WITFOR 2005 Environment Commission Report
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Executive summary

This report summarises the findings of the WITFOR 2005 Environment Commission. The report gives an overview of typical environment applications and highlights the state-of-the-art in the research area. Environmental applications typically consist of two major elements: a decision support element (which helps decision makers to make informed decisions) and an integration element, which consists of two parts: integration of very distinct tools and data integration across institutional, political and geographical boundaries. This is why environmental applications are typically very complex software systems.

In the spirit of WITFOR 2005, the commission proposes to create a project-based collaboration between developing and developed countries which shall be based on two major activities: a capacity building activity and a research activity.

The capacity building activity will enable developing countries to better use ICT in environmental applications. It will be based on joint conferences, seminars and short courses. This activity can be founded on similar activities carried out in the past in development countries but needs to be adapted considerably to satisfy needs of developing countries.

The research activity will implement a large scale information network in South Africa, potentially including neighbouring countries, using current developments in the European Framework Program. This activity is strongly related to global initiatives and shall be the seed for an African participation in world-wide information infrastructures.

Introduction

The scope of the Environment Commission is the IT support of environmental decision making. Such IT systems are usually called ***Environmental Information and Decision Support Systems*** (EIDSS). Traditionally, these software systems are used to monitor the state of the environment, to analyse and model environmental processes, to assess potential consequences of decisions and thus help decision makers to make informed decisions.

Typical examples of EIDSS are

- Systems for the monitoring of environmental media, eg. air and water pollution monitoring systems; these systems are used for the monitoring of long term changes as well as for short term alarming.
- Systems to support analysis, modelling and simulation of environmental and man-made processes; they are used in environmental authorities as well as in scientific organisations.
- Systems planning (e.g. land management); they are often used by public authorities and by the private sector in order to support planning decisions.
- Systems for the analysis of impact and the management of risk; they are often used in order to prepare baseline knowledge and scenarios for policy decisions.
- Systems for crisis management which support alarming, public safety and crisis communication, forecasting and operational support; they are strongly targeted towards the protection of the citizen.

In recent years it has been recognised that there is a cross-cutting theme. Because environmental processes do not stop at political borders, the integration of disparate systems across institutional, national and geographic boundaries is an urgent need. This is particularly the case when supporting cross-national risk and disaster management applications.

Problem area investigated

ICT for Environment, also known as ***Enviromatics***[1], often involves disparate data sources, large amounts of data and high computational demands. Software solutions for end users are often complex applications using a variety of informatics methods. These methods can be, for instance: data and information management networks, numerical modelling and simulation, geographical information systems, artificial intelligence methods or satellite imagery.

[1] In this report, the term ***Enviromatics*** will be used as a synonym for the subdomain of Informatics dealing with the analysis, design and implementation of Environmental Information and Decision Support Systems (EIDSS). The terms ***Environmental Informatics*** and ***Eco-Informatics*** are also used in the community and mean the same.

Typical application areas of Enviromatics include:

- Monitoring of environmental media (eg real-time air pollution monitoring systems, emission inventories, monitoring via bio-indicators)
- Water resource management (see case study 1)
- Impact assessment in agriculture (eg effects of pesticides on water bodies)
- Modelling the effect of global change (eg on agriculture)
- Information systems of national, regional or local government bodies (eg inventories of water protections areas, hazardous sites information systems, information systems for the public)
- World-wide monitoring programs and related services (eg GEOSS[2], GMES[3])
- Large scale spatial data infrastructures (eg INSPIRE[4]) including supporting environmental baseline information
- Risk and disaster management systems (see case study 3 and project 2)

Particularly important is the fact that ***real solutions for end users*** are often a composition of a different software methodologies and tools. Thus, Enviromatics systems are typically inherently complex software systems solving inherently complex tasks. It is often very difficult to cope with this complexity in such a way that end users are still capable of using these systems.

Findings

This section gives an overview of where Enviromatics is currently positioned. It is not intended to be a literature review. The main focus is to highlight past development, to demonstrate typical application examples and to highlight some hot-spot needs for future research, which will be proposed in the next section.

Status of knowledge

The research field of Enviromatics is huge and global. It is very difficult to capture it as a whole. Enviromatics applications are both looked at from a pure practitioners point of view (and are thus present in many application fields like water resource management, ecology, risk management, etc.) and from an Informatics point of view (what are typical challenges in different informatics sub-domains and how do we design and build such complex applications?).

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[2] Global Earth Observation System of Systems, see: earthobservations.org
[3] Global Monitoring for Environment and Security, see: www.gmes.info
[4] Infrastructure for Spatial Information in Europe, see: inspire.jrc.it

Scientific communities and activities

With respect to the Informatics point of view, there are two major scientific communities in this field. First there is a strong European community, with a centre of gravity in Germany (EnviroInfo conference series). Secondly, there are substantial communities in Canada, Australia, New Zealand and the United States. Overall, these communities each have traditionally had slightly different but complementary foci. World-wide representation is achieved through **IFIP Working Group 5.11 "Computers and Environment"**[5] with its conference series **ISESS**[6]. It is impossible in this context to give an overview of different research streams in all these communities, but there have been many specialist working groups and specialist workshops on different topics, in particular in Europe. True global representation in these scientific communities is still weak in many areas, in particular in Africa and Asia (although applications do exist). A cross-cutting community is that of the Open Geospatial Consortium (OGC)[7], which deals with geographical information in general and is a base tool for Enviromatics. This cross-cutting community has a much better representation in developing countries through organisations like the Global Spatial data Infrastructure Association (GSDI)[8]. There are also a number of NGOs assisting with coordination and networking of Enviromatics activities and individuals. One of these is EIS-Africa[9].

Balancing global initiatives and local needs

Global initiatives such as GEOSS and GMES have recognised that the potential benefits of past investment in environmental monitoring systems have not been achieved. Existing investments can be exploited to the benefit of many more people only if data sources and applications are made widely available. This is only possible through ***interoperability***. Interoperability is the implementation of open standards for data discovery, exchange, semantics as well as for re-use of services. As more interoperability is achieved, users across the world and across domains will be able to exploit the rich environmental data sources at little extra cost and thereby focus on applying Enviromatics for decision support and making a difference. Aspects of interoperability are already achievable through the efforts of ISO[10], OGC and other standards generating bodies. Many challenges remain in the areas of data fusion, understanding the meaning of information and how to use it (semantics) and in developing more useful applications that can exploit new systems.

Local needs can usually not be separated from global tasks. Many local applications need global datasets and many local applications are cross-border systems (eg flood forecasting systems in Europe, which would have to cover between 4 and 16 countries).

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[5] See: www.enviromatics.org
[6] International Symposium on Environmental Software Systems, see: www.isess.org
[7] See: www.opengeospatial.org
[8] See http://www.gsdi.org/
[9] Environmental Information Systems Africa www.eis-africa.org
[10] International Organisation for Standardisation, see: www.iso.org

Overcoming national, regional, organisational and thematic boundaries is key to success. For both global and local applications today ***interoperability is the most important need*** to build useful applications for end users.

ICT Challenges in developing countries

With respect to ICT challenges in developing countries, the first WITFOR environment commission report[11] has given the following assessment of the situation:

> *"Developing countries encounter several obstacles that prevent them from becoming beneficiaries of ICT. The main challenges can be summarized as follows.*
>
> *a) **Lack of appropriate communication infrastructure**. Developing countries do not have adequate financial and human resources to expand telecommunication services to remote geographical locations. Urban and rural communities do not have equitable access to ICT.*
>
> *b) **Absence of clearly defined ICT policy and emphasis**. Only a few countries on the continent have developed their ICT policy and strategies. For most countries, expansion of communication services to rural areas is given lower priority.*
>
> *c) **Shortage of skilled human resources**. Developing countries suffer not only from a lack of adequate communication infrastructure but also from the skilled manpower. There is a shift of ICT professionals from academia to industry within a country resulting in a severe shortage of college teachers and university professors. The brain drain is another reason for the shortage of ICT professionals. In South Africa for instance, about 25% of the ICT skilled manpower leaves the country every year.*
>
> *d) **Lack of funding for training and investing in ICT infrastructure**. Although some developing nations and organizations donate some funding for training, this money is not appropriately used due to mismanagement. On the other hand, the monopoly nature of communication services does not allow private investors to take part in improving the infrastructure.*

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[11] D.A. Swayne, K.E. Solem (co-chairs), Mieso Denko and Ralf Denzer, *Environmental Forecasting and Futures*, Report by Commission #7, WITFOR 2003, Vilnius, 25-29 August 2003

*e) **In adequate computing resources**. A large proportion of the population in developing countries does not have access to personal computers. Some of these do not even have a reliable electricity supply.*

*f) **Cost of ICT services are high in some countries**. Although hardware and software costs are relatively low, the cost of telecommunication services and Internet access is not affordable to most low-income communities."*

Some of these issues are cross-cutting issues which are also addressed by other WITFOR commissions (eg by the Infrastructure commission). Others are addressed both by this commission and other commissions (eg the need for training in our domain).

The view presented above is mainly targeted to individual, in particular rural, end users. This commission wishes to include and discuss, on a broader scale, government organisations as end users. In their case, communication infrastructures are also critical issues, but they also have the same problem as developed countries, namely the need for information infrastructures.

Case Studies

The following case studies are examples of how Enviromatics has been applied and what its benefits can be. The first case study is a typical decision support system for the management of a water body. The second and third case studies showcase the use of ***multiple*** monitoring data sources, data fusion and modelling. These were implemented in the early days of interoperability. They are only a taste of what will be possible with once global, comprehensive interoperability is achieved. The research proposal presented in the next section (of testing the ORCHESTRA Architecture in Africa) takes a step towards greater interoperability and greater benefits to all from Enviromatics.

Case study 1: Lake Malawi Decision Support System

David A. Swayne, CRLE, Canada

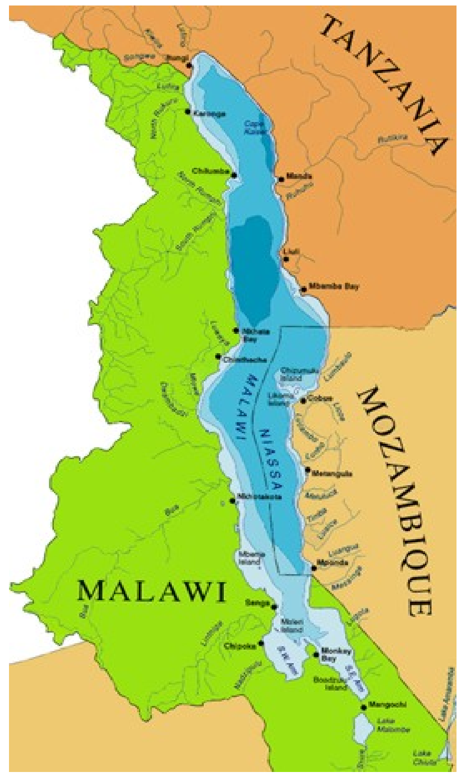
The Lake Malawi Decision Support System[12] provides background information regarding the Lake Malawi/Nyasa/Niassa catchment from previous studies, modelling results from the AGNPS model for the Linthipe subbasin, and modelling results from a hydrodynamic model of Lake Malawi / Nyasa / Niassa.

Lake Malawi/Nyasa/Niassa is located in the southern end of the great rift valley systems which fracture the ancient plateau of eastern Africa. The lake has existed in the rift for over two million years. It is the fourth deepest inland water body in the world with its greatest depths (700 m) extending below sea level. It is the ninth largest by area and the fourth largest body of freshwater on the globe. The lake is surrounded by mountains with highest elevations to the north where the mountains rise over 2000 m above the lake's surface, and lower elevations to the south.

[12] See: www.crle.uoguelph.ca/malawi

The lake is a great resource for the riparian peoples of Malawi, Mozambique and Tanzania. For the people on the lakeshore, it provides the basis for life itself through abundant water for drinking and domestic uses, easy transport and possible use for irrigation of crops.

The lake is also renowned for its fabulous biodiversity, especially among the numerous cichlid fishes. Malawi/Nyasa/Niassa has more species of fish than any other lake in the world. Many of these fishes are colorful and highly sought after by the aquarium trade. The inshore distribution of these fishes and their inquisitive behaviour make them attractive to view and adds immeasurably to the tourism potential of the lake.



The system presents key issues for the management of the Lake and examines the potential impact of various scenarios related to these issues. The goal for the development of the model is to provide a tool to predict the behaviour of physical processes in the lake on a seasonal basis.

In addition, the model should assist in making wise land and water management decisions based on changes in Lake water quality likely to arise as a result of proposed development and the conservation/protection options presented to them. Particular objectives of the system are to give answers to the following questions:

- How nutrients entering at various points in the Lake affect phytoplankton growth and development, the destratification of thermoclines, and how the rate of eutrophication is likely to change over time;

- How seasonal inflow of sediments from various rivers draining into Lake Malawi/Nyasa/Niassa move within the lake;

- How lake long-shore, deep and surface offshore current patterns might effect movement and dispersal of pollutants or threatening weeds.

Case study 2: Information System for Marine Aquatic Resource Quality

Jonathan Williams, MTS, United Kingdom

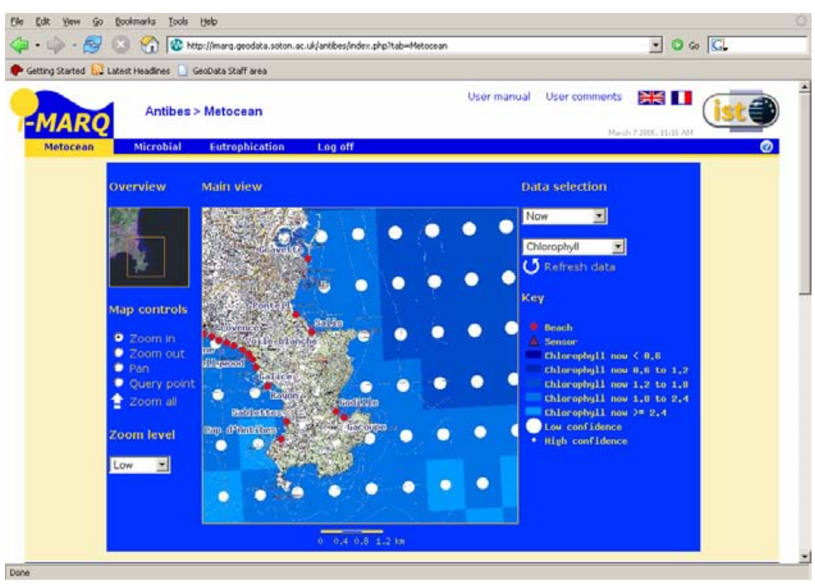
Marine environmental monitoring is undergoing rapid and sustained growth. A wide range of users and administrators of marine resources require concise and ergonomic information for decision support, in order to maintain and enhance environmental quality in face of growing pressure on resources. In particular, tourism in coastal areas is demanding ever increasing environmental quality and requires daily and seasonal information on coastal environment quality and stress. These trends create a rapidly growing demand for solutions, comprising: the ability to process high volumes of raw data; to extract highest quality information; and to present it in a form which maximises usability and understanding.

Management of environmental risks in coastal and marine waters is increasingly important, as regulatory policy moves from discharge compliance alone towards impact minimisation. Decision-making (for operational and remediation management) requires access to best quality information on key environmental quality parameters. However, current data resources are fragmented and generally sparse both spatially and temporally. They also possess varying uncertainty.

The i-MARQ system[13] (Information System for Marine Aquatic Resource Quality) addresses this need, helping companies and authorities to anticipate problems and minimise the impact of their activities, whilst also helping coastal tourism to develop sustainably with enhanced public confidence in the environmental integrity of recreational waters.

The i-MARQ project is developing enhanced decision support paradigms which can optimally exploit diverse data resources, and present probabilistic results in the geographic formats required by diverse decision-makers. Application of data fusion techniques permits forecasting of parameter best estimates and uncertainties, based on the underlying data statistics. This determination of information robustness is considered an essential ingredient of advanced environmental decision support systems. i-MARQ combines three core components in a distributed environment: decision support visualisation, access to data resources & sensor networks, and state-of-the-art data fusion.

In the past, environmental management of coastal waters was based on historic datasets. These could indicate where deterioration had occurred, but gave no indication of the dynamics of environmental degradation. Naturally, historic data alone cannot allow pre-emptive action to be taken to minimise impacts on other users. i-MARQ addresses this problem by allowing environmental risk to be forecast, thereby allowing action to be taken in order to avoid or ameliorate the risk. This ability to forecast risk is central to risk management, and opens up new



13 See: See: www.imarq.info

opportunities to minimise exposure to hazard. In particular, for regulatory authorities it helps focus scarce human resources onto locations posing significant risk, greatly enhancing their operational effectiveness.

The data fusion capability allows all available data sources to be used, generating the best possible estimate of risk. Whilst measured data are vital, the system also uses model predictions to enrich the available data resource. The fusion technique also determines the level of uncertainty within its forecasts, thereby allowing users to assess whether the risk forecast is sufficiently robust to justify intervention.

Case study 3: Wide Area Monitoring Information System

Philip Frost / Andrew Terhorst, South Africa

Fire has always been an important a part of the African continent and its inhabitants. Most of the world's burned biomass matter is from the savannas, and because two-thirds of the Earth's savannas are located in Africa, it got the name "continent of fire". In the region of 90 % of all fires in Africa are human induced, set during the dry seasons and used as a tool in agriculture, hunting, the preparation of food and numerous other activities.

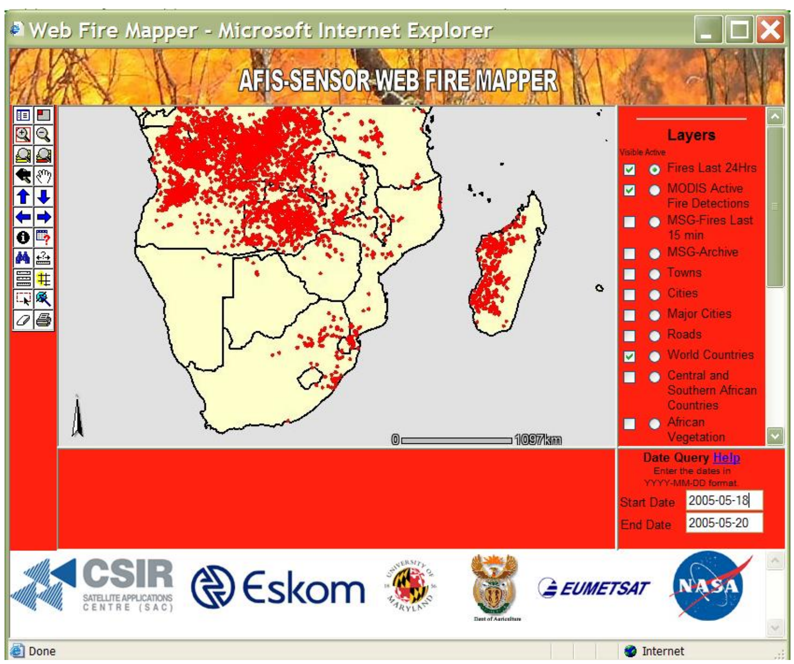
The extent of biomass burning is believed to have increased significantly over the past 100 years with increased population densities resulting in more frequent burning across the continent. The size of these burns might also be getting smaller due to increased amounts of human activities such as agriculture and the improvement of general infrastructure in and around towns and cities. An increase in the frequency and distribution of fires in African will have serious effects not only on global warming but also land cover change and the destruction of infrastructure and ultimately loss of life. It is therefore essential to have accurate measurements of fire parameters such as frequency and distribution (Environmental Science & Technology, March 1995).

One of the best ways to accurately determine the exact location and extent of fires is to have a global perspective from space. Since no satellites, until now, have ever been dedicated to fire monitoring and measuring, most observations of fires from space have been obtained from existing satellites developed for other purposes. Fire measurements mostly came from the polar orbiting Advanced Very High Resolution Radiometer (AVHRR) on the National Oceanic and Atmospheric Administration (NOAA) series of satellites.

In 1999 and 2002 NASA launched the Terra and Aqua satellites, which each carry the Moderate Resolution Imaging Spectro radiometer (MODIS). These sensors scan the earth eight times a day in 36 spectral bands including a mid infra red band dedicated to fire detection (Justice, C., et al. 2002). Improved fire detection is also possible through the latest geostationary satellite from Eumetsat called Meteosat Second Generation (MSG). MSG can produce active fire location information every 15 minutes over the entire African and European continent.

The Dahlem Conference on Fire in the Environment in 1992 proposed the development of a Vegetation Fire Information System. This provided a vision for an information system composed of satellite and *in-situ* observations (Malingreau, 1993). Most of the Vegetation Fire Information Systems were designed to predominantly serve the global change research community, with little emphasis on fire suppression and the near real time detection of fires. In 2002 damages to infrastructure and loss of grazing due to wild land fires in South Africa were estimated in the region of $ 50 million. An urgent need was identified to develop a satellite based information system that could provide information on the frequency and distribution of fires over time for the change detection research community but also a near real time tool that could provide early detection of fires to fire managers.

The Advanced Fire Information System (AFIS) has been developed as a service module of the Wide Area Monitoring Information System (WAMIS), which aims to deliver fire information products to researchers, Fire Protection Agencies and Disaster managers all over Southern Africa in support of effective decision-making in the monitoring of natural and manmade fires. AFIS is the first near real time operational satellite fire monitoring system in Southern Africa. The system is based on the MODIS Rapid Response and Web Fire Mapper systems that have been developed at the University of Maryland and NASA over the last few years. Funding for the development, installation and operational running of the system has been made possible through ESKOM, South African National Department of Agriculture and the CSIR SAC.



Terra and Aqua MODIS as well as MSG data are directly received at the CSIR SAC at Hartbeeshoek, South Africa. Here dedicated workstations calibrate, geo corrects and execute fire detection algorithms to produce fire location files.

The text information is immediately transferred to the main web GIS server where it is displayed on to regional maps. Internet users can access the server, analyse fire location information, add additional information layers such as roads and towns and query fire location information from previous dates.

A SMS alert system has been developed to provide rapid alert to fires in specifically defined areas. South Africa's power company ESKOM utilizes the SMS alert system to enable rapid response to fires underneath power lines. AFIS scans a 2.5 km buffer a long side all transmission lines searching for fires every 15 minutes. As soon as a fire is detected by either of the satellites an SMS message will be generated indication fire location and distance to the power line. This information is sent to the regional ESKOM manager.

Researchers more interested in the frequency and distribution of fires in specific areas can register to receive a daily email. The email will contain a referenced image and a list of all fires detected within the defined area. Information such as date, time, location (lat/long), detected temperature and confidence of each fire will be included in the list. Researchers in Angola, Mozambique, Lesotho, Swaziland, Botswana and Zimbabwe have been monitoring fire prone areas since beginning of July 2004.

The two MODIS satellites are polar orbiting, moving around the North and South Poles every 98 minutes while the earth is turning from west to east. Terra scans the Southern African region between 10 – 11:30 am while Aqua scans in the afternoons between 14:00 – 15:30 pm. Each satellite also scans the region at night (Terra @ 22:00 pm and Aqua @ 03:00 am). The AFIS web server is updated with MODIS fire locations 35 minutes after a satellite Validation results indicate that in many biomes the minimum flaming (~800-1000K) fire size typically detectable at 50% probability with MODIS is on the order of **$100m^2$** (Giglio, L. et al. 2000).

MSG is a geostationary satellite that scans the African continent every 15 minutes in a south to north direction. The biggest limitation is its coarse resolution with limits the detection of small fires. Validation of the minimum detectable fire size for MSG in Southern Africa is currently being researched. Validation in the USA on similar satellites have shown detectable sizes in the region of **$500m^2$**, but scan angles, biome, sun position, land surface temperature, cloud cover, amount of smoke and wind direction will be the final determining factor

A clearer understanding of the extent, impact and changes in biomass burning is necessary to enable African governments to draw up effective legislations on the management of fires. The AFIS is providing essential information to both the researcher and the fire manager requiring near real time alerts. The system can be accessed via the internet: www.wamis.co.za/eskom/checkboxes/sa.htm

Actions to be taken

This section presents those actions proposed by the Environment commission to be taken up after WITFOR 2005. Considerable funding will be required in order to create impact.

Research

A brief overview of research requirements is given here. It is not meant to be comprehensive nor fully representative. Lists are given of research requirements by Environmental domain and Information domain.

Major requirements that are implied by these lists are research into the application of the Information domains within and across the Environmental domains.

Lastly, successful research depends on a good source of top students, world class mentors or lead researchers and sufficient critical mass. These are social and political issues that go hand in hand with the more scientific requirements listed here.

Research is required in the following ‘information-rich’ Environmental domains

- Water resources. For example for the establishment and operation of Catchment Management Agencies
- Food Security
- Biodiversity conservation
- Disaster Management
- Health. For example cholera and malaria.
- Environmental monitoring and enforcement. For example monitoring of air and water pollution or the implementation of the National Environmental Management Act in South Africa.

Research is required in the following Information domains

- Integration of information infrastructures
- Data fusion and integration
- Semantic interoperability
- Technical interoperability
- Modelling and simulation
- GRID computing
- Distributed systems
- Information system sustainability

These research topics will be tackled as part of the projects proposed below.

Projects

Project 1: Capacity Building for Environmental ICT

Project Description

The project will conduct a joint ***ISESS / CSIR / WITFOR Workshop on Sensor Web Technologies*** combined with ***The First African Enviromatics Seminar***, targeted at graduate students. The workshop will be held mid-March 2006 in South Africa and will be co-sponsored by IFIP, CSIR[14], EIG[15] and potentially other organisations.

Project Macro Plan

The workshop will be announced in June 2005 and will follow a standard procedure for the organisation of conferences. The course can pursue 2 alternative models: either a participation model (students join the conference and work on a scientific paper) or a project model (groups of students collaborate on projects).

Resource Requirements

The main resource requirement for this project is the availability and funding of internationally renowned lecturers and stipends for students of various African countries to participate. An additional resource requirement is to cover the risk of the scientific workshop. Overall, ***two bronze sponsors of WITFOR, eg environmentally conscientious companies or organisations, would be sufficient to sustain this activity***.

Project 2: Global Sharing of Information Infrastructures

Project Description

The project intends to share developments for a European environmental information management capacity (FP6 project ORCHESTRA[16]) with an African region. ORCHESTRA has a strong relationship with INSPIRE and GMES, as it aims to contribute to the specification of a large scale information management capacity. ORCHESTRA is a 3-year project with a budget over 14 M€. It was started in September 2004. The first specifications of the architecture will be available during the year 2005.

Project Macro Plan

The project will either conduct a feasibility study for the application of ORCHESTRA in Africa or implement an ORCHESTRA information network in Africa, thus validating the ORCHESTRA Architecture at a different continent. The seed for the project will be in

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[14] Council for Scientific and Industrial Research, see: www.csir.co.za
[15] Environmental Informatics Group, see: www.enviromatics.net
[16] Open Architecture and Spatial Data Infrastructure for Europe, see: www.eu-orchestra.org

the Republic of South Africa, where it will find a strong home in CSIR, an RSA parastatal research agency.

Resource Requirements

This project will require considerable resources. The nucleus of personnel is available through the extensive expertise in CSIR and in the ORCHESTRA project. Financial resources will be considerable yet scalable depending on the way the project is conducted. ***The commission would expect funding sources similar to European Framework research or World Bank projects***.

WSIS and MDGs addressed by these actions

The World Summit for the Information Society (WSIS) is to be held in Tunisia in September 2005. Points from the Geneva 2003 Phase 1 Declaration relevant to the Witfor Environmental Commission are listed below along with Environmental Commission responses.

1. The Declaration recognizes that ICTs are an essential foundation for an inclusive Information Society and embraces the idea of universal, accessible, equitable and affordable ICT infrastructure and services as a key goal of all stakeholders that will help build it. The cross-cutting theme of interoperability in this Commission and projects such as ORCHESTRA address this goal.

4. If universal access is the foundation of a true Information Society, capacity building is its motor. The declaration acknowledges that only by inspiring and educating populations unfamiliar with the Internet and its powerful applications will the fruit of universal access ripen. The capacity building seminar this Commission proposes addresses this goal.

7. On the question of Intellectual Property, the Declaration underlines the importance of both encouraging innovation and creativity and the need to share knowledge to spur such innovation and creativity. Much of Enviromatics and indeed the projects proposed here, particularly ORCHESTRA, accur with an Open philosophy – Open Architecture, Open Data, Open Source. Thus the intellectual property created in these ventures is placed into the public domain to be shared and built on by all.

11. And finally, the Declaration expresses an unconditional support and commitment to close the Digital Divide through international cooperation among all stakeholders The projects and seminar presented and proposed by this Commission represent a variety of developed world – developing world cooperation models.

One United Nations Millennium Development Goal (MDG), Goal 7, is directly addressed by this Commission:

***Ensure environmental sustainability**: Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources; Reduce by half the proportion of people without sustainable access to safe drinking water; Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020.* The information and decision support necessary to realise this goal depends almost entirely on Enviromatics and the political and social conditions that enable its fruitful application.

Expected outcomes

This section summarises the expected outcomes of the post-WITFOR process.

Research

The projects proposed here have research components that address some of the research needs listed above. They will build capacity in Africa and foster applied research in Enviromatics. For example a scientific paper may be produced at the proposed seminar. The implementation of ORCHESTRA in Africa will required research to adapt it to local conditions and requirements and novel local research may be undertaken that will contribute back to ORCHESTRA itself.

Projects

Project 1: Capacity Building for Environmental ICT

The expected outcome of this project is to harness world-wide capabilities in Enviromatics teaching to develop a course for developing countries. This course will have to adapt to the needs in developing countries. The 2006 activity presented here shall only be the entry point into a long-term sustainable collaboration in training of ICT for the Environment.

Project 2: Global Sharing of Information Infrastructures

The expected outcome of this project is threefold. First, European framework research shall be transported to Africa and the project shall act as a model of how information infrastructures can be shared with developing countries, thus making maximum use of the resources spent in EU FP6. Secondly, the results of the ORCHESTRA project shall be validated in Africa, thus giving additional feedback to the developers of infrastructures by having an additional pilot area. Finally, as ICT for the Environment can not even stop on a level of continents, this exercise will help to support the movement towards truly global environmental information management and service infrastructures.