Earth Observation for Health

International trends & developments

How to promote earth observation applications?

How to get funding?

Capacity building

0. Introduction

Mark Noort, consultant, project manager

HCP international:
consulting, marketing of earth observation

Coordinator GEONetCab:
project for promotion & capacity building of earth observation applications

Earth observation applications

- On the verge of reaching new user communities
- These new user communities need to be involved
- Weakest link / last mile aspects are important
- Marketing needed: promotion & capacity building

Life cycle of products & services

Initialization

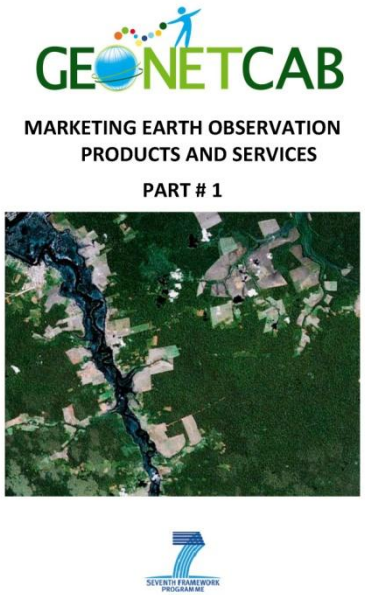
System analysis & design

Rapid prototyping

System development

Implementation

Post-implementation



Assessment of business & funding opportunities

- Categories of environmental products & services
- Life cycle phase of product or service
- Regional context, level of technological & economic development
- Optimum marketing mix

1. International trends & developments in marine environment

Trends

- Increasing population
- Economic growth
- Increasing urbanization
- Increasing (energy) consumption
- Increasing mobilization -> motor vehicles

Leads to increased pollution of water, air and soil

Trends (2)

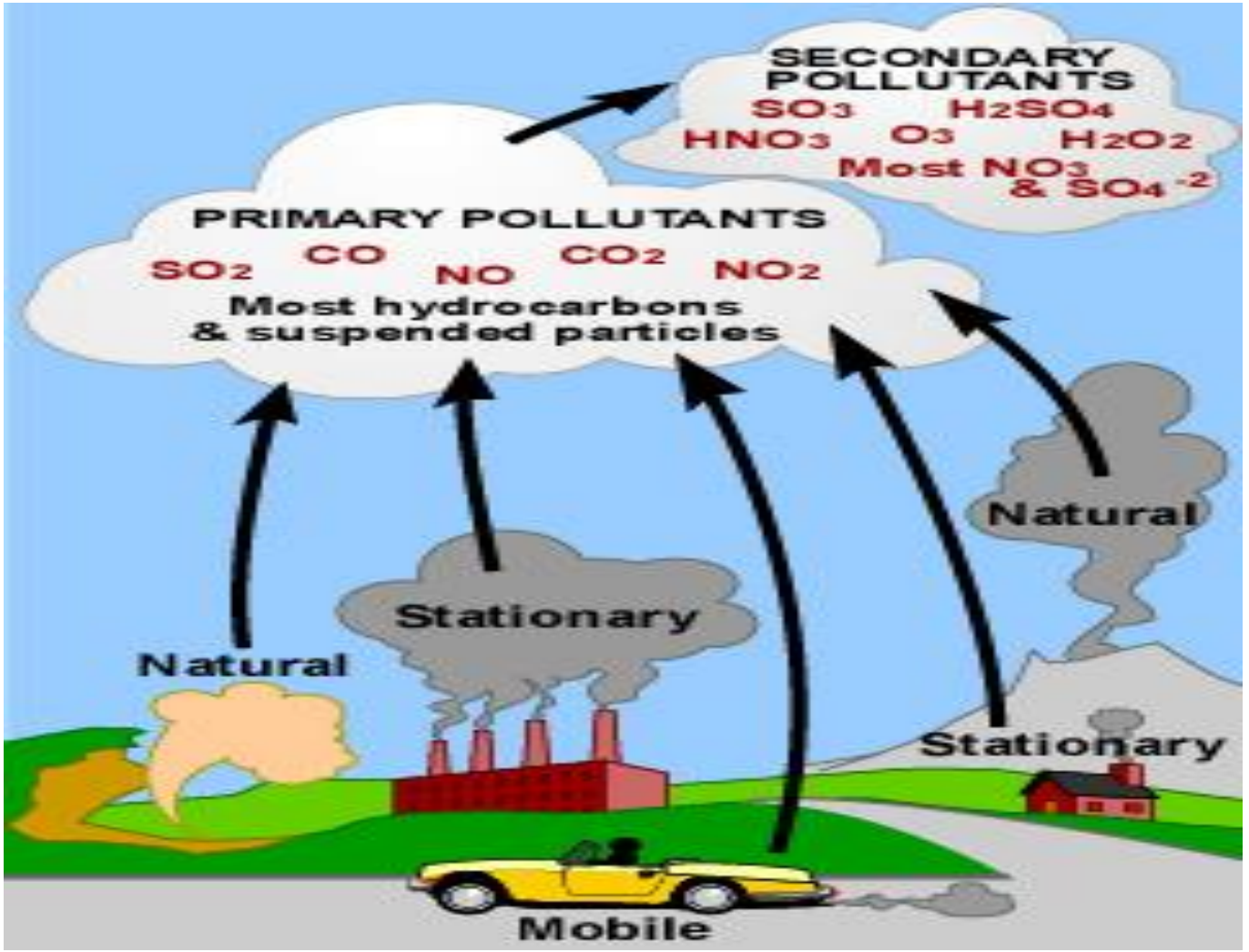
Positive trends:

- New, cleaner technologies available
- Increased attention for environmental issues
- Increased attention for sustainable economic development
- Improved living standards and increased life expectancy
- Improved monitoring, forecasting and early warning -> focus of Earth observation
- Improved understanding of processes affecting human health -> focus of Earth observation

Focal points:

- Air quality (pollution, aeroallergens, dust storms)
- Fighting disease (malaria, meningitis, dengue, rift fever, west nile virus, cholera, etc.)
- Climate change and health

Type and sources of air pollutants



Optical remote sensing for measurement and monitoring of emission flux (EPA Handbook)

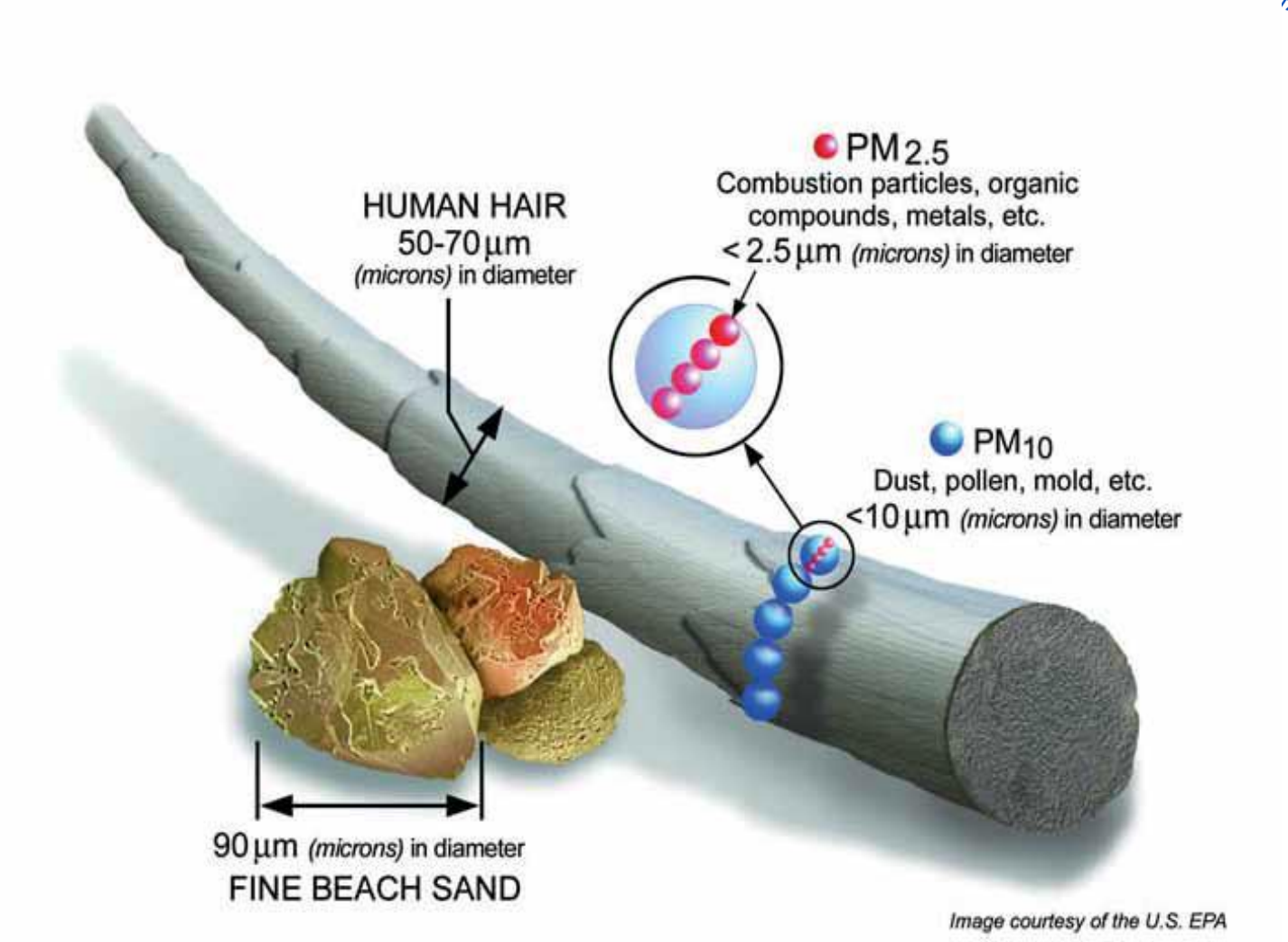
Air quality

Main observations for Europe:

- Particulate matter (PM) and ozone (O_3) are most harmful for human health;
- Emissions of air pollutant declined in last decade: improved air quality across the region for some pollutants;
- Emission reduction does not always cause a drop in atmospheric concentrations, especially for PM and O_3;
- Pollutants of interest: PM, ground-level O_3, nitrogen oxides, sulfur dioxide, carbon monoxide, heavy metals, benzene and benzo(a)pyrene.
- AirBase database: http://www.eea.europa.eu/themes/air/air-quality/map/airbase

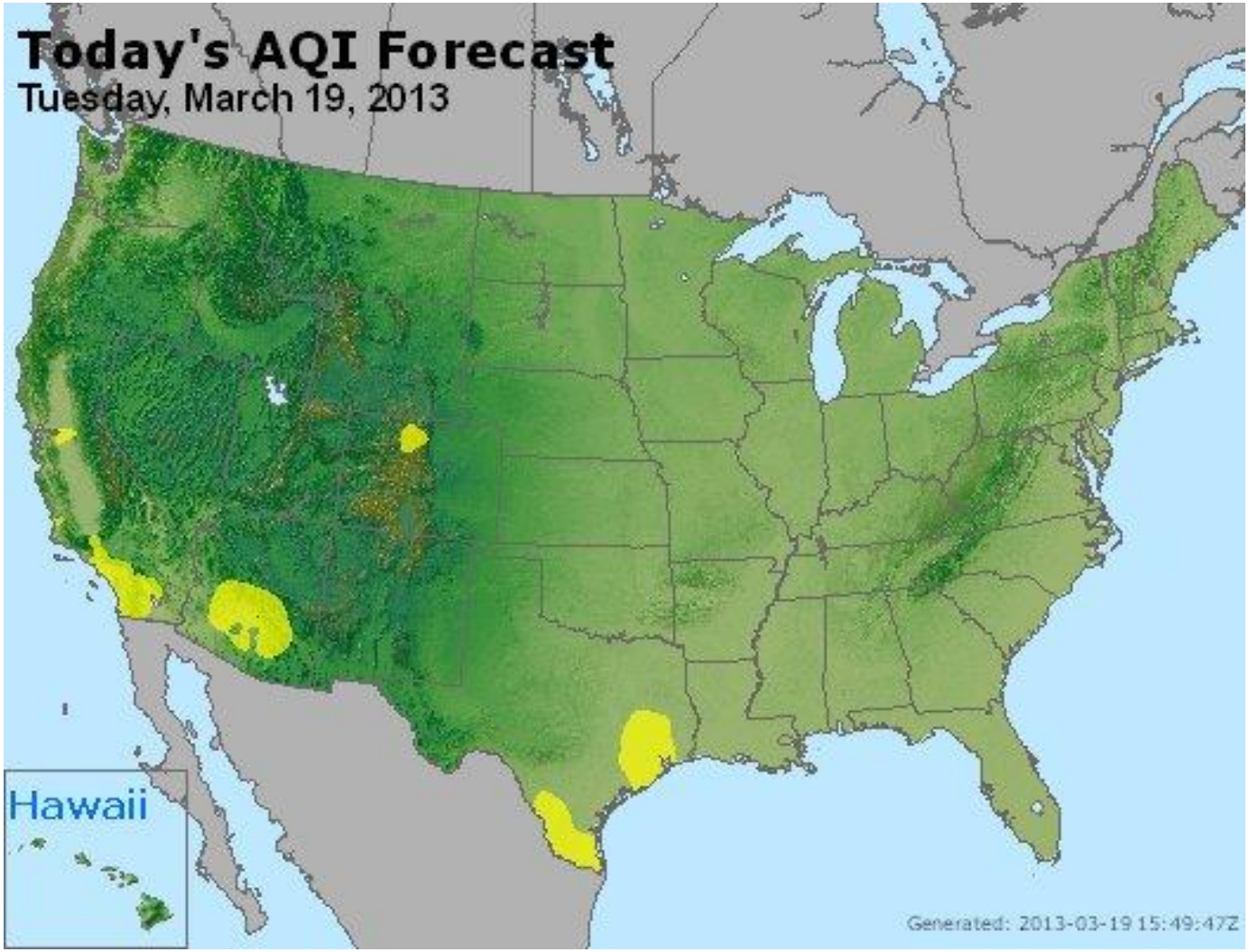
Air quality in Europe - 2012 report (EEA)

Particulate matter, relative size



EPA (2010)

Air Quality Index map of the US



AIRnow website: http://airnow.gov/

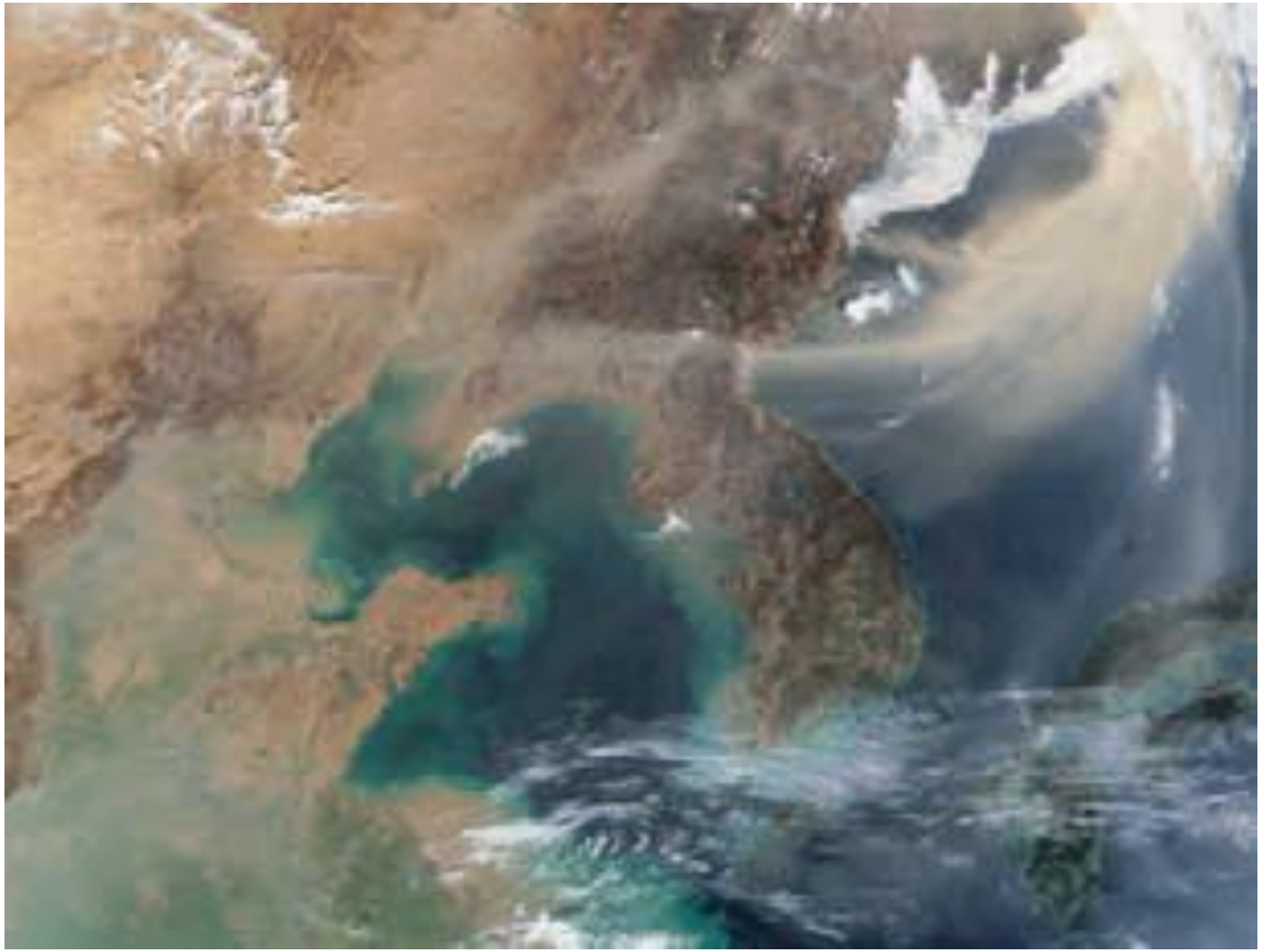
References:

Air quality in Europe – 2012 report (EEA)

Air Quality Index – a guide to air quality and your health (EPA)
Brochure that explains air quality index, causes of air quality variation (ozone, particle pollution, sulfur dioxide, carbon monoxide), health effects and possible action (avoidance)

The EveryAware sensor box: a tool for community-based air quality monitoring
Description of sensor box that users can apply to measure / monitor air traffic pollution

Air quality: sand and dust

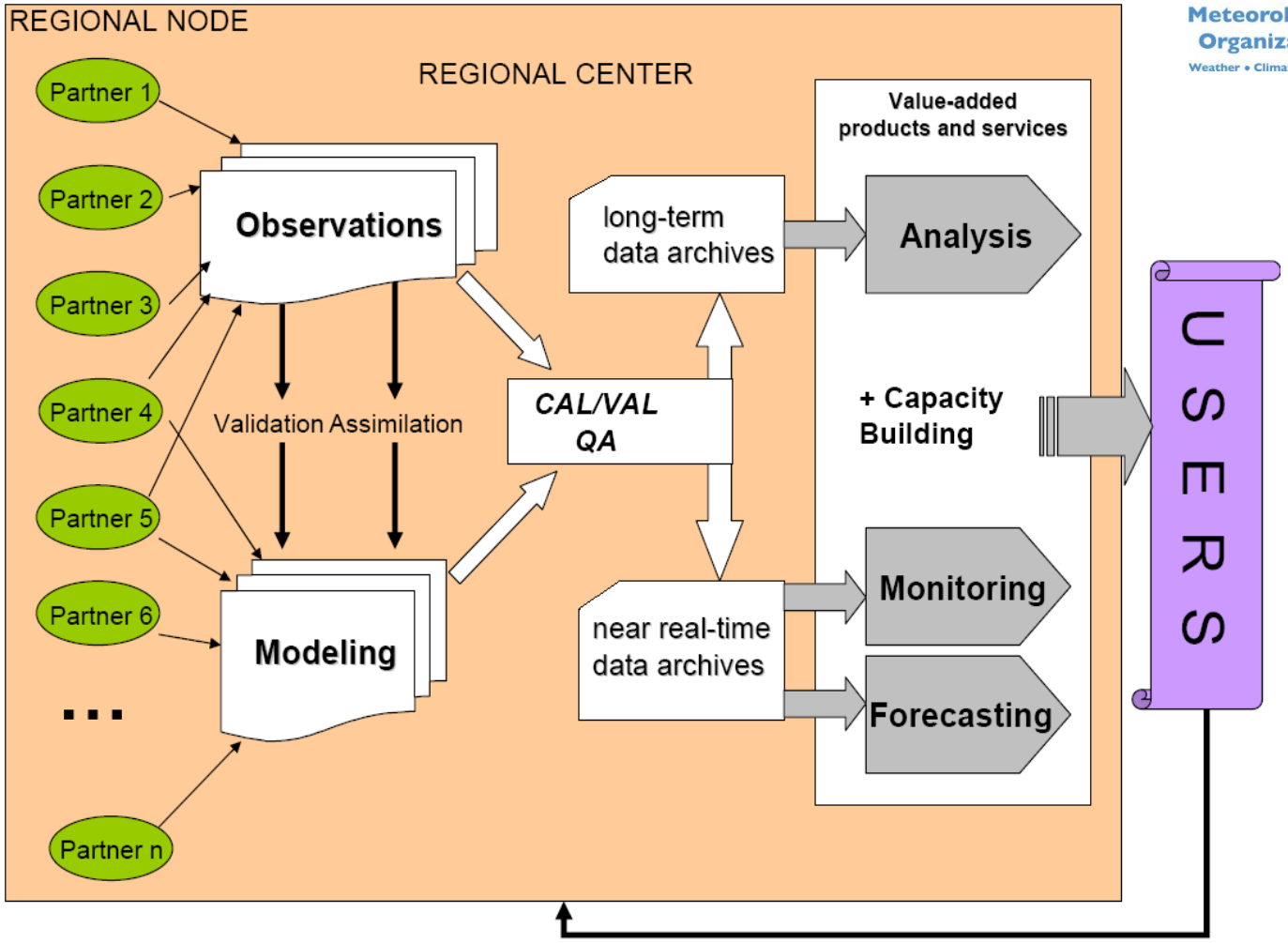


Sand and dust storm over Japan (MODIS image, 2002)

Dust storm life cycle

Dust storm early warning (UNEP)

Information flow SDS-WAS



Sand and dust storm warning, advisory and assessment system (WMO)

References:

Forecasting and early warning of dust storms (UNEP global environmental alert service)
Presents general process and role of forecasting and early warning

Dust and sand storms (Ministry of the Environment Japan)
Description of how the sand and dust storm mechanism works and the usefulness of improved forecasts and early warning

WMO sand and dust storm warning, advisory and assessment system (SDS-WAS) – science and implementation plan 2011 - 2015
Research to improve forecasts, modelling and information to user communities, including meningitis risk in the Sahel region

Fighting disease

Example:

Roll back malaria - malaria early warning systems (WHO):

- Initiative for the prevention and control of malaria epidemics in Africa
- Comprehensive approach, including an suitability analysis of transmission and vulnerability risk indicators
- Uses WHO/UNICEF HealthMapper: http://healthmapper.software.informer.com/

For more examples see section 2.

Climate change and health

Areas of concern:

- **Infections:** malaria, diarrhea, meningitis, dengue fever are the most important ones
- **Emergencies:** floods and cyclones, drought, airborne dispersion of hazardous materials
- **Emerging environmental challenges:** heat stress, UV radiation, pollen, air pollution

Atlas of health and climate (WHO/WMO)

More references:

Human health climate change brochure (US global change research program)

Predicts: increase in risk of illness and death related to extreme heat and heat waves, reduced extreme cold, challenge to meet air quality standards, more extreme weather events (storms, floods, wild fires), increase of some diseases transmitted by food, water or insects (west nile, lyme, salmonella, etc.), increased pollen health risk

Human health, climate change 2007: impacts, adaptation and vulnerability (IPCC)

Covers: heat and cold effects on health, wind, storms and floods, drought, nutrition and food security, food safety, water and disease, air quality and disease, aeroallergens and disease, vector-borne, rodent-borne and other infectious diseases, occupational health and UV radiation

2. Steps to promote earth observation for health

State-of-the-art

Earth observation is new technology.

Learn technical skills, but when back in professional practice, it has to be put to good use.

That involves ‘selling’ it.

How to do that?

To whom? Could be your own boss, local authorities, communities, etc.

Categories of products and services

- Air quality forecasting / early warning / monitoring
- Epidemics forecasting
- Relationships between diseases and environmental factors

All these categories, particularly the 2nd & 3rd, are of course linked, the time/response factor providing the main distinction.

Introduction example: United States

- **Air quality**: emissions from industrial processes and motor vehicles, particulate matter in the air (sand, dust, volcanic and noxious gases, smoke and soot from fires)
  - measure air masses (monitor extent and source of emissions)
  - track health impact from fires
  - track dust (meningitis, other diseases)
  - monitor trace species in the air (carbon monoxide, ozone)
- **Temperature**: extremes (heat waves lead to weather-related deaths, aggravation of chronic diseases)

From: Using Earth observation data to improve health in the United States (CSIS)

Introduction example: United States (2)

- **Water**: health risks caused by
  - droughts (affects supply of fresh water, famine, fires)
  - floods (spread of diseases, fuel, pollutants)
  - contamination (chemicals, toxins, sewage)

  Special attention to 'health' of the ocean.

- **Infectious disease and disease vectors**: environmental factors (land and water surface temperatures, rainfall, water depth, marine organisms) contribute to disease outbreaks, changes in weather and climatic conditions (example: cholera).

From: Using Earth observation data to improve health in the United States (CSIS)

Introduction example: United States (3)

Remote sensing data requested by public health community:

- Climate change parameters and health
- Heat island effects on urban areas
- Precipitation (water, drought)
- Data on at-risk population
- Detection of algae blooms that are harmful to health
- Pesticides and crop prediction

From: Using Earth observation data to improve health in the United States (CSIS)

Introduction example: United States (4)

Public health community users are interested in:

- Areas of intrinsic variability or high trend (rapid change)
- Integrated Earth observation climate models for health impact (novel ways of using high spatial resolution)
- Indicators to monitor climate-change-related health outcomes within surveillance systems
- Development of early warning systems
- Improved decision support for vulnerability and adaptation assessment, operational predictions and understanding of the decision making process

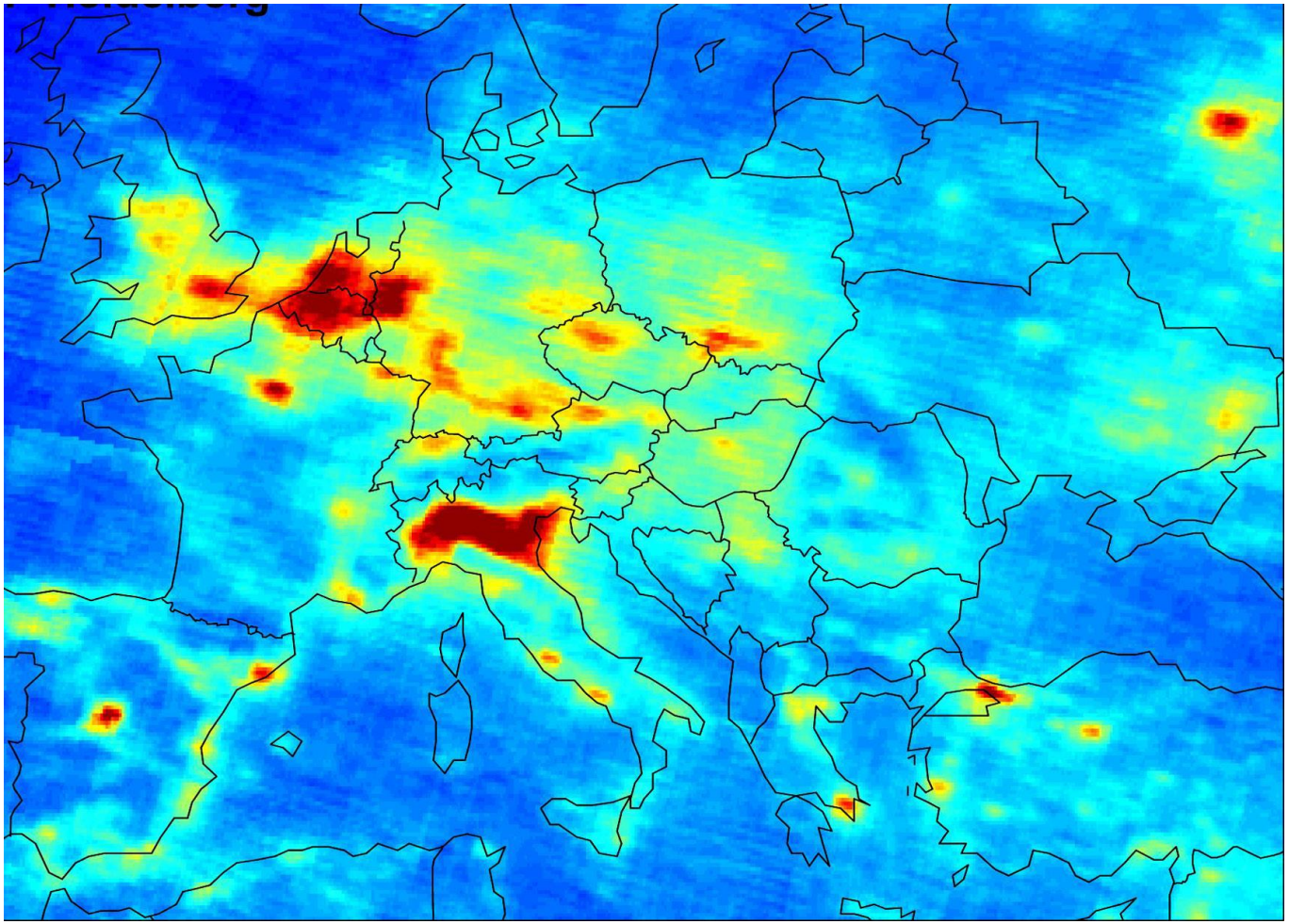
From: Using Earth observation data to improve health in the United States (CSIS)

Air quality example: Europe

- Healthcare costs associated with poor air quality: € 189 billion/year
- Satellite-based air quality assessments support the European Commission's goal of improving reduced life expectancy due to airborne particulate matter by
  - compliance monitoring support to environmental agencies,
  - early warning of pollution exceeding allowed levels
- The WHO estimates that by reducing illness caused by airborne PM the EU could save up to € 29 billion/year
- Regional and municipal governments already provide citizens with detailed air pollution alerts

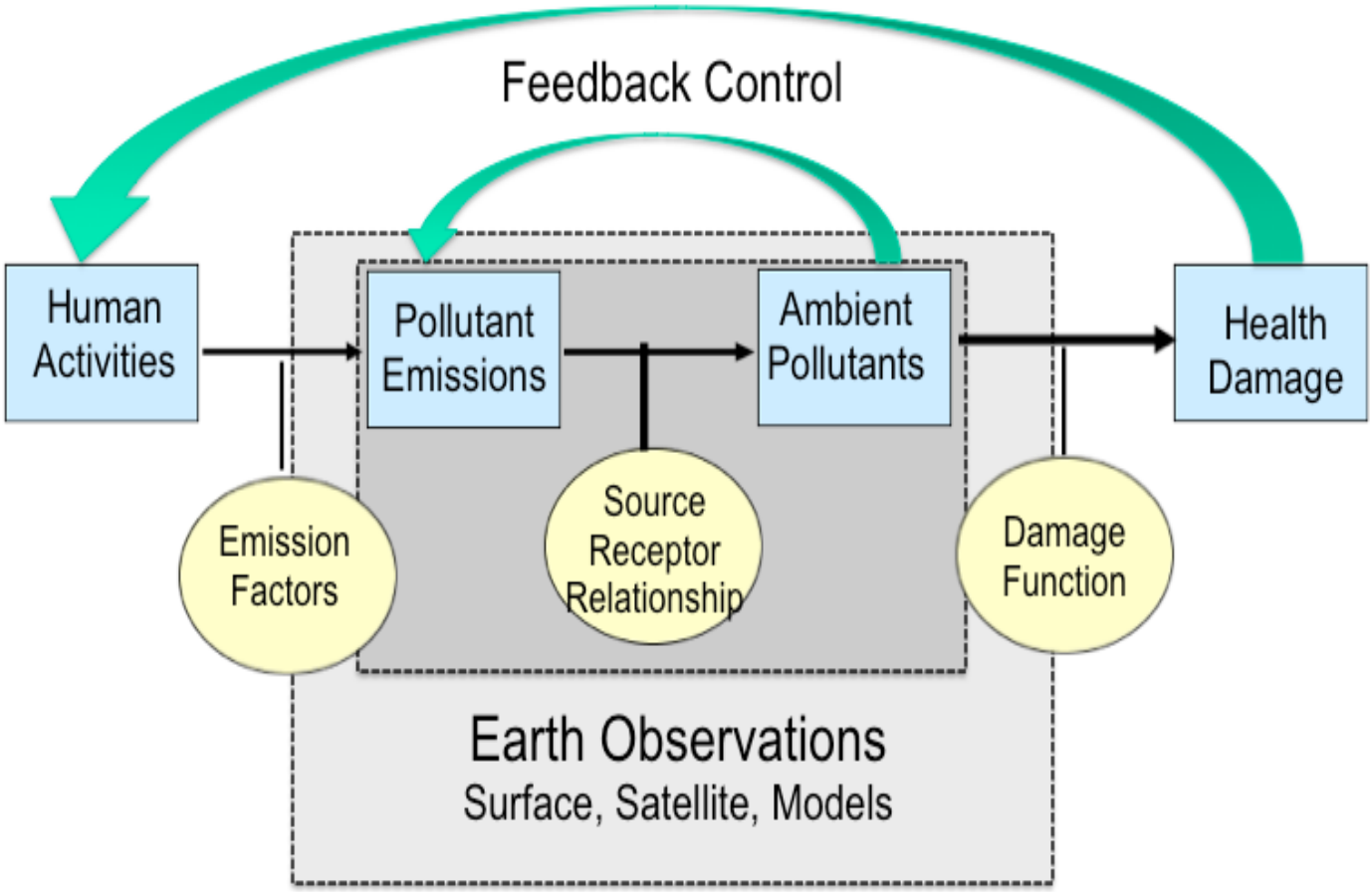
From: Monitoring the air we breathe from space (GMES)

Air quality example: Europe (2)



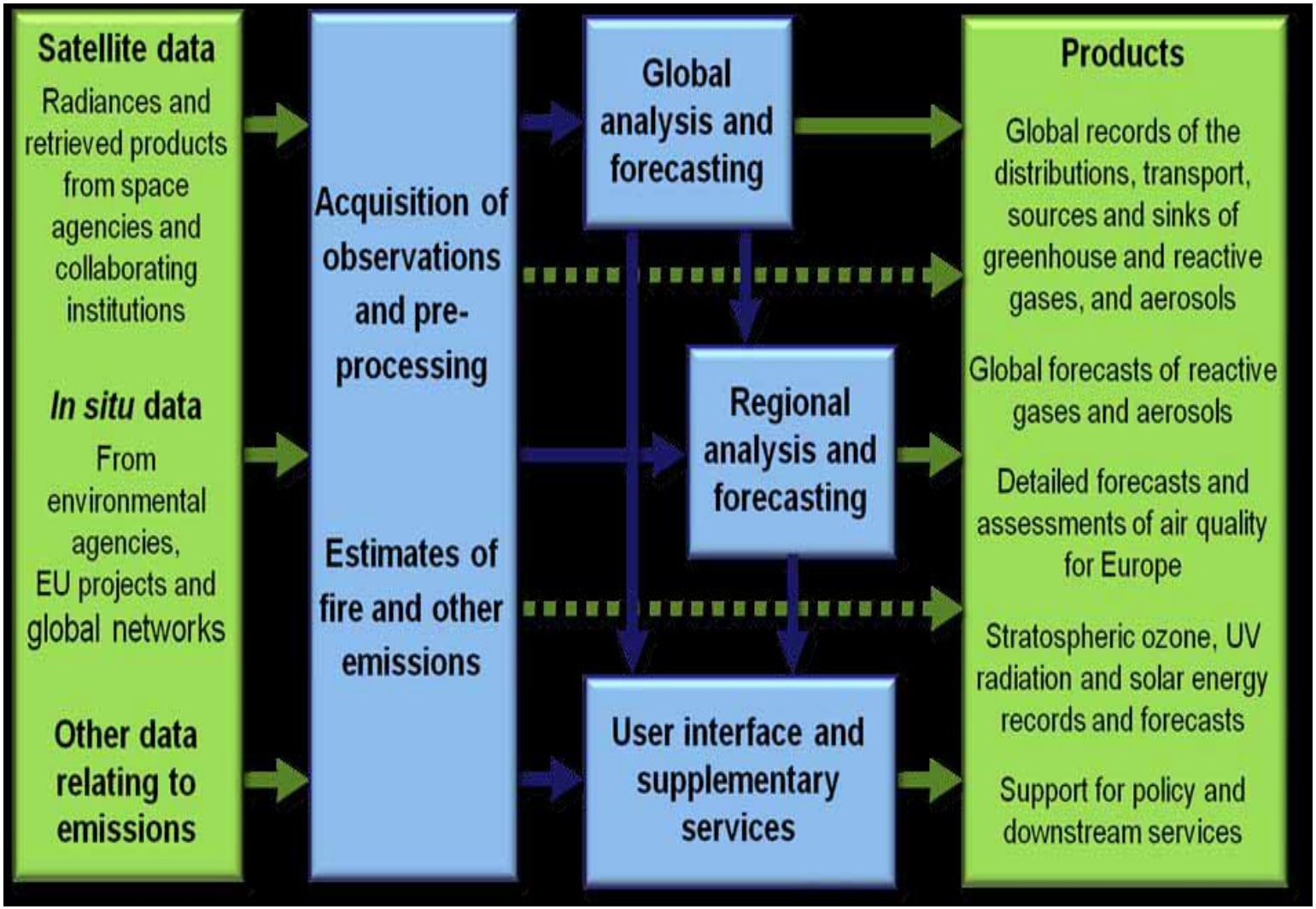
Mean density of nitrogen oxide (January 2003 – June 2004)

EO priorities: air quality for health



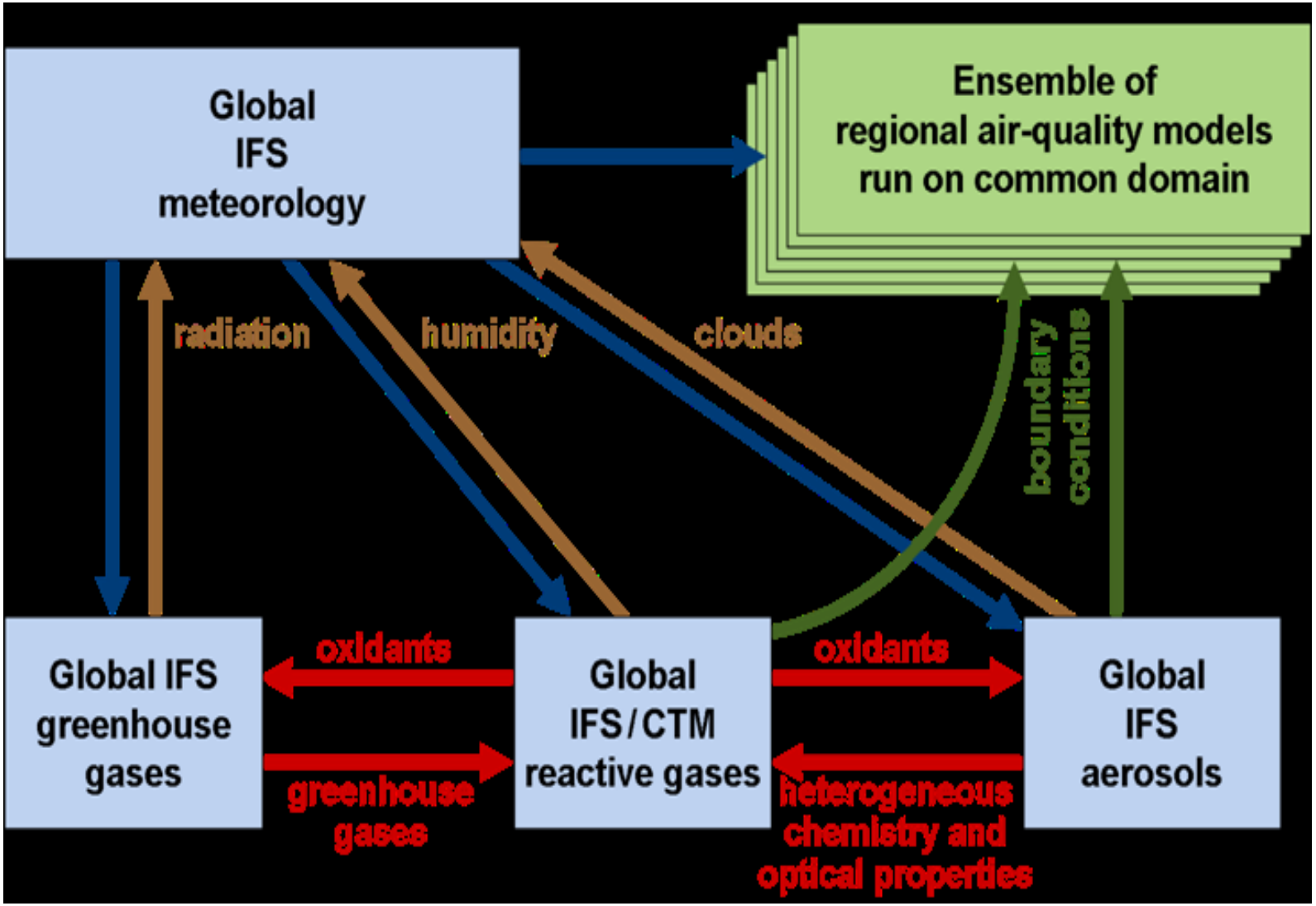
Framework for categorizing earth observations for air quality and health

Example: comprehensive air quality approach (1)



Monitoring Atmospheric Composition and Climate project structure

Example: comprehensive air quality approach (2)



Integrated forecasting system

Air quality references:

Critical earth observations priorities, health societal benefit area: aeroallergens

Priority observations needed: ground-based samplers, temperature, humidity and precipitation, thunderstorms, wind direction, speed and persistence, air pollution, land cover data

Critical earth observations priorities, health societal benefit area: air quality for health

Focus on air pollutants ($PM_{2.5}$, PM_{10}, O_3, NO_2, SO_2), observation coverage and utility; proper allocation of multi-pollutant observations, assuring spatio-temporal coverage & including the chemical precursors of secondary pollutants, such as $PM_{2.5}$ and O_3

Air quality references (2):

Particulate matter in the atmosphere of Dakar, Senegal (Planet Action)

Pilot on monitoring of particulate matter, measurement of aerosol optical depth, specifically aimed at Sahara desert dust; combination of in-situ and EO; satellite observations can detect gradient & therefore hotspots of emission

Air pollution using remote sensing and GIS, Cyprus

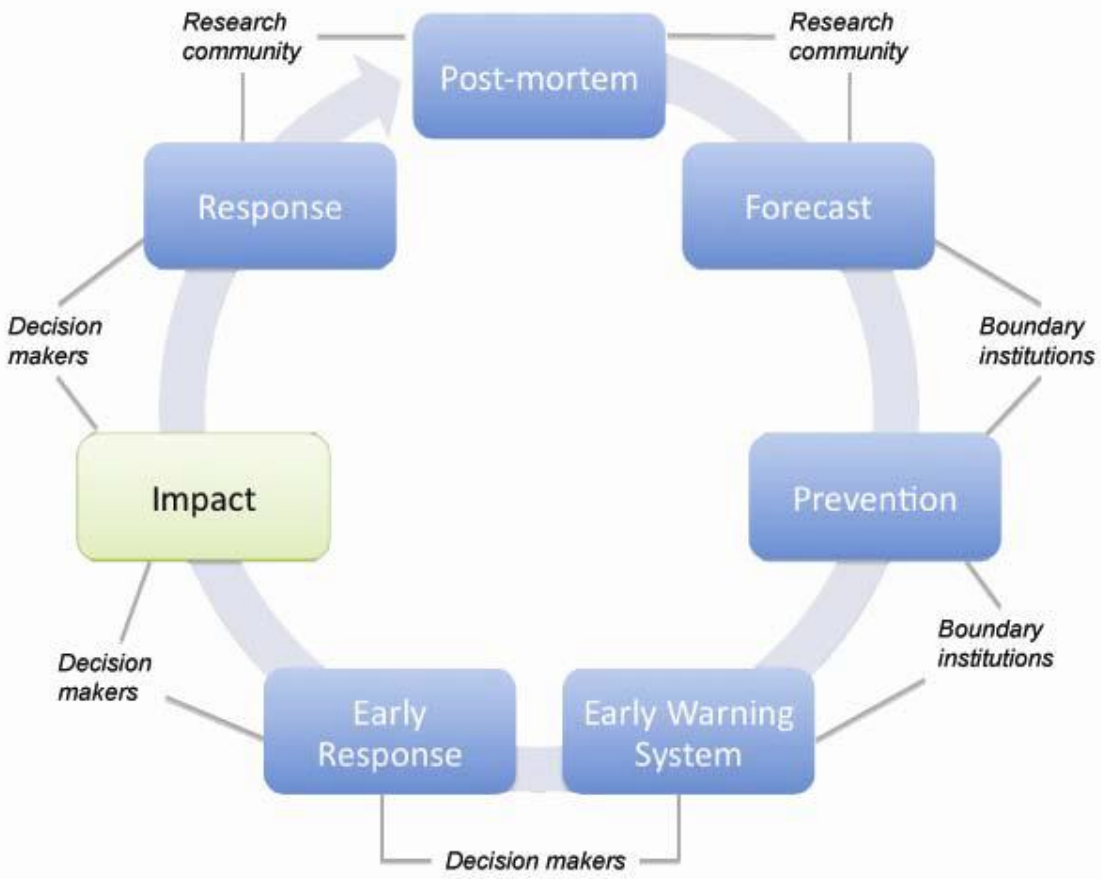
Case study on the use of satellite observations for air pollution monitoring and modelling

SERVIR air quality monitoring Central America

Description of the use of EO for an air quality monitoring system and public information, including 'SmogBlog', agricultural fires, vulcanic eruptions, Saharan dust + capacity building

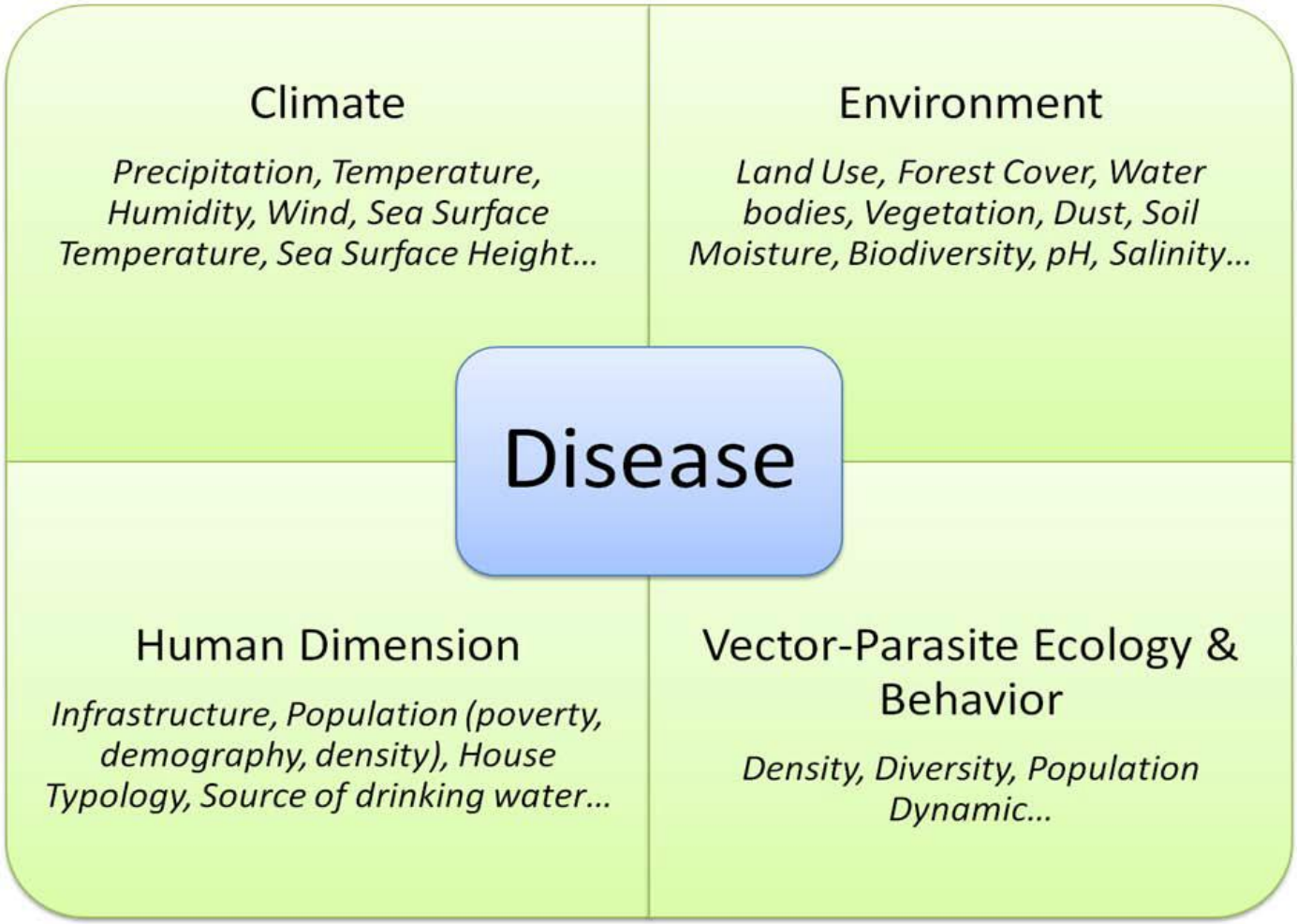
http://www.servir.net/

Epidemics forecasting & environmental factors



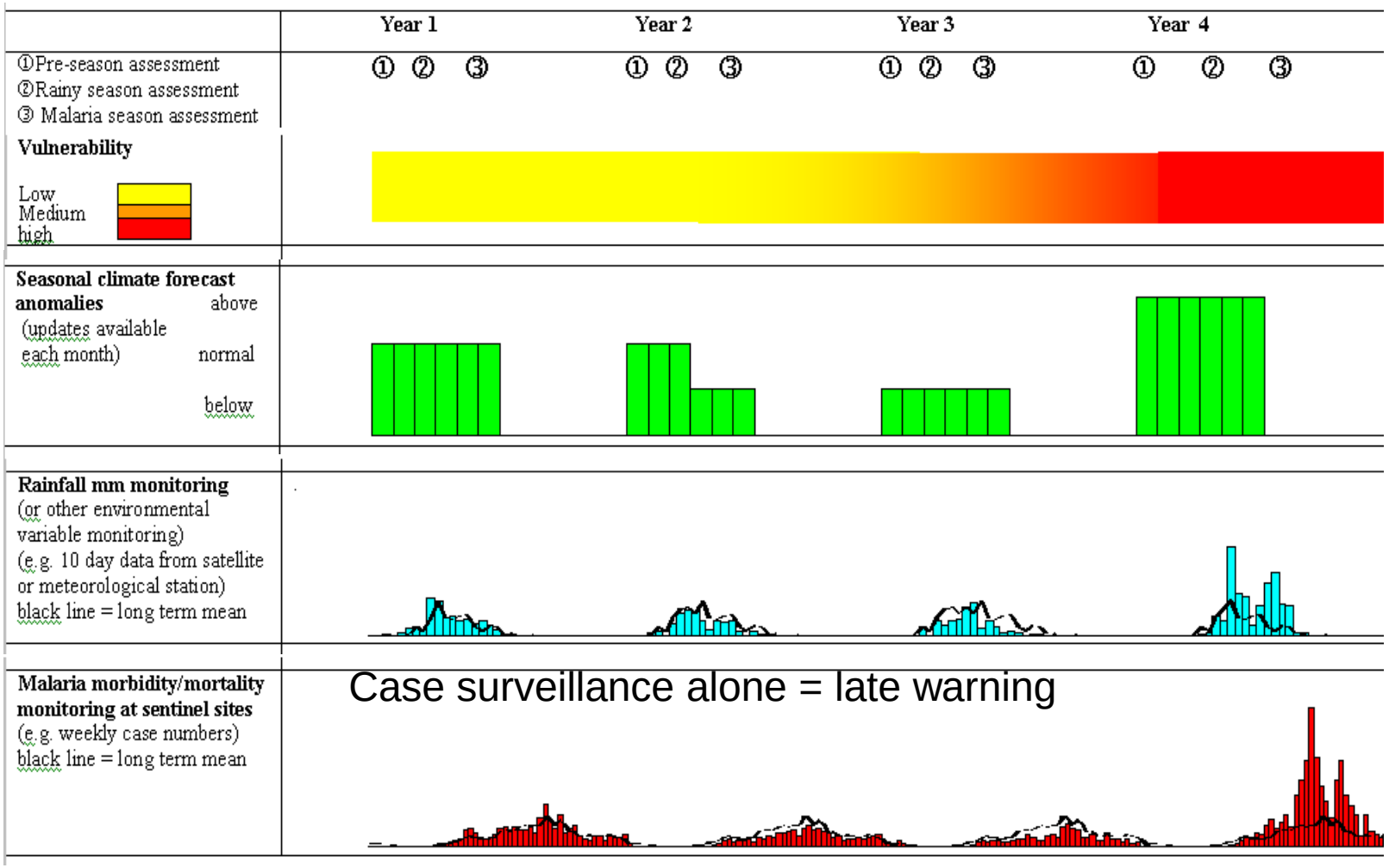
User cycle framework (EO priorities)

Epidemics forecasting & environmental factors



Epidemiological system showing the four main categories of EO (EO priorities)

Malaria early warning systems



Integrated MEWS gathering cumulative evidence for early and focused epidemic preparedness and response (WHO 2004)

EO for malaria early warning systems

- Vulnerability assessment (pre-season, rainy season, malaria season)
- Seasonal climate forecast anomalies
- Rainfall monitoring
- Correlation rainfall – incidence and vegetation (NDVI) - incidence
- Malaria morbidity/mortality monitoring at sentinel sites
- Short-term forecasting and long-term forecasting

From: IRI presentation

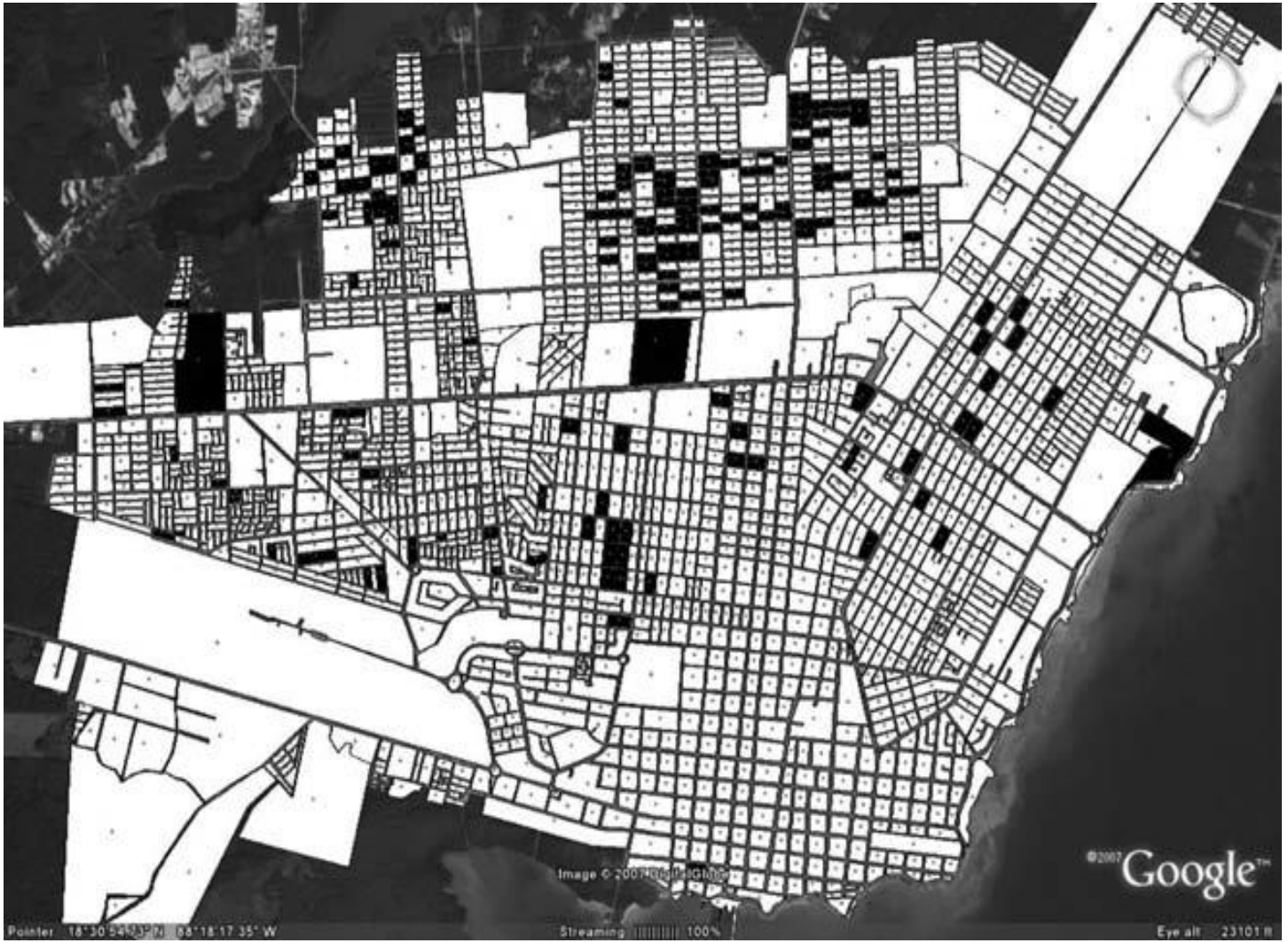
Useful sites for early warning

- IRI, Columbia University http://iridl.ldeo.columbia.edu/maproom/.Health/ (malaria, meningitis)
- CNES RedGems http://www.redgems.org/ (malaria, rift valley fever, dengue, vibrio diseases and cholera)
- NASA SERVIR http://www.nasa.gov/mission_pages/servir/index.html (general)
- ISID Pro-MED http://www.promedmail.org/pls/otn/f?p=2400:1000 (diseases general)
- USAID FEWSNET http://earlywarning.usgs.gov/adds/ (famine)

Tele-epidemiology

From: CNES Strategy, Satellite data and modeling for Public Health

Use of Google Earth



Distribution of city blocks with dengue cases, Chetumal, Quintana Roo, Mexico (2006)

Epidemics and environmental factors references:

Use of Google Earth to strengthen public health capacity and facilitate management of vector-borne diseases in resource-poor environments

Case study from Mexico; Google Earth images used to extract urban infrastructure patterns
Positive: easy to use and easy to learn
Negative: spatial analysis and modelling capacity is limited

Connecting ecosystems, biodiversity, and human health: using earth observations to reduce and prevent infectious diseases

Presentation on establishing links between human health and environmental factors with a call for integrated tools and approaches that link ecology to human health

Epidemics and environmental factors references (2):

State of the art for environmental and health monitoring in air and water (EO2HEAVEN)
Overview of regulations, feasibility of measuring and monitoring practices (including EO) and future developments

Satellite remote sensing variables as environmental risk factors and their association with child nutritional status and survival in a context of climate change
Relation between NDVI and child nutrition: rainfall data is less reliable than NDVI in monsoon systems with high intensity rainfall

Telesanté (CNES) *see also GEONetCab success stories*

HappySun *Something different: UV-radiation information for tourists and the tourist sector (Italy)*

GEO Health task: scope

- **Develop tools and information systems** for the environment and human health
- **Advance the integration** of Earth observations and forecasts into health decision-making processes
- **Engage with health users and decision-makers** to identify needs
- **Increase capacity building** on use of Earth information by the health user-community
- **Establish linkages with other Societal Benefit Areas**, such as ecosystems, biodiversity, climate and disasters

Possible business opportunities

- Scientists, public health organizations, NGOs, general public
- Mainly G2G or B2G market, government or international organizations are in virtually in all cases the paying client
- Opportunities for businesses in developing countries: refinement of existing models for local circumstances and processing of data flows
- Air quality particularly relevant in the large, densely populated cities

Marketing of earth observation

Marketing of earth observation is difficult.

New technology, few big companies, lots of small ones.

Lots of reports describing the bottlenecks, like reliability, data access, data continuity, etc.

Means that relatively a lot of effort is needed to promote EO.

Points to keep in mind:

- Look for opportunities, where can you have most success in a short time: quick-wins.
- Target the right audience to start with: who would be interested and listen to you?
- Identify the problem that they are trying to solve: is it the same as yours?
- Learn to speak the same language. Example ‘ZPOM’: this is a term most politicians do not understand and do not care about (although ‘zone potentially occupied by mosquitoes may be sufficient explanation). Use terms related to profits and losses.
- Look for examples from elsewhere (success stories): solutions that work and are affordable.

Be patient:
introduction of new technology
and / or applications takes time

3. How to get funding for your activities

Approach

- Share information on your subject (a thing you are doing) and think that is interesting for your contact, then look for the link. Could this solve a problem for your partner? Are adjustments necessary? Need other parties be involved? Take it from there.
- LEADS, LEADS, LEADS

GEONETCAB

How?

- Establish your network.
- Look for opportunities.
- Write a good proposal.
- Promise much, but not too much.

Proposal outline

(more detailed version in separate document, see also www.geonetcab.eu)

1. Introduction / relevance
2. Objective(s)
3. Activities
4. Output
5. Management & evaluation
6. Risk assessment
7. Time schedule
8. Budget

Annexes

Other references

- Civicus: writing a funding proposal
- Michigan State University: guide for writing a funding proposal
- ESRI: writing a competitive GRANT application
- REC: project proposal writing

GEONETCAB

Again:

- *SHARED PROBLEM*
- *SHARED LANGUAGE*
- *SHARED SOLUTION*

If all else fails, try to link with a more popular (and easy to understand) topic.

4. Capacity Building

General

Marketing is promotion + capacity building.

Especially for the introduction of new technologies capacity building is important at all levels.

Capacity building is the instrument to increase self-sufficiency and make solutions work.

Think of:

- Different instruments for different levels: workshops for decision makers and awareness raising, detailed technical training for professionals.
- Provide follow-up. Getting funding for good capacity building is difficult: everybody agrees that it is important, but nobody has time.
- Training is usually part of funding of big projects that are managed by big companies or ministries, as a consequence capacity building is forgotten (in the end).
- Aim at small budgets that are available without having to tender.

Examples & references

Approaches to GIS programs in health education
Short examples from different universities (no EO as such, but it is a small step)

EPA handbook: optical remote sensing for measurement and monitoring of emission flux
Also not strictly EO, but explains remote sensing techniques with similar underlying processes, including optical, LIDAR and thermal infrared

SERVIR and public health
Examples of projects and capacity building to support public health initiatives in the developing world, making use of EO

GEONetCab capacity building web www.geonetcab.eu
Compilation of tutorials, references, open-source software, etc.

GEO Portal: www.earthobservations.org

More references

A Rough Google Earth Guide

MEASURE Evaluation Global Positioning System Toolkit (USAID)

Handbook of Research on Developments and Trends in Wireless Sensor Networks: From Principle to Practice

Further details:

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www.geonetcab.eu