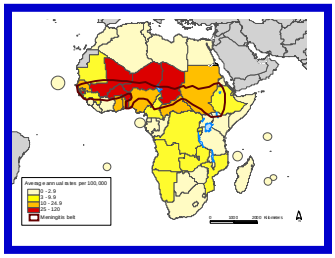
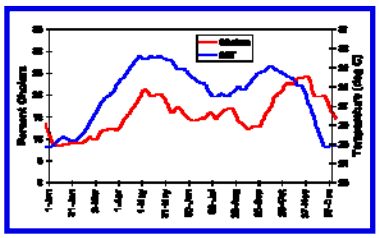
IEEE Committee on Earth Observation (ICEO) workshop summary: GEOSS Workshop XXVIII – Health and the Environment

GROUP ON EARTH OBSERVATIONS





GEOSS Workshop XXVIII: Health and the Environment.

Venue: World Metrological Organization (WMO), Geneva, Switzerland

Date: Tuesday July 7th Through Thursday 9th, 2009

This workshop will focus on advancing the development of standards and methodologies for integrating global public health information with environmental observations to improve health decision-making at the international, regional, country and district levels. The workshop will provide a forum to review existing systems, tools, and best practices in this domain, and to identify collaborative operational projects that will address high priority health needs. Particular emphasis will be on improving the collection and distribution of coordinated epidemiological and environmental information to meet the diverse needs of the health community.

For more information, refer to the ICEO website: http://www.ieee-earth.org/.

GEOSS Workshop XXVIII – Health and the Environment

World Meteorological Organization, Geneva, Switzerland
Tuesday July 7, through Thursday July 9, 2009

Co-organizers:
Amy Budge, Pietro Ceccato, Emily Firth, Gary Foley, Donna Hudson, Felix Kogan, Murielle Lafaye, Francoise Pearlman, Jay Pearlman, David Rogers ,Giovanni Rum, Andreas Skouloudis, Madeleine Thomson

Summary

This workshop addresses steps forward in the expansion of existing health databases such as the WHO Open Health database to more effectively incorporate environmental information. To move in these directions, the workshop will provide a forum to review existing systems, tools and best practices and to identify collaborative operational pilot projects that can address high priority health needs. Particular attention will be on improving the collection and distribution of coordinated epidemiological and environmental information to meet the diverse needs of the health community. This workshop will also launch the "Health and the Environment Community of Practice". This new community of practice will address the user perspective of issues involving environment and health with an emphasis on using environmental observations to improve health decision-making at the international, regional, country and district levels.

Background

The Global Earth Observation System of Systems (GEOSS) is envisioned to cover all aspects of Earth observations and by this will introduce a new capability for monitoring environmental processes. GEOSS is a complex "system of systems," including sensors, communication systems, spatio-temporal data infrastructures and other components essential for understanding the Earth and its impact on a host of important societal benefits. In addition, GEOSS includes models and data fusion processes to create information from the observation data that is essential for decision making. The 2003 Earth Observations Summit established the objective *"to monitor continuously the state of the Earth, to increase understanding of dynamic Earth processes, to enhance prediction of the Earth system, and to further implement our international environmental treaty obligations"*. GEOSS goals are to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behavior of the Earth system.

The GEOSS 10-year Implementation Plan states that GEOSS will provide the overall conceptual and organizational framework for integrated global Earth observations to meet user needs. GEOSS will be a system of systems consisting of existing and future Earth observation systems, supplementing but not supplanting their own mandates and governance arrangements. It will provide the institutional mechanisms for ensuring the necessary level of coordination, for strengthening and supplementing existing Earth observation systems, and for reinforcing and supporting component systems in carrying out their mandates.

The emphasis of GEOSS is on societal benefits, initially in nine key areas. Sound management of the Earth system, in both its natural and human aspects, requires information that is timely, of known quality, long-term, and global. Interpretation and use of Earth observations requires information on drivers and consequences of change, including geo-referenced socio-economic data and indicators. The nine areas addressed in the GEOSS Implementation Plan are:

- Disasters: Reducing loss of life and property from natural and human-induced disasters
- Health: Understanding environmental factors affecting human health and well-being
- Energy: Improving management of energy resources

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- Climate: Understanding, assessing, predicting, mitigating, and adapting to climate variability and change
- Water: Improving water resource management through better understanding of the water cycle
- Weather: Improving weather information, forecasting and warning
- Ecosystems: Improving the management and protection of terrestrial, coastal and marine resources
- Agriculture: Supporting sustainable agriculture and combating desertification
- Biodiversity: Understanding, monitoring and conserving biodiversity

Although all of the above societal benefit areas (SBAs) of the Implementation Plan are important for GEOSS, this workshop will focus specifically on Health.

The GEO Work Plan

The GEO 2009-2011 work plan takes the GEOSS 10-year Implementation Plan through its midway point, and has an increasing focus on putting the components of GEOSS into place. This phase of the plan will enable connections to be realized between diverse observing, processing, data-assimilation, modeling and information-dissemination systems. The new work plan will also enhance the role of users and Communities of Practice within GEO. The work plan has several tasks associated with Health. GEO is addressing the use of environmental information for predicting and responding to disease and health issues. A long term objective is integration of this information into a global health data base for health system managers. GEO health task HE-09-01, which is the primary task addressed in this workshop, is aimed at improving in-situ environmental and health data collection for the utilization and validation of remotely-sensed data.

Workshop Theme

The workshop will focus on how GEOSS can support the collection & distribution of health and environment information and meet the diverse needs of the health community. The workshop outcome will be a refined set of requirements based on existing developments. These will guide the connection of WHO's Open Health information tool and other health and environmental information systems to the GEO Portal and GEOSS Common Infrastructure (GCI) in the 2009-11 timeframe.

Workshop Objectives

- Confirm approach for developing an integrated GEOSS environment and WHO Open Health Information System
- Expand participation and contributions to GEO Workplan tasks and synergies between tasks
- Launch the "GEOSS Health and Environment Community of Practice"
- Launch an action Plan for collection of environmental health-related information, including a call for contribution
- Formulate recommendations for new Pilot Programs (such as malaria or other disease) to assess and validate the environment-health integrated Information System
- Establish plan for November Workshop in Washington DC, USA

To establish a framework for discussions, the 3 day workshop will include invited presentations by decision makers, user communities' representatives, providers of health and environmental information, and observation system developers. Break out sessions will allow the audience to further explore key topics in small interactive groups. A concluding session will summarize the workshop outcomes and way forward.

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Sponsorship

The organizations and agencies listed below are acknowledged for providing financial, organizational and/or logistical co-sponsorship of the GEOSS workshop:

Centre National d'Etudes Spatiales (CNES)

Committee on Earth Observing Satellites (CEOS)

United States Environmental Protection Agency (US EPA)

European Commission Joint Research Center (JRC)

IEEE:

- IEEE Committee on Earth Observations (ICEO)
- IEEE Engineering in Medicine and Biology Society (EMBS)

International Research Institute for Climate and Society (IRI)

HC Foundation (HCF)

National Oceanographic and Atmospheric Administration (NOAA)

World Health Organization (WHO)

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Workshop Attendees Listen to Presentations

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Workshop Agenda

Day 1 Morning Session
Moderator: Murielle Lafaye

Time	Topic	Speaker
SESSION 1: Opening		
9:00	Welcome and Opening	**Jose Achache ,** Director GEO Secretariat
9:15	Introductions and Logistics	**Francoise Pearlman**, IEEE
9:20	Workshop Objectives	**Donna Hudson**, EMBS
9:40	GEOSS and Health, introduction to the Work Plan	**Giovanni Rum**, GEO Secretariat
10:00	Climate change and Health – one health approach	**Pai-Yei Whung**, EPA
10:20	Health and Environment User Perspective	**Emily Firth,** WHO
SESSION 2: Information Systems for Health		
10:40	Break and Refreshments	
11:00	Environmental information use and tools for Health information systems – an overview	Panel: **Pietro Ceccato**, IRI (keynote speaker/ chair) 1. Objectives – **Pietro Ceccato** 2. Expanding and Accelerating Public Health Applications through NASA Earth Science Research - **John Haynes,** NASA 3. Satellite data provider - **Murielle Lafaye**, CNES 4. Satellite data provider – **Felix Kogan**, NOAA 5. Integration of systems (Global health Observatory) – **Knut Staring** WHO 6. National Meteorological and Hydrological Services - **Haleh Kootval**, WMO 7. Integration of systems (GEO portal) – **Giovanni Rum**, GEO Secretariat
12:30	Lunch (no host in WMO cafeteria)	

Day 1 Afternoon Session
Moderators: Emily Firth

SESSION 2: Information Systems for Health (Continued)

Time	Topic	Speaker
13:45	Interoperability, standards and best practices	**Donna Hudson,** IEEE
14:05	Introducing Communities of Practice concepts	**Sarah Carter**, EPA

SESSION 3a: On-going Initiatives underlining use of environmental Information for Health – Air , and Water-Borne Diseases

14:20	Overview of Air/ Water-borne disease initiatives Using MERIT as an example	**David Rogers**, HCF
14:40	Panel of Decision makers, users and provider addressing information system approaches, needs and gaps/challenges	Panel Topics: Air-borne and atmospheric-related diseases: Chair **David Rogers** • Meningitis - **Eric Bertherat,** WHO • Air quality and health – **Andreas Skouloudis,** JRC • Air pollution (aeroallergens health) – **Hillel Koren,** University of North Carolina • Heat Health Watch Warning System at Météo France August 2003 - July 2006 : from tragedy to saving lives – **Jean-Claude Cohen,** Meteo France
15:45	Refreshment Break	
16:30	Panel continued and dialogue with workshop Participants	Water-born diseases: Chair **Juli Trtanj** • Cholera in Mediterranean sea – **Murielle Lafaye,** CNES • Environmental Stressors and Disease – **Tracy Collier**, NOAA • Early warning systems for water-borne diseases - **Juli Trtanj,** NOAA
17:30	Day 1 summary	**Murielle Lafaye, Emily Firth, David Rogers**
18:00	Adjourn Day 1	

Day 2 Morning Session
Moderator: Andreas Skouloudis

SESSION 3b: On-going Initiatives underlining use of environmental Information for Health – Vectorr Born Diseases

Time	Topic	Speaker
8:45	Remote sensing, health and climate change: global research priorities	**Simon Hales,** WHO
9:00	Overview of EWS applications to Vector Borne Diseases	**Steve Connor**, IRI
9:30	Panels of Decision makers, users and providers addressing information system approaches, needs and gaps/challenges Note: there will be a 15 minutes refreshment break approximately half way through the panel (10:45)	Chair **Felix Kogan**, NOAA Panel Topics: • Malaria - **Johaquim DaSilva** (WHO-AFRO, Zimbabue), **RC Dhiman** (ICMR, India - Ongoing initiatives for development of EIS for Malaria in India), **Jiratiwan Kruasilp** (GISTDA, Thailand), **Christoph Rogier** (IMTSSA, France – remote sensing and malaria risk analysis in the French Army), **Rainier Sauerborn** (Institute of Tropical Medicine, University of Heidelberg, Germany) • Plague – **Eric Bertherat** (WHO, Switzerland) • Dengue – **Francisco Mendonca** (Univ. Federal do Paraná - Dep. Geografia Centro Politécnico, Brazil); **Mario Lanfri** (CONAE, Argentina) • Rift Valley Fever - **Jacques-André NDIONE** (Centre de Suivi Ecologique de Dakar, Sénégal) - Building a EWS for Rift valley fever in Ferlo (Senegal): what can be expected from remote sensing; **Pierre Formenty** (WHO, Switzerland)
12:00	Panel and other workshop Participants Dialogue	
12:30	Lunch (no host in WMO cafeteria)	

Day 2 Afternoon Session
Moderator: Jay Pearlman

SESSION 4: Environmental Information Needs

13:30	Summary of Session 3 findings	**David Rogers** HCF and **Steve Connor**, IRI
14:00	Space-based solutions and collaborative network development in support of health and climate change adaptation: Case studies from Namibia and Burkina Faso	**Joerg Szarzynski** UN-SPIDER
14:30	Potential Pilot Programs – approach and convergence – a view to the future	West Africa (Burkina-Faso: Meningitis), East Africa (Ethiopia - malaria), South America (Argentina/Uruguay/Brazil - dengue) – Moderator **Joan Aron**, USEPA and **Pietro Ceccato**

SESSION 5: Break-out session

15:30	Break-out charter	**Jay Pearlman**, IEEE
15:40	Refreshment Break	
16:00	Breakout sessions (Note: continued on Day 3)	Define user needs, recommend approaches, identify pilots Group 1 – infrastructure and requirements Group 2 – community of practice Group 3 – potential pilot programs
17:30	Day 2 summary	**Steve Connor, Emily Firth, Jay Pearlman**
17:45	Adjourn Day 2	

Day 3 Session
Moderator: Steve Connor

SESSION 5: Break-out session (continued)

Time	Topic	Speaker
9:00	Break-out sessions continued (same groups as Day 2)	Define user needs, recommend approaches, identify pilots
10:20	Break	
10:45	Reports from Break-out groups	Break-out leaders and rapporteurs

SESSION 6: Concluding session

12:00	Lunch (no host in WMO cafeteria)	
13:00	Launch the "GEOSS Health and Environment Community of Practice"	**Giovanni Rum**
13:30	Infrastructure and Requirements	**Murielle Lafaye**
13:45	Formulate recommendation for Pilots	**Pai-Yei Whung**
15:15	Break	
15:45	Workshop summary and wrap up	**Giovanni Rum, Emily Firth, Pai-Yei Whung**
16:15	Adjourn Workshop	

Presentations and Discussion Summary

July 7, 2009 (Workshop day 1)

Murielle LaFaye from CNES opened Session 1 and welcomed the attendees.

Jose Achache, the GEO Secretariat Director**,** provided an introduction to GEOSS. He stressed that GEOSS is about informed decisions. Mankind has become a geophysical parameter. We need to introduce earth sciences into the decision making process. Observations for the System of System should be shared between disciplines, across boundaries and countries and coordinated. There are duplications and gaps in observations as well as sustainability gaps. The GEO process is closely connected to the political process. Ensuring access to data can be provided by many mechanisms such as the GEO portals, data sharing principles, free access to LANDSAT archive, and global digital elevation model at 30 meter resolution. Prof Achache closed his presentation by providing examples which involve both health and the environment: meningitis, air quality and health. He

stressed the need for connectivity between information systems in various domains such as climate, and bio-diversity.

Francoise Pearlman provided the workshop logistics comments and previewed the agenda. She indicated that the proceedings will be available on the ICEO website at http://www.ieee-earth.org/Conferences/GEOSSWorkshops#GEOSSWorkshopXXVIII-Health.

Donna Hudson from the University of California and the IEEE Engineering in Medicine and Biology Society highlighted the workshop objectives. Prof. Hudson gave examples of information systems for health and also information systems for the environment. She indicated that in order to achieve an integrated system, the first objective is to establish an environment for sharing technical information. Practical outcomes would include the creation of pilot project where on-going working groups continue to collaborate. She concluded by reminding the audience of the final objectives of the workshop: defining user needs; establishing a recommended approach; identifying projects, and defining the next steps to do something practical.

Giovanni Rum from the Geo Secretariat provided an introduction to the GEO work plan. He listed the GEO main objectives. Health is an example of one of the societal benefit areas (SBAs) involved in a System of System. The work plan is the agreed framework to implement GEOSS. It includes a set of practical tasks which are carried out with the help of countries and participating organizations. The plan is structured in 2 parts: 1) GEOSS fundamentals which are cross-cutting; 2) specific actions targeted in the 9 GEOSS societal benefit areas. Health has 3 overarching tasks. The task sheet is the actual working tool; it includes a description of the activity with deliverable and schedule, and a list of participants. The health tasks include: HE-09-01 Information system for health; HE-09-02 monitoring and prediction systems for health (4 subtasks) ; and HE-09-03 end to end projects for health (3 subtasks). He showed how the 3 tasks will be linked and discussed the objectives of each task.

Q&A
Jay Pearlman from IEEE: HE-09-02 appears focused on air quality; should it be broader?
Giovanni Rum – focus areas are a function of the interest of the task participants

Pai-Yei Whung, USEPA chief scientist, gave a briefing on climate change and health – one-health approach. She gave a brief introduction to USEPA. Dr Whung introduced the “one-health” approach stressing the importance of climate change and health. Her talk was in 3 parts: highlight of proposed U.S. climate policy, discussion on climate and health, and possible role of GEOSS in climate and health. Dr Whung addressed several key climate policies including: 1 the black carbon bill which would direct EPA to conduct a comprehensive study on black carbon emission to improve world-wide public health; 2) the American Clean Energy and Security Act which has sections on climate change and health; 3) EPA’s proposal one reporting of greenhouse gas emissions, and 4). EPA’s proposed greenhouse gases endangerment finding. She then addressed climate change and health, differentiating between climate variability and climate change. She stressed the potential impact to human health of climate change. She gave examples of health impact, and EPA’s interest in the areas of water, flood, and resulting sewage overflow, and potential increase in water-borne diseases. Another example was addressed, heat wave health vulnerability mapping. EPA has initiated a climate change and health workgroup which brings a cross-EPA perspective. EPA is also participating in interagency work on climate change and health, including work with WHO. Potential roles for GEOSS in climate change and health include a focus on development of health warning systems, and inclusion of environmental health as a component of public health.

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Q & A; **Yves Tourre**- regarding the distinction between climate change and variability; what is the scale on the viewgraph showing trends?
Pai-Yei Whung - It should be seamless between weather, climate variability and climate change
Jean-Claude Cohen- He notes that cold spans have been as much health impact as heat waves
RC Dhiman (from India)- He looks forward to roles of GEOSS in climate and health.

Emily Firth from WHO provided the health and environment user perspective. She gave a brief overview of the topic: opportunity, control strategy and decision making framework, role of environmental information systems, and finally the end-to-end challenge. How can we apply the tools at a global level, but also maintain value for a country and district level? The framework for this includes: 1) natural history of diseases (risk); 2) country capacity (how can the country respond in case of outbreak - infrastructure); 3) technical means (existence and availability of medical supplies). Environmental considerations apply mostly to item 1, but also more indirectly to 2 and 3. Environmental information should be considered in line with other strengthening activities and partnerships. Ms Firth gave example of health projects which contribute to the strengthening of decision making. In many cases, these involve partnerships. This needs to happen at all levels of decision making: multi-source, multi-sectors, multi-level (across different geographic levels and regions). She addressed the role of environmental information, and gave examples within WHO (country health information; neglected tropical diseases; epidemic and pandemic response, etc). Risk assessment relies on tools support such as generating international risk maps (yellow fever, rift valley fever). Decision support tools are essential for early warning (example meningitis). There is a need for strategic prioritization – WHO has an internal working group addressing this. Finally, end to end solutions need to tie in the various levels of decision making.

Q&A
Yves Tourre - why is WHO not joining GEO?
Emily Firth– the decision is not a her level
Giovanni Rum– not being a member of GEO does not prevent WHO from working together with GEO participants
Hillel Koren – are there examples of using satellite images for warning and risk assessment?
Emily Firth– she is not aware of any use specifically regarding GEOSS, but there are examples of forecasts integrated into decision making tools; she is looking at technical integration from the IRI data base into the global observatory; she is also aware of data feeds from FAO, population data from Landsat, etc.

Session 2 of the workshop, Information Systems for health, was introduced by **Pietro Ceccato** from IRI**.** He gave an overview of environmental information use and tools for health information systems. Environmental information such as climate, land use, and biodiversity is necessary but needs to be complemented by other information and integrated with vulnerability of human population into a decision support system. Available data includes in-situ and remotely sensed data, each with their own challenges.
Pietro then introduced the current initiatives to be addressed further by panel participants. These initiatives include the development of synergy between National Meteorological and Hydrological services and Ministries of Health (Haley Kootval); remote sensing products (John Haynes, Felix Kogan and Murielle Lafaye); and development of integrated systems to combine and analyze disease data with environmental data.
He then highlighted the experience from IRI. This includes: study and analysis of many remotely sensed products (rain fall measurements for example); study the relationship between the environmental factors and diseases; and environmental monitoring and forecasting products via the IRI data library. He indicated that the data is provided through the internet, with the goal of making access as easy as possible. IRI provides tools as well (example of a tool to compare time series of rain fall in Africa versus average rain fall). The data is integrated with other systems, being displayed on Google earth, or NASA worldwind server. IRI provides training in summer course and in-country. As community works together to develop products showing links

with diseases, the products need to be integrated into decision systems, and finally the decision makers need to be trained

John Haynes from NASA applied science program for public health reminded the audience of his mission statement. He emphasized the need to partner with decision makers from the start to build an interdisciplinary community. He reviewed the constellation of earth science remote sensing observatories, addressing current and future satellites. The NASA applied science program bridges the gap between research and health. It focuses primarily on infectious diseases, emergency preparedness and response, and environmental health. He then addressed the potential health effect of climate variability. For example, global climate change may affect air quality through increase in ground level ozone and production of airborne allergens. John Haynes then discussed several examples of projects done in collaboration with other organizations, indicating the source of the remotely sensed data in each case: Enhancement of the environmental public health tracking network (EPHTN) in collaboration with CDC and EPA; dust surveillance in the Southwest in collaboration with UNM, Arizona, and CDC), leading to predictions of dust storms. Increased accuracy is shown when including satellite information in addition to ground information. He also showed charts on Malaria and Avian Influenza. He mentioned the Laboratory for Global Health Observation, and indicated that NASA scientists are teaching remote sensing classes as part of the curriculum.
.
Q&A: **Yves Tourre** – what kind of feed back are you getting from the multi-disciplinary curriculum?
John Haynes – it opened a whole new thought process for students

Murielle Lafaye introduced the French space agency, CNES. CNES is in charge of proposing space strategy for the French government and conducting space programs.
She introduced the concept of tele-epidemiology. It is a multi-disciplinary approach, bringing together environmental data, epidemiologic data, animal data, and sanitary data. Key elements include: understanding the mechanisms on the ground, identifying key parameters (pathogen, environment), integrating space components and developing adapted products for/with the users such as risk maps. Murielle Lafaye gave the example of rift valley fever (information includes the location of ponds, mosquitoes risk, cattle distribution area, etc). CNES is a facilitator more than a data provider The distribution is done by scientific laboratories and industrial partners involved in satellite missions. She gave a list of laboratories and data/product they distribute. She highlighted the RedGems site (RedGems stands for Re-emergent Diseases Global Environment Monitoring from Space) where space data is integrated with other information. The site is organized by diseases (example Rift Valley Fever) and projects. (Vibirio sea project). She concluded by discussing the new CNES focus on information and data exploitation.

Q&A – **David Rogers** – he asked Murielle to comment on sustainability of projects
Murielle Lafaye– sustainability is a very important point; bring users into GMES process at European level
Jay Pearlman – he asked about CNES cooperation with other space agencies
Murielle Lafaye – they cooperate with CONAE in public health; they although cooperate with the Algerian space agencies; it is an on going process
John Haynes - continuity of operations is a major issue for US; the National Academy Decadal Survey provides blue print of spacecrafts which shoould be launched over next 20 years.

Felix Kogan from NOAA addressed the vegetation health indicators used for monitoring and predicting vector-born diseases. He gave some statistics on the global burden of infectious diseases for a variety of diseases including Malaria. He then discussed the impact of environment on Malaria: climate and landscape determine the distribution of mosquitoes; weather affects the timing and duration of the outbreak, warm and wet surfaces stimulate mosquito activities. In situ information is not dense enough, thus the use of a satellite-based Advanced Very High Resolution Radiometer (AVHRR) (30 years of data are available). The vegetation health estimate

makes use of the following elements: chlorophyll, moisture, and temperature. The technique has been used for interpretation regarding agriculture, fires, malaria spread.. Felix Kogan gave the example of using Malaria risk maps – looking at moisture condition versus thermal signatures. Validation is performed using in-situ data.. He gave further examples of malaria, Rift Valley Fever, and Dengue. See the NOAA website at http://orbit.nesdis.noaa.gov/smcd/emb/vci.

Q&A
Christophe Rogier – emergence of resistance to drugs was responsible for increase in malaria cases/mortality; another factor is naturally acquired immunity. There are many other factors associated with the level of transmission which must be taken into account
Jacque-Andre Ndione (Senegal) – suggests using vegetation condition index rather than normalized differential vegetation index (NDVI)
Ramesh Dhiman (India) – technique does not account for variations in economic condition

Knut Staring from WHO, introduced the Global Health Observatory (GHO) which will be released in the near future (by the end of the summer). The GHO includes data and tools. It is a part of the global health platform, which should expand beyond the global level to the country level. He summarized the criteria and operating conditions. He showed the portal and disseminating platform, currently under testing. There are data views for the inexperienced user, and more advanced capabilities for experienced users. There will be dynamic country profiles. All data views can be downloaded as either pdf or excel. An interactive mapping example was given for Sudan.. He also showed a data overlays for health facilities in sub-Saharan Africa.

Q&A
Yves Tourre:- are you willing to create linkages with other health information systems in the world?
Knut Staring –the system has not been launched, but this approach is consistent with the whole philosophy
Yves Tourre - how do you see the linkages with the European Center for Disease Control (ECDC)
Knut Staring - we are always thin king of linkages with CDC and ECDC; on the technical view we are very interested in collaborating with everyone.
Jay Pearlman – how do you indicate the uncertainty in the provided data?
Knut Staring – it is mainly in the meta-data via foot notes and comments

Haleh Kootval from the WMO Public Weather Services program addressed the synergy between the Meteorological offices and the ministries of health. She showed WMO's global operational network of data observation, collection, processing and delivering services to various user sectors. There is growing awareness of the linkages between human health and weather, and climate and in order to apply weather and climate information to the health sector, National meteorological and Hydrological Services (NMHS) need to shift from the role of provider of data and products to that of provider of societal services. In order to achieve this, there are a number of issues to consider including inadequate communications between NMHSs and users and lack of understanding on each side of each other's needs and capacity, lack of capacity in some NMHSs to deliver relevant and useful services, and difficulty in integrating these services into the national development plans and strategies. The approach adopted by the Public Weather Services Programme to build capability of NMHSs to overcome these challenges is through the concept of "Learning through Doing", whereby WMO has a facilitating role to bring together NMHSs and user sectors.. Issues to consider when delivering services include: improving communications with users and working together to deliver an improved range of services. Haleh Kootval gave the Madagascar project as an example, with its planning, implementation, and review phases. The planning phase focused on an assessment of capacity and needs between the Meteorological service and the Ministry of Health. The effort was focused on Malaria, Rift Valley Fever and Plague. The project resulted in the formation of a Weather, Climate and Health Working Group with the participation of the NMHS and Ministry of Health in Madagascar. Implementation of the work plan included training, research into climate

and disease relations, participation in the health and climate work of similar Working Groups in other countries and working with regional centers, and upgrading of meteorological observation network. Modest investments were shown to result in important outcomes. The experience gained in Madagascar can be replicated in other countries and WMO plans to assist NMHSs of its Member countries to build up their capability in service delivery through similar initiatives in other countries.

Giovanni Rum from the GEO secretariat briefed the GEOSS Common. The GCI includes the portal, clearing house, and registries. The Initial operating capability period has been extended through September 2009. A schematic diagram of GEOSS depicts the interactions between GCI components. Giovanni Ruminvited users to visit the portals and provide comments. He described the registries, and gave some examples. Registration is recommended and is quite easy. He briefly discussed the Architecture Integration Pilot (AIP) user cases. He then gave an example of a community access via community catalogue (data server) or portal (applications).

Q&A
Yves Tourre - On the pilot slide there are 2 words we are not used to: client and business
Giovanni Rum – in this case business is not related to money it describes the process through which the observation is transformed into the products; client is a software client

The presentation of Giovanni Rum ended Session 2 of the workshop. Pietro Ceccato thanked the presenters for their presentations, concluding the first day's morning session.

Donna Hudson from IEEE opened the afternoon session with a discussion on interoperability, standards and best practices. There is a need to be able to combine various sources of information (example e-medical records) in order to develop decision-making models. She provided a definition of interoperability, both technical and organizational. When considering connections with this workshop, during the definition phase, the focus is on people/organizations working together, while during pilot implementations, technological interoperability needs to be considered as well. Donna Hudson then talked about barriers to interoperability and techniques to overcome those barriers, both from the point of view of people/organizations and technologies. She mentioned the integration of Health Information Systems and Global Earth Observation Systems as an example of technologies interoperability. Syntactic interoperability allows systems to exchange data while semantic interoperability is the ability to automatically interpret the information using a common information exchange reference model. She then gave a variety of examples including Government involvement (EC's SEMIC.eu and US CORE.gov), regional interoperability (INSPIRE, OGC standards and others); Geospatial information (GEO standards and best practices); and. interoperability in health care (electronic medical records, HL7 standard for health systems). New technologies are introduced every day and they need to be plug-and-play. Donna Hudson closed her briefing by stressing the importance of common terminology and standards.

Q&A
Murielle Lafaye - she mentioned the work of the CEOS WGISS group
Donna Hudson - agreement to share the data is a negotiation issue.

Sarah Carter, EPA AAAS fellow, introduced the concept of Community of Practice (CoP). Three characteristics of a CoP are crucial: the domain (health and environment), the community of those who interact, and the practitioners, working toward some goal. She gave a list CoP classic characteristics, and then focused on 7 elements of a successful CoP. They included: common problem and goal; convener of stature; strong leader; majority interest; formalized charter; principals have to be at the "table" and willing to make decisions; common information infrastructure. She then focused on the CoPs associated with GEO and listed on the GEO website. The costal zones, water cycle, and energy CoPs have statements defining what they are trying to do including very specific tasks. A CoP can bridge gaps between data and end users (example air quality). CoPs

can serve multiple goals: for example providing tools specific to the community as well as addressing broader GEOSS constituents. Looking at the potential health and the environment CoP, she provided the following suggestions: establish goals and outcomes for the next 3 years, and establish levels of interest in different ideas. Includes several communities (such as operational modeling and forecasting community, earth observation community, local and regional environment managers, public emergency and health officials, public information delivery community(with outputs to the public officials.

Q&A
Julie Trtanj - how can we best identify outcomes for public health?
Sarah Carter - focus on pilot projects, but it is really up to the community to set directions
David Rogers – you talked about an ad-hoc community but last slide shows a process which is related to safety of life (members cannot come and go at will, as there is a 24/7 service to the community)
Sarah Carter – the outcomes need to be more permanent and survive the ad-hoc nature of CoP
Joaquim Da Silva – this is a bottom-up process, not institutional; we have to live with that fact. The more participants, the better, as long as the interest is there
Sarah Carter - it is always good to bring new ideas

David Rogers from the Health and Climate Foundation briefed an ongoing initiative (use of environmental information to improve health outcomes to provide context for the subsequent discussions. Decision-making timescales vary from hours to decades. There have been recent advances in the climate side, but still very large gaps between data and early warning systems. David Rogers addressed the evolution from climate outlook to health warnings, including all of the factors (socio-economic for example). He gave health examples from the heat and air quality as successes. Organizational changes include the development of the climate and health working group, and the notion of public service platform, to exploit new partnerships. Examples include the Ethiopia working group, and MERIT which is under leadership of WHO, but not a WHO program. As a Public service platform, he cited the climate service for the health sector (separates operational service from product delivery). In summary, David Rogers looks forward to engagement of the health community through WHO to establish an appropriate structure within the international community for delivery of climate services for the health community; he suggests the creation of national public service platforms to encourage cross-sector interaction within the health sector; he emphasizes the creation of science and training opportunities through collaboration across disciplines.

Eric Bertherat from WHO addressed epidemic meningitis. It is strictly a human disease. There is direct transmission from person to person, carried in the pharynx. The burden is particularly acute in the meningitis belt, with 10 to 15% fatalities. There is a huge difference of incidence between Europe/USA and Africa's meningitis belt. There is a seasonal increase and there are large epidemics during the dry season (6 to 8 weeks). Outbreak control includes: presenting lethality through case control; and reactive vaccination (detect outbreak, and launch vaccination within 4 to 6 weeks after detection of the outbreak). A new vaccine will allow real prevention effort, however it will take 10 years to cover the whole meningitis belt. The strategy is to start introduction of the new vaccine in the highest risk area. One question though: is the belt location going to change as a result of climate change? Eric Berherat then discussed the Meningitis environmental risks information technologies (MERIT) initiative. The meningitis belt was first described in 1963. The belt was the result of several risk factors; the incidence of meningitus starts increasing with the first fire and decreases/stops with the first rain. It has been linked with the wind from the desert (Hamattan). Many factors contribute to the current situation – introduction of new strain, environmental factors, vaccination of million of children. MERIT looks for common technical platforms to address 3 specific objectives: improve the application of climate and environmental information; enhance national and regional surveillance; and strengthen decision-making an public health policy development. Key partners include WHO, WMO, GEO, Health and Climate Foundation,

IRI, and several others. The focus is on very practical decision tools. The final chart of the presentation, shows a very hazy picture taken at 1pm in Nigeria to illustrate the impact of the Hamattan.

Q&A
Yves Tourre – do you have time series long enough to address the move of the Meningitis belt?
Eric Bertherat - yes and some districts are more affected than others; we are trying to clarify what other risk factors are involved (vaccination coverage, new strain, etc)
Joaquim DaSilva – the belt mores a bit to the south from time to time; do we know why? The climatic factors are not the same down south.

Andreas Skouloudis from JRC addressed health and air quality. Legislative directives are becoming stricter and keep requiring new data. Reporting at the national level hides environmental consequences on health due to data aggregation. A bottoms-up approach requires details from many disciplines, in comparable spatial and temporal resolutions. Andreas Skouloudis listed a number of questions regarding impact of the environment on health, such as: how many children are exposed to traffic emission, and what is a safe distance of living; are children affected when living next to ports, and many other questions. He then introduced the target differentiated methodology. The technique makes use of population density maps with high spatial resolution arranged by age group , together with suitable data layers (example traffic load). He gave an example of EU15 results for 2000 and 2005 using static maps. He then focused on two specific examples: intensive agriculture and its linkge to migration of labor and NO2 consistent monitoring. New technologies are available, such as "lab on a chip" sensors for toxic elements (currently installed in the port of Malta) which relay the information once per week. He would like to use the same type of devices for water quality. Connectivity between environment and health info system (CEHIS) final report provides specific recommendations.

Hillel Koren – do you have additional data
Andreas Skouloudis - yes

Hillel Koren gave a presentation on aeroallergens and airways diseases. He presented an overview of the Aeroallergen project. The project, which focuses on identifying user needs for earth observation data, to support public health activities. The project is divided in 3 parts, vectors (Pietro Ceccato is the lead), air quality (Rudy Hussar is the lead) and allergens (Hillel Koren is the lead). Hillel Koren then discussed the asthma epidemics triggers (genetics plus environmental) and economic impact. At least 10% of the population is affected with minorities and low-income population being disproportionally impacted. He provided a list of the atmospheric aerosols (anthropogenic and biological). He gave examples of application of air pollution data by end users. The impact of the regulation is extremely important. There was increased health protection in the US from the particulate matter national ambient air quality standards. Data provided through outreach mechanisms (such as air quality index, interactive Web course) is extremely important. Switching to aeroallergens, there is an impact of climate change to the level and toxicity of rag weed pollen for example. Also birch pollen comes earlier by about 3 or 4 weeks. There are models and maps forecasting particular allergens, but they are not necessarily used. Future needs include identifying and quantifying variables that affect pollen and other aeroallergens – there are complex biological, climatic and meteorological factors to be considered.

Q&A
Jean-Claude Cohen- information on pollens is much less accepted in Europethan general pollution information; do you have the same situation in the US?
Hillel Koren - there is much more reporting in Europe than in the US; the information is not sufficiently widespread
Joaquim DaSilva - do you use the aeroallergens for staffing shifts in hospitals for example (the way a sailor or surfer uses the web information)?

Hillel Koren - it is not widespread

Jean-Claude Cohen from Météo France presented the Heat Health Watch warning system showing the effect of cooperation between the ministry of health and the meteorological office. He then showed the heat wave situation in August 2003 with 15000 excess death in France and 50 to 75000 in Europe. Météo France developed a health warning chart (4 color level from green – no-heat wave, to yellow, orange and then red – intense heat wave). The levels are linked to pre-established action plans. A bio-meteorological index has been developed and thresholds are included in maps. A plan was developed and in place for the 2006 heat wave. It was forecasted a few days before. Lessons from the 2006 heat wave: they developed a model and validated it for 2000 through 2003. For 2006, they compared the expected mortality ratio versus observed ratio. There were approximately 4400 avoided death from the heat wave period largely due to public awareness, national response plan, and warning charts. This provided an approach for other projects such as cold span watch warning, and bio-meteorological products (UV, pollution, pollens).

Q&A
David Rogers - what was the role of the ministry of health – what is a sanctioned health product?
Jean-Claude Cohen – it was a long and painful process
Yves Tourre - they had a workshop of all the different French agencies
Jean-Claude Cohen – it was a dynamic solution

Juli Trtanj introduced the section of the panel on water-born diseases, indicating that over 60% of emerging infectious diseases are caused by zoonotic pathogens, and that 71% of those are from wild life. Vibrio strains are the most common cause of seafood-borne diseases. Changing ocean temperature appears to impact their range and potential for infection. Coastal impacts include beach closures due to bacteria.

Murielle Lafaye, talked about space tools for water-borne diseases. She addressed primarily vibrio, which is found in water and seafood. A high number of people live on the Mediterranean coast, resulting in increasing pressure. CNES is using MODIS 300 m resolution for water color, but its usefulness is limited due to blanking along the immediate coast. There is a problem in the transition between earth and water; the problem is regional, so a generic approach cannot be proposed. For the VIBRIOSea project, they set up a network of in-situ samples, and developed statistical analysis of the relationship between the environment factors and vibrio. The VIBRIOSea consortium has 8 partners. Sampling was done at 0, 300m, 1km and 3km. The data is on the redgems.org website. As indicated earlier, space-based water color radiometers suffer from damping at the transition along the coast. Initial findings indicated that the relationship for the vibrio and the environmental factors is very complex. Regional modeling is needed as well as possibly a new space instrument.

Q&A
Hillel Koren - were you looking at vibrio cholera?
Murielle Lafaye - not specifically cholera; parameters are chlorophyll, salinity
Rainer Sauerborn – what is the color code of the map – is it temperature?
Andreas Skouloudis – are you using a classical verification method?
Murielle Lafaye – yes; every site uses same protocol; 1 sampling per week
Felix Kogan NOAA has been performing a black sea study regarding coastal vegetation; it is being published
Giovanni Rum – current remote sensing is not a good fit for this purpose
Murielle Lafaye – models have been developed at regional level to deal with the problem of blanking; a mean between several measurements can be used as a workaround.

Tracy Collier from NOAA talked about the role of environmental stressors and their relationship to disease. In addition to looking at environment and pathogens, interaction with the host environment (animals and human) is

also taken into account. He gave the example of salmon going through the dams on the Columbia River. Some number of fishes were exposed to contaminants and subjected to stressors (physical or chemical), resulting in quantitative measurements showing an increase in disease resistance for the fish that were barged around the dams. He introduced the concept of sentinel species. He gave as examples the role of organochlorines in cancer-associates mortality in California sea lions; also sea otter population density decrease due to pollution. He concluded by emphasizing that environmental factors such as reduced water quality almost certainly have an effect on host resistance to pathogens.

Juli Trtanj from NOAA introduced NOAA's mission – to understand and predict changes in earth environment. She summarized the NOAA organization. She also addressed interagency work with NASA, NSF, and EPAI. There is a new emphasis on the Climate and Health area. She mentioned the One health working group within NOAA and interagency involvement. There are three main goals for the ocean and human health initiative (OHHI): lead the development of ocean and coastal related health early warning systerms, enhance benefits from the sea, build the OHH community. The conceptual model for human health and environment interaction is a loop which includes a suite of environment stressors (e.g. climate change, regional issues), resulting in ecosystem responses and human health outcomes. These outcomes are followed by responses and actions from governments, institutions, communities, and individuals. This is followed by evaluation, mitigation, and feedback. Juli Trtanj then talked about the need for early warning to enable earlier and thus more effective outbreak detection and response. She asked how, given a changing global environment, we can adapt and stay ahead of the curve. She gave a number of examples, such as the use of sea surface temperature as an early warning for cholera. Another example had to do with vibrio in the gulf of Mexico, where factors such as chlorophyll, salinity and sea surface temperature, were included . Only sea surface temp showed any correlation. She also discussed sampling for baseline modeling and predictions for vibrio as well as harmful algae bloom events, and others. Some of the key pieces that are needed are not there yet. One must include satellite data as well as various kinds of in-situ sources (including low-tech), sentinel species, and looking at the social context. A framework for Early Warning System was provided, which could be applied to pilot projects. She listed the following characteristics: problem focused; scalable; time scales from days to decade; participants with well defined roles; integrated health data available. She closed her briefing by mentioning a couple of pilot project for the group to consider: cholera/vibrio Early Warning System, coastal water quality monitoring, integrating marine diseases and contaminants.

Q&A
Hillel Koren - usually beaches are closed after something happens; it is desirable to predict the situation
Juli Trtanj - may be in a year, we could do a forecast based on sea surface temperature; for bacteria; there is work going on in the great lakes where the model works for particles; they are putting the pathogens in the model now – it is very promising but there is a lot of observation data
Joaquim Da Silva – are there any initiatives for the developing world?
Juli Trtanj - some of the sampling initiatives could be used with training; the cholera work in Bangladesh for example

Murielle Lafaye and **David Rogers** closed the first day of the workshop. They thanked the speakers for the level of the presentations and the audience for their passion. This is a new and difficult discipline, but there are many interesting initiatives.
David Rogers cited that a focus on health outcomes is needed to guide the collaboration. There are real problems with common themes: surveillance, earlier warning, environmental information, sociological factors and other considerations.

Yves Tourre – when we talk about Early Warning (example avian flue pandemic), how can we coordinate all of that? Who is "we"? There is a need for joint efforts and a body with authority.

IEEE Committee on Earth Observation (ICEO) workshop summary: GEOSS Workshop XXVIII – Health and the Environment

July 8, 2009 (Workshop day 2)

Simon Hales from WHO opened the day. He presented the global research priorities for remote sensing, health and climate change. He talked about the WHO work plan area of global burden of disease, looking at relevance of GEOSS, and potential applications of remote sensing. There is a lot of potential in the areas of modeling empirical relationship between climate and various health related factors (such as water security, food security, vector-borne diseases, others). Another area is that of vulnerability and adaptation assessment due to climate change (indicators of vulnerability), by modeling the spatial distribution of relevant exposure (physical environmental exposures, physical infrastructure, demography, etc). The last area is the support of Early Warning, and emergency response.

Stephen Connor from IRI spoke about Early Warning applications to Vector-borne diseases. Climate change impact on vector-borne diseases is a concern. He compared long terms trend, versus decadal variability, versus inter-annual variability. There may be a long term trend for warming, but there was a downward trend over 30 years. There was a similar pattern for rainfalls in the Sahel. Chart compares long term (18% variance) versus decadal (27% variance) and inter-annual variability (55% variance). The goal is to move to identify and respond to epidemics much earlier. Stephen Connor introduced the Vector-borne disease transmission cycles (similar to one health concept). He talked about using climate information to predict infectious diseases, with specific focus on malaria in the discussion. Water is important for mosquitoes breeding in cities. Temperature affects the rate of the parasite development. He gave historical examples of early warning system (1911 proposal for India further developed into the 20's). In 1949, the data was reviewed using statistical analysis. Moving forward, there was a major epidemic in 1996/98, leading to a demand for an integrated framework for a Malaria Early Warning System (MEWS). Monitoring and surveillance are not sufficient (you are already in the middle of the epidemic when you can act). The idea is to try and fill the gap by planning, preventing and responding. There is demand for evidence-based health policy. He gave the example of Bostwana (more than 20 years of case confirmed data) where they performed vulnerability monitoring. and seasonal climate forecasting, resulting in 5 months leading time. The addition of environmental monitoring enabled localized response and decrease of the lead time to 2 months. In addition, case surveillance includes the use of case thresholds with specific action plans at district level, district level with national level alert, and national level. Stephen Connor then addressed the annual MEWS activities for Southern Africa. The 2005/06 season was a test case. It was a wet year following 3 drought years, and exhibited a classic post-droughts epidemic. The number of cases was much reduced when compared with the prior major epidemic in 96/97. This may be an example of climate change adaptation. There is growing interest to apply this approach to other countries (Columbia, West Africa, East Africa, etc). Interplay between rain fall and temperature is complex and varies with location. There is a climate information tools for Malaria which can be queried on line (it indicates climate suitability for malaria transmission showing rain fall, temperature, and relative humidity). The data for Africa is not very good, however MODIS night time passes give a good approximation of night time temperature for the continent. He discussed the use of temperature and rainfall data, as well as a number of other parameters in vectored capacity models. He mentioned that data is underutilized. He emphasized the establishment of multi-agency working groups – ministry of health and partners in public health (Summer institute at IRI in NY, Ethiopia, Madagascar, Kenya). Stephen Connor recommended the use communities of practice; providing a lot of training, keeping people networked, and innovating (use of iphones, etc). Technology may be available; the local staff needs to be trained to use their data. Surveillance and adaptive control systems need to be informed more broadly by changes in environment, community vulnerability, and climate risk.

Q&A
Christophe Rogier – In Bostwana, can you attribute the decrease in cases to monitoring systems rather than to the introduction of new drugs?

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Stephen Connor – there is a combination; the change in the drug made a massive difference, but you still have the underlying climate variability

Christophe Rogier – In Mali, weather monitoring has less interest in endemic areas

Stephen Connor – the actual product was commissioned for Angola, and they did the rest of the countries as well; the seasonality maps can get you some information (such as eliminating non-malaria cases)

Christophe Rogier – do you have connections with the MAP project?

Stephen Connor - we do not work together very well

Rainier Sauerborn – should spatial targeting be relevant?

Stephen Connor - yes; for example it is relevant for the shift in the meningitis belt; there is a need for stratification map in Malaria (Ethiopia has map developed in the 50's; there is a need to use locally available data (ground based data to be blended with satellite data)

Yves Tourre – what are the metrics used to show that using the climate information can be cost effective?

Stephen Connor - cost of control (prevention versus treatment); prevention cost is a bout one tenth the cost of treatment

Felix Kogan introduced the panel members, for the panel on vector-borne diseases, stressing satellite observations and applications. There is a big gap between research and services. To overcome this gap, validation is needed. We have users and developers. What is being developed should be user friendly.

Joaquim DaSilva from WHO's regional office for Africa spoke about experience using products from the climate community in Southern Africa. There is a partnership with most climate organizations in the region. The goal is for experts in the region to collaborate. They have been provided with climate forecast and have developed risk mapping for malaria for each country in the region. Predictions are made in how the season is going to play out and each country records a different score. Experience shows that the information has been useful in allocating resources over the last 6 years. They try and gather as much information as possible to inform risk maps at the country and district level. Early Warning is linked to contingency plan (usually with emergency stock piles for response to decrease the magnitude of the epidemics).

Ramesh Dhiman from the National Institute for Malaria Research in India, spoke about India's approach to Early Warning Systems (EWS) for Malaria and Dengue. He showed the dengue endemic situation. He also showed the distribution of other vector borne diseases in South East Asia (Japanese Encephalitis, Filariasis, Chikungunya, Malaria). He showed a map of the outbreaks for the above diseases, highlighting the areas which are of interest for EWS. He addressed malaria vulnerability due to climate; the reasons for Malaria outbreaks include unexpected heavy rain and changes in ecological conditions, as well as lack of adequate surveillance and other administrative issues. Ramesh Dhiman addressed the data needs for EWS. These include existence of a surveillance system, monthly meteorological data, environmental data (rain falls, sea surface temperature, land surface temperature), vegetation index, socio-economic situation, and intervention measure. The correlation between Malaria and meteorological parameters as not consistent for the whole country: there is good correlation in some areas, but it is inconclusive in others. There are ongoing projects on climate variability and change (framework for forecasting Malaria being developed with Michigan University; impact of climate change on Malaria and Dengue at nationals level) . There are gaps and challenges, and a need for capacity building.

IEEE Committee on Earth Observation (ICEO) workshop summary: GEOSS Workshop XXVIII – Health and the Environment

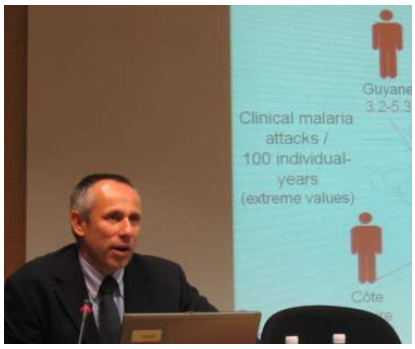
Q&A

Rainer Sauerborn – how do you extract the data when over 60% go to private practitioners?

Ramesh Dhiman - It is true that the reporting system doen not capture all the cases of Malaria(as persons go to private practioners also). But the epidemiological data compiled through active and passive surveillance reflect the trend all over the years.

Jiratiwan Kruaslip from Thailand spoke of the malaria work in her country. They developed the malaria distribution pattern based on time series analysis. She focused on a district with endemic malaria in Tak province for a pilot study using remote sensing. She showed resulting risk maps for various seasons. They are planning to combine satellite data from THEOS for further analysis.

Christophe Rogier from the Institute for Biomedical Research of the French Army, discussed the incidence of malaria in the French army stationed in Africa.



He did a study involving about 1100 people in 5 countries of Africa, looking at adherence to chemo-prophylaxis, environmental data, and individual characteristic. He used NDVI from Terra satellite. There were big differences between companies depending on the individual missions. NDVI was the major factor. In Dakar, malaria transmission is highly seasonal (very localized and during 2 months only). The environmental factors at a small scale are very important. He compared 3 models: the best one used portion of "built classes" within 200m and distance to vegetation classes. They looked at breeding sites, and whether they can be identified with remote sensing. They are doing a study of 45 sites (200mX200m), looking at characteristics of water bodies and larva density, and measuring mosquito's aggressiveness and malaria transmission. They are looking for remote sensing indicators to reflect this situation.

Rainier Sauerborn from the Institute of Tropical Medicine at the University of Heidelberg, addressed the integration of environmental and health information systems using a case in Burkina Faso. He discussed the need for comprehensive data for decision-making; there are several sources of data (socio-economic and environmental) leading to intervention design. For the socio-economic data, start with the population data, use regular full censuses, and add vital events registration, household panel surveys 2 times per year, and then include the environmental information systems. He gave the example of the Nouna district in Burkina Faso. He developed a demographic surveillance system (networking represents most climate situations). For Nouna, he superimposed satellite data and demographics. Most sites are run by ministries of Health. The network is financed by Gates and others. Rainer Sauerborn then addressed some research questions including the need to establish consistent health metrics, doing modeling of the climate sensitivity of Malaria, impact of climate change on malnutrition, others. He concluded by asking the role of research institutions produced micro-datasets in GEOSS.

IEEE Committee on Earth Observation (ICEO) workshop summary: GEOSS Workshop XXVIII – Health and the Environment
Q&A
Joaquim DaSilva – the initiative is very helpful is explaining the natural history of the diseases, but missing the rest of development in the district
Rainier Sauerborn - demography is not only health specific; it is a platform which can be used for non-direct issues

Eric Bertherat from WHO discussed plague. The characteristics of the carrier is specific to location (flee, rodent) and environmental factors. Re-emergence is quite frequent. Central Asia is the cradle of the disease. For example, in Kazakhstan the disease carriers are present in 40% of the territory. The carrier reservoir varies between marmot, and other rodents. They do surveillance of the reservoir and carry out large vector control (DDT in rodent burrows, vaccination to camels and people). They need to improve surveillance of the animal reservoir. In satellite imagery they can see the network of burrows from the great gerbil, and see the change in color (as the rodent die, the grass comes back). There is an ongoing project to map the great gerbil's distribution in plague foci.

Francisco Mendonca from the Federal University of Paraná – Brazil, addressed Dengue fever spread in Southern Brazil. Dengue is considered an urban disease in Brazil. The disease has been expanding rapidly. He addressed the influence of climate on transmission of dengue fever, due to rain fall in summer. He listed contributing factors to the expansion of the disease such as inaccessibility of the housing to the health public campaign, inadequacy and inefficiency of sanitization services, resistance of the vector to insecticides, and climate change. He showed the distribution by region. He looked at climate variability and relation to dengue, looking at change in rain fall and changes in way of life. The studies include case occurrences, vector information, socio-economic information, and satellite imagery. They do not work with decision-makers. He gave a list of challenges, such as improving the knowledge of the infection dynamics, improving studies on the risk of incidence of Dengue fever, improve diagnostics and monitoring, increase campaigns of prevention, and finally emphasize the importance of the environmental factors and social aspects in the public health policies.

Jacques-Andre Ndione from the Centre de Suivi Ecologique de Dakar, Senegal discussed Rift Valley fever (RVF) in West Africa. The disease is at the crossroad of three systems: pathogen, human/cattle, and environment. He gave a brief history of RVF epidemics. Ponds are of critical interest as they provide areas of free access for cattle, and human and breeding sites for vectors. Studies addressed rainfall events versus vector aggressiveness. A combination of in-situ and satellite data lead to the generation of risk maps. Next step is validation, and building of an early warning system.

Pierre Formenty from WHO discussed forecasting Rift Valley Fever outbreaks. He highlighted the need for an integrated strategy from forecasting to surveillance. Risk map show ponds, and cattle locations. Satellite images and ground pictures were shown for both Sudan and Madagascar. Those were 2 different cases: 1 ingesting carrion, one associated with rice fields. Classical transmission is via Aedes. Animal outbreaks preceded human outbreaks. There is a need for forecast readiness, followed by mass animal vaccination, and early detection. Forecasting model based on ecological findings produces monthly risk maps; this lead to success with the 2006 outbreak forecast in Somalia and East Kenya. There are forecasting limitations however, and a need for forecasting field teams to start actions with national services. The model is not specific enough however and needs to be improved.

IEEE Committee on Earth Observation (ICEO) workshop summary: GEOSS Workshop XXVIII – Health and the Environment

Mario Lanfri from CONAE, the Space Agency of Argentina, discussed the Cordoba ground station and satellite data which can be acquired there. A vegetation index is calculated using SAC C (he gave some additional examples including a volcanic eruption). He introduced SIASGE, a constellation for disaster management. CONAE is a remote sensing data provider and has been working since 2001 in landscape epidemiology. He gave the example of dengue fever spread in South-America. Data aggregation was performed at province/state level. The MATE project (Dengue in Argentina) was initiated to build a statistical model using entomological data, rain fall data, temperature, NDVI, etc. The project uses all Landsat non-cloud images available on a 16 day cycle. Another collaboration with CNES is using SPOT IMAGE in Ignazu, and includes field work. An advanced training school on Landscape Epidemiology has been conducted in cooperation with UNOOSA. This 5 week training class has included f2 people of each country in South America. A Master degree in emergency early warning and response space applications is being offered by the faculty of Mathematics, Astronomy and Physics at UNCba and CONAE.

Note: in order allow participants to maintain the afternoon on schedule, further questions and discussions were deferred to the break-out sessions

Stephen Connor provided a summary of session. There were quite a few issues of geographic data scales identified throughout the presentations. However, there is evidence of some progress with very crude resolution data. But when countries go toward elimination, we are going to need much finer resolution (vector breeding in pond, bottle cap, etc). Mario Lanfri from Argentina provided a map of Dengue which included Africa, even though Dengue is not considered a major issue for Africa.

Joerg Szarzynski from UN-SPIDER spoke about space-based solutions and collaborative network development in support of health and climate change adaptation including case studies in Burkina Faso and Namibia. He mentioned that nobody had discussed disaster medicine. He contrasted the space-based view versus disaster management view on the ground. The two communities do not necessarily share the same view. Remote sensing products are important for forecasting and after the disaster to see what happened. He gave a number of examples such as a typhoon in the bay of Bengal, the 2004 tsunami in Thailand, distribution of refugees in refugee camps, tele-medicine and tele-surgery). Key space-based information questions from a user perspective include: where do you find the data; what are the costs; what is the quality and actuality; and who is involved. UN-SPIDER mission and mandate is to provide access to all types of space-based information and services relevant to disaster management. Joerg Szarzynski provided a list of events UNOOA contributed to. They are implementing a network of national focal points and regional support offices. Activities include space-aid (space-based information and communication support), web portal (www.un-spider.com launched 2 weeks ago), technical advisory support, and capacity building. He then discussed the disaster management international charter to create maps for the affected countries (example floods in Namibia, typhoon in Myanmar, earthquake in China), He provided a case study in Africa (Burkina Faso – locust invasions). There are a lot of scientific projects, but how can they contribute to GEOSS? Challenges include integrating all of the data to produce the right products for the users. UNOOSA has received official request by government for a technical advisory mission for Burkina Faso to see how to bring back to the country the data provided by the various study programs. Another example is the Namibia (floods in March 2008). The international charter was triggered. This was followed by a technical mission, and then by a sensor web pilot project to develop useful flood forecasting tools. There will be a special session on health and remote sensing at the UN_SPIDER workshop in Bonn on 21-23 October 2009. There is a need for knowledge transfer between space and disaster management communities.

Joan Aron, EPA AAAS fellow, together with **Pietro Ceccato** from IRI moderated an initial discussion regarding potential pilot program. She listed some concept/preliminary criteria to guide the discussion/selection:

multiple organizations involvement, 1 to 3 years time frame, user representation, multiple source of data including observations (in-situ, remotely-sensed, multi-domain), address modeling and analysis aspects, and interest in pursuing proposed ideas.

Andreas Skouloudis from JRC indicated interest in technical studies and possibility to provide resources.

Jay Pearlman from IEEE introduced the charter for the break-out sessions. Three topics were to be addressed: Health and Environment interoperability, pilot projects and community of practice. The goal is to develop workshop recommendations in each area and help toward planning the November follow-on workshop in Washington DC. Jay Pearlman provided a list of questions to be addressed by each break-out group. Group leads were identified for each group as follows: Health and Environment Infrastructure – Murielle Lafaye and Jay Pearlman; Pilot project group 1 – John Haynes and Hillel Koren; Pilot project group 2 – David Rogers and Juli Trtanj; CoP – Giovanni Rum and Christophe Rogier.
The plenary session was closed and participants joined one of the break-out group for discussions through the rest of the afternoon and the beginning of the next morning.

July 9, 2009 (Workshop day 3)

Break-out group reconvened at the start of day 3. The break-out session reports followed mid-morning.

Juli Trtanj and David Rogers, co-chairs of the Pilot Project breakout group gave the report back from the pilot project group.

The two potential pilot project groups were combined into a single group including the following participants: Pietro Ceccato, Steve Connor, Joaquim DaSilva, Ramesh Dhiman, Emily Firth, John Haynes, Hillel Koren, Jiratiwan Kruasilp, Mario Lanfri, Jacques-Andre Ndione, David Rogers, Juli Trtanj, Joerg Szarzynski, Anne Urdiroz, and Pai-Yei Whung (note others may be participated and not signed the attendance list).

The following project criteria for pilots were identified, using as a starting point the discussion moderated by Joan Aron and Pietro Ceccato on day 2. It was noted that these criteria could be used for the upcoming pilot projects as well as other GEOSS projects. The pilot projects should:

1. Be problem driven (fully engage WHO, FAO, and governmental level - ministries of health, public health services; fully engage disease community and environment community)
2. Have a multi-disciplinary and multi-organizational approach
3. Be structured with clearly defined roles – WHO defines the process and steers; leads are providers of data
4. Contribute to the quality of the health system; there must be a capacity building component allowing for sustainability of the project beyond the initial pilot project duration
5. Exhibit a holistic approach to data access including health, environment and socio-economic data
6. Demonstrate effective and sustained internal communication among parties
7. Enable evidence-based improved decision making (there was a discussion on duration – 2 to 3 years?)
8. Have evidence of resource commitment (people, funding, etc)
9. Involve inter-regional collaboration and international collaboration
10. Provide a base for expansion, being scalable local to local and local to national to international

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A list of potential project needs/characteristics was generated, based on the material discussed over the prior 2 days of the workshops. Considerations included potential expansion of existing projects. The list is provided below:

1) Malaria Early Warning in Thailand – there are a number of ongoing activities which can be built up; they include: modeling (THEOS data), web based early warning; public health partners; government involvement - the Thailand Ministry of health is involved; there are NASA and UN-SPIDER connections as well
2) Rift Valley Fever Early Warning system in Senegal – the system is well developed; it is possible to expand process to consider urban malaria or dengue; add expertise in modeling; partnerships with other organizations (NASA, NOAA, USAID, etc); compare East and West Africa approach; work across regions
3) Dengue in South-America - In Argentina, the potential for using remote sensing is being studied; the Ministry of Health works at both national and provincial levels; there could be a multi-disciplinary group (bio, epidemiology, remote sensing); requirements would come from Vector-control experts; what could GEO bring to the table? Note: the following details were added after the meeting: Dengue's Fever in Latin America. Integrating research institutions (INPE / Brazil, FIOCRUZ / Brazil, Univ. Federal do Parana / Brazil, CONAE / Argentina; UNAM / Mexico, etc) to study the natural and social conditions of dengue's fever. These studies may indicate the social conditions (climatic and urban) which are favorable to the occurrence of epidemics, as well as the most vulnerable populations to the disease. To decision-makers it will indicate measures of prevention and social control of the disease.
4) Malaria, dengue and others in India - training about integration of climate and health; there is an early warning system; climate change considerations are important: integration to understand population at risk from climate change; multi-disciplinary approach (remote sensing, modeling, etc); national program from Ministry of Health (roll back malaria, etc); they need modeling support and training (WHO, IRI)
5) Vibrio/ - India/Bangladesh Cholera – there are ties with the Ministry of Health in Bangladesh; more robust modeling is needed; climate predictions need to be down-scaled; there is a need to start modeling long term climate change impact on the region; there are comparative studies ongoing in the US which are multi-disciplinary, with well defined requirements; the project is scalable to other regions; value added from GEO: additional remote sensing capability; down scaling climate; scalability
6) Respiratory and cardio diseases in developing countries (South America – Chile, Argentina). PAHO, EPA, CDC, others; pro-active approach because allergies are increasing; GEO can help export existing outreach programs
7) Coastal water - Chemical containment; harmful algae bloom; pathogens (seafood safety); SE Asia (Vietnam, China, Thailand); climate change context; GEO could assist with capacity building
8) Southern Africa (SADC) – there is growing confidence with the Ministry of Health to make SADC malaria free (Namibia, Botswana, Zimbabwe, Swaziland); GEO could help with the definition of regions of high receptivity, monitoring, coordination with WHO in-country teams; cholera could be included

Following on the need for resources, the following were discussed:

1) UN-SPIDER (possible resource opportunity: West Africa, Namibia, Thailand, Bangladesh)
2) NASA support for SERVIR (Central America – Panama; East Africa – Kenya), and work in Thailand; Feb 2010 NASA proposal (need Federal agency or NGO linked to the project)
3) EPA (Air-Now, black carbon, Glory satellite; capacity building potential)
4) MEWS – continuing research on climate impact on Malaria; integration of data library with SERVIR and Openhealth; capacity building – training in Madagascar; good platform to discuss exchange of ideas; GEO capacity building proposal

The next steps include:

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1) Fleshing out project criteria
2) Looking at possible projects meeting the criteria. User focus needs to be stressed (what problem the users are trying to solve).
3) Addressing the potential for inclusion of a new task in the GEO work plan rather than a call for proposal
4) Reaching out to the community at large, such as GEO presentation to WHO and FAO assemblies
5) Note – need enough of a project definition to be able to request resources (example FP7 programs)

Murielle Lafaye gave the report back on the health and environment infrastructure breakout session. The break-out group was co-lead by Murielle Lafaye and Jay Pearlman, and included Joan Aron, Carsten Dettmann, George Jungbluth, Felix Kogan, Murielle Lafaye, Francisco Mendonca, Jay Pearlman, Rainier Sauerborn, and Andreas Skouloudis. The objectives for the health and the environment information system focused on support of modeling, monitoring, early warning, mitigation and adaptation. Pilot projects will be used to provide guidance regarding development of the infrastructure. A list of desired characteristics for the information system infrastructure was provided. The pilot projects will demonstrate end to end value of the environmental and health information systems, as well as providing other benefits (such as fostering international cooperation, demonstrating standards and best practices examples, and others). Recommendations included:

1) Defining framework for information infrastructure in 2009
2) Funding a GCI compatible prototype to be built using existing technology within one year
3) Incorporating capacity building and education
4) Supporting integrated demonstrations of societal benefits through one of more end-to-end pilot(s)
5) Involving decision makers from the start
6) Working with GEO Capacity Building and Architecture and Data Committees.

Giovanni Rum gave a combined report from the Community of Practice break-out session and launch of the CoP. The break-out group included Sarah Carter, Joy Guillemot, Francoise Pearlman, Christophe Rogier, and Giovanni Rum. Giovanni and Christoph were co-chairs. After reminding the audience of the key questions to be addressed, and briefing general material on CoPs, Giovanni Rum highlighted the following steps forward for launching the CoP:

1) Identify a core group of co-leaders and interested participants; co-leaders will then notify the GEO secretariat of the creation of the CoP and provide the terms of reference
2) Review the GEO work plan regarding potential addition of a new subtask (final input due by August 21st)
3) Activate interaction with User Interface Committee regarding user requirements and recommendations
4) Participate in the planning for the GEOSS Workshop XXXI – Using Earth Observation for Health – a workshop of the GEO Health ands the Environment Community of Practice, to be conducted on 12 -13 November 2009 in Washington DC
5) Ensure participation to the GEO IGOS symposium on November 19, in Washington DC
6) Develop and outreach plan and a calendar of activities for 2010

Murielle LaFaye and Ramesh Dhiman agreed to be co-leaders for the Health and the Environment CoP. In subsequent discussions, Joaquim DaSilva agreed to be added to become a co-leader as well. A sign-up sheet was circulated asking for indication of interest in joining the CoP. That information is included in the workshop attendance list provided as appendix 2.

Information infrastructure – Murielle Lafaye and Jay Pearlman

Murielle Lafaye and Jay Pearlman expanded on the earlier briefing from the break-out session. They provided a simplified architecture diagram identifying the potential infrastructure and components. They identified four types of data: demographic, epidemiological, environment/physical infrastructure, and economic data. Information access would accommodate both technical and legal considerations. The predictive modeling, trend detection and expert assessment would process the data and convert it into useful information, which can then

be used by decision makers and other users in performing vulnerability assessment, early warning, and mitigation/adaptation studies. After reviewing the group's recommendations, Murielle and Jay highlighted the interaction with the pilot projects, indicating the need for clear definition of the projects, and outcomes.

Formulate Recommendation for Pilot Projects – Pai-Yei Whung (chair), David Rogers, Juli Trtanj

1. Propose initial outcome of the Pilot Project workgroup; further Define Project Criteria
2. Recommendation for formulation of Pilot Projects, if any, and the use of the example of Pilot Projects

Pai-Yei Whung, with pilot break-out leads Juli Trtanj and David Rogers

A. Pilot Project Criteria – User-Driven and Responding to Health Requirement

1) Each project should fully engage its partners (e.g. WHO, FAO, Ministry of Health, Ministry of Environment)
2) Focus on health outcomes through well-defined projects
3) Producers and Users jointly identify needs and develop and demonstrate solutions for health benefits
4) Community and organizational support to ensure sustainability

5) Interdisciplinary and multi-organizations involvement

6) Ensure the health community drives the project but it does *NOT* necessarily have to be the organizer for the project

7) Projects must contribute to or build on existing efforts and enhance health system capacity; including capacity building and sustainability

8) It should have a holistic approach to data (e.g. social, economic, environment, health)

9) It must demonstrate institutional platform and effective communication processes among partners

10) The project must have a likelihood of demonstrable benefit(s) in 2-3 year of success for evidence decision-making, and scalability

11) Inter-regional in nature

12) Evidence for resources

13) Where possible, build upon and expand existing developments.

B. Examples of Projects

1) Malaria in Thailand
2) Dengue in South America – GEO added value is the possibility of best practice, and new resources from GEO
3) Dengue, Malaria in India – Training and integration of climate and health, training on modeling
4) Cholera – An on-going collaboration between US and Bangladesh, a comparative study between the US and India. GEO added-value scalability

5) RVF – Africa (Senegal), existing capabilities, capacity building (Dengue), potential new partnership (USDA, NASA, NOAA)

6) Cardiovascular, respiratory impacts of air quality – AirNow and AirNow International, Glory, Particulate Matter and black carbon, training component

7) Air allergen and climate change in South America – PAHO, CDC and EPA

8) Costal water – pathogen and chemical, discussion is on the way in China and Vietnam

9) Southern Africa – Intense focus on monitoring on malaria

10) Outreach to Health community

C. Path Forward

1) Establishment of criteria: a paper will be developed addressing criteria for pilot projects; a draft paper will be issued by August 1st for circulation and comments from the workshop participants; comments will be requested by August 10th, and criteria will be published by August 20th..

2) Development of a new GEO subtask: Giovanni Rum proposed that a new GEO sub-task be added to the work plan. George Jungbluth from NOAA suggested using the established GEO Malaria sub-task as an example. Jay Pearlman suggested that a small team (John Haynes, , Hillel Koren , Jay Pearlman , David Rogers, Juli Trtanj, Pai-Yei Whung) develop a task recommendation, to be submitted to the GEO secretariat by August 10th.

3) Request for pilot project interest
1) A call for a 2 page white paper for pilot projects will be issued upon release of the project criteria

Emily Firth from WHO initiated the workshop summary and wrap-up. She indicated that the workshop served as an instigator for people within WHO to establish their needs and accept the enthusiasm of the GEO community. This is resulting in a more coordinated response between different departments within WHO. For example, there is an informal working group within WHO regarding the use of environmental data. The next step is to articulate how these efforts can align with existing activities within GEO. She thanked GEO and IEEE for organizing the workshop and sharing of information. She stressed the need to continue maintaining energy.

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David Rogers followed her, highlighting the difficulties of working across disciplines. Depending on their domain, communities will understand opportunities for the health application side regarding environment and other the other way around; it is a very interactive process. GEO provides opportunities to rethink the communications. There is a need for every body to be engaged all the time.

Joaquim DaSilva from WHO-AFRO indicated that he looks forward to join the community of practice. He subsequently offered to be a co-lead of the CoP.

Giovanni Rum– A community of practice for health and the environment is starting, with Ramesh Dhiman and Murielle Lafaye as co-leads; we will need others to join them to start the process. It is a good opportunity to reinforce the interactions with the health community. Giovanni then thanked the participants and adjourned the workshop

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APPENDIX 1 – WORKSHOP ATTENDANCE LIST

Last Name	Title	First Name	Email	Organization	Country
Achache	Prof	Jose	secretariat@geosec.org	GEO Secretariat, Director	GEO Secretariat
Appelbaum	Ms	Madelyn	madelyn.appelbaum@noaa.gov	NOAA	USA
Aron	Ms.	Joan	aron.joan@epa.gov	U.S. Environmental Protection Agency	USA
Bastier	Mr.	Stéphane	stephane.bastier@medes.fr	MEDES-IMPS	France
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Collier	Dr	Tracy	tracy.k.collier@noaa.gov	NOAA	USA
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Da Silva	Dr	Joaquim-Zim	DaSilvaJ@zw.afro.who.int	WHO-AFRO Intercountry team, Harare Zimbabwe	Zimbabwe
Dettmann	Mr.	Carsten	Carsten.Dettmann@bmvbs.bund.de	BMVBS Federal Ministry of Transport	Germany
Dhiman	Dr	Ramesh	dhimanrc@icmr.org.in	New-Dehli, India	India
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Ndione	Dr.	Jacques André	jacques-andre.ndione@cse.sn	Centre de Suivi Ecologique	Senegal
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Whung	Dr	Pai-Yei	whung.pai-yei@epa.gov	USEPA	USA

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APPENDIX 2 – SPEAKERS SHORT BIOGRAPHIES

Prof. José Achache

Secretariat Director

José Achache became the first Director of the GEO Secretariat in 2005.

Of French nationality, Prof. Achache graduated from the Ecole Normale Superieure in Paris. He obtained a doctorate in geophysics at the Université Pierre et Marie Curie in 1979 and a doctorate in physical sciences at the Université René Descartes in 1984. He was a Visiting Scholar at Stanford University from 1979 to 1980.

Prof. Achache began his career at the Institut de Physique du Globe de Paris as a Research Assistant and then as “Chargé de Recherche”. In 1989, he became a Professor, created the Department of Space Studies and was appointed Director of the Graduate School of Earth Sciences.

In 1996, he joined the French Geological Survey (BRGM) as deputy director of the Research Division and the following year became its director. In 1999, he joined the French Space Agency (CNES) as advisor to the President and, in 2000, he was appointed Deputy Director General of CNES.

In 2002, Prof. Achache joined the European Space Agency (ESA) as Director of Earth Observation. While at ESA, he developed the Global Monitoring for Environment and Security (GMES) programme in partnership with the European Commission.

José Achache is the author of a scientific and geopolitical essay entitled Les Sentinelles de la Terre, which discusses the benefits of Earth observation for a better management of the planet, adaptation to environmental changes and the mitigation of disasters and epidemics. He has published more than 70 scientific papers in international journals on subjects in Earth sciences, geophysical imaging, planetary sciences, Earth observation from space, natural hazards, and space and science policy.

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Joan L. Aron, Ph.D.

Dr. Aron is a AAAS Science and Technology Policy Fellow in the Office of Science Policy of the U.S. Environmental Protection Agency. Her focus is on the application of Earth observations to public health. She is collaborating with the EPA ecosystem services research program on health benefits. She is also engaged with the health task team of the International Working Group of the interagency U.S. Group on Earth Observations.

Dr. Aron's scientific background is in public health, global environmental change, climate change, Earth system science, ecology, epidemiology, population biology, and mathematical modeling. Her experience in global change and public health includes: 1) editing an interdisciplinary graduate textbook Ecosystem Change and Public Health: A Global Perspective (Johns Hopkins University Press, 2001) deemed outstanding by the NASA Earth Science Education Product Review; 2) organizing a conference and workshop for the World Health Organization, World Meteorological Organization, and United Nations Environment Program on climate change and variability and their health effects in the Caribbean (Barbados, 2002); and 3) coordinating an interdisciplinary professional development workshop for the Inter-American Institute on Global Change Research on climate and health in the Americas (Jamaica, 2005). Other recent accomplishments include editing a design guide for undergraduate Earth system science education and publishing a textbook chapter on the use of mathematical modeling in infectious disease epidemiology. Her prior professional positions include being president of a nonprofit organization Science Communication Studies, associate faculty in the Dept. of Epidemiology at the Johns Hopkins Bloomberg School of Public Health, assistant professor in the Dept. of Population Dynamics at the Johns Hopkins Bloomberg School of Public Health, and senior staff fellow at the National Cancer Institute. She earned her Ph.D. in biology at Princeton (focus on mathematical biology and ecology), her masters in information technology management at Johns Hopkins University, her post-graduate diploma in mathematical statistics at Cambridge University, and her B.A. summa cum laude in applied mathematics at Harvard University.

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Dr Eric Bertherat

Specialist in Public Health and Tropical medicine, medical officer at WHO for 8 years.
E.B is the focal point for plague and epidemic meningitis in the department of Epidemic and Pandemic Preparedness and Response.
He took part and lead many outbreak responses including on cholera, hemorrhagic fevers, Nipah virus, plague and meningitis.
He is the current chair of the Meningitis Environmental Risk Information Technologies (MERIT) initiative

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Dr Pietro Ceccato

Pietro Ceccato trained originally as an agronomist and soil science scientist. He spent two years in Central African Republic working with local communities to improve agricultural practices. He obtained a Master in Environmental Management using decision-support systems and worked as a research scientist at the Natural Resources Institute in United Kingdom. He developed remote sensing products to monitor active fires and vegetation status for assessing the risk of fire occurrence. He worked at the European Commission Joint Research Centre (Ispra, Italy) on the use of remote sensing to monitor vegetation status and used this work to obtain his PhD in Remote Sensing (2001, University of Greenwich, UK). Pietro then joined the UN Food and Agriculture Organization (Rome, Italy) to develop an early warning system for Desert Locust monitoring. He developed remote sensing products and Geographical Information Systems to be used operationally by the Ministries of Agriculture in 21 countries in Africa and Asia.

Pietro joined the International Research Institute for Climate and Society in 2004. His current research activities include the development and integration of environmental remote sensing products into early warning systems for human health, pest management and fire risk.

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Dr Jean-Claude Cohen

Jean-Claude Cohen is Dr. in meteorology at Météo France, national coordinator for weather and Health since 1996.
Author or co-author of several papers concerning biometeorology for French and international reviews, and of a General public book :
"Practical guide to weather and Health " - heat waves, cold spans, allergies, pollution, sun rays, Le Cherche Midi editions, June 2006.
He has been working on various impacts of atmospheric environment on human health,mainly extreme temperatures, solar UV, pollution and pollens, meteo-sensitive diseases ... as well as on impacts of climate change on Health, including an article in the annual "ONERC repport to the Prime Minister and the Government" (2007).
He is member of the ISB, expert at the French Agency on Sanitary and Environment Security (AFSSET), and is engaged in a working groups of the Ministry of Environement and the Ministry of Health on "impacts of Climate Change on Public Health - economical aspects ".

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Dr Tracy Collier

As Director of the Environmental Conservation Division of NOAA's Northwest Fisheries Science Center, Dr. Tracy Collier supervises a research enterprise comprised of approximately 90 scientists. The Division's four research programs are Watershed Processes, Ecotoxicology, Environmental Chemistry, and Marine Biotoxins. Dr. Collier's research interests over the years have covered some of the first work on metabolism of PAHs by fish, studies of the impacts of oil spills on marine fish and mammals, the enzymology of carcinogen activation and detoxication, and assessing overall effects of contaminants on fish populations through the use of field investigations. His current personal research interests are in the areas of environmental toxicology, field investigations of causality, the use of marine mammals and fish as sentinel species for assessing relationships between oceans and human health, and assessing the effects of multiple stresses on organismal health, for example how exposure to pollution affects disease resistance. He holds faculty appointments at Oregon State University and Washington State University, and serves on a number of regional, national, and international panels and committees. He has over 125 scientific publications.

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Dr Stephen Connor

Stephen Connor joined the International Research Institute for Climate and Society at Columbia University, New York in May 2002. Previously he was based at the Liverpool School of Tropical Medicine and worked extensively in sub-Saharan Africa for the UK Medical Research Council and the UK Department for International Development's (DFID) Malaria Knowledge Programmes. He has a background in Development Studies/Natural Resource Economics, has specialized in the geography of infectious disease, and has a PhD from the Faculty of Medicine at Liverpool University.

Stephen has worked closely with the World Health Organization in Geneva and WHO-AFRO's Inter-Country Programmes on Malaria Control, providing technical support to Ministries of Health. He has been a frequent advisor to WHO's Roll Back Malaria Technical Resource Network on Epidemic Prevention and Control. Former Study Group Coordinator, Health Issues in Development, for the UK Development Studies Association. He is currently serving as a member of the World Meteorological Organization Task Force on Socio-Economic Applications of Weather, Climate and Water Services. He is the Director of the PanAmerica Health Organization/World Health Organization Collaborating Centre on Early Warning Systems for Malaria and other Climate Sensitive Diseases.

Research Interests
The interaction of climate, environment, economy and social vulnerability in determining the patterns and persistence of infectious disease in the developing world, and how research knowledge may be used to improve public health and sustainable livelihoods in the communities affected.

Professional Qualifications
Stephen is a Fellow of the Remote Sensing and Photogrammetry Society (FRSPSoc) and a Chartered Biologist (CBiol, MIBiol).

Role at the IRI
A member of the IRI senior management Stephen directs research activities which integrate the use of environmental remote sensing products into the various IRI regional projects and monitoring activities. He is a member of the Management Committee for the IRI's Africa Regional Program, and serves as a committee member on the Asia-Pacific Regional Program, the Latin American and Caribbean Regional Program, and the Ad Hoc Policy on Resources Working Group.

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Dr Joaquim Da Silva

Dr Da Silva is with WHO-AFRO in Harare, Zimbabwe. He is a Medical Doctor with a MPH with focus on epidemiology. (MD, MPH). In the last 6 years, he has been working in the operationalization of the Malaria Early Warning System (MEWS) in East and Southern Africa. He has also a background of working in epidemics control and complex emergencies.

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Dr Ramesh Dhiman

NIMR (ICMR), New Delhi

Ramesh Dhiman is working at National Institute of Malaria Research under Indian Council of Medical Research, Delhi as Senior Grade Deputy Director since 1991. He possesses PhD degree in Zoology/Entomology and his interests are epidemiology of malaria, dengue and leishmaniasis. He has worked on the application of satellite remote sensing in different ecological paradigms of malaria eg. Delhi, Karnataka, Assam and Andaman Nicobar Islands in India. In collaboration with NOAA, an exploratory work on the possibility of using Vegetation Health Indices in forecasting of malaria has also been undertaken. Currently he is working on the application of remote sensing using Indian Remote Sensing satellite, IRS 1 D with LISS IV sensor at village level in malaria endemic districts of Karnataka and land use mapping in connection with impact of climate change on malaria and dengue.

Dr Dhiman is also Principal Investigator of a Phase II collaborative project with Michigan University on early warning of malaria outbreaks in Gujarat and Rajasthan in India.

Development of Environmental Information System for malaria and other vector borne diseases in India is in the wish list of Dr Dhiman.

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Ms Emily Firth

Emily Firth is a Technical Officer in the Public Health Information and GIS programme at the World Health Organization. She holds a B.Sc. in Biological Ecology from the University of New South Wales and a Masters in Climate and Society from Columbia University. In 2007 she moved to Geneva to join the Group on Earth Observations Secretariat within the Health Societal Benefit Area, and actively contributed to the establishment and management of the MERIT (Meningitis Environmental Risk Information Technologies) Project. In her current role at WHO, she is responsible for project managing the development of the Global Health Observatory, increasing collaboration between the scientific and health communities working in environment-health information systems. Prior to this, she was responsible for coordinating a government program in Australia as part of climate change mitigation efforts to increase the investment in and development of new renewable energy projects.

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Mr. **John Haynes**

John Haynes graduated from the University of South Alabama in 1999 with a B.S. in meteorology. In 2002, he graduated with an M.S. in meteorology from the University of Oklahoma. The first portion of his thesis work ("Analysis of Warm Season Morning Convection across the Southern Great Plains") was published in the December 2003 edition of Weather and Forecasting.

John entered NASA Headquarters in 2002 through the Presidential Management Fellowship (PMF) program. As required by the PMF program, John completed two detail assignments during his fellowship. The first was a three-month assignment in 2003 at the NOAA Hydrometeorological Prediction Center (part of the National Centers for Environmental Prediction (NCEP)). The second was a six-month assignment in 2004 in the office of Rep. Roger Wicker (First Congressional District, Mississippi). John converted to a standard civil service position at NASA Headquarters in August 2004 upon graduation from the PMF program.

Currently, John is Program Manager for Weather Applications, Public Health Applications, and the Gulf of Mexico Initiative in the Applied Sciences Program of the NASA Science Mission Directorate.

John is a member of the American Meteorological Society and serves on a variety of interagency working groups (including the Joint Program and Development Office Weather Working Group, the Oceans and Human Health Working Group under JSOST, the Office of the Federal Coordinator of Meteorology Volcanic Ash Working Group, USGEO, the US THORPEX Executive Council, and the Climate Change Science Program). John has received several awards during his tenure at NASA including a 2005 NASA Aviation Safety and Security Program Award, a 2005 NASA Group Achievement Award, a 2006 NASA Group Achievement Award, and a 2006 One NASA Award. In 2006, John was honored by his alma mater (the University of South Alabama) as an Exceptional Alumnus of the School of Meteorology.

IEEE Committee on Earth Observation (ICEO) workshop summary: GEOSS Workshop XXVIII – Health and the Environment

Dr. Donna Hudson

Dr. Donna Hudson received her Ph.D. from UCLA in 1981 and has been on the Faculty of the University of California since that time. She is currently Professor of Family and Community Medicine and Director of Academic Research and Technology at University of California, San Francisco and a Faculty Member in the Joint Graduate Group in Bioengineering, UCSF and UC Berkeley. She is also a member of the Executive Committee of the Graduate Group in Biological and Medical Informatics at UCSF and the Clinical and Translational Informatics Graduate Program. Dr. Hudson is a Fellow of the IEEE as well as a Fellow of the American Institute for Medical and Biological Engineering. She has over 200 publications in the areas of medical decision support systems, neural network modeling, complex analysis of biosignals, and healthcare informatics. Dr. Hudson was President of the International Society for Computers and Their Applications (1999-2001) and is a Senior Member of ISCA. She has held a number of offices in the IEEE Engineering in Medicine and Biology Society (EMBS) including At-Large Representative to the Administrative Committee (1998-2000), Vice President for Publications (2001-2002), Vice President for Financial Planning (2003-2005), President-Elect (2006), and President (2007-2008). She is currently a candidate for Vice-President-Elect of IEEE Technical Activities.

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Ms Jiratiwan Kruasilp

Geo-Informatics Scientist, GIS Data Application Sub-division; Geo-Informatics and Space Technology Development Agency (Public Organization)

I started my study for Master of Geography on the topic “Geographic Information System for determining Dengue Fever risk areas in Nakhon Ratchasima Province, Thailand” at Chulalongkorn University in 2004. During the study, I also spent time working at entomology section, National Institute of Health (NIH), Thailand. After graduation, I then moved to the National Disaster Warning Center, Ministry of Information and Communication Technology, in 2007. My duty is to act on surveillance of Disaster and distribution of information among the population in risk areas. In 2008, I moved to join GISTDA, Thailand. My work mainly concerned the analysis of satellite data for disaster monitoring such as flood, forest fire, invasion on forest, etc. At present, I interested on the combination of environmental factor and satellite image to determine the distribution pattern of Vector-borne diseases as well as the Database Management using open source in combination with GIS.

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Dr. Felix N. Kogan

Dr Kogan is a Physical Scientist, at the National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite Data and Information Services (NESDIS), Center for Satellite Applications and Research (STAR). Main duties include research and development in the application of satellite data to the solution of environmental problem with the specific emphasis on land, atmosphere and socioeconomic activities. The achievements include development of Vegetation Health theory, algorithms for calculation of satellite-based vegetation health indices and their applications, which include monitoring drought, fire risk, El Nino/La Nina imacts on land, vector epidemics, moisture and thermal conditions of the land surface, land cover/land change, climate variation/change, development of time series characterizing land and atmosphere, data processing. These developments contributed to agriculture, forestry, ecosystems, environmental and food security, climate and weather, human-environment interaction, climate forcing, large-scale meteorological hazards, invasive species, air pollution, land-water interaction, and development of satellite data sets, processing technique, application and interpretation. He is principal investigator on numerous national and international projects and a leader in transferring of new technologies. He is the author and co-author of more than 150 scientific papers, including book chapters.

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Mrs Haleh Kootval

Haleh Kootval is the Chief of the Public Weather Services Programme of the World Meteorological Organization and in that capacity has over the past 14 years developed the Public Weather Services Programme of WMO and has assisted the National Meteorological and Hydrological Services of WMO Members to set up and develop their national Public Weather Services programmes. This programe is today recognized as the most important vehicle for the communication of achievements and outputs of the work of National Meteorological and Hydrological Services in the area of service delivery to all sectors of society that require weather, climate and water-related services.

Her work with the National Meteorological and Hydrological Services of WMO Members concentrates on safety of life, livelihood and property as well as making the public and decision makers aware of the social and economic value of weather services provided to the public. For that purpose, developing expertise among the Met Services to identify the needs of the public and to respond to those requirements through provision of timely, accurate and useful warnings, forecasts and other information is the major focus of Haleh's work. Efficient and effective dissemination of public warnings and forecasts, capacity building among the Met Services, developing and maintaining coordination with the media, disaster management authorities and government decision makers is particularly emphasized in the Public Weather Services Programme.

Haleh is a meteorologist who specialized in tropical forecasting and was the head of the Brunei Meteorological Service and the Permanent Representative of Brunei with WMO prior to working in WMO.

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Hillel S. Koren, PhD

Dr. Hillel Koren, an internationally recognized leader in the field of environmental health research and scholarship, has made significant contributions to our understanding of the immunological mechanisms and environmental factors involved in asthma and other diseases.

Dr. Koren served as senior science advisor to the US Environmental Protection Agency's (EPA) National Health and Environmental Effects Research Laboratory (NHEERL) and leader of the Asthma and the Environment Research Program for the EPA's Office of Research and Development. From 2001 through 2007, he oversaw comprehensive, multidisciplinary basic and applied research focused on reducing the burden of asthma triggered by environmental factors.

In addition to his positions as Adjunct Professor of Immunology at Duke University, Dr. Koren serves on the Board of Trustees of the Fraunhofer Institute of Toxicology and Experimental Medicine (ITEM) in Hannover, Germany. He has received numerous awards for leadership in environmental health research, including an EPA Bronze Medal awarded in 1999 for excellence in initiating and implementing an international collaborative arrangement between the US EPA and the National Research Center for Environment and Health in Germany.

Dr. Koren has been active in many national initiatives, including the National Asthma Education and Prevention Program, the Department of Health and Human Service's "Healthy People 2000" report, the National Research Agenda for Occupational Asthma and Chronic Lung Disease, and has served on the President's Task Force on Environmental Health Risks and Safety Risks to Children Workgroup on Asthma. He has also been an advisor to various international organizations, such as the WHO International Program on Chemical Safety and the International Inhalation Symposia organized by ITEM.

Dr. Koren has published extensively (with more than 200 publications and contributions to four textbooks) in the areas of immunology and environmental pulmonary cell and molecular biology. His most recent research has focused on the interconnection between the environment and human health ("ecohealth"). He has received support from the National Institutes of Health (NIH), most recently as a co-Principal Investigator on a National Science Foundation/National Institute of Environmental Health Sciences grant to UNC's Ecology of Infectious Disease Program. In addition to being a researcher, he is a respected teacher, having mentored students at Duke University and UNC, as well as postgraduate fellows around the world. He has served on the editorial boards of several scientific journals and is considered a thought leader in many national and international professional societies, including the American Thoracic Society, European Society of Immunology, International Society of Environmental Medicine, and the International Association for Ecology and Health.

A native of Israel, Dr. Koren lives in Durham, North Carolina. He earned an MSc in microbiology at the University of Tel Aviv and his PhD at the Max-Planck Institute for Immunobiology and the University of Freiburg, Germany, where he was a European Molecular Biology Organization fellow. Following his postdoctoral training at the University of California, Berkeley and as a Fogarty Fellow at the National Cancer Institute (NCI) in Bethesda, Maryland, he joined the Microbiology and Immunology faculty at Duke University, where he was a Principal Investigator on several NIH/NCI grants and a recipient of an NIH Research Career Development Award. In 1984, Dr. Koren joined the EPA's NHEERL in Chapel Hill, and in 1992, he became Director of the Human Studies Division in Chapel Hill, a post he held for 10 years. He retired from the EPA at the end of 2007.
Dr. Koren travels widely as an invited speaker and advisor on topics associated with the environment and human health, and to conduct site visits for environmental health research programs in respiratory diseases and immunology. He has addressed audiences at conferences and universities in venues around the world and is proficient in English, Hebrew, and German, and can also communicate in French.

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Mrs Murielle LAFAYE

Murielle Lafaye Is Application Programme coordinator at CNES, the French space agency.
She promotes the use of space techniques for societal benefit areas such as transports, new technology for information and communication, ressources management, risk management and health.
As CNES environment-climate-health Programme responsible, she supports users-driven demonstration projects gathering users, scientific partners and service operators. Based on a CNES patented concept, for water born, air borne and vector borne transmissible infectious diseases, dynamic pathogen agents risk maps have being developed.
Mrs Lafaye is CEOS Societal Benefit Area Coordinator for Health, and contributes to the dynamic of the Environment and Health community of Practice.

Prof. Mario A. Lanfri.

Prof. Mario A. Lanfri works with the space agency of Argentina, CONAE, in the area of development of applications of satellite data for both, Disaster Management and Landscape epidemiology. He graduated as a physicist from National University of Cordoba (NUC), Argentina. Between 1987 and 1997, he belonged to the staff of the Atmospheric Physics Group of the Faculty of Mathematics, Astronomy and Physics at NUC. In 1997, he joined CONAE as member of the Telemedicine Project (1997-2001). Since the inauguration of the Gulich Institute (GI), he is working in both, Landscape Epidemiology and Satellite data applied to natural and anthropogenic Emergencies projects. He was also PM of the International Charter activations. At present, he is member of the GI academic staff and act as professor of the "Master on Remote Sensing Applications to early warning systems of emergencies". He also conducts research activities writing papers on the above mentioned topics and advising human resources.

Dr Jacques-André Ndione

Dr Jacques-André Ndione (MSc in Geography 1995 and PhD in Climatology 1998) is a senior scientist in climatology and a Programme Officer at ***Centre de Suivi Ecologique*** **(Dakar, Senegal)**. His main areas of expertise are physical geography, climatology and environment-health. He has long experience working as a PI in multidisciplinary research in national and international teams, set in Senegal. Since 2001, he is working with CNES (***Centre National d'Etudes Spatiales***) on Environment-Health issue in Senegal, specially on Rift valley fever emergence and risk. **The Centre de Suivi Ecologique (Senegal, CSE)** is a Senegalese institution specializing in the field of natural resources management and environment. It is a public utility association, placed under the tutelage of the Ministry of Environment and Nature Conservation (MEPN). CSE has developed a scientific and technical partnership with several national and international institutions (national agencies, private sector and universities…) in different sectors.

Ms Francoise Pearlman

Francoise Pearlman has thirty years of experience in engineering and management including system of systems engineering, software engineering and software/ system integration and test. For over fifteen years, she has applied her management expertise to Government programs with focus on development, integration and field test of digitization software/systems. Francoise has also participated in numerous technical reviews and proposals for a wide range of information systems and Command and Control programs.
After a career in technical management for major aerospace corporations, she is currently president of Western Resources and Applications, a small women majority owned partnership. She obtained a masters Degree in Aeronautical Engineering from the University of Washington, and a Masters in Business and Administration from the University of New-Mexico. She is a member of IEEE, and is the focal point for GEOSS workshops within the IEEE Committee on Earth Observation (ICEO).

Jay S Pearlman, PhD
IEEE

Dr. Jay Pearlman was Chief Engineer of NCOC&EM at Boeing and a Boeing Technical Fellow. He was responsible for advanced development of information systems. Previously he was Northrup Grumman deputy program manager of Hyperion on the NASA EO-1 satellite program. He has a Ph.D. from the University of Washington and a B.S. from the California Institute of Technology. Jay is a Fellow of the IEEE and was IEEE Geoscience and Remote Sensing VP for Information Services. Dr. Pearlman is Chair of the IEEE Committee on Earth Observation and Co-Chair of the GEO Architecture and Data Committee, which is the organization building the GEOSS SoS information infrastructure. Jay is a member of the the Committee of Earth Studies of the US National Research Council and the US National Academy's Ocean Studies Board. Dr. Pearlman has more than 75 publications and 25 international patents.

Pr. Christophe ROGIER, MD, PhD

Researcher in the fields of malaria epidemiology and parasite population dynamics. Since 2004, head of the Parasite Biology and Epidemiology Research Department of the Institute for Biomedical Research of the French Army and head of the team "Emerging diseases & mosquitoes" of the UMR 6236 – "Unité de Recherche en Maladies Infectieuses et Tropicales Emergentes – URMITE" of the University of Marseille 2, France. Formerly chief of the epidemiology unit of Pasteur Institute of Dakar, Senegal, 1989-1996. Military physician trained in epidemiology, biostatistics, entomology, immunology, genetics and molecular biology at the universities of Bordeaux and Marseille and at Pasteur Institute in Paris, France.

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Dr-Ing. Andreas N. Skouloudis
Principal Scientific Officer
at the Directorate of the Institute for
Environment & Sustainability

Dr Skouloudis holds a doctorate degree in Mechanical Engineering, a MSc and a degree in Physics with more than 27 years professional experience.

Works for 23 years at the European Commission. Currently, at the Environment & Health task force with the mandate to handle policies and legislation in association with energy transport, climate change, telematics, and related emerging technologies. He has over 140 publications related with environment, meteorology and multiphase dynamics.

Previous post as head of the "Urban Impact Assessments" sector at the Environment Institute. In this sector he managed 12 scientists "*for defining at large urban domains, the emission reductions from stationary and transport sources, for achieving air-quality objectives during future years"*.

Developed and utilised state-of-the-art tools for providing the scientific background to the various Commission communications based on the use of advance information technology tools. Developed and coordinated in the appropriate European Commission services the modelling methodology for all daughter directives of the European Commission on air-quality. Assessed the synergy of economic and technological scenarios at the EU, for the abatement of pollution until 2010 with cluster analysis. Gained contracts from the Japanese Automobile Industries and with a consortium of five French Automobile and Oil refinery industries for the validation of future air-pollutions forecasts.

Evaluated the effects of Health Pollution in Children due to transport emissions in cities and due to marine emissions near major shipping lines. Used satellite data for the assessment of navy and marine near the coast lines in the frame of WHO-DG SANCO collaboration. Work reported at the Inter-ministerial conference in Vienna, June 2007.

Optimised telematic techniques for dealing with transient effects (forest fires, chemical industry accidents etc) with recommendations to European Parliamentarians. Assessed of Gulf war fires on the South-West Asia climate. Developed the methodology of catch-tank sizing for the containment runaway chemical reactions (AIChE project) carried out by DIERS in US.

Memberships: Member of American Geophysical Union, US
Fellow of Institute of Physics, UK
Member of the American Nuclear Society, US

Dr. Jörg Szarzynski
Senior Expert
UN-SPIDER
United Nations Platform for Space-based Information for Disaster Management and Emergency Response
Internet: www.unspider.org

Dr. Jörg Szarzynski works as senior expert for the United Nations platform for space-based information for disaster management and emergency response (UN-SPIDER) since January 2008. Within the team he is responsible for technical advice, information management, collaborative network development and the cluster on health and climate change adaptation. He holds a M.Sc. in Geography and a Ph.D. in Physical Geography and Hydrometeorology with key competences in climatology, geo-biophysics, remote sensing, and tropical ecology. During the last years he worked as team leader for a Biophysical Forest Monitoring Program in Latin America (Venezuela), scientific researcher at the Center for Development Research, University of Bonn, responsible scientist for a biophysical monitoring network and aircraft observation missions in Burkina Faso within the BIOTA West Africa and GLOWA-Volta projects, and senior scientist at the German Aerospace Center (German Indonesian Tsunami Early Warning System, Indonesia). Major topics cover applied climatology, climate risk assessment, impact of landuse/landcover changes, land degradation, environmental change and human health, capacity building, and web based data and information management. He has more than 15 years of largely field based international experience in experimental work, especially regarding geophysical monitoring networks combining *in situ* measurements and remote sensing applications in West and Central Africa, Latin America, and South East Asia

Juli Moore Trtanj, M.E.S.
Oceans and Human Health Initiative
NOAA, National Ocean Service

Juli Trtanj is the Director of the Oceans and Human Health Initiative (OHHI) at the National Oceanic and Atmospheric Administration (NOAA). The main goals of the OHHI are to lead the development and delivery of health early warning systems to reduce ocean-related health risks, and to enhance the health benefits from ocean-derived food and natural products. Prior to implementing the OHHI, Ms. Trtanj started and managed the Climate Variability and Health Program for NOAA to develop capacity to use climate information to reduce health risks in Africa, Asia, and Latin America. She also developed and managed a joint climate and health program with the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and EPRI (formerly the Electric Power Research Institute). Research funded under these programs has informed the IPCC and the US Climate Change Science Program. She has contributed to, reviewed, and edited, health-related sections of the past three IPCC reports and two recent Climate Change Science Program reports. In addition, she has authored several papers including the US National Assessment-Potential Consequences of Climate Variability and Change, Health Section.

Ms. Trtanj is a member of the Joint Subcommittee on Ocean Science and Technology, Interagency Working Group on Harmful Algal Blooms, Hypoxia, and Human Health, and the Interagency Working Group on Climate Change and Health and has served on several interagency, international, and bi-lateral committees. She serves on the Advisory Board for Virginia Sea Grant , works closely with the ocean and climate observing communities, and supports and participates in a wide range of public information and outreach activities.

In 1995, prior to arriving at NOAA, Ms. Trtanj was awarded a U.S. National Sea Grant College Policy Fellowship on Capitol Hill where she worked on domestic and international marine policy issues including fishing capacity reduction and marine aquaculture. While working with the United Nations Development Programme, Ms. Trtanj developed fisheries and marine biodiversity conservation policies for Latin America and the Caribbean. In 1994, she earned her Masters in Environmental Management from Yale School of Forestry and Environmental Studies, and her Bachelors in 1996 from the University of California Santa Barbara. She has an extensive background in foreign commodities trading, portfolio management, and venture capital.

Dr Pai-Yei Whung
Chief Scientist, USEPA

As the Chief Scientist, Dr. Whung provides program management and technical support to the EPA Science Advisor both independently and by leading the OSA staff. The Chief Scientist reports to the EPA Science Advisor and shares fully with the Science Advisor in planning, policy development and implementation, oversight, and direction of all cross-Agency scientific efforts.

Dr. Whung is an experienced researcher, a successful leader of scientific research programs, and excels in the development of science-based environmental policies and programs, strategic planning, and management of large research offices and staffs in both national and international arenas.

Dr. Whung has a doctoral degree in climate change and marine and atmospheric chemistry, and a Masters degree in oceanography. She has fifteen years of field research experience, and eight years of program and office leadership, in air quality, water quality, weather, sustainable ecosystems, climate change and agricultural research. Her research has been published in peer-reviewed journals and presented at many professional meetings. Prior to joining EPA, Dr. Whung worked in the Agricultural Research Service at UDSA. Prior to that, she served at the National Oceanic and Atmospheric Administration (NOAA), including a detail to the World Meteorological Organization.

She has successfully worked with the Office of Management and Budget (OMB), the Office of Science and Technology (OSTP), and Congress on scientific initiatives. In addition, she has led the development of several policy documents with multiple federal and state agencies, governors associations and universities; notably the National Science and Technology Council Subcommittee on Disaster Reduction strategic action plan for implementation of a National Integrated Drought Information System.

Dr. Whung’s experiences with EPA includes conducting research in Tampa Bay and Chesapeake Bay, developing analytical techniques with EPA scientists, and initiating interagency science programs, notably the Air Quality Forecasting Program between EPA and NOAA.