

Workshop Report

“In-situ monitoring and Earth observation in the framework of GMES and GEOSS”

Brussels, 31 May 2007

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Executive Summary

Earth Monitoring is at a turning point world wide. The awareness of the risks inherent to an uncontrolled development of human activities has led to environmental protocols, to the setup of new partnerships, such as the Global Earth Observation System of Systems (GEOSS) and the European GMES initiative (Global Monitoring of Environment and Security), and the need to develop synergies between existing capacities internationally. These initiatives encompass in-situ, airborne and spaceborne sensors' deployment, interconnected ground infrastructures for, data sharing, processing and analysis, value added information production up to systems for decision-making.

The last decade has seen huge progress in sensor network technologies: small computers and sensors costing tens of euros, tiny operating systems running in hundreds of bytes of memory, short-range radios consuming minimal power, and multi-hop networks covering local areas. Sensor network research has now to take advantage of the increasing trend towards more powerful computers and sensors, higher-level operating systems services, mixes of radio technologies, and wide-area networks connecting sensornets in global deployments. Another opportunity for sensor networks could come from very cheap throw away sensors (RFID and beyond). In the same time, remote sensing is becoming increasingly accurate and flexible, and these improvements are now in the process of being successfully applied to a wider range of platforms including high altitude platforms and UAV, which present new and added possibilities for civil earth observation.

It is by now well accepted that the proper monitoring of our planet will require the use of both in-situ and remote sensing techniques. While these approaches are operationally very different, they have each an essential role to play in any serious plan to monitor a site, region, country, or the Earth as a whole. Unfortunately this synergy is neither yet realised nor fully appreciated, in part because of the different technologies involved and

¹ The views expressed in this report do not necessarily represent those of the European Commission or the European Association of Remote Sensing Companies (EARSC).

skills required to operate them, in part because of the resilience of traditional working practices (resistance to change), in part also because of arguments linked to training; to the need to implement new tools and models, just to name a few...

The Workshop was held on May 31st 2007 and was jointly organised by the European Commission, Information Society and Media Directorate-General, Unit H4 "ICT for Sustainable Growth" and the European Association of Remote Sensing Companies (EARSC). This workshop was the 3rd in a series to gather stakeholders in the area of ICT for Environmental Risk Management and consult their views on how to move towards the goal of a *Single Information Space for the Environment in Europe* (SISE). This was also the occasion for a cluster of FP6 IST projects (including DEWS, DYVINE, InterRisk, OSIRIS, SANY, WINSOC, WARMER) to present their achievements so far in the field of sensor networks for disaster management.

The main objectives of the workshop were:

- to bring together experts in the fields of remote-sensing, in-situ monitoring and sensor networks and to increase mutual knowledge of their communities,
- to assess the potential of new trends in this domain for new applications,
- to explore the mechanisms of synergy between in-situ and remote sensing and to evaluate their impact,
- to identify technical and non-technical obstacles to the uptake of the proposed solutions..

The meeting raised a lot of interest with about 100 participants representing a wide range of stakeholders in the field. Indeed, more than 130 persons registered to this event; latest registrations had however to be refused due to space limitations.

Key strategic issues which emerged during the workshop include the following :

- Organisational interoperability versus technical interoperability
- Increased synergy between space and in-situ observations and services
- Interfacing and upgrading existing monitoring systems with new emerging technologies.
- Total cost of ownership (i.e. integration, deployment, maintenance, training, operation etc.) is too high due to lack of standards and lack of reliability.
- Sustainability of in-situ data component for GMES is a critical issue.
- Human factor remains a non-negligible (limiting) factor in the definition and deployment of a monitoring and alerting system based on in-situ data.

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1. Presentations

A list of all the presentations is included as Annex B of this report. The PowerPoint presentations can be found on the Commission's website at http://cordis.europa.eu/fp7/ict/sustainable-growth/workshops_en.html.

2. Key Achievements & Lessons Learned

2.1. *Technical Interoperability*

- We are in the middle of a wireless (r)evolution which enables new applications of (wireless) sensors. Examples given included:
 - Wireless controlled lightning, temperature fire in buildings
 - Car to car communications
 - "Seveso" plant monitoring
 - Monitoring of infrastructure: bridges, tunnels, dams etc...
- There are important achievements in miniaturization of sensors (e.g. RFID etc) and the resolution of the powering problems of sensors via wireless energy. This opens a perspective of massive deployment of sensors.
- On the sensor and sensor network architecture side, there are various projects defining centralized or decentralized strategies to avoid concentration. Others look at wide range of platforms and sensors: scalable, plug-in/out, self-healing networks. These approached are not yet mature, but are promising.
- There seems to be a consensus that remote sensing and in-situ data are complementary and have different intrinsic qualities. The combination of these data may serve many applications, some of which were presented during the workshop. Both the EC and ESA have on-going projects aiming to demonstrate applications from complementary remote sensing and in-situ observations. Airborne sensors provide a nice alternative to both in-situ and remote sensing with important advantages w.r.t. conventional remote sensing such as lower cost, real-time deployment, no orbital constraints, easy change of payload etc.

2.2. *Organisational Interoperability*

Despite technological advances, the "organisational interoperability" remains an important obstacle against deploying SISE and contributing to GMES and GEO. Beyond interoperability of environmental data, SISE implementation could drive a wide ICT agenda including electronic signature, billing services etc...

EU environmental legislation should foster standardised monitoring and sharing (not selling) of environmental data. The level of achievable standardization may depend from

one community to another. For instance, EUMETSAT has a well organized, federated user community which facilitated standardization.

3. Key Issues

3.1. Synergy Remote Sensing and In-situ and Data Fusion

Various participants perceived the concepts of "Earth observations", "remote sensing data", "in situ data" differently in the absence of well established definitions. GMES defines remote sensing data as satellite data and everything else as in-situ data. For another speaker it makes a lot of sense to call everything "remote sensing" as the operator of the sensor is in both cases (i.e. remote sensing and in-situ) remote with respect to the location of the sensor. Several speakers noted that from an IT point of view, Remote Sensing and in-situ sensors can be treated in the same way as "moving or fixed sensors" and do not require different technology. This would mean that differentiating remote from in situ data does not matter so much.

It was stated a number of times that one cannot exploit space data without in-situ data. The synergy between space and in situ data is however not yet realized. Several reasons for this lack of synergy were cited: different technologies, resilience of traditional working practices, linked to training, need to implement new tools and models.

The deployment of more sensors requires the management of the sensor data flows and multiple source data fusion. Data fusion from heterogeneous (wireless) sensor networks is a complex challenge. There is a lack of a unified and generic data fusion methodology and lack of standards for fusion.

Several project presentations referred to data synergy and data fusion:

- The JDL fusion methodology² is being further investigated by the SANY project (<http://www.sany-ip.eu/>) in order to develop a generic concept for data fusion based on four different levels ranging from data smoothing and noise removal, to pattern extraction, contextual/relational/causality aspects and spatial/temporal extrapolation.
- Two ESA projects, COPS and COPS-B presented a number of applications exploiting synergies between in-situ and space-born data.
- The WARMER project exploits Google Earth maps and correlation with/calibration of space data.
- DYVINE proposes a hierarchical approach with data fusion and processing at intermediary levels and simplified alerts at the upper level.

² Joint Directors of Laboratories

Participants also noted that aggregated/fused data for some (scientific) applications may be useless and cannot replace access to the original data.

3.2. Total Cost of Ownership

A second issue is that procurement, deployment, configuration, operation and maintenance of a sensor network remains high. The total cost of ownership of a sensor network and usage of in-situ data is still too high because of various reasons: lack of reliability, lack of standards, education, node size, battery etc. This cost should decrease to cope with the general trend of decreasing funding in favour of operational monitoring.

3.2.1. Telecommunications Business Model and Reliability

Sensor networks rely more and more on (wireless) communication solutions (e.g. GPRS) and machine to machine communication. The communication system plays a central role in many applications presented during the workshop. There is a clash of cultures: Internet versus telecom. The Internet presents the advantage of offering an open environment. New business models are needed, e.g. to allow connecting to the best available network at one time whatever the telecom operator.

3.2.2. Lack of Standards and Interoperability

Sensors are heterogeneous: active/passive, wireless/wired, fixed/mobile. Eventually all mobile devices may become sensors. Standards are required to reduce development cost. The OGC Sensor Web Enablement (SWE) standards are being used in many of the projects presented during the workshop: OSIRIS, SANY, DEWS, InterRisk, ORCHESTRA, COPS, COPS-B etc.

Several of the FP6 projects aim to contribute to the standardization of interfaces to sensors and sensor networks, including SANY and OSIRIS. DG INFSO representatives reiterated that it is crucial that projects adopt existing standards and contribute whenever possible to the standardization process. The Integrated Projects OASIS and ORCHESTRA were cited as good examples which have contributed already.

3.2.3. Accuracy and Reliability of Data

Some issues were raised related to the required accuracy and reliability of in-situ data. As many monitoring systems react on thresholds being exceeded which are defined in regulations, it is crucial that the data is accurate and reliable to avoid false alarms etc.

3.3. Data Policies

Interoperability requires solutions for the current data policy issues. Remote sensing and in-situ data is often not available or cannot be shared because of too restrictive data policies. EU GMES, EEA and others gave various examples of this issue, including the lack of a European wide DEM.

Making available sensor data to the research community might create applications which cannot even be imaged for the moment. A compromise should be found allowing research institutes to access the raw data (and not only aggregated data which is useless for many models) but at the same time respecting the economic issues, causing the current restrictive data policies.

3.4. Sustainability

GMES could do a lot to ensure sustainability of space remote sensing systems. The Shared Environmental Information System (SEIS) announced by DG ENV and EEA could help sustaining parts of the in-situ monitoring capability in Europe. EEA stated that the sustainability in-situ component within the GMES core services is a real critical issue which should start with the funding line. There is no sustained funding available or foreseen today.

The representative of the EU GMES bureau remarked that intake of in-situ data for GMES projects is currently random. For sustainability purposes, systematic and guaranteed approaches are needed.

3.5. Human Factor

Technical solutions are sometimes available, but the human factor prevents their exploitation. Many examples were presented during the workshop:

- Regulations preventing use of high altitude platforms with airborne sensors,
- Last mile problem to reach the population, e.g. for tsunami alerts,
- Multi-lingual issues,
- Exact meaning of alerts generated by sensor systems. Language has to be precise,
- Alert information has to be sent to the right people at the right time.
- The final user should be involved during design and development of the system.
- Change of user behaviour hardly happens; resistance against changing modes and tools of operation.

4. ANNEXES

4.1. Annex A - Attendance List

LIST OF PARTICIPANTS

WORKSHOP: "In-situ monitoring and Earth observation in the framework of GMES and GEOSS", Brussels, May 31st, 2007

1	AETS - Apeave SUDEUROPE Group	Gérard	TAREL
2	AQUAPOLE	Vincent	TIGNY
3	ARGOSS	Hans	WENSINK
4	ATLAS Elektronik GmbH	Holger	KLINDT
5	ATOS Origin	Borja	IZQUIERDO
6	Belgium Institute for Space Aeronomy	Simon	CHABRILLAT
7	Speaker BMT Cordah (SANY Project)	Z.A.	SABEUR
8	BNSC, British National Space Centre	Michael	ROSE
9	BRGM - ST/DIR	Pierre	LAGARDE
10	CEFAS, Centre for Environment, Fisheries and Environmental Science	David	MILLS
11	CEN, European Committee for Standardization	André	PIRLET
12	Centre for Science, Society and Citizenship	Emilio	MORDINI
13	Coastal & Marine Resources Centre	Declan	DUNNE
14	ControlWare	Birgitte	HOLT ANDERSEN
15	CRUE (Conferencia de Rectores de Universidades Españolas)	Rafael	SPINOLA
16	CS Communication & Systems	Anne	CHANIÉ
17	Speaker D'Appolonia (EU-FIRE)	C.C.	TASSINI
18	Datamat S.p.A.	Federico	ROSSI
19	DG ENTR, GMES Bureau	Josiane	MASSON
20	Dutch Space Agency (NIVR)	Ruud	GRIM
21	Speaker EADS (DYVINE project)	P.	CHROBOCINSKI
22	EADS ASTRIUM	Patrick	RUDLOFF
23	Moderator EARSC	Paul	KAMOUN
24	EC- JRC	Alan	STEEL
25	EC, DG ENTR	Jan	ULRICH
26	EEA	Markus	ERHARD
27	Speaker EEA (Eionet)	C.	STEENMANS
28	Speaker ENVIROMATICS (SANY project)	R.	DENZER
29	Speaker ESA	S.	DELIA
30	Speaker ESEAS Central Bureau	Bente Lijja	BYE
31	Speaker EU-DG ENV (INSPIRE)	H.	de GROOF
32	Speaker EU-DG-ENTR-H7 (GMES-Bureau) - GMES programmes	W.	STEINBORN
33	Rapporteur EU-DG-INFOS	I.	COENE
34	Moderator EU-DG-INFOS	J.	PEREIRA
35	Moderator EU-DG-INFOS	K.	FABBRI
36	Moderator EU-DG-INFOS	M.	MONTEIRO
37	Moderator EU-DG-INFOS	M.	SCHOUPE
38	Moderator EU-DG-INFOS	Guy	WEETS
39	EU-GMES BUREAU	Arno	KASCHL
40	Speaker EUMETNET	U.	GÄRTNER
41	Speaker EUMETSAT	Vincent	GABAGLIO
42	EuroGeographics	Tokyo	WICKS
43	EuroGOOS	Patrick	GORRINGE
44	European Commission - Joint Research Service	Jean-Paul	MALINGREAU
45	European Space Imaging	Rob	POSTMA
46	Eurosense	André	JADOT
47	Eurosense	Emile	MAES
48	Fraunhofer-Institute IITB	Kym	WATSON
49	FSU Jena - Earth Observation	Christiana	SCHMULLIUS
50	GEO	Giovanni	RUM
51	Speaker GFZ- POTDAM (DEWS project)	J.	WÄCHTER
52	Speaker GIM nv/sa, Geographic Information Management	V.	SCHREURS

53	GISAT s.r.o.	Tomas	SOUKUP
54	GRICES	Ana	PONTE
55	GTD sistemas de Información	Francisco-Javier	BUSTO
56	IIASA, International Institute for Applied Systems Analysis	Steffen	FRITZ
57	INASMET/TECNALIA	Jesús	MARCOS
58	Independent Expert	Ulf	BJURMAN
59	Speaker	INDRA Space	D.
60	Infoterra Limited	Graham	DEANE
61	INSA S.A.	Vicente	RUIZ
62	Institute of Meteorology and Water Management, Poland	Piotr	STRUZIK
63	International Institute for Geo-Information Science and Earth Observation	Bert	BOER
64	LogicaCMG	Chetan	PRADHAN
65	LSCE/IPSL, Laboratoire des Sciences du Climat et de l'Environnement	Philippe	CIAIS
66	LSCE/IPSL, Laboratoire des Sciences du Climat et de l'Environnement	Christiane	TEXTOR
67	LuxSpace Sàrl	Willibald	CROI
68	NAGREF - National Agricultural Research Foundation	Leonidas	TOULIOS
69	National Meteorological Administration, Romania	Gheorghe	STANCALIE
70	National Research Council of Italy (CNR) - Biophysical Institute (IBF)	Stefano	VIGNUDELLI
71	NERSC (INTERRISK project)	T.	HAMRE
72	OHB-Technology	Stephen	HOLSTEN
73	ORACLE	Fulvio	SANSONE
74	Speaker	ORACLE	W.
75	PLANETEK	Paolo	MANUNTA
76	PRO DV Software AG	Lars	TUFTE
77	QinetiQ	Wyn	CUDLIP
78	ReSAC - Remote Sensing Application Center	Vassil	VASSILEV
79	RIKZ - National Institute for Coastal and Marine Management	Richard	DUIN
80	Royal Military Academy	Karin	MERTENS
81	Saab Space AB	Hans	FRITZ
82	SciSys UK Ltd	Adrian	GRENHAM
83	Speaker	Selex-Communications (WINSOC Project)	P.
84	Slovak Hydrometeorological Institute	Pavol	NEJEDLIK
85	SOST, Spanish Office of Science and Technology	Juliana	CHAVES-
86	SPMD sarl	Marc	CHAPARRO
87	Squaris Consultants	Annie	DUFRESNE
88	Starlab	Marina	LALÉ
89	Speaker	SYSTEAM (WARMER Project)	MARTÍNEZ
90	Tartu Observatory	L.	SANFILIPPO
91	Speaker	TELEATLAS	Anu
92	Speaker	Thales Communications (OSIRIS project)	J.
93	TNO	D.	REINART
94	TRAGSATEC	Chris	PITTEURS
95	TÜBITAK SPACE	Julia	TACYNIAK
96	University BREMEN - Institute for Marine Environmental Sciences	Hilal	BREMMER
97	Speaker	University of Münster (OSIRIS Project)	Michael
98	Speaker	UNOSAT	S.
99	VCS Aktiengesellschaft	Francesco	GIMÉNEZ-MORENC
100	Speaker	VITO (OSIRIS project)	Peter
101	Yuzhnoye State Design Office (Ukraine)	N.	YÜCE
		Oleg	DIEPENBROEK
			JIRKA
			PISANO
			SCHEIDGEN
			LEWYCKY
			VENTSKOVSKY

Annex B - Presentations List

Welcome (09h00-09h30) - G. Weets (EU-DG INFSO) & P. Kamoun (EARSC)

Discussion1: Sensors network architecture: (09h30-10h30)

Moderator: J. Pereira (EU-DG-INFSO)

- Current trends in sensor networks, J. Pereira (EU-DG-INFSO)
- Sensor networks interoperability, R. Denzer (ENVIROMATICS, SANY Project)
- Open architecture for smart and in-situ sensor networks, D. Tacyniak, S. Jirka (THALES COMMUNICATIONS, OSIRIS Project)
- Self-organized wireless sensor networks, P. Capodiecì (SELEX- COMMUNICATIONS, WINSOC Project)
- Data base integration of multiple sensors, J. Jackson (ORACLE)

Discussion 2: Pilot implementations: (10h45-12h30)

Moderator: K Fabbri (EU-DG-INFSO)

- Sensors for forest fire detection: C.C. Tassini (D'APPOLONIA, EU-FIRE Project)
- Sensor networks for tsunami monitoring: J. Wächter (GFZ-POTDAM, DEWS Project)
- High Altitude Platforms for environmental monitoring and risk management: N. Lewyckij (VITO, OSIRIS Project)
- Multi-parametric approach to water quality: L. Sanfilippo (SYSTEA, WARMER Project)
- Visual sensor integration: P. Chrobocinski (EADS, DYVINE Project)

Discussion 3: Integration of in-situ and EO sensors: (14h00-15h00)

Moderator: P. Kamoun (EARSC)

- Combining EO and in-situ: T. Hamre (NERSC, INTERRISK Project)
- Sensor Fusion Services: Z.A. Sabeur (BMT Cordah, SANY Project)
- COPS project: Cooperating EO sensors: D. Carrasco (INDRA)
- Demonstrate innovative ways to exploit EO and in-situ data synergies: V. Schreurs (GIM)

Round Table 1: Integration of in-situ and EO sensors: (15h00-16h00)

Moderator: P. Kamoun (EARSC)

- Mapping of in-situ communities: C. Steenmans (EEA)
- GEO/GEOSS introduction/ Meteorology and air pollution: U. Gartner (GEO Executive Council)
- Integration in mapping: J. Pitteurs (TELEATLAS)
- GMES fast track applications: W. Steinborn (GMES Bureau)

Round table 2: Infrastructure and Policies: (16h15-17h00)

Moderator: M. Monteiro (EU-DG-INFSO)

- The Community Environmental Policy Context: H. De Groof, (EU-DG-ENV)
- Infrastructure and Support for Research and Services (SSE, HMA, Keops,): S. D'Elia, (ESA)

Final Round table: "Technology and Systems Roadmap: what's next" (17h00-17h30)

Moderator: M. Schouppe (EU-DG-INFSO)

- Participants: B.L. Bye (ESE), Markus Erhard (EEA), V. Gabaglio (EUMETSAT), G. Rum (GEO secretariat), W. Steinborn (EU-DG-ENTR), G. Weets (EU-DG-INFSO).