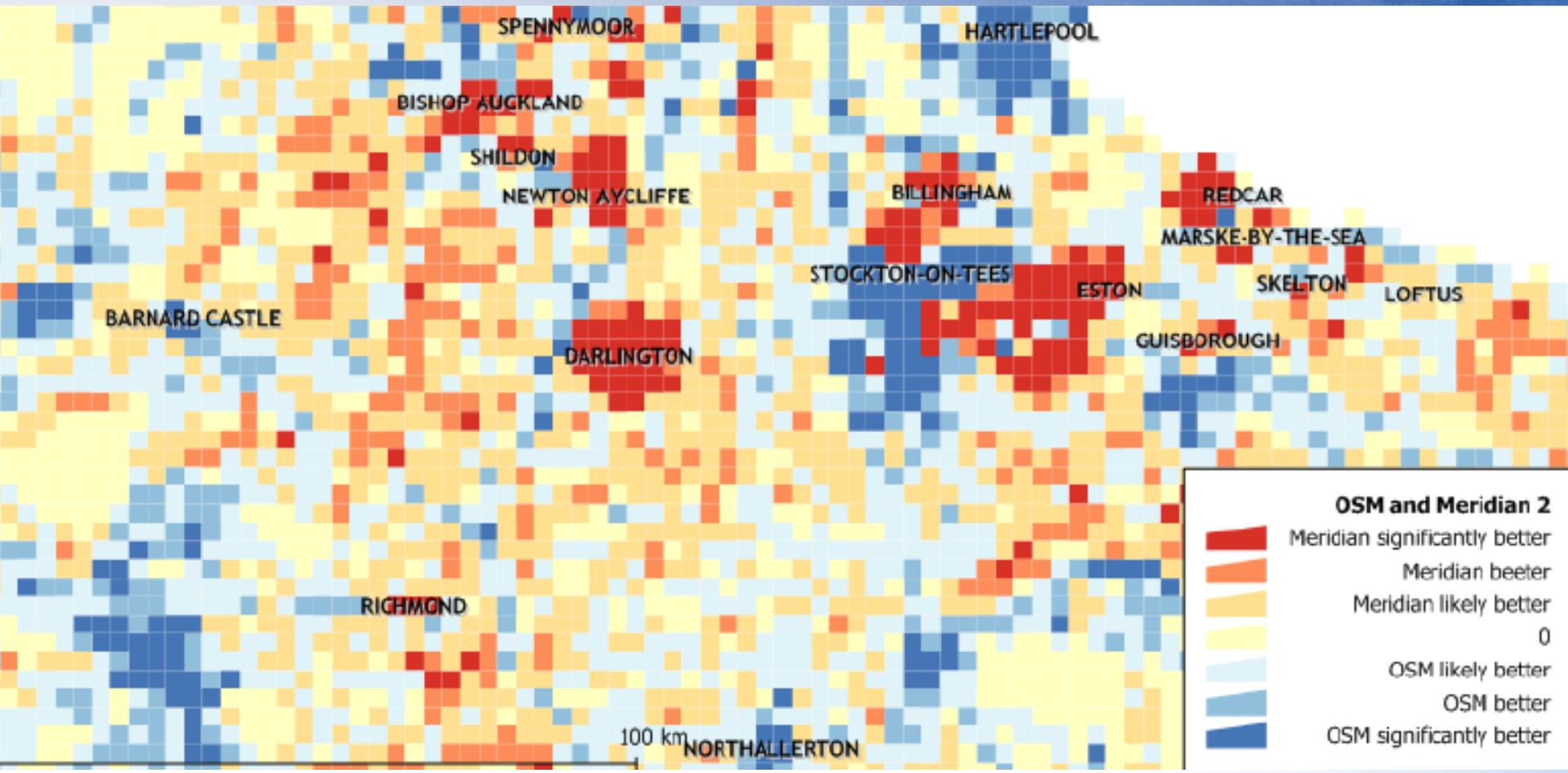
- Girres and Touya (2010) France – semantics (and other parameters)
- Haklay (2010) UK – completeness

Table 4 Quantitative attribute accuracy assessment: Attribute filling of the shapefile layers extracted from CloudMade (October 2009) completely covering France

Layer	Geometry	Objects	Field	Informed field	Uninformed field	Ratio %
France_poi	Point	111,440	« NAME »	111,440	0	100
France_highway	Polyline	886,680	« TYPE »	756,655	130,025	85
			« NAME »	382,896	503,784	43
			« ONEWAY »	143,274	743,406	16
France_coastline	Polyline	1,200	« NAME »	47	1,153	4
France_administrative	Polyline	51,413	« ADMIN_LEVEL »	51,352	61	99.9
			« NAME »	838	50,575	2
France_water	Polygon	12,507	« NATURAL »	12,507	0	100
			« NAME »	2,041	10,466	16
France_natural	Polygon	24,756	« TYPE »	24,756	0	100
			« NAME »	4,505	24,333	18

Experimental approaches

- Zielstra and Zipf (2010) Germany – accuracy
- Girres and Touya (2010) France – semantics (and other parameters)
- Haklay (2010) UK – completeness



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Newcastle experiments on geometric comparability

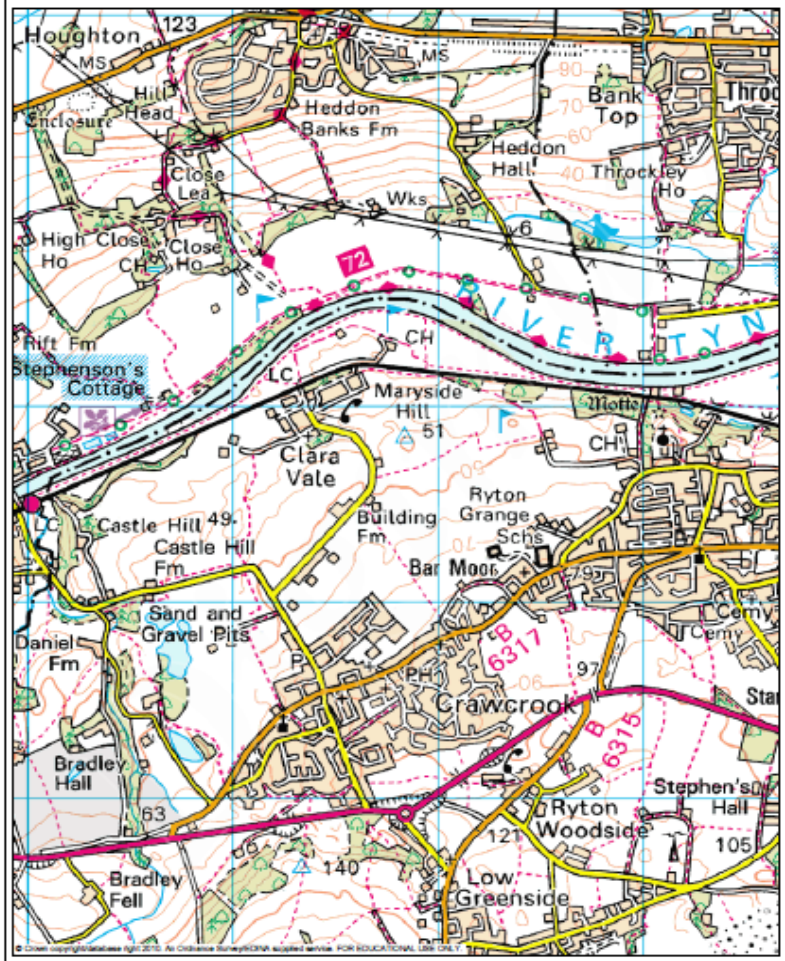
- Large-scale, not small scale data
- Comparison for data integration purposes: OpenStreetMap / OS
- Concentration on determining factors:
  - type of feature / nature of landscape
  - data collection method
  - expertise of data collector

Study areas

- Cramlington, Northumberland
  - Urban area with hard features
- Clara Vale, Northumberland
  - Rural area with soft features
- Creation of a reference dataset
  - Comparison of ‘official data’ (Ordnance Survey) and ‘VGI data’ (OpenStreetMap)

Cramlington / UK

Clara Vale / UK



Cramlington (Google Street View)

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Clara Vale (Google Street View)

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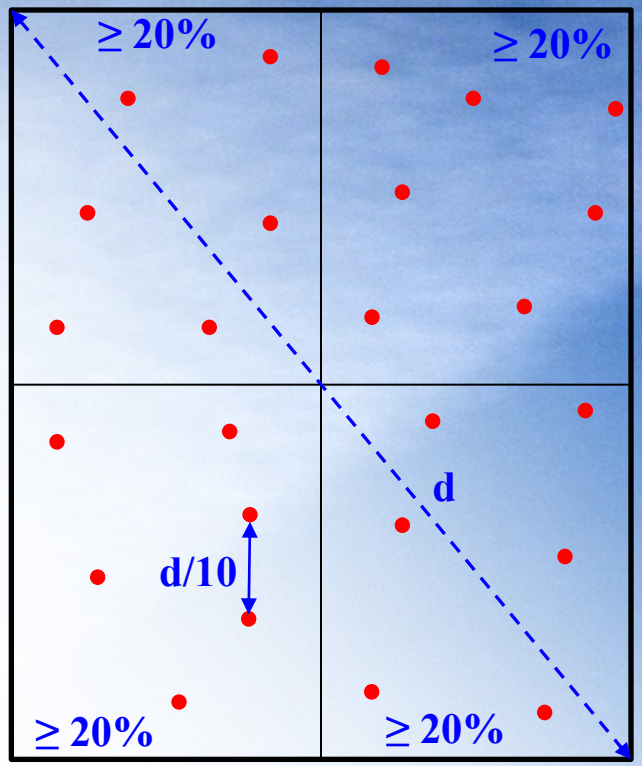
Geometrical comparison

- National Standard for Spatial Data Accuracy (NSSDA)
  - Tested points ≥ 20 points
  - A minimum of 20% of the sample points are located in each quadrant
  - Distance between points ≥ d/10

$$RMSE = \sqrt{\frac{1}{n}\left(\sum_{i=1}^{n}\delta x_i^2 + \sum_{i=1}^{n}\delta y_i^2\right)}$$

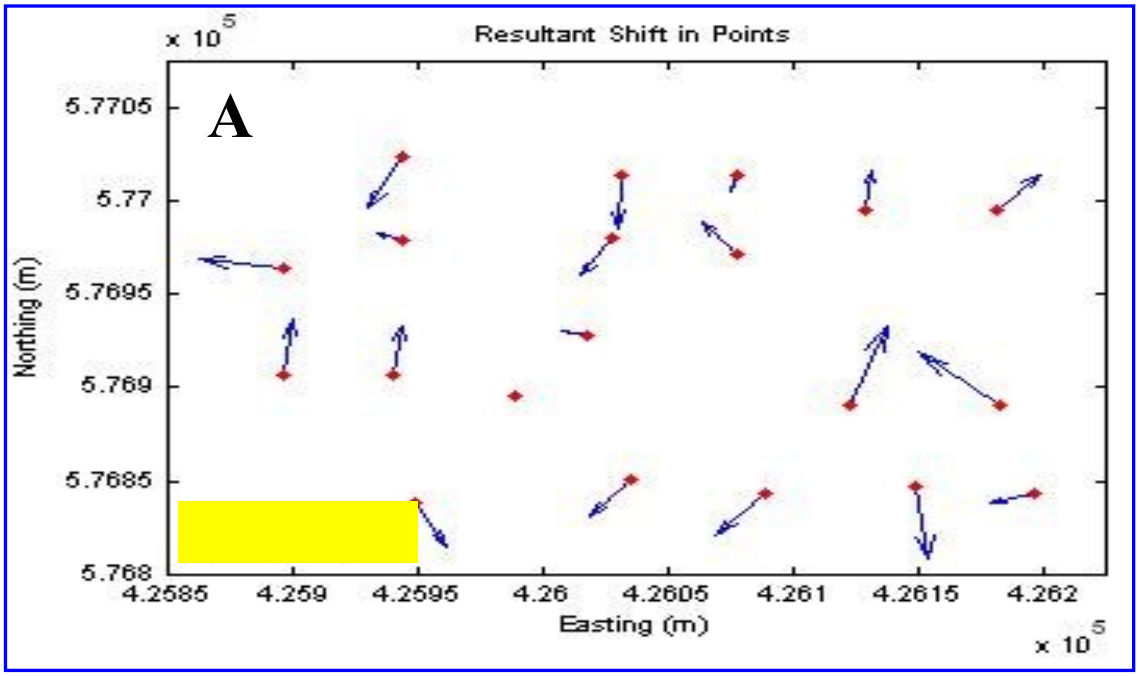


Geometrical comparison

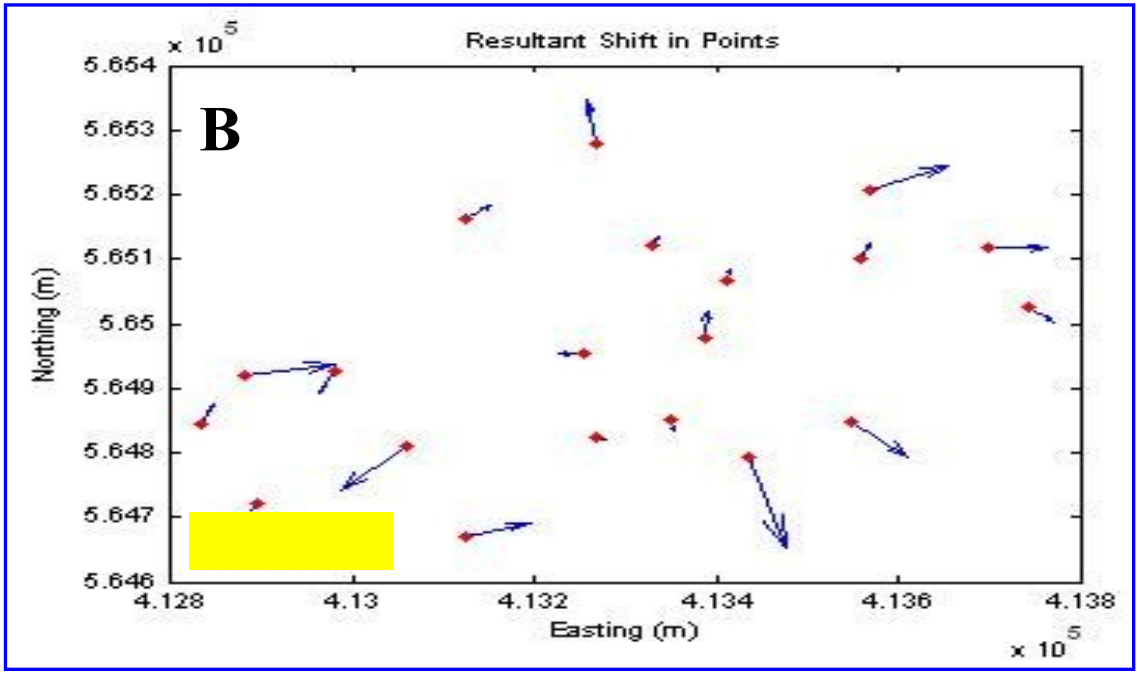
Comparisons of RMSE and NSSDA accuracy of compared datasets

		RMSE(m)	NSSDA accuracy(m)
Urban area, UK	FS/OS	0.492	0.846
	FS/OSM	5.429	9.143
	OS/OSM	5.331	8.989
Rural area, UK	FS/OS	1.843	3.190
	FS/OSM	11.650	20.162
	OS/OSM	10.887	18.832

FS / OS data
RMSE= 0.478 m

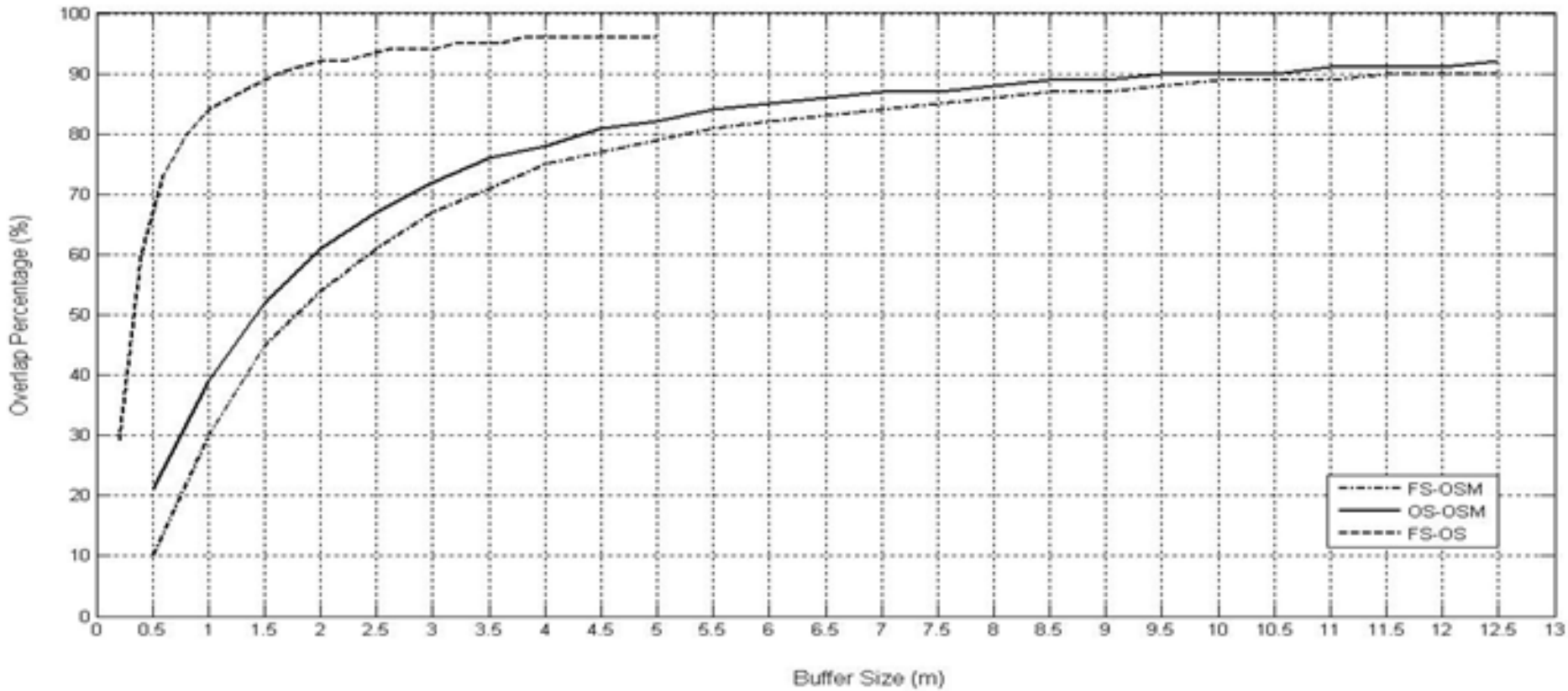


FS /OSM data
RMSE= 11.032 m



Linear displacement

An example of overlap information of roads in an urban area, UK



Areal comparison

- Comparative measures of polygon characteristics

Examples of 7 moment invariants of compared datasets

		FS	FM	OSM
Urban area, UK	7- Moments	1.85108238646506	1.89001507034833	1.56908203370849
		0.676600780054538	0.729962945130622	0.335373471713145
		0.233448302839737	0.267667161267928	0.0605591551248832
		0.750316226280423	0.822267015494153	0.334242273805489
		0.153616129162584	0.189278623466423	0.0218145701863227
		0.43296222290291	0.493429527929644	0.131961318307499
		1.8312107781601e-008	7.43662095440819e-008	7.10871985189128e-007
Rural area, UK	7- Moments	20495.184479386	75443.9928203039	48225499296.0036
		58999866.0268901	1073970995.77469	9.07041885436089e+020
		230717651378.386	19370141980978.6	2.09525131641157e+031
		230747917719.997	19370660096412.9	2.09525131644362e+031
		2.41806602897163e+022	1.61072173320842e+026	3.4451456295601e+062
		1.02767825569229e+015	3.80120101545707e+017	5.18970613279153e+041
		-1834908876800	-8238135246848	3.71382011785614e+027

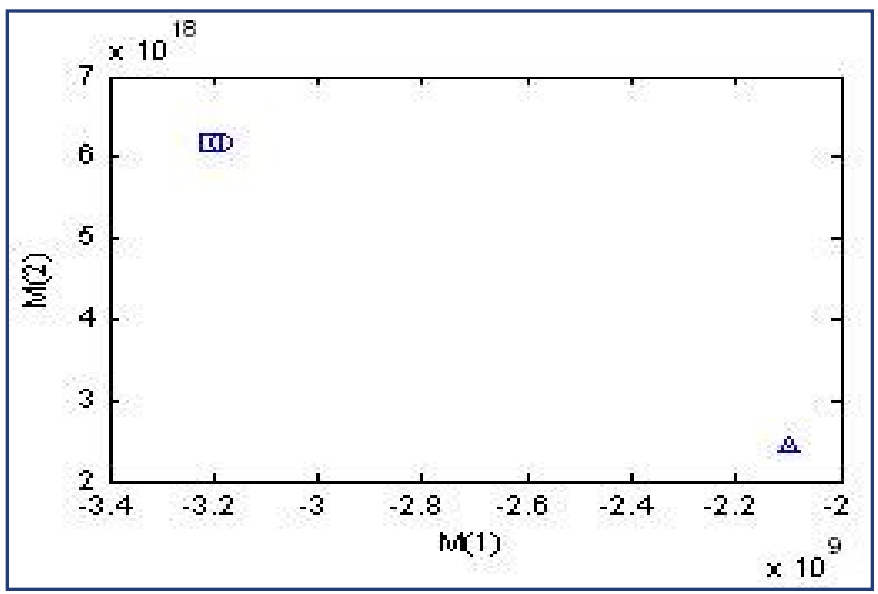
- Regular moments (Hu, 1965)
  - Area moment invariant, invariant to translation, rotation and scaling

$$m_{pq} = \iint_N x^p y^q f(x,y)\,dx\,dy$$

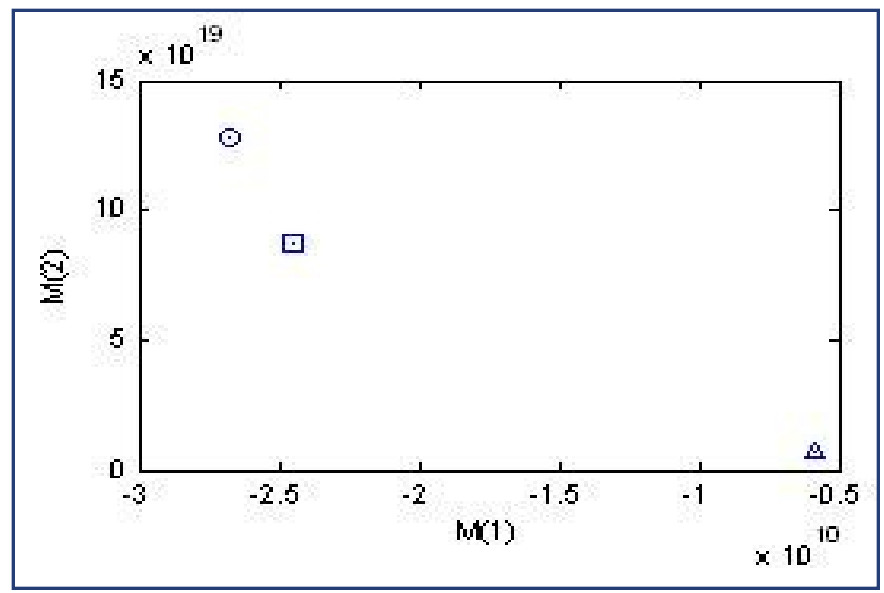
- Improved moment invariants (Chen, 1993)
  - Set of invariant functions evaluated on the shape boundary only

$$m_{pq} = \int_C x^p y^q \,dl$$

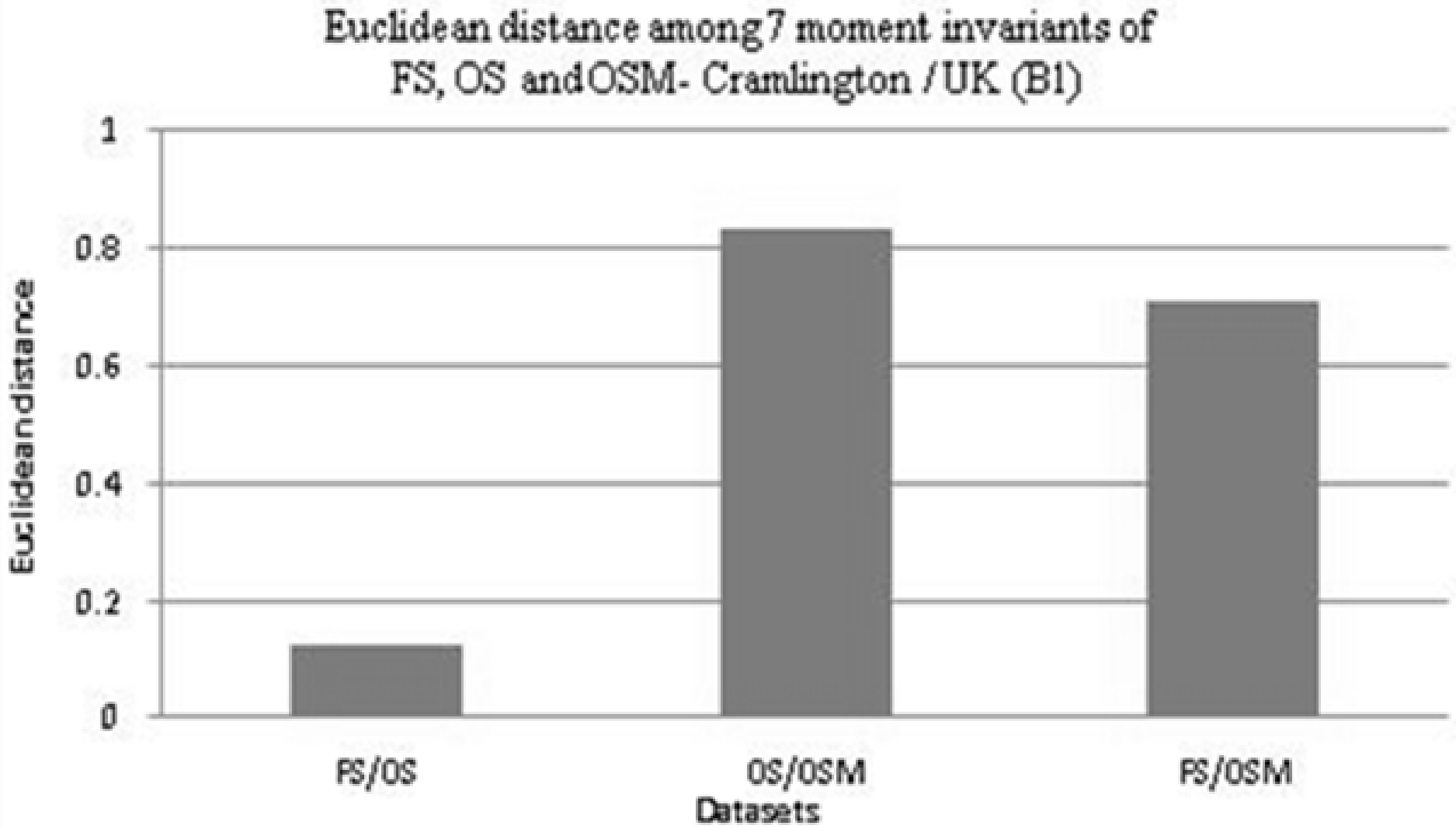
□ FS, ○ OS and △ OSM



Urban area



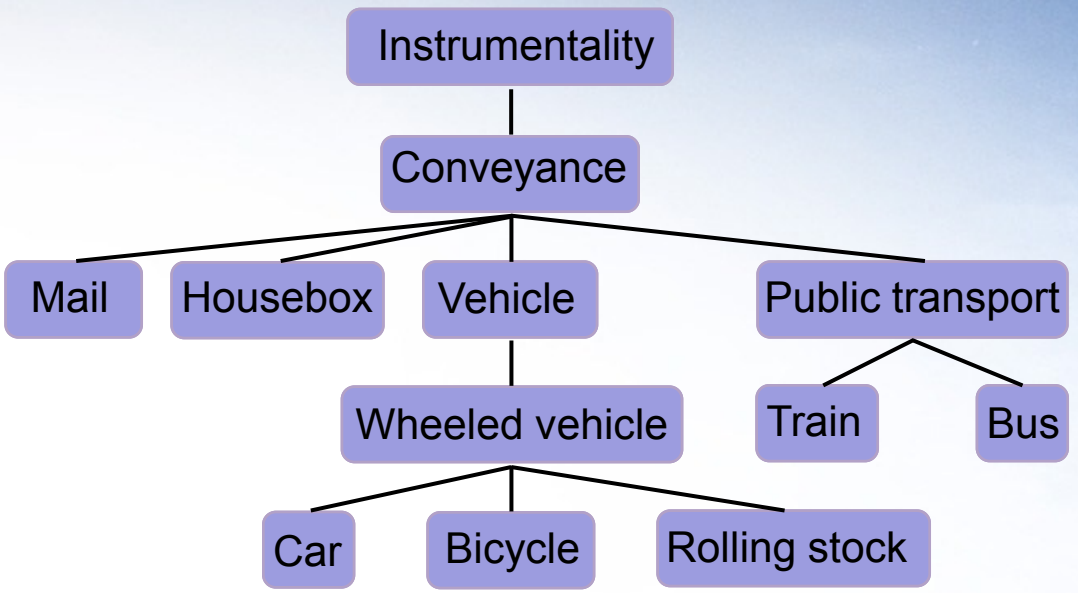
Rural area


Euclidean distance among 7 moment invariants of
FS, OS and OSM- Cramlington / UK (B1)
1
0.8
0.6
0.4
0.2
0
Euclidean distance
PS/OS
OS/OSM
PS/OSM
Datasets

Semantic comparison

- In effect, comparing specified attributes
- Equivalent to exercises to ‘combine legends’
- Use of ontologies
  - assessment of semantic similarity of official and VGI categories

WordNet



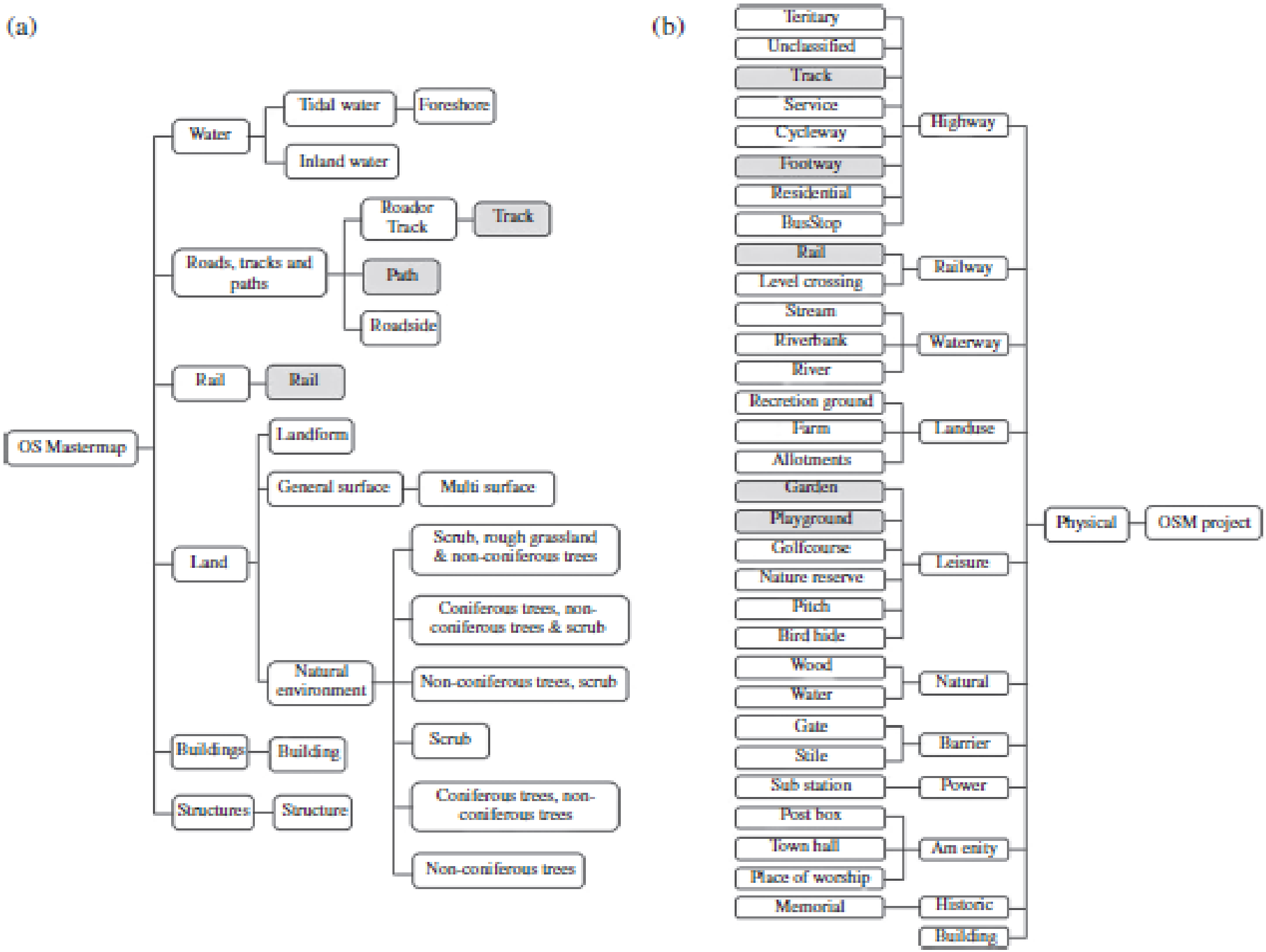
- establishing synsets and hierarchies
- semantic connections established
- testing of relationships using dictionaries

Table 1. Results of feature-based approach in Cramlington (urban).

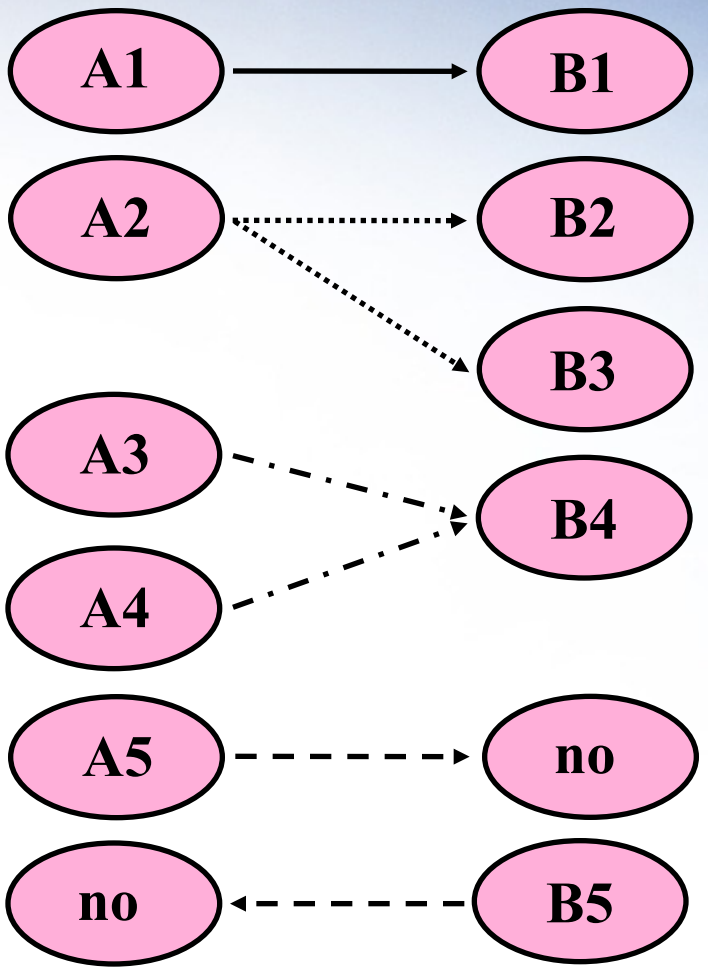
Semantic similarity score	Rate (%)
$0.00 \leq S < 0.25$	54
$0.25 \leq S < 0.50$	19
$0.50 \leq S < 0.75$	27
$0.75 \leq S \leq 1.00$	0

Table 2. Results of feature-based approach in Clara Vale (rural).

Semantic similarity score	Rate (%)
$0.00 \leq S < 0.25$	58
$0.25 \leq S < 0.50$	20
$0.50 \leq S < 0.75$	11
$0.75 \leq S \leq 1.00$	11


(a)
OS Mastermap
Water
Tidal water
Foreshore
Inland water
Roads, tracks and paths
Roador Track
Track
Path
Roadside
Rail
Rail
Land
Landform
General surface
Multi surface
Natural environment
Scrub, rough grassland & non-coniferous trees
Coniferous trees, non-coniferous trees & scrub
Non-coniferous trees, scrub
Scrub
Coniferous trees, non-coniferous trees
Non-coniferous trees
Buildings
Building
Structures
Structure
(b)
Teritary
Unclassified
Track
Service
Cycleway
Footway
Residential
BusStop
Highway
Rail
Level crossing
Railway
Stream
Riverbank
River
Waterway
Recreation ground
Farm
Allotments
Landuse
Garden
Playground
Golfcourse
Nature reserve
Pitch
Bird hide
Leisure
Wood
Water
Natural
Gate
Stile
Barrier
Sub station
Power
Post box
Town hall
Place of worship
Am enity
Memorial
Historic
Building
Physical
OSM project

Schema node relationships



One-To-One

One-To-Many

Many-To-One

Target Lacks Data

Source Lacks Data

Node relations	Rate
Single correspondences (One class in Source-To-One class in Target)	0%
Single correspondences (One class in Source-To-Many classes in Target)	44%
Single correspondences (Many classes in Source-To-One class in Target)	53%
Missing correspondence (Source Lacks Data)	47%
Missing correspondence (Target Lacks Data)	41%

Results of schemas relationships in Cramlington

Node relations	Rate
Single correspondences (One class in Source-To-One class in Target)	0%
Single correspondences (One class in Source-To-Many classes in Target)	43%
Single correspondences (Many classes in Source-To-One class in Target)	57%
Missing correspondence (Source Lacks Data)	43%
Missing correspondence (Target Lacks Data)	39%

Results of schemas relationships in Clara Vale

Similarity measures

- Semantic similarity
- Structural similarity
- Data-type similarity

Influences on the accuracy of OSM data

- Factorial analysis
  - three factors considered
    - number of contributors (“Linus’ Law”)
      - identifying individuals responsible
  - nature of the area
    - hard or soft features
  - method of data collection
    - field or office data sources?

- Data source was the major influence

Empirical testing in Baghdad

Comparisons of RMSE and NSSDA accuracy of compared datasets

		RMSE(m)	NSSDA accuracy(m)
Baghdad, Iraq	FS/GDS	1.246	2.149
	FS/OSM	5.903	10.190
	GDS/OSM	5.806	10.012

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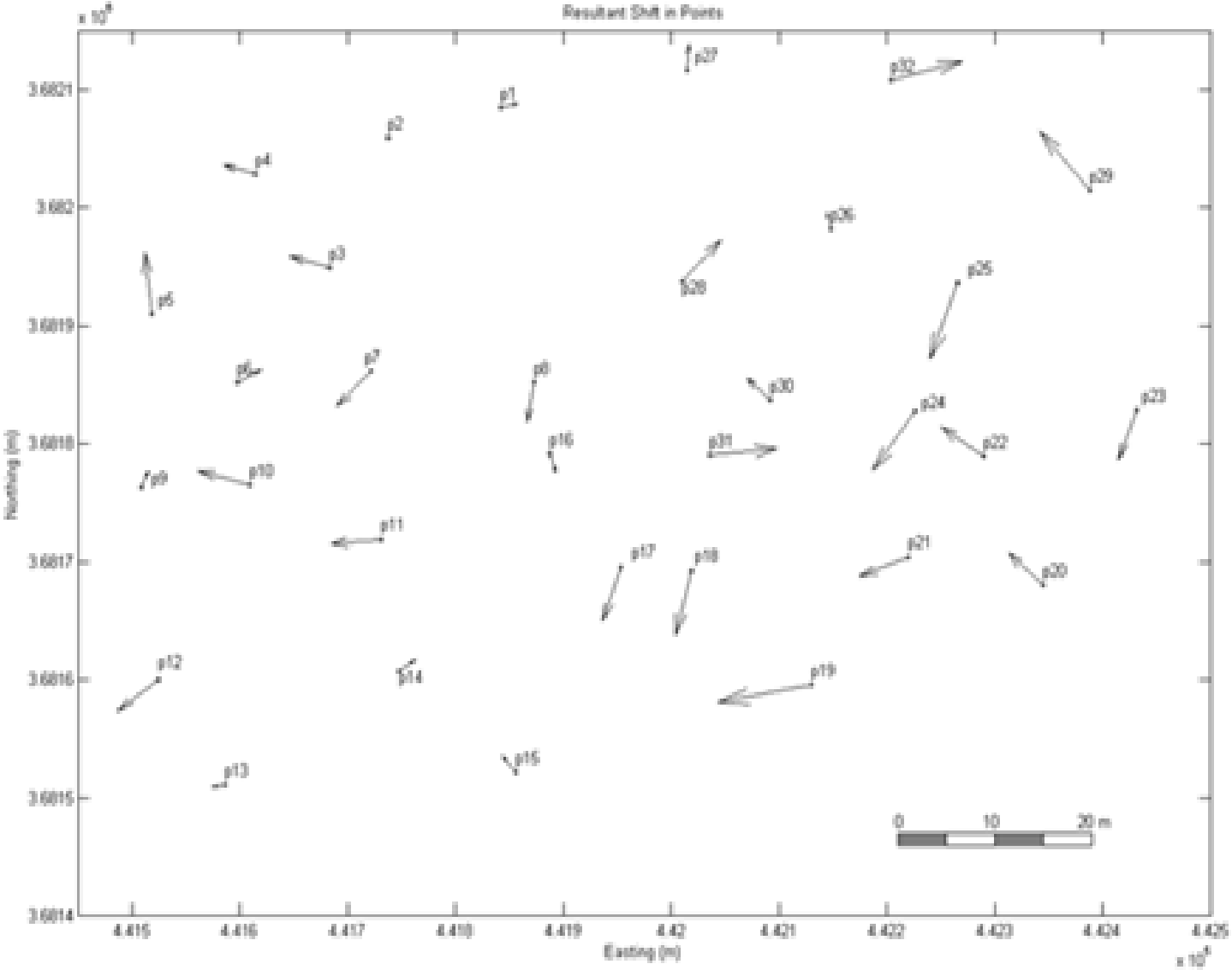
Identifying the magnitude and direction of differences between GDS-OSM data in Baghdad, Iraq



Semantic similarity tests in Baghdad

Applications for data interaction

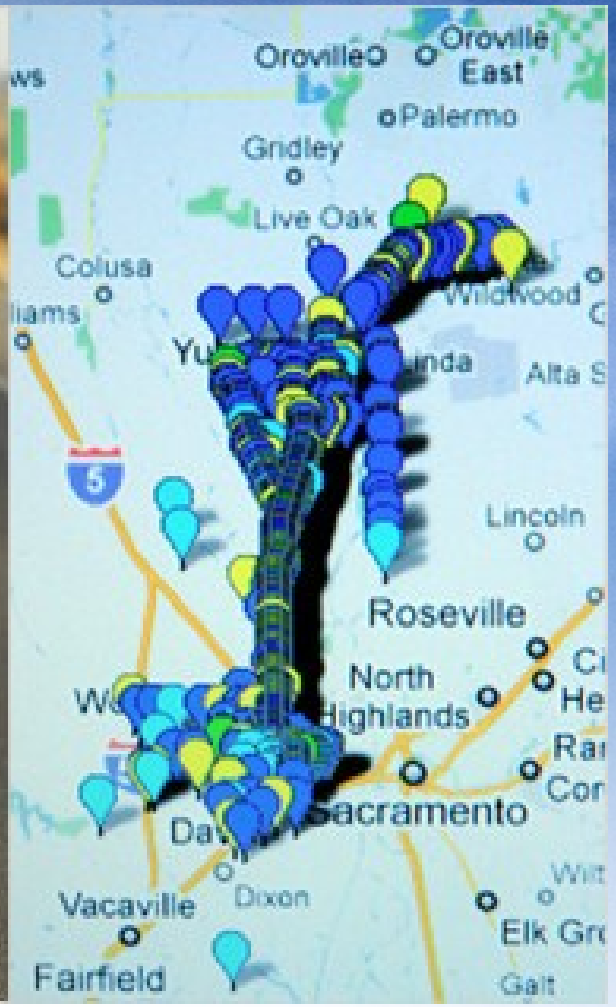
- Photosynth
- SatNav
  - TomTom
- Hazard and disaster mapping
  - Sri Lanka
  - Haiti
- SDI
  - INSPIRE

- … more mapping examples later

Further applications for interaction

…

- Environmental monitoring
  - Natural England
- Mapping of informal settlements
  - example of Kibera, Nairobi
- Engineering and citizen-based development
  - water / sanitation engineering



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OpenStreetMap, Kibera, Kenya

View | Edit | History | Export | GPS Traces | User Diaries | log in | sign up

ADC CHURCH
Obama Computer Services
Peace of Christ Church
A.C.F Church
Uganda Railway
Huruma Primary
Mashimoni Primary
Risa Children Center
Kibera All Nation
Kambi Muru Nursery
Magoso Primary School
Laini Saba Nursery and Primary School
Y.M.C.A. School
barber shop
St Elizabeth Medical Clinic
Holly wood barber shop
Church
Kambi Muru Mosque
New Life Herbal Clinic
Posho Mill
kerosene pump
A.B.C Church
Uwanjani Shop
Jahoma Bay Chemist
PAG School
Dot.Com Lady Base
Changing Times Centre
Maranatha Academy
Drug Fighters Primary School
Godled Medical Center
Chemist
Hiki Butchery
Mama Maria hair salon
Wholesale
Siloam
WSUP
100 m
200 ft
Permalink
Shortlink

Newcastle University

Civil Engineering and Geosciences

13 January 2012 Last updated at 15:23

Earthquake calls blamed on jet sonic boom

Public reports of an earthquake felt in south east Scotland and north east England have been blamed on the sonic boom from a military jet.

The British Geological Survey (BGS) was called by people as far apart as Eyemouth in the Borders and just north of Sunderland on Thursday afternoon.

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Survivors found on Italian ship

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Second arrest over couple's death

Lansley calls for implant action

Girl, 8, and woman found killed

Features & Analysis

Summary

- Need for caution
- Approach to crowdsourcing
  - active data
  - passive crowdsourcing
  - variability of data collection / reality
  - high-quality / low-quality databases?
- Is integration possible?