

System Integration of Mobile Technologies & Geospatial Decision Support Systems in Public Health

ISPRS Commission VIII, Working Group 2 (Health)
Advances in Geospatial Technologies for Health

11-14 September 2011

Santa Fe, NM USA

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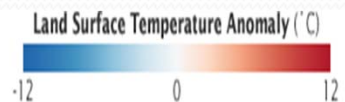
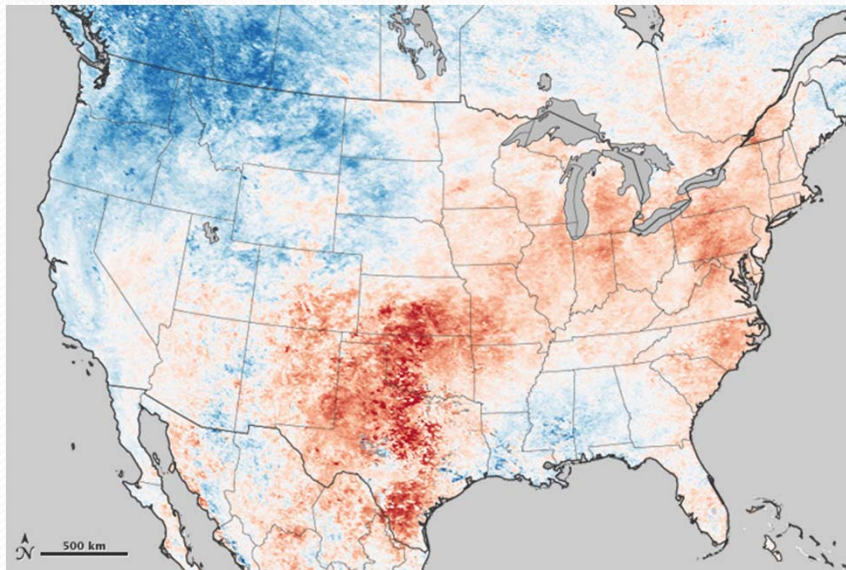


Outline

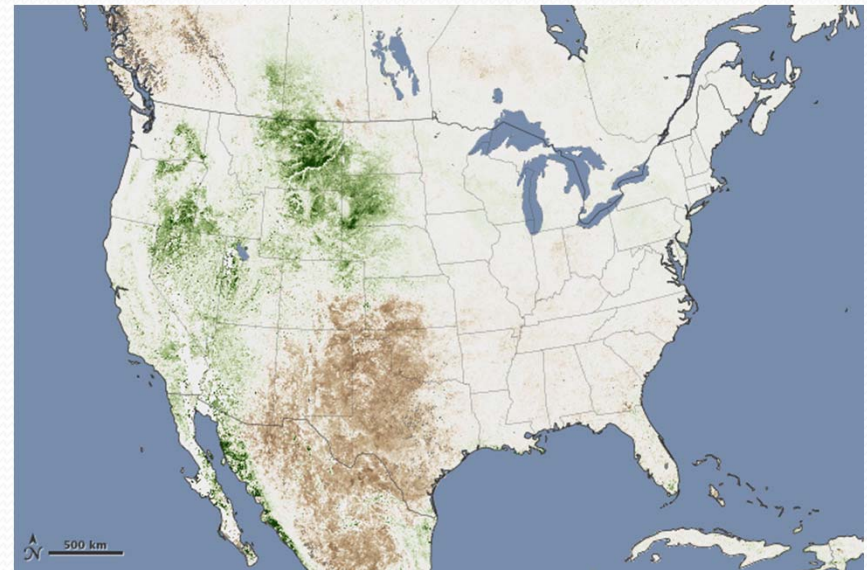
- The Public Health Challenge
- Existing models
- New/evolving models
- Proposed model
- Further research

Public Health Hazards July 2011

Heat Wave Across the US (Terra MODIS, NASA EO)



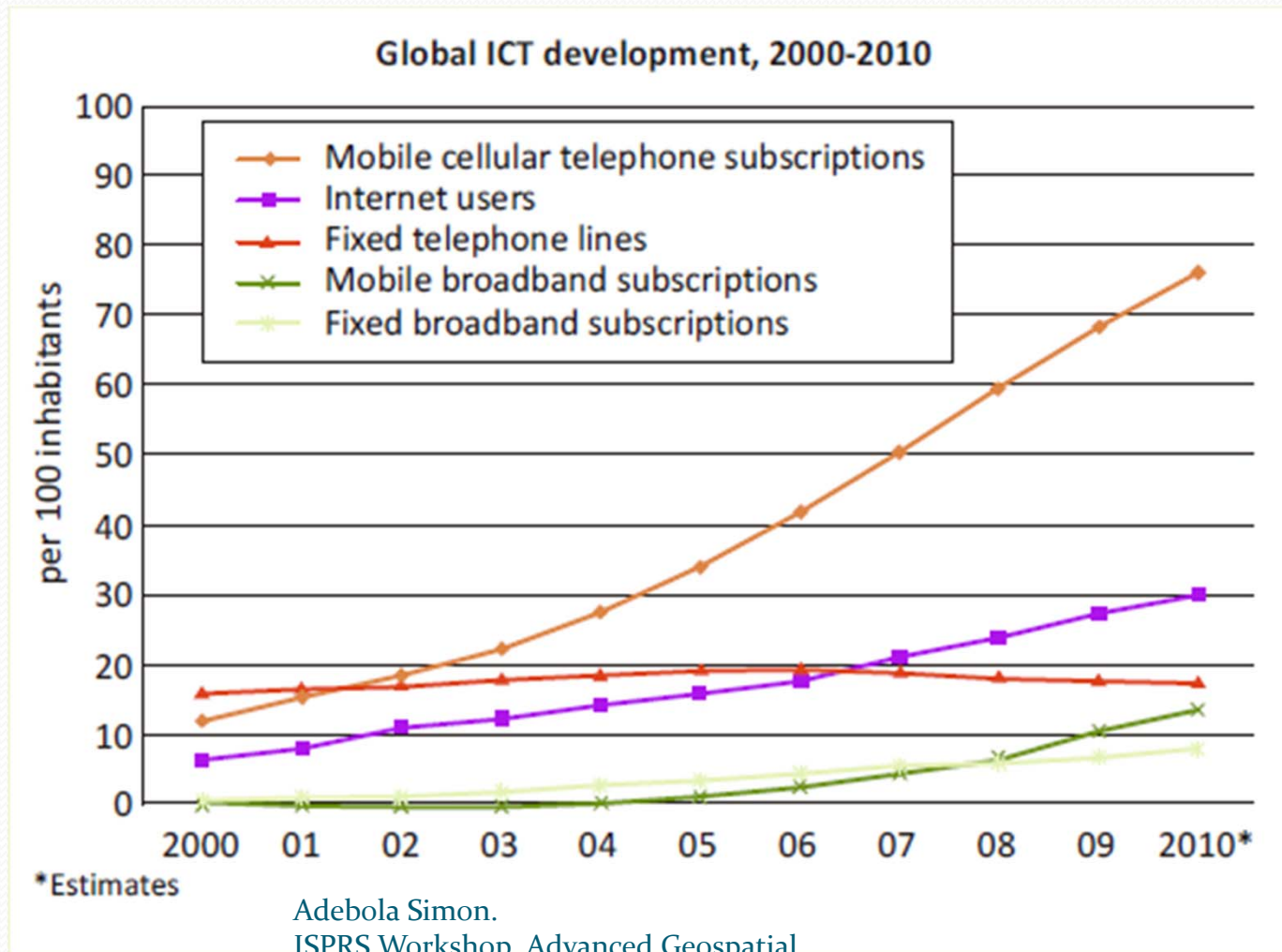
Drought Across the US (NOAA-18 POES AVHRR, NASA EO)



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The Promise of Mobile Technology

(ITU 2011, Trends in Telecommunication Reform)



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Location, Livelihood, Loved Ones

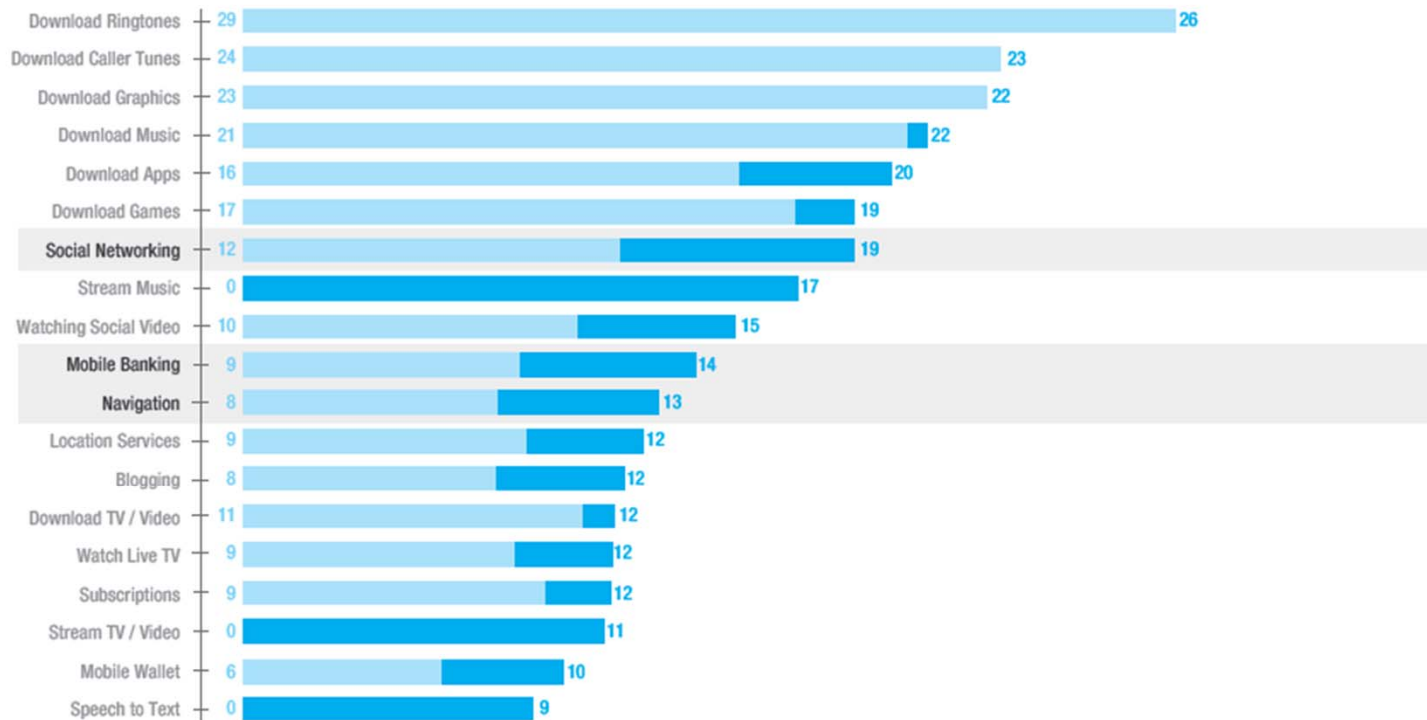
(TNS Mobile Life: The Holistic Portfolio)

Social networking, mobile banking and navigation services are seeing strong growth in 2011

USAGE OF SERVICES

2010 2011

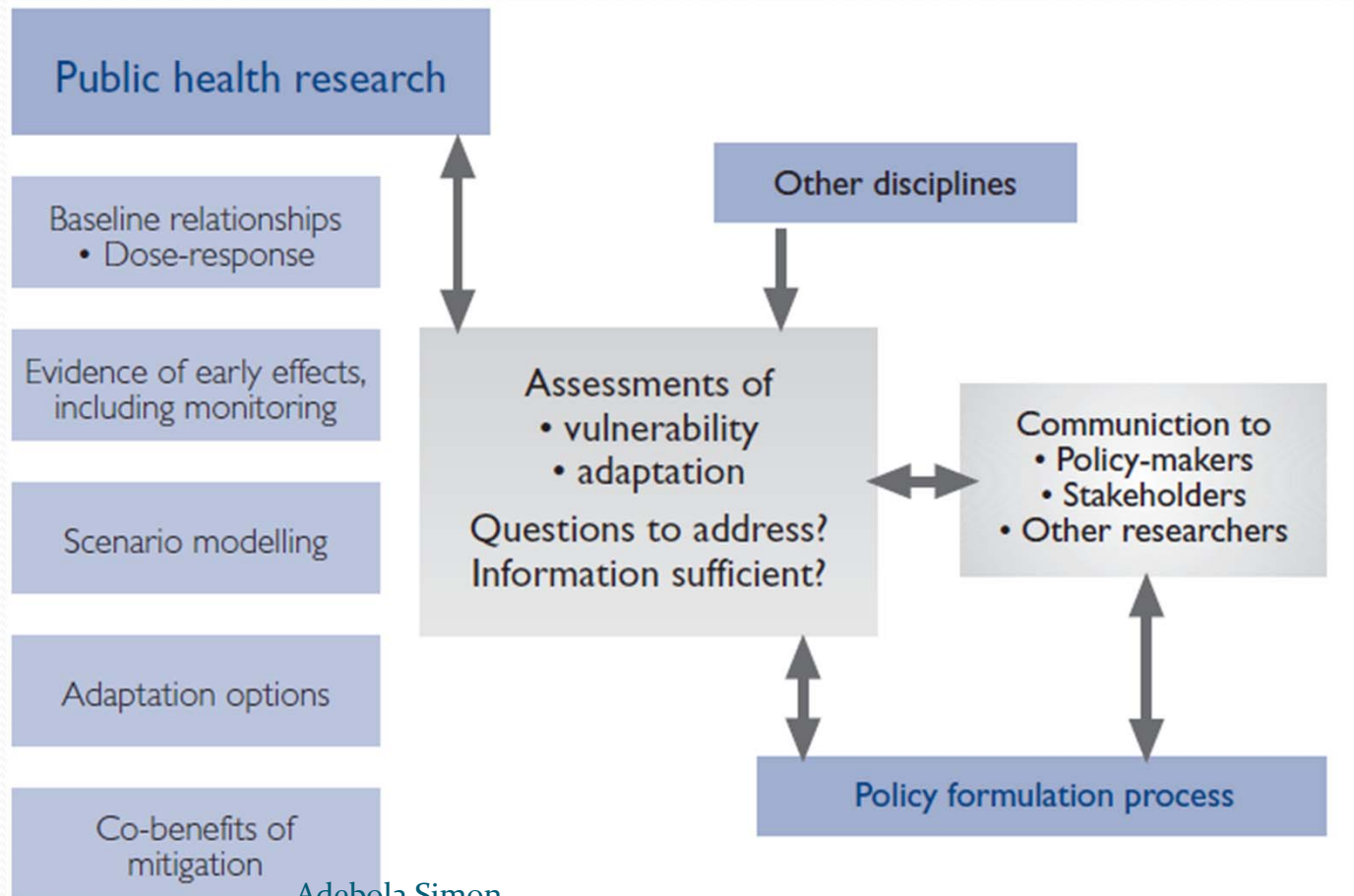
Source: Mobile Life: GTI 2011



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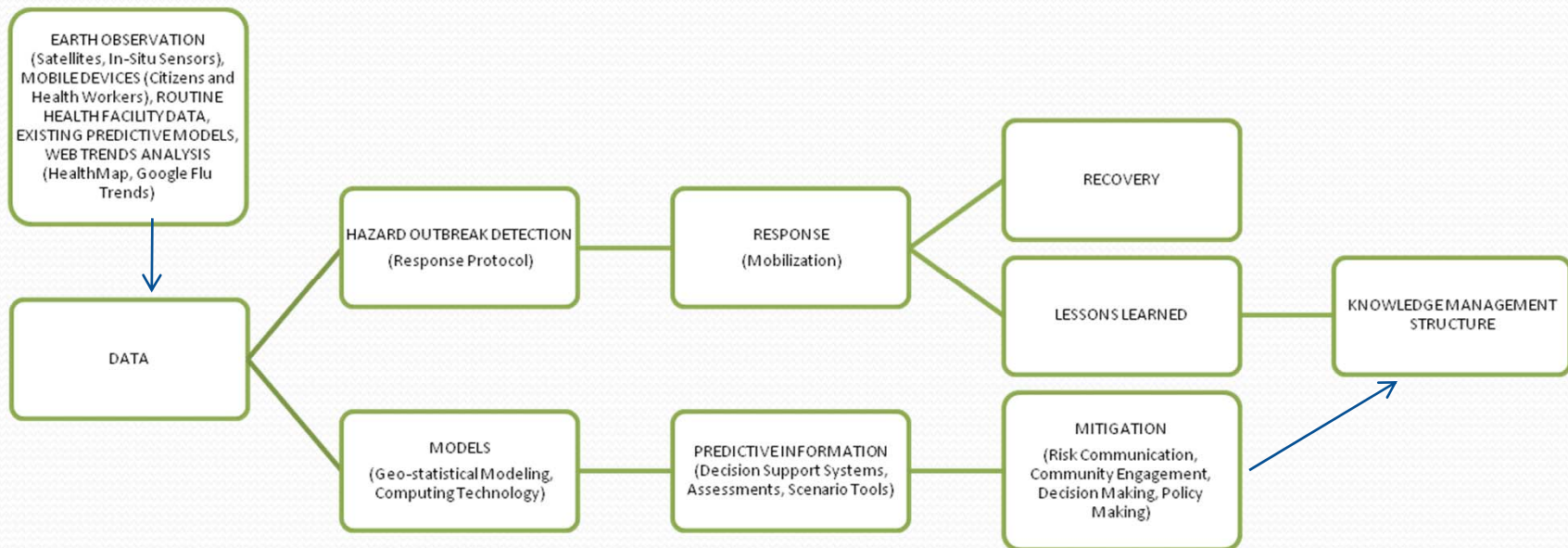
Challenges

(WHO, WMO, UNEP: *Climate change and human health - risks and responses. Ch. 4. 2003. Geneva*)

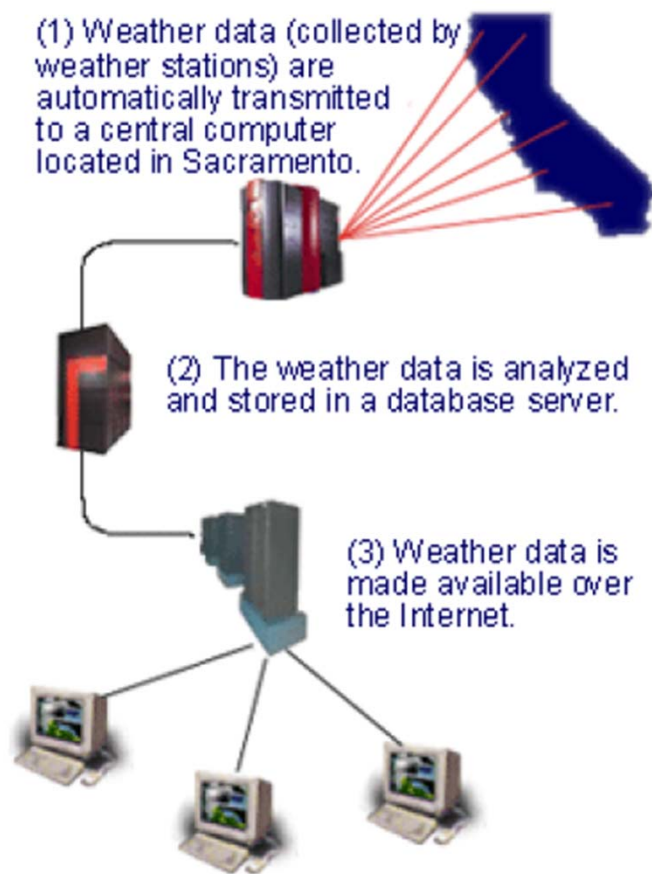


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Ideal Context



California Irrigation Management System (CIMIS)



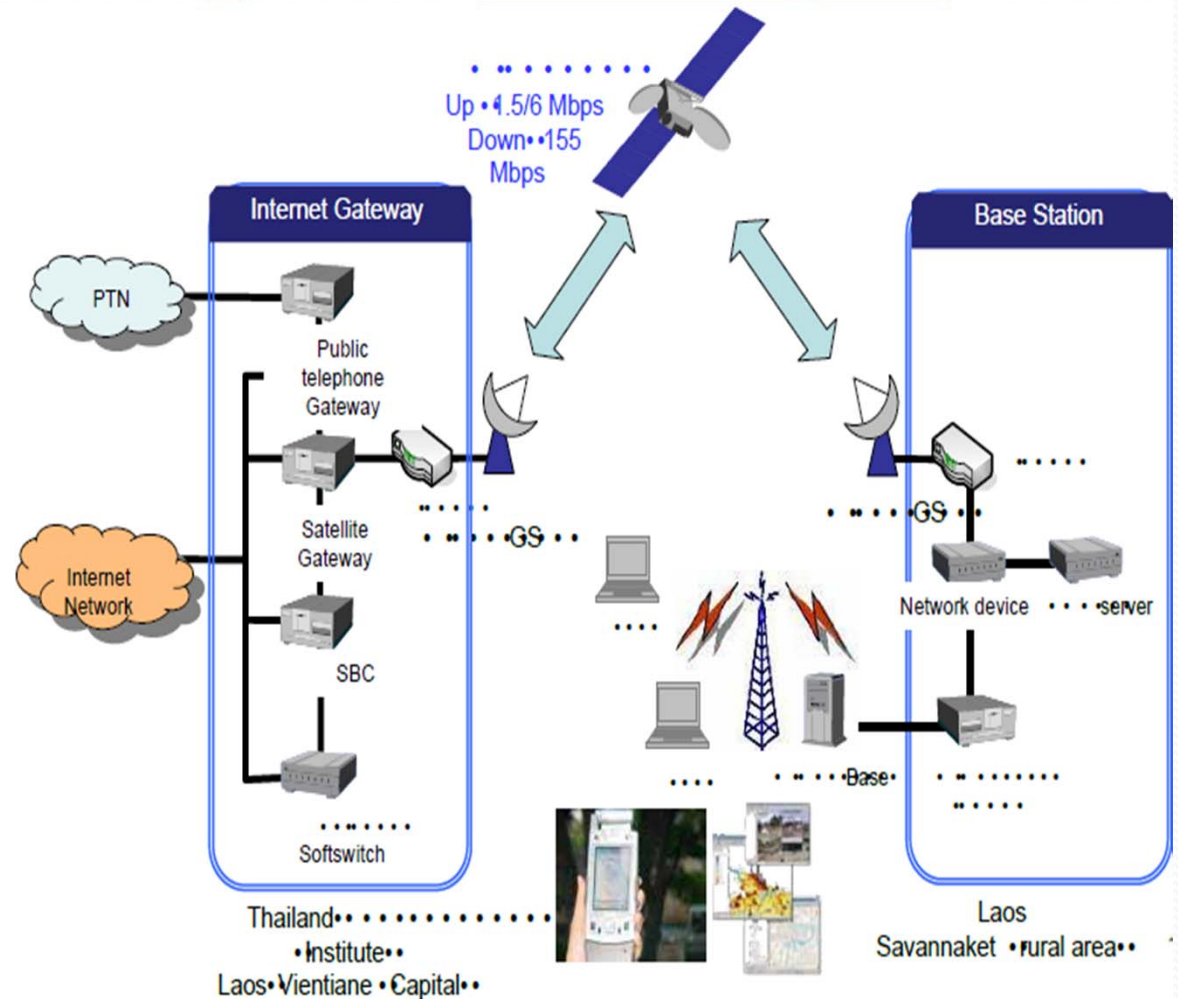
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“Scientists are also testing the use of mobile devices for distributing and exchanging data with growers who want to customize the satellite data for their farms. Participating growers will have the option of providing voluntary updates on applied irrigation via a secure data system accessible by cell phone or Web browser.”
Amy Julia Harris (HMB Review)

Communication and Information Systems for the Control of Avian Influenza (CISCAI) JAXA/JASF

Thailand, Vietnam, Laos, Indonesia.

System integrates Web GIS, SMS Communication Systems, Volunteer Mgt. Systems, WiMAX, and Wifi networks. Multilingual.



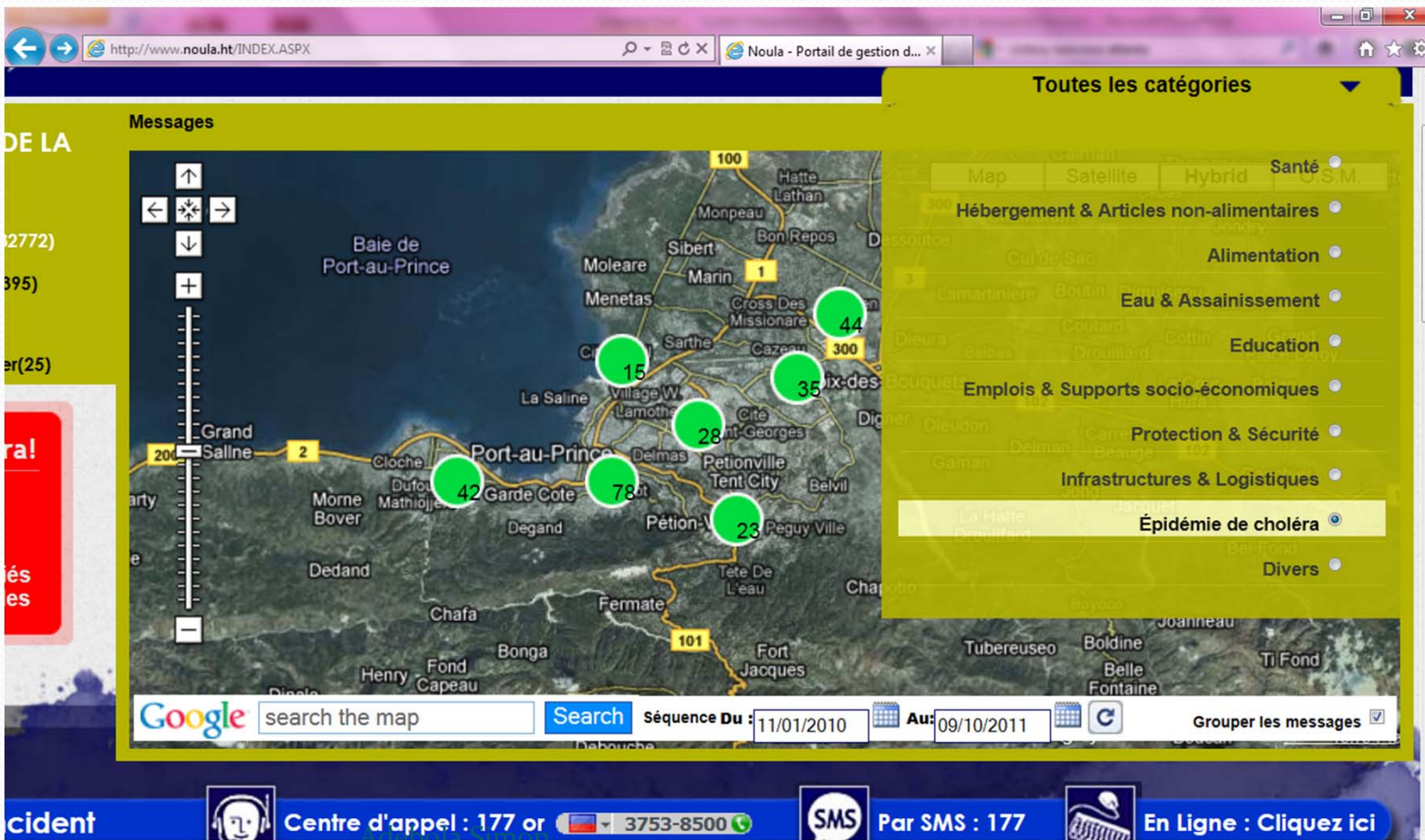
Igarashi T, JAXA's Concept on Space Initiatives for Health, 2010, GEO, Paris



Ushahidi.com

- Brazil, China, Haiti, Indonesia, Japan, Kenya, Mexico, Syria, Samoa, US. etc.
- “A small army of volunteers works to collect information to put on the map. Ushahidi pulls some of this data in from official sources, like the United Nations, but has really found its power in curating Twitter posts, e-mails and text messages from disaster sites.”- CNN

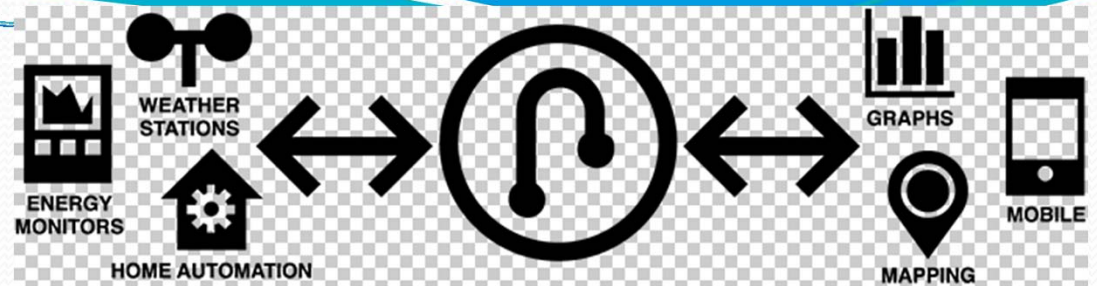
Noula.ht



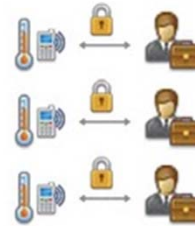
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Pachube.com

- Real-Time Open Data Web Service for the Internet of Things
- Mobiles, sensors, devices
- Over 100 countries
- Radiation, air quality, weather etc.
- **Earth Browser:** Use this app to browse *realtime values* from Pachube.com sensor feeds and datastreams located all around planet Earth. Overlay new search results by changing bar colors and supplying new search terms.

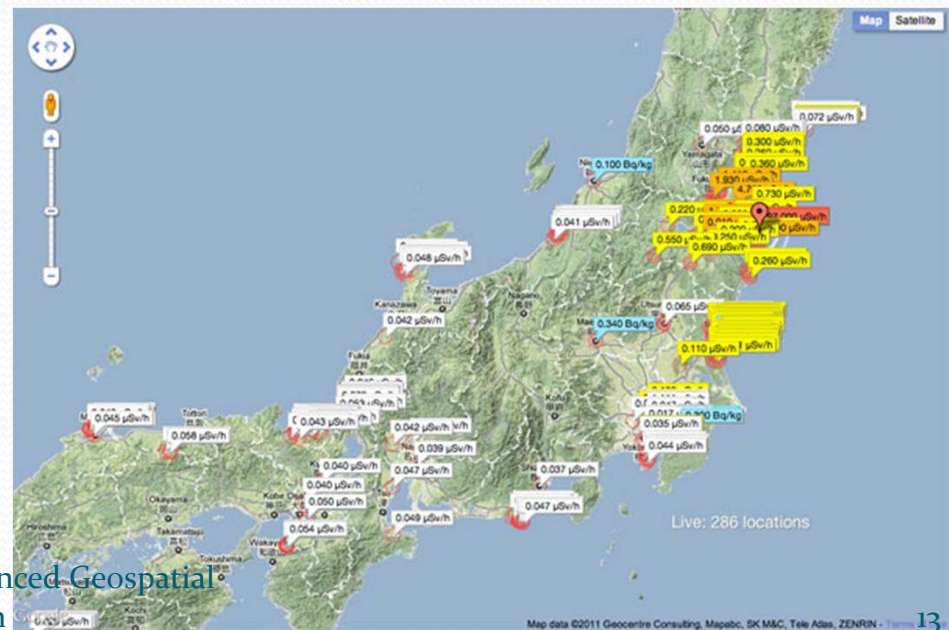
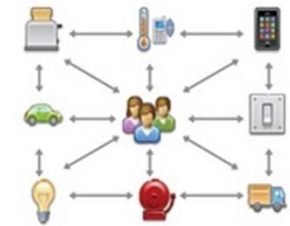


Machine to Machine



data silos → open data

Internet of Things



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Dynamic Continuous-Area Space-Time (DYCAST) System

- A biologically based spatiotemporal model that uses public reports of dead birds to identify areas at high risk for West Nile virus (WNV) transmission to humans
- In spite of declining prediction rates, results show DYCAST served during the severe 2005 California epidemic as a timely and effective EWS
- Potential technologic solutions are mobile phone application software and text messaging to disseminate information and facilitate the reporting of dead birds.

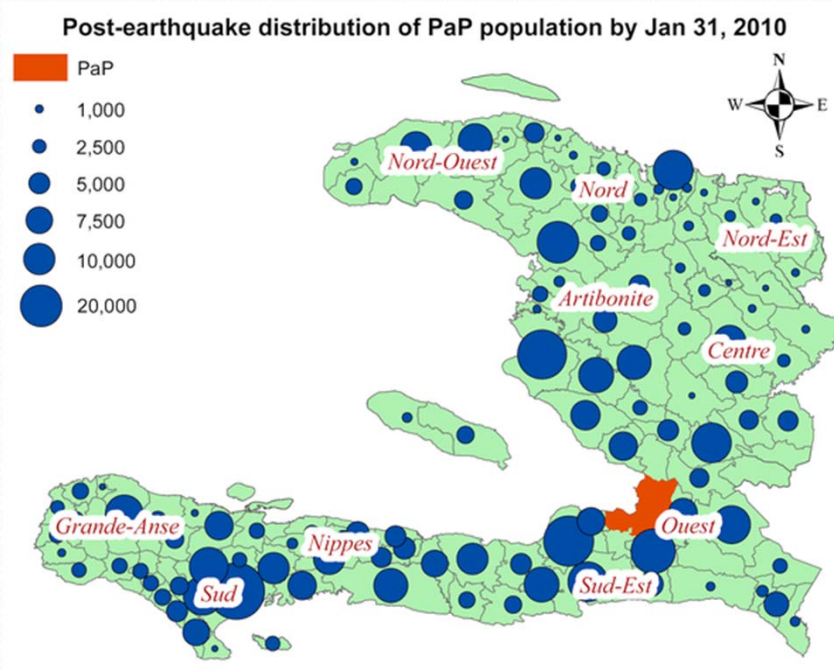
(Carney RM et al, Early Warning System for West Nile Virus Risk Areas, California, USA- ISPRS Workshop, Advanced Geospatial Technologies for Health Vol. 17 No. 8 - August 2011, EID Journal - CDC)

Tracking Population Movement Using SIM Card Position Data

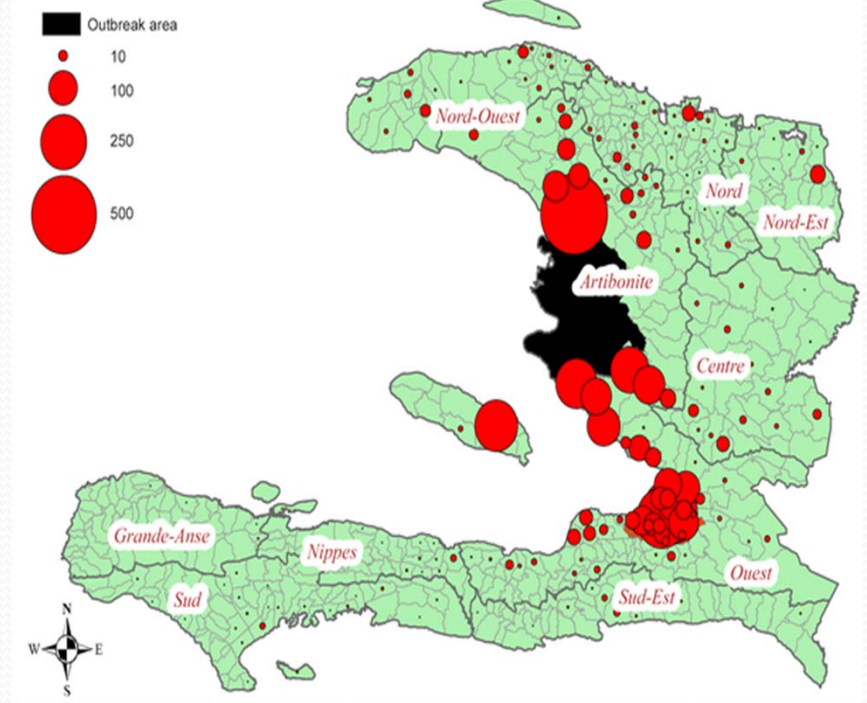
(Bengtsson L. et al, Improved Response to Disasters and Outbreaks by Tracking Population Movements with Mobile Phone Network Data: A Post-Earthquake Geospatial Study in Haiti
 PLoS Medicine 2011)

IDPs, food, WASH, healthcare

Increased transmission of cholera



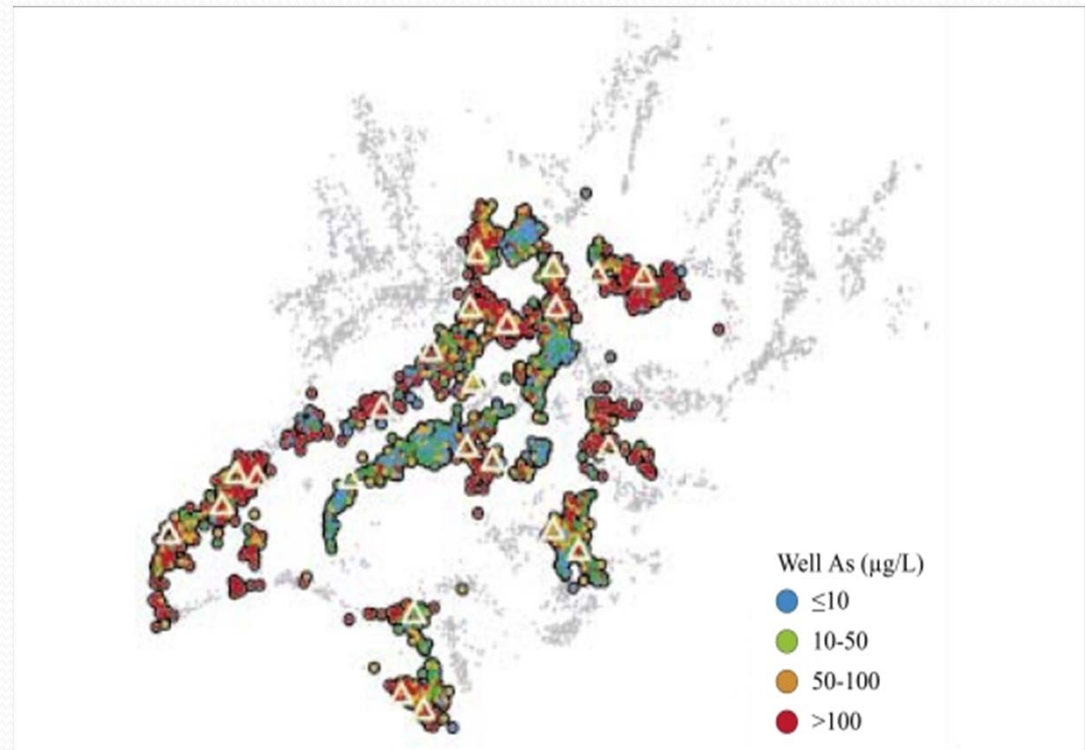
Average daily numbers of sims that moved out from the communal sections surrounding Saint-Marc, Oct 15 to Oct 23, 9:00 am, 2010.



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Bangladesh Arsenic Mitigation and Water Supply Program (BAMWSP)

- Help optimize interventions by guiding the choice of the drilling method that is likely to reach a safe aquifer and identify villages that need exploratory drilling .
- “Users download and update the BAMWSP data through the Short Message Service (SMS) offered by local providers which and is more reliable and less expensive than the Internet protocol. In this configuration, a mobile phone is connected to a laptop acting as a server. SMS requests are handled by jSMSEngine and MySQL, a robust open software model database server. The software queries the database, runs a search algorithm programmed in R that estimates the start-depth, and sends the response back to the mobile phone via SMS.”



The arsenic content of well-water. The location of community wells is indicated by triangles

Text and Image Source: van Geen et al, Targeting Low-arsenic Groundwater with Mobile-phone Technology in Araihasar, Bangladesh. J Health Popul Nutr. 2006 September; 24(3): 282–297.

Applied OGC Standards

- Sensor Web Enablement (SWE) architecture
- Sensor Event Service (SES)
- Event Pattern Markup Language (EML)
- Web Processing Service (WPS) Interface
- Web Map Service (WMS)
- Geography Markup Language (GML)

<http://www.geoinformatik2010.de/public/abstracts/everding.pdf>

<http://dl.acm.org/citation.cfm?id=1879580>

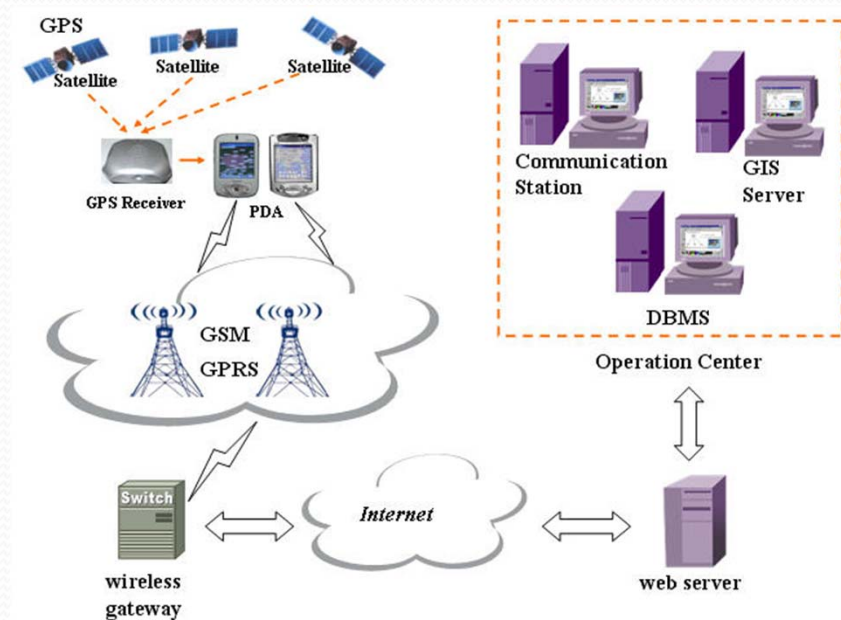
<http://elogeo.nottingham.ac.uk/xmlui/handle/123456789/17>

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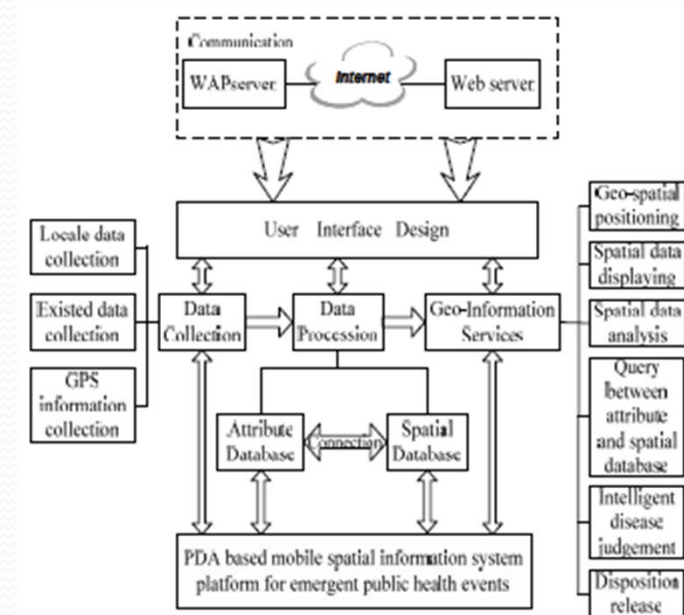
DESIGN AND IMPLEMENTATION OF MOBILE SPATIAL INFORMATION SYSTEM FOR PH EMERGENCY

(Wang et al, ISPRS Congress Beijing 2008 Proceedings)

System Architecture



Functional Architecture

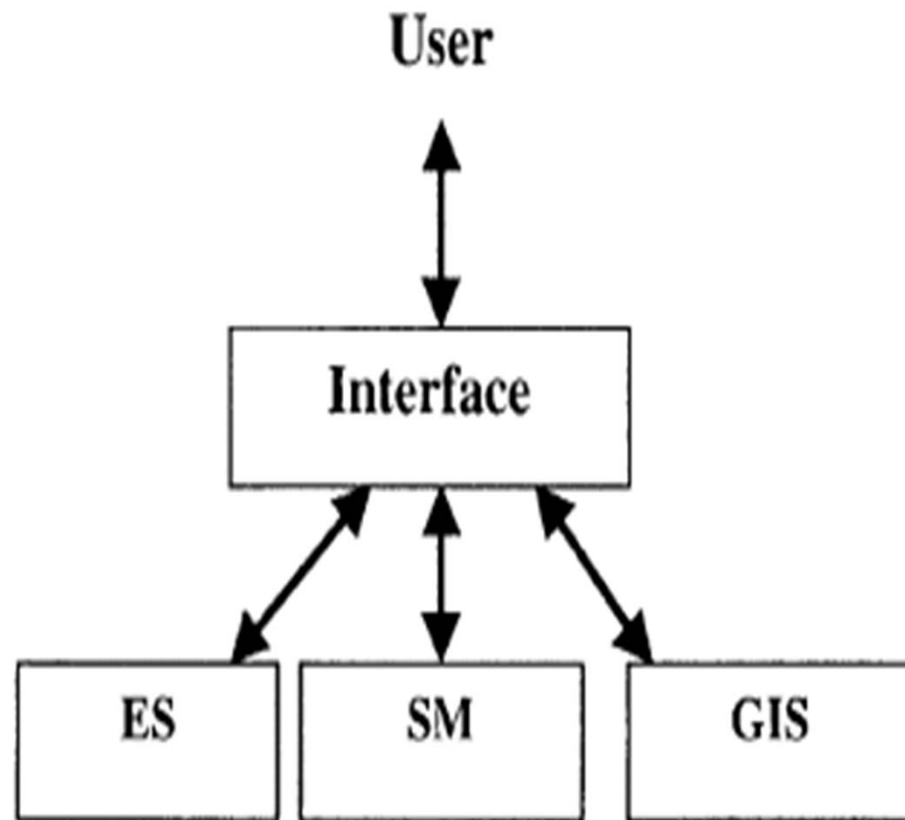


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Integrated Expert System, Simulation Models, and GIS in a Decision Support System

- Mobile devices are applied at the level of the user
- The flow of information is bidirectional
- Interfaces provide for ease of use with features that permit easy comprehension, data input, interpretation e.g. multilingual capabilities.
- Expert systems provide knowledge bases, adaptive machine learning, querying and didactic functions
- Simulation models incorporate predictive functions based on validated public health modeling
- The GIS enables the mapping and analysis of geospatial data within the system

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Adapted from Lukashev, Droste and Warith, Review of Expert System (ES), Geographic Information System (GIS), Decision Support System (DSS), and their applications in landfill design and management. *Waste Manag Res* 2001 19: 177



Further Research

- What systems have successfully combined earth observation, decision support and mobile technologies?
- What technical specifications have these required, off the shelf, customised, proprietary?
- How much have they cost?
- What roles have mobiles and other last mile technologies played, and what promise do they hold?
- Has the communication being mainly uni-directional or bi-directional?
- Can mobiles serve this purpose alone or other technologies have to support?

Further Research, Inputs and Outputs

- Issues with health data quality and quantity
- Anonymized data has a lot of uses
- Location and Mobility
- Financial competence
- Drug purchases
- Drug usage
- School absenteeism
- Behavior change modification
- Risk communication of geospatial-based risk mapping
- Proactively harness complementary data sources



Further Research, Processes

- Simulation environments
- Testing the reliability of incoming, population derived data streams and the effect of mobile data on geospatial models
- Plug-ins, APIs, mash-ups
- Bi-directional, real time, collaborative



Further Research, Processes

- Water and sanitation hazards can be detected and mapped for immediate action. Planning of appropriate places to site latrines and wells using water table data, DEM, and populations. Geo-navigation capability on mobiles can help planners align data on maps with actual location
- Immunization planning using collaborative approaches around maps downloaded on site or prepared beforehand based on potential correlates (roofs, wells, yards, roads etc). Combined with stocks and supplies, monitoring of completion targets etc.



THANK YOU

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California Irrigation Management System

Name	California Irrigation Management Information System (CIMIS)
Designer	NASA, USDA
Location	United States of America
Year	
Implementation Stage	Pilot
Focus	Water, Agriculture
EO	Yearly fluctuations in precipitation and soil moisture
DSS	Irrigation: Daily Crop evaporation and transpiration estimates,
mTech	Receive customized satellite imagery, provide voluntary data on applied irrigation
Other Technology	Secure data system, Web browser
Last mile	
Resolution	
Optical	
Radar/Lidar	
Link	http://www.hmbreview.com/articles/2010/08/12/news/doc4c62da0265d09365994442.txt

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Discussion Points

- Survey mode
- PPGIS
- Abundance of mobile-based surveillance systems wrt Integrated mobile capability in DSS



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