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CYCLOPS

CYber-Infrastructure for CiviL protection Operative ProcedureS

Project Results Presentation

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ACRONYMS

ANPHORE	APPLICATION OF METHODOLOGIES ADDRESSED TO THE HYDRO-METEOROLOGICAL FORECAST FOCUSED ON THE ENVIRONMENTAL RISK
ANPC	Autoridade Nacional de Protecção Civil
AUPs	Authorization User Policy
BOSS4GMES	An European project for GMES
CYCLOPS	Cyber-infrastructure for CiviL protection Operative Procedures
DORII	Deployment of Remote Instrumentation Infrastructure
EELA	E-infrastructure shared between Europe and Latin America
EGEE	Enabling Grids for E-sciencE
ESFRI	European Strategy Forum on Research Infrastructures
FIRESTATION	an integrated software system for the numerical simulation of fire spread on complex topography from DEM, University of Coimbra
GENESI-DR	Ground European Network for Earth Science Interoperations - Digital Repositories
GILDA	Grid INFN Laboratory for Dissemination Activities
GMES	Global Monitoring for Environment and Security
GRIDCC	GRID ENABLED REMOTE INSTRUMENTATION WITH DISTRIBUTED CONTROL AND COMPUTATION
INSPIRE	Infrastructure for Spatial Information in the European Community MOU
MOU	Memorandum of Understanding
NREN PC	National Research and Education Network Programme Committee
OGC	Open Geospatial Consortium
OWS	OGC Web Services
PREVIEW	Prevention Information and Early Warning is a EU project on Risk Management
QoS	Quality of Service
RISK-AWARE	RISK ADVANCED Weather Forecast System to Advice in Risk Event Management
Risk EOS	The RISK-EOS services combine the use of satellite observation data with exogenous data and modelling techniques.
SME	SMALL MEDIUM ENTERPRISE
VO	Virtual Organisation
WCS	Web Coverage Service

1. PURPOSE OF THE DOCUMENT

This document is a report which collects together the CYCLOPS project results for dissemination to different interested audiences such as Grid communities and Civil Protection agencies. It also reports on national and international initiatives and projects, SMEs, training activities and related projects.

The structure of this document shows the approach used in the project. Following an introduction, it describes a set of related projects, namely grid-based technologies/EGEE, risk management, and GMEs-based services. It then presents the business of Civil Protection and the use cases selected. These highlight the grid requirements for Grid-based CP applications. The research strategies and enhancements needed for the EGEE infra-structure are identified, based on the use cases. Dissemination of training and knowledge to different communities are also key points of the project.

2. EXECUTIVE SUMMARY

Civil Protection is a complex, multidisciplinary activity which involves high human and material costs. A large degree of heterogeneity of data sources, activities and expertise, at regional and/or local CP agent level, can be seen in most EU countries. The problem is aggravated by the fact that this kind of activity frequently transposes country borders, notwithstanding some international projects intended to normalize data and procedures, mainly on geospatial or risk data acquisition. Another serious problem is the insufficient level of collaboration between CP and R&D community.

The EU Commission has stimulated cooperation between different EU countries, and even with other countries (EUA, Japan, India, Latin America, etc.), in the field of CP in order to decrease the high costs and also to increase the effectiveness of intervention on any type of hazards occurrence.

The participation of R&D community has been largely related to the simulation of natural or human-made disasters, as this kind of work is important in order to promote new procedures and even new equipment for hazard intervention.

With increasing computational power and data acquisition capabilities, using new kinds of in-situ sensors and satellite features with data available just in time, R&D community can have real time or near real time intervention in CP procedures.

Cyclops (CYber-Infrastructure for CiviL protection Operative ProcedureS) is one of the first projects in Europe to include R&D (mainly GRID researchers) and CP community in order to develop a proof of concept in using a computational

grid infra-structure to build real time or near real time CP applications. A related section of a Cyclops technical annex is transcribed here:

"The Global Monitoring for Environment and Security (GMES) concept was endorsed by the EU Commission in 2001 with the aim of "establishing by 2008 a European capacity for Global   Monitoring of Environment and Security" to gather and use all available data and information in   support of sustainable development policies. GMES has the potential to stimulate economic growth by creating innovative value-added services. The challenge for GMES is to use these services to   enable decision makers to better anticipate or mitigate crisis situations and management issues   related to the environment and security. The Final Report for the GMES Initial Period recognised   the European Civil Protection (CP) as one of the GMES service categories. This report outlines the importance of developing enabling e-infrastructures and virtual organisation services to serve specific   GMES applications. Indeed, the EU EGEE (Enabling Grids for E-Science in Europe) project   provides a powerful GRID platform to implement services for specific application Communities.
However, GRID evolution has mainly focused on technology, while, GMES services have mostly been user-oriented. Thus, there is a need to cross-disseminate the approaches, requirements and visions of the diverse Communities, in order to fully exploit the GRID capabilities for GMES applications. CYCLOPS brings together these two important Communities: GMES and GRID, focusing on the operative sector and needs of European CP. The main objectives of CYCLOPS are: e-IRG and INSPIRE. In fact, Consortium partners are involved in all these   projects and initiatives.

1) To disseminate EGEE results to the CP Community, assessing EGEE infrastructure for CP   applications. A variety of activities will focus on dissemination and outreach, training, workshops, possibly in close relation with EGEE events and on promoting a close collaboration between the   two communities.
2) To provide the EGEE Community with knowledge and requirements that characterise the CP services. These requirements will also be used to assess the possibility for the development of an   advanced grid platform enabling Real Time and near-Real Time services and implementing a   security infrastructure very close to the defence systems standards.
3) To evaluate the possibility to utilise the present EGEE services for CP applications, developing   the research strategies to enhance EGEE platform.
4) To develop the research strategies to enhance EGEE platform, especially for Earth sciences   resources. CYCLOPS will contribute to the EU policy developments establishing liaisons and synergies with   other existing projects and initiatives dealing with GMES, GRID and complementary sectors, among them: PREVIEW, Risk EOS, RISK-AWARE, BOSS4GMES, EGEE Networking Activities   and Application Support"

3. RELATED PROJECTS

In the following subsections, we present finished or ongoing projects related to CP and CYCLOPS in Europe and in the rest of the world. Some of them have explicit collaboration with CYCLOPS, referenced in D3 (RISK WARE; ANPHORE, EURORISK, EGEE, E-IRG, GRIDCC)). The description inserted here is limited to E-IRG, EGEE, GENISIS-DR and DORII. Most of the text descriptions are based on the published official web pages of each project.

3.1.   E-IRG

The e-Infrastructure Reflection Group (e-IRG) coordinates a high level approach for the introduction of a (grid-based) infrastructure for e-Science in Europe. The mission of e-IRG is to provide support at political, advisory and monitoring level, the creation of a policy and an administrative framework for easy and cost-shared electronic resources (focusing on Grid Computing, data storage and networking resources) across technological and national domains. The IRG recommends sharing policy guidelines for national grid initiatives and regional and European-wide infra-structure projects. It also contributes to international policy and policy drafting bodies like ESFRI, NREN PC, etc.

It is primarily focused on e-Science application user groups to define novel architectures, but also addresses wider application domains such as eLearning, eHealth, eCulture and eBusiness within ERIA (European Research and Innovation Area). It also addresses governance issues of Grid development and draws upon the experience of NREN community (Structure, Operations, AUPs).

The e-IRG consists of official delegations from the Ministries of Science of various European countries and coordinates its activities with international initiatives outside of Europe. It also defines the relationship between the GRID infrastructure in Europe and similar projects world wide.

3.2.   EGEE & GRID

The partner responsible for the management of Cyclops project (INFN) plays an important role in the EGEE Consortium and has formal support for opening the GRID to the Civil Protection related communities. The INFN also participates in the technical management boards and in software development groups in which the main decisions are taken.

Many of the applications already developed in EGEE Grid rely on Earth Sciences covering a very large domain of topics, ranging from Earth Observations, Solid Earth Physics, Hydrology, Flood prediction and Climate studies. The analysis of the porting of these applications in the EGEE Grid infrastructure may be of great interest for the CYCLOPS working groups, as most Civil Protection applications deal with geospatial information for running models and making predictions, in order to manage emergency situations.

Another key role played by INFN concerns the training of the Civil Protection community regarding the use of the EGEE Grid platform. Training events range from the introductory knowledge dissemination level to highly specialized courses and workshops, tailored to specific user's needs. INFN cooperated with the EGEE training organisation in order to exploit, whenever possible, analogous scheduled events and avoid duplication of work, and also exploited the INFN GILDA training infrastructure to organize events by itself.

INFN also plays a major role in several EGEE related projects which aim to develop a Grid infrastructure outside Europe, such as EELA (Extending EGEE to Latin America), EUCHINAGRID (Interconnection &   Interoperability of Grids between Europe & China), EUMEDGRID (Empowering e-Science across the Mediterranean) and EUINDIAGRID (Joining European and Indian Grids for e-Science Network Community).

UMINHO has a background in GRID technologies, being a member of SWE European Federation. UMINHO is also the leader of project CROSS-FIRE, a nationally-funded CP related project, which aims to port to the Grid and improve the effectiveness of the FIRESTATION application: an application that shares some of RISICO's requirements.
More recently, it has also participated as a partner in EELA-2 project.

As described above, several CYCLOPS's partners have groups working on the GRID and participating in EGEE. This context eases the migration of CP applications to GRID technologies and EGEE infra-structures.

3.3. GENISIS-DR

GENESI-DR, short for Ground European Network for Earth Science Interoperations - Digital Repositories, has the challenge of establishing open and seamless access to Earth science digital repositories for European and world-wide science users. GENESI-DR will operate, validate and optimise the integrated access and use available data, information, products and knowledge originating from space, airborne and in-situ sensors from all digital repositories dispersed all over Europe. It intends to demonstrate how Europe can best respond to the emerging global needs relating to the state of the Earth, a demand that is unsatisfied so far.

The project recently signed a Memorandum of Understanding (MOU) with Cyclops. This MOU is justified as both projects envision the creation of a standardized approach to the implementation of Open Geospatial Services Web Services (OGS-OWS) on top of Grid infrastructures. Towards this end, Cyclops has created a architecture prototype for implementing OGC-WCS and OGC-WPS. Furthermore, the collaboration between these two projects enables the dissemination of knowledge between Earth Observation and Civil Protection communities and the sharing of services and infra-structures.

The GENESI-DR web site is: http://www.genesi-dr.eu/ which contains the overall project development plan.

3.4.   DORII

The DORII (Deployment of Remote Instrumentation Infrastructure) project aims to deploy e-Infrastructure for new scientific communities, where, on the one hand the ICT technology is still not present at the appropriate level, but on the other hand there is a demand for it in order to empower its daily work.

DORII deals with a reference group of scientific users, with experimental equipment and instrumentation which are not integrated, or only partially integrated, within the European infrastructure.

The DORII project focuses on selected scientific areas, particularly the Earthquake community, with various sensor networks; the environmental science community; and the experimental science community, with synchrotron and free electron lasers.

As project DORII aims for the full integration of experimental equipment and instrumentation within the European e-Infrastructure, such EGEE, Cyclops and DORII signed a MOU based on their shared goals.

4. TRAINING WORKSHOPS AND ACTIVITIES   [D7, D10, D13]

The Cyclops dissemination plan included several training workshops, previously described in more detail in deliverables D7, D10, D13 and D18.

The objective is to give the participants of different training activities, both in Europe and the rest of the world, the possibility to create and submit jobs to the grid, check the status of submitted jobs and manage data transfers to/from Grid and dependence between jobs.

One important tool available in the training workshops is the EGEE COOKBOOK, developed to familiarize people with the EGEE GRID environment.

The first training workshop was held in Bologna from 11-13 April, 2007 and was organized by the project leader, the INFN. The main audience was Cyclops partners, who are potential recipients of EGEE dissemination and training events.

The first half-day of the workshop was dedicated to a number of presentations focusing on CYCLOPS activities, and presented by the Project Manager, CNR-IMAA, DDSC-EMA and DPC partners. After the CYCLOPS related presentations, the training session started with two introductory talks made by Dr. Marco Verlato about "The EGEE project and middleware overview".

The training courses then proceeded, covering in detail the four main areas of the gLite middleware architecture: Security, Information System, Data Management and Job Management. Theoretical lessons were alternated with practical exercises, experienced by each student from his own laptop connected to the GILDA (Grid INFN Laboratory for Dissemination Activities) infrastructure, via the wireless network link made available by the INFN-CNAF structure hosting the event. GILDA is a training infrastructure spread over three continents which has been a reference point for dissemination and training activities since the beginning of EGEE.

The Second Training Workshop, held in Chania from 5-7 May, 2008, was also organized by INFN, the project leader.
The workshop opened with welcome speeches from the Vice Rector of TEI-Crete Institute, Prof. Kaliakatsos, and from the Head of Civil Protection of Chania Prefecture, Mr. Koukianakis

The first half-day workshop focused on Cyclops activities with the participation of the hosting partner from TEI-CRETE and the project manager, Dr. Roberto Sorani. A presentation of DORII project regarding CP application was also scheduled.
Following this, Prof. Filippos Vallianatos talked about the GMES-related activities of the Geophysics & Seismology Laboratory of the Technological Educational Institute of Crete, with special focus on the potential application of grid techniques in the understanding of Solid Earth Physics. Dr. Roberto Sorani presented the status and short term actions of the Cyclops project.

The training courses then proceeded, covering in detail the four main areas of the gLite middleware architecture: Security, Information System, Job Management and Data Management. Theoretical lessons were alternated with practical exercises, experienced by each student from his own laptop or desktop workstation, connected to the GILDA infrastructure via a cable or wireless network link, made available by the local structure hosting the event.

A session was also dedicated to the provision of guidelines for joining the real production grid infrastructure, and in particular, the officially recognized CYCLOPS Virtual Organisation, both as users and site managers.

The final half-day was dedicated to explaining the grid porting strategies used for RISICO and SPC-GD. As Risico was more advanced in the porting path, it was the one used most for the demonstration.

5. DISSEMINATION ACTIVITIES [D01,D02,D04,D12]

This project was intended to disseminate the results between Grid researchers, GRID and the Civil Protection community, not only those involved as project partners, but also the rest of the research (mainly GRID) community. To bridge the gap between Civil Protection and Grid communities, one must be aware of grid functionalities and services, while acknowledging the main problems of and

applications from CP. Furthermore, it is important to participate in standardization organizations, in order to normalize data and procedures for a wider range of applications and services.

The first open initiative of Cyclops involved partners and external experts reviewing the scientific and technological knowledge needed for Civil Protection applications and its support by GRID services and technologies.

The midterm workshop was fully integrated within the 2nd Iberian Grid Infrastructure Conference, held in Oporto on the 12th – 14th May, 2008, at FEUP, Faculdade de Engenharia da Universidade de Porto. 'IBERGRID'2008 is the second edition of a series of Iberian Grid Infrastructure Conferences, initiated in 2007 within the framework of the bilateral agreement for Science and Technology, signed in November 2003 between Portugal and Spain, aiming to leverage the construction of a common Iberian Grid Infrastructure and the fostering of cooperation in the fields of grid computing and supercomputing".

The last dissemination initiative, Project final conference, will be held in Rome, Italy, in December, under the title "Towards a European e-Infrastructure for Civil Protections - 1st Workshop".

Most of the dissemination activities of Cyclops produced a set of Web references available from the main project site. A list of some of these references (papers, presentations, etc.) will be referred at the end of this document. The web site had around 100,000 (web) accesses to its public area.

6. THE BUSINESS OF CIVIL PROTECTION [D06]

In spite of having different internal organization, there are common objectives among Civil Protection agencies in Europe, namely to prevent natural and man-made hazards, related to major accidents, disasters or calamities; to prevent loss and damage to the population, material resources and environment, to protect the life, health and property of citizens from natural, technological and other major hazards, and to protect cultural heritage, historic buildings and monuments, resources and the infrastructure.

As the overall objective of Cyclops is to bring CP agencies into touch with existing Grid technologies, it is important to identify similarities and differences between the different CP agencies analysed (Portugal, Greece, France and Italy).

The common elements are very simple and general within the complexity of Civil Agency Operations.

The three levels of operation (local, regional and national) share responsibilities and priorities depending on disaster intensity. Each level has its own attached operations centre and limited interaction which grows as a function of the dimension of crisis. In a major crisis the responsibility is assumed by the

Minister of the Interior with eventual participation of other Ministers, depending on the type of crisis. Each CP Agency structure adapts in near real time to the dimension of the disaster. Naturally, high level management takes control of big disasters. All other important and more generic issues use a generic hazard approach, with growing emphasis on disaster mitigation in order to reduce the impact of disaster and better the preparedness of planning with regards to response. Another motivating factor for the use of GRID Technologies by CP applications is the sharing of data between several CP agencies at different levels and of different nations.

One distinction between CP centres or agencies, even at national level, is the use of different equipment and applications. CP centres may use their autonomy to buy different computational solutions. This situation has a negative impact on sharing policies. Another difference is that CP agencies do not share the same operations to manage a crisis, namely mitigation, preparedness, response and recovery.

In France, responsibility for CP is shared across ministries and administrative levels. Unlike the Italian CP agency, the Greek agency is not responsible for risk prevention plans. There is a Competence Centre in Italy whereas other countries share similar agreements with meteorological services. With a greater or lesser degree of integration between services involved in CP, security services assume a key role. The management of security services is of great importance in GRID infra-structure, which supports the integration between the different organizations involved in CP.

7. USE CASES [D9]

This project selected two use cases for evaluation: one related to forest fire management in Italy and another related to flood management in France. These cases were instrumental in defining CP application requirements as well as the migration path for grid-enabled technologies, including data storage, parallel computing and data communication.

7.1. RISICO

RISICO (RISchio Incendi e COordinamento), was developed and designed by CIMA, and has as its main goal the assessment, at national level, of forest fire dynamic hazard, based on the Canadian Fire Weather Index.

The architecture of the RISICO application divides the Italian territory into different squares of variable dimensions, depending on the computational power available and the precision needed for the application using, as input data, dynamic variables such as fuel, wind etc….The gridification of such an application enables the increase in resolution from 1Km to 100m and faster response times for more accurate decision making.

7.2. SPC-GD

In France, dangerous natural phenomena forecasting is carried out by external organizations. This role is performed by the floods warning services (SPC) for flood management. The area monitored for the flood warning service SPC-Grand Delta covers all the tributaries on both the right and left banks of the river Rhône (SPC-GD, 2006).

Data collection is another important point together with sensor network technologies. In general, sensor networks are long-term ago used for CP applications world-wide, such as a satellite network. The current issue is the use of small and in-situ (power life) sensor networks. The use of such in-situ sensor network data in the grid (Sensor In Grid) is an interesting area of research.

8. ANALYSIS OF REQUIREMENTS FOR CP APPLICATIONS [D11]

To grid-enable a CP application we must first answer the following questions: a) what kind of modifications must be carried out to EGEE&GRID? b)what modifications need to be made for the applications to run on EGEE&GRID infra-structure?
Analysis of two symbolic Civil Protection applications for Flood and Forest Fire management by Cyclops provide the answers to the above questions.

When one visits a CP agency many geographical maps are on display, meaning that geospatial data support is the first functional requirement. In the geographical data field there are many standard efforts. Open Geospatial Consortium (OGC) is an important example. This data information can be published and accessed using web services (OWS). This normalization is also justified by data sharing between the different actors.

Another important challenge is security, in terms of data access to replicated files or databases, in order to prevent energy failures.

In a crisis situation, a large amount of data needs to be transferred between the different actors, thus increasing the required bandwidth.

Yet another important requirement is support for real time or near real time services. Flood events, in particular, occur suddenly; therefore the system must react as soon as possible. Hence, time is an important variable on the supporting GRID infra structure. Response time, jitter, data loss and bandwidth are QoS parameters which have been used for many years in traditional computer networks. With services accessible by web interface, workflows and parallel applications running in the grid, the definition of QoS must be more generic, including, for example, job and data management parameters. These

kinds of requirements define the scope of research for the new grid-enabled CP applications.

9. EGEE ENHANCEMENT [D14]

The revision of the EGEE grid enhancements for the support of CP applications includes a large set of functionalities, some of which were derived from the needs of GMES services.

Typical CP applications, as seen from the CYCLOPS use cases, present technical requirements arising from GMES and near Earth Observation (EO). The two use cases analyzed identified the following functional and non-functional requirements: geospatial information access and publishing, data policy, authentication and authorization, file replication, QoS negotiation and computational power.

EGEE grid architecture is a new computing infrastructure which provides seamless access to computing power and data   storage, distributed all over the globe. Naturally, the communication of data addresses the scalability of computer power to face more complex problems.
Grid enables a redundant storage. As a node fails the grid network may switch the high volume of data generated by scientific experiments to another node of grid.
The grid is composed of small grids owned by organizations. The authorization/authentication infra-structure is based on X.509 infra-structure. Authorization is based on Virtual Organization (VO). A VO is a set of resources and users.
The available technology enables simple replication of files between different geographical grid points. However, to avoid unauthorized access to raw data, the replicated data must be encrypted.

Civil Protection applications infrastructures need to react in a given time in the event of crisis and even in monitoring to obtain given data.   Real time computing is needed to address some of these applications. Near real time is only a delay introduced on RT by data or communication processing.

A requirement that most CP applications share is the need for access to Geospatial Data. This kind of information must be published for presentation or further processing. Standards arising from initiatives such as INSPIRE, GEOSS, GMES are important in several applications other than CP.

Quality of Service is an original term from computer networks based on a set of parameters, namely bandwidth, response time, jitter and packet loss. With success of Web services and associated workflows, QoS can be viewed in a more general form. Any service provider or software component with a web interface can have an associated QoS.   With this general definition the set of parameters can be more specific. In the case of grid, QoS can be defined using

a subset for each component, namely Computing Element (CE), Storage Element (SE), Network Element (NE) and eventually Instrumentation Element (IE). Signalling protocols are used to assure QoS and Service Level Agreement (SLA) at lower layers.

Web portal is a web page that gives access to data or a function. For CP use cases especially, it is necessary to have an aggregated view of a diverse data set (rainfall, hydrological data, etc.) coming from different centres and elaborated via different tools. Confrontation of results from different models is therefore desired in real / near-real time. This is also common for Earth Observation applications.

Event notification is a common term, used in communication software to denote the generation of small messages which may be caused by applications. In a dynamic grid, distributed services must be able to notify an interesting modification in state.

Another important resource to be shared on the grid are instruments controlling a given phenomena. GRIDCC middleware developed a platform built on well proven technology that can be deployed on top of existing grid middleware, extending the grid e-infrastructure for the control and monitoring of remote instrumentation. EGEE gLite is the reference grid middleware for GRIDCC and EGEE is also the e-infrastructure where instrument grid technology is deployed and integrated. The main approach used is to adapt GRIDCC components like VCR (Virtual Control Element) and IE (Instrument Element) to   match CP related applications.

One of principles of the Grid is the local (site) autonomy. Local site grids maintain the control of their resources even when they are part of a larger grid. Resource owners maintain control over their resources imposing local policies. The adoption of Virtual Organization (VO) is a decentralized way to enforce resource sharing data policy. VO is the key to identify a set of jobs and data that perform a given task and has access rights to the shared resources.

A workflow manager enables the definition of a flowchart of jobs which may be submitted into the grid. It is used for all kinds of applications throughout the Earth Science Community In order to be used it is important, in many scenarios, to have some graphical tools to manage workflows, not only for CP applications. This management includes the creation, submission and monitoring of workflows sent to the grid.

Another important technology for providing grid services are the web services which can be grouped into Web Portals, or used in independent form. Some of the required features concern normalization efforts in which Cyclops must be involved, yet another new area of important research.

Most of CP requirements are shared with Earth Observation applications, namely distributed data acquisition from remote sensors, and some features above.

10. RESEARCH DIRECTIONS [D15, D16]

CP applications have specific needs that the current infrastructure and services are not able to provide.

Following on from the existing systems analysis, the use cases requirements and the purpose-defined architecture, the next step was the prototyping of the selected applications using the EGEE infra-structure. The work that has been done points to the revision of the architecture.

In terms of requirements, we limit our presentation to the functional or non-functional requirements, not already referred to in EGEE enhancements.

The first requirement is sensor interaction, since some CP applications require sensor interaction for phenomena monitoring and also for crisis reaction and recovery.

Resolution scalability and user friendliness, are standard non-functional requirements which may be necessary as data resolution needs to increase (for instance 1m instead 1km) without affecting its response time.

Some limitations must be taken into account as constraints for the architecture which addresses heterogeneity using standards, as well as consider the boundaries of the grid infra-structure.

Due to its complexity, the architecture was implemented using layers, namely the strategic layer, the geospatial services layer and the resource provision layer. The strategic layer includes the warning, emergency, risk estimation, scenario and forecasting concerns of the CP business model and has as its main contributors CP and GMES communities. The Geospatial Services layer concerns measurement, observation, data sets, sensors, models and algorithms and has as contributors EO, Geospatial Community using Web services as its main technologies. The resource layer is the well-known grid infra-structure supported by EGEE.

Based on such architecture, a system for CP applications is proposed, using as vertical layers the security infra-structure and the interoperability platform, used by services at any layer. This last platform enables the connection of CP with the external world. Security is needed for authentication, authorization, integrity and confidentiality within CP and the outside world. Presentation services and business logic are related with user-friendly interfaces and the logic of CP applications.

11. DISSEMINATION OF EGEE TO CP   [D17]

The most relevant dissemination activities directed "To bridge the gap between CP and GRID" consisted in the presence of Cyclops partners in GRID-related events, in particular those involving the CP community. Cyclops participated in 13 Grid-related conferences with papers and live demonstrations of applications.

Another significant accomplishment is the support for the Cyclops VO in 12 production grid sites from three different countries.

12. **CONCLUSIONS**

This document summarizes the Cyclops project results, detailed in Deliverables 1-17, and shows the work path followed during the Cyclops project.

Cyclops project results have proven the utility of GRID for CP applications and interleaved people from the two communities. Enhancements to the grid infrastructure were identified and are interesting research paths.

To conclude, we would like to emphasize that the Cyclops results point out the importance and the requirement for cooperation and interoperability among CP related projects.

13. ANNEX I: CYCLOPS DELIVERABLES

The deliverables produced by the project partners are the main documentation regarding Cyclops project activities, which are available from the project web page (http://www.cyclops-project.eu). In the context of this deliverables, we highlight the following reports

[1]   **Mazzetti, P., Verlato, M. and Nativi, S.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Project Open Conference. Work Package 1. Deliverable D01". June, 2006

[2]   **Scipioni, Anna and Oliveira, José.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Report on Cyclops Project. Open conference. Deliverable D02". Rome. July, 2006

[3]   **Sorani, R.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Perspective on cooperation with existing projects and initiatives. Deliverable   D03". Rome. August, 2007

[4]   **Oliveira, José.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Report on CYCLOPS Project. Dissemination Plan. Deliverable D04". Rome. January, 2007

[5]   **Verlato, Marco.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Training Events Plan. Deliverable D05". Cyclops Open workshop. Rome. December, 2006

[6]   **Thierion, v., Ayral, P., Mangione, D., DeRosa, C., Oliveira, J., Vallianatos, F., and Nardin, P.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Business Process Analysis Document. Deliverable D06". Rome. August, 2007

[7]   **Dal Pra, Stefano and Verlato, Marco.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. EGEE Cookbook: A Guide for Civil Protection Grid Users. Deliverable D07". Rome. May, 2007

[8]   **Thierion, v., Ayral, P., Mangione, D., DeRosa, C., Oliveira, J., Vallianatos, F., and Nardin, P.**
"Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. Existing analysis
document. Deliverable D08". Rome. August, 2007

[9]   **Thierion, v., Ayral, P., Mazzetti, P., Magioni. D., and Nardin, P.** "Cyclops - CYber-Infrastructure
for CiviL protection Operative ProcedureS. Use-Cases Document. Deliverable D09". Rome.
August, 2007

[10]   **Verlato, Marco.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS. First
Training Workshop. Deliverable D10". Rome. April, 2007.

[11]   **Sauvagnargues-Lesage, S., Thierion, V., Mazzeti, P. and Oliveira, J.** "Cyclops - CYber-
Infrastructure for CiviL protection Operative ProcedureS. System requirements Document.
Deliverable D11". Rome. August, 2007.

[12]   **The Cyclops Consortium.** "Cyclops - Mid-Term Project Workshop (Report). Deliverable D12".
Second Iberian Grid Infrastructure Conference. Oporto, May, 2008.

[13]   **Verlato, Marco.** "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS.
Second Training Workshop (Report). Deliverable D13". Chania. June, 2008.

[14]   **Mazzetti, Paolo and Angelini, Valerio** "Cyclops - CYber-Infrastructure for CiviL protection
perative ProcedureS. Request for Enhancements. Deliverable D14". May, 2008.

[15]   **Mazzetti, Paolo and Angelini, Valerio** "Cyclops - CYber-Infrastructure for CiviL protection
Operative ProcedureS. Request for Enhancements. Deliverable D15". May, 2008.

[16]   **Mazzetti, Paolo and Stefano Nativi** "Cyclops - CYber-Infrastructure for CiviL protection
Operative ProcedureS. Research Strategies for E-Science infra-structure. Deliverable D16". May,
2008.

[17]   **Verlato, Marco**. "Cyclops - CYber-Infrastructure for CiviL protection Operative ProcedureS.
Dissemination and Coordination Activity Final Report. Deliverable D17". October, 2008.

14. ANNEX II: MEETING, JOURNAL AND THESIS

The dissemination of Cyclops project activities included several presentations on
meetings, journals and thesis related with CP and Grid issues, mainly focused on the
GRID community, Earth Science, Space and other related R&D communities.

Title	EGEE'06 Conference, Geneva ,Switzerland, September, 2006
Web page	http://indico.cern.ch/sessionDisplay.py?sessionId=114&slotId=0&confId=1504#2 006-09-27
Comment	V.Angelini et all presented a poster about the implementation of WCS over EGEE.
Ref	V. Angelini, P. Mazzetti**,** and M. Mazzucato, "*Implementation of Web Coverage Service functionalities over the EGEE"*. 25-29 September 2006**,** Geneva Switzerland.
Abstract	http://indico.cern.ch/contributionDisplay.py?contribId=180&sessionId=23&confId =18714
Link	http://indico.cern.ch/getFile.py/access?contribId=180&sessionId=23&resId=0&m aterialId=poster&confId=18714
Audience	Grid R&D Community
Visitors	191 (via Cyclops web site)

Title	Journey InGrid '06, Braga – Portugal, November, 2006
Web page	http://www.lip.pt/ingrid06/
Comment	Paolo Mazzetti, an invited talk
Ref	Paolo Mazzetti, Grid-technology, "*Geospatial Sciences and European Civil Protection applications"*, INGRID 06, 11 November, Braga, Portugal.
Abstract	Not applicable
URL	Presentation accessible at http://www.cyclops-project.eu/Default.aspx?id_menu=11&id_page=4&id_content=117

Audience	Grid R&D Community
Vistors	801 (via Cyclops web site)

Title	2nd GRID & e-Collaboration Workshop for the Earth Science and the Space Community, Frascati, Italy, December, 2006
Web page	http://www.congrex.nl/06M36/programme.html
Comment	Lorenzo Bigadli et. all outlines the project Cyclops, focusing on several of important project issues as participants, objectives, CP applications requirements and research issues.
Ref	Lorenzo Bigagli, Anna Scipioni, Stefano Nativi, Jerome Bequignon, Mirco Mazzucato, Vincenzo Cuomo. "*CYCLOPS Grid for the Disaster Management Community*", 2nd "GRID & e-Collaboration Workshop for the Earth Science and the Space Community" ESA-ESRIN, 11-12 December, 2006, Frascati, Italy.
Abstract	`Not applicable`
URL	*www.congrex.nl/06M36/day1/PM04_Bigagli.ppt*
Audience	Grid, Earth Science and Space R&D Communities
Visitors	799 (via Cyclops Web page)

Title	European GeoInformatics Workshop, Edinburgh, UK, March, 2007
Web page	http://www.nesc.ac.uk/esi/events/712/
Ref	Paolo Mazzeti, "*Cyclops Project*", EGWI, Edinburg, UK, March 7-9, 2007.
Abstract	Not applicable
URL	Not applicable
Audience	Geoinformatics R&D Community
Visitors	912 (via Cyclops Web page)

Title	OPEN GRID FORUM (OGF), Manchester, UK, May, 2007
Web page	*www.ogf.org/OGF20/events_ogf20.php*
Comment	Stefano Nativi presents the implementation of Geosciences services on the grid.
Ref	Paolo Mazzetti, Stefano Nativi, Mirco Mazzucato, Marco Verlato and Jerome Bequignon "*CYCLOPS-Project: Implementation of Geosciences services on Grid platform for GMES*, OGF, 7-9 May, Manchester, UK*.
Abstract	Not applicable
URL	http://www.nesc.ac.uk/action/esi/download.cfm?index=3406
Audience	Grid R&D Community
Visitors	1015 (Via Cyclops Web page)

Tiltle	International Union of Geodesy and Geophysics, Perugia, Italy, July,2007
Web page	http://www.iugg2007perugia.it/
Ref	V. Angelini, P. Mazzetti1, M. Verlato, S. Nativi, "*Implementation of Geospatial services on Grid platform for Civil Protection applications*", Perugia, Italy, 2-13 August, 2007.
Abstract	Not applicable
URL	Poster accessible at http://www.cyclops-project.eu/Default.aspx?id_menu=11&id_page=3&id_content=123
Audience	Geodesy and Geophysics R&D community
Visitors	44 (Via Cyclops Web page)

Title	EGEE'07 Conference, Budapest, Hungary, October , 2007
Web page	http://egee2.eu-egee.org/egee07/home.html
Comment	Marco Verlato, Paolo Mazzetti, Stefano Nativi and Valerio Angelini presented a poster and a demo .
Ref	Marco Verlato, Paolo Mazzetti, Stefano Nativi and Valerio Angelini, "*Implementation of Geospatial services on Grid platform for Civil Protection applications,*" EGEE 07, 1-3 October, Budapest, Hungary.
Abstract	http://indico.cern.ch/contributionDisplay.py?contribId=180&sessionId=23&confId=18714
URL	Poster accessible via http://indico.cern.ch/contributionDisplay.py?contribId=180&sessionId=23&confId=18714
Audience	GRID R&D Community
Visitors	645 (via Cyclops Web page)

Title	SC07: International Conference on High Performance Computing, Networking, Storage and Analysis, Reno, USA, November, 2007
Web page	http://sc07.supercomp.org/
Comment	In this conference, Marco Verlato presents a poster.
Ref	Marco Verlato, "*Implementation of Geospatial services on Grid Platform for Civil Protection Applications*". International Conference on High Performance Computing, Networking, Storage and Analysis, November 15-21, Reno, USA
Abstract	not applicable
URL	Poster accessible at http://www.pd.infn.it/grid/poster/CYCLOPS%20poster.jpg
Audience	High Performance Community
Visitors	182 (via Cyclops web page)

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Title	3rd GRID & e-Collaboration Workshop for the Earth Science and the Space Community, Frascati, Italy, JANUARY, 2008
Web page	http://www.congrex.nl/07C29/agenda.asp
Comment	In this workshop, Paolo Mazzetti has given a presentation
Ref	Paolo Mazzetti, *"CYCLOPS and the disaster management experiences"*, 3rd GRID & e-Collaboration Workshop for the Earth Science and the Space Community, Frascati, Italy, January 16-17, 2008.
Abstract	Not applicable
URL	Presentation accessible from http://www.congrex.nl/07c29/agenda.asp
Audience	Grid, Earth Observation and Space Community
Visitors	189 (from Cyclops Web page)

Title	3rd EGEE User Forum, Clermont-Ferrand, France, February, 2008
Web page	http://indico.cern.ch/conferenceDisplay.py?confId=22351
Comment	The participation of Cyclops on this forum was the following poster and oral presentation
Ref	Mirko D´ Andrea, Stefano Dal Pra, Marco Verlato, Francesco Gaetani and Valerio Angelini, "*Grid computing for wildfire danger assessment: porting RISICO on gLite"*., EGEE Forum, Clermont-Ferrand, France , 11-14 February, 2008.
Abstract	http://indico.cern.ch/contributionDisplay.py?contribId=85&sessionId=37&confId=22351
Poster	Accessible from http://indico.cern.ch/contributionDisplay.py?contribId=85&sessionId=37&confId=22351
Audience	GRID R&D Community
Visitors	669 (From Cyclops Web page)

Title	2nd IBERGRID'08, OPORTO, PORTUGAL, MAY 2008
Web page	www.ibergrid.eu/2008/programme.html
Comment	Midterm Cyclops Workshop was organized with collaboration with the 2nd Ibergrid'08 to use to occasion for more strict contacts between CP and Grid communities

Ref	Stefano Nativi, *"The Cyclops Project"*, Invited Talk. 2nd Iberian GRID Application Conference, 12-14 May 2008.
Ref	Panel about *European Civil Protection Infrastructure* chaired by Carlos Pires and including Jorge Papaspiliou, Vincenzo Cuomo, Mirco Mazzuccato,Stefano Nativi , Xavier Viegas , Rui Almeida and Roberto Sorani.
Comment	Paolo Mazetti et all present the following paper:
Ref	P .Mazzetti, S. Nativi, V. Angelini, M. Verlato, A. Pina, P. Fiorucci *"A Grid Platform for the European Civil Protection e-Infrastructure: the Forest Fires use scenario"* . 2nd Iberian GRID Application Conference, 12-14 May 2008.
Comment	A poster and oral conference was given by people of ARMINES/EMA . The references are the following:
Ref	Thierion V., Ayral P.-A., Sauvagnargues-Lesage, S., Nardin P., (2008), "*Flash flood management: the CYCLOPS French use case*", 2nd Iberian GRID Application Conference, 12-14 May 2008.
Ref	Thierion V., Ayral P.-A., Sauvagnargues-Lesage S., Nardin P., (2008*), "CYCLOPS Session, Flash floods Applications"*, 2nd Iberian GRID Application Conference, 12-14 May 2008.
Comment	Cyclops UMINHO people presented the following paper and poster:
Ref.	A. Pina, B. Oliveira, A. Serrano, V. Oliveira, *"EGEE Site Deployment & Management Using the Rocks toolkit"*, 2nd Iberian Grid Infrastructure Conference, Porto, 12-14 May, 2008.
URL	(uploaded paper) https://pop.cp.di.uminho.pt/cyclops/wp-content/uploads/2008/09/egee08.pdf
URL	*(Presentation):* https://pop.cp.di.uminho.pt/cyclops/wp-content/uploads/2008/09/ibergrid-presentation-amp.pdf
URL	*(full Presentation):*https://pop.cp.di.uminho.pt/cyclops/wp-content/uploads/2008/09/cyclops_ibergrid2008_sensors.pdf
Ref	A. Esteves, J. Macedo, A. Serrano, V. Sá, L. Lopes, M. Caldas, CYCLOPS SESSION *"Enabling mote-based Environment Sensor Network for Civil Protection Grid Based Applications*", Cyclops Session, 2nd Iberian Grid Application Conference, Porto, 12-14 May, 2008.
URL	*(poster):* https://pop.cp.di.uminho.pt/cyclops/wp-content/uploads/2008/09/cyclops_ibergrid2008_sensors.pdf
Comment	Several other research groups, with related interest, presented communications at the Cyclops Session on Ibergrid :
Ref	Monique Petitdidier "*Geoinformatics and Grid*", Cyclops Session, 2nd Iberian GRID Application Conference, 12-14 May 2008.

Ref	Xavier Viegas, "*Decision Support Tools in Forest Fire Management*", Cyclops Session, 2nd Iberian GRID Application Conference, 12-14 May 2008.
Audience	GRID R&D Community
Visitors	193 (From Cyclops Web page)

Title	OGC-OGF Collaboration WORKSHOP ,BARCELONA, SPAIN, JUNE 2008
Web page	http://www.ogf.org/OGF23/
Comment	Stefano Nativi, Paolo Mazzetti and Marco Verlato. "*CYCLOPS Project. CYber-Infrastructure for CiviL protection Operative ProcedureS* "OGC-OGF Collaboration Workshop. Barcelona, 2-6 June 2008.
Abstract	Not applicable
URL	http://www.pd.infn.it/~verlato/docs/CYCLOPS/ Presentation_Nativi_OGF.ppt
Audience	Not applicable
Visitors	Not applicable

Title	WORLD WATER CONGRESS, Montepellier, France.1-4 September 2008
Comment	*ARMINES/EMA Cyclops results was presented at World Water Congress (Montpellier, France, 1-4 September 2008) by an article and an oral presentation with the following reference*
Ref	Thierion V., Ayral P.-A., Sauvagnargues-Lesage S., Bressand F., Nardin P., Sorani R., "*Floods forecasting and warning operations enhancement by Grid technology adoption in Civil Protection organization*, the 13th IWRA World Water Congress 2008, Montpellier, 1-4 September 2008, 13p.
URL	http://wwc2008.msem.univ-montp2.fr/index.php?page=proceedings&abstract_id=859
Audience	Water Research Community
Visitors	Not applicable

Title	EGEE'08 Conference Istanbul. Turkey , September, 2008
Web page	http://egee08.eu-egee.org/
Comment	Best Application Presentation award given to the CYCLOPS team of Marco Verlato (INFN), Stefano Dal Pra (INFN) and Valerio Angelini (CNR-IMAA) for their
Ref	Marco Verlato, Stefano Dal Para, Valerio Angelini, "*G-RISICO: A Wild Fire Risk Assessment application running on an advanced Grid infrastructure*", Application presentation at EGEE'08 Conference, Istanbul ,Turkey, 22 – 26 September 2008.
Comment	Pina et all, from UMINHO presents the following poster
Ref	A. Pina, B. Oliveira, A. Serrano, V. Oliveira, "*EGEE Roll – A framework to Fully-automated site Deployment & Management*", EGEE'08 Conference,

	Istanbul ,Turkey, 22 – 26 September 2008
Abstract	(Abstract): http://indico.cern.ch/abstractDisplay.py?abstractId=23&confId=32220
Poster	(Poster) https://pop.cp.di.uminho.pt/cyclops/wp-content/uploads/2008/09/egee-istambul-1.pdf
Audience	Grid Community
Visitors	41 (from Cyclops Web page)

Title	SC08: International Conference for High Performance Computing, Networking, Storage and Analysis, Austin, USA, 2008
Web page	http://sc08.supercomputing.org/
Comment	A demo and poster of Cyclops G-RISIKO (Grid-enabled RISIKO) , will be presented in this conference.
REF	Not applicable
Audience	High performance community
Visitors	39 (from Cyclops Web page)

Title	Journal Geophysical Research Abstracts
Comment	"Geophysical Research Abstracts (GRA) is an international, interdisciplinary journal for the publication of collections of short summaries (abstracts) of up-to-date research in the Earth, planetary and space sciences in separate issues". Some of work done at Cyclops was published in GRA.
Ref	M. D'Andrea, S. Dal Pra, V. Angelini, P. Fiorucci, F. Gaetani, P.Mazzetti, M. Verlato, "*G.RISICO: a grid architecture for high resolution nation-wide forest fire risk assessment*". Geophysical Research Abstracts, Vol. 10, EGU2008-A-07307, 2008, SRef-ID: 1607-7962/gra/EGU2008-A-07307, EGU General Assembly 2008
URL	http://www.cosis.net/abstracts/EGU2008/07307/EGU2008-A-07307.pdf
Ref	F. Vallianatos, G. Hloupis, J. P. Makris, "*Challenges in Computational Solid Earth System science in the frame of CYCLOPS project*", Geophysical Research Abstracts, Vol. 10, EGU2008-A-07118, 2008, SRef-ID: 1607-7962/gra/EGU2008-A-07118, EGU General Assembly 2008
URL	http://www.cosis.net/abstracts/EGU2008/07118/EGU2008-A-07118.pdf?PHPSESSID=

Title	Map-i Joint Doctoral Program in Computer Science, Portugal
Web page	http://www.map.edu.pt/i/2007/thesis
Comment	Vitor Oliveira, a Cyclops collaborator started a PhD thesis on CP&GRID ,
Ref	*V. Oliveira," Civil Protection applications in a Grid supported environment*", supervisor A. Pina, Universidade do Minho, Portugal, 2008
Link	https://pop.cp.di.uminho.pt/cyclops/wp-content/uploads/2008/11/civil-protection-applications-in-a-grid-supported-environment1.pdf

Title	PhD Thesis - École de Mines de Ales, France
Comment	Vicent Thierion, will present the flood management knowledge acquired in the French case" its PhD thesis at end at 2009.
Ref	V. Thierion , "*Geomatic and distributed computing using for flash floods crisis management"*, supervisor Sophie Sauvagnargues-Lesage., École de Mines de Ales, France, 2007.

15. ANNEX II: REFERENCES RELEVANT TO RESEARCH-DRIVEN WORK

This set of papers was referenced by Cyclops documents.The inclusion intends to refer R&D people and organizations with knowledge relevant for Cyclops related activities.

[1]   ACKERMAN, K.STRAFALA, P.MENZEL, R.FREY, C.MOELLER, L.GUMLEY, B.BAUM, S.W.SEEMAN AND H.ZHANG, "*Discriminating clear-sky from clouds with Modis Algorithm theoretical basis document (MOD35)",*October 2002. WEB : http://modisatmos.gsfc.nasa.gov/_docs/atbd_mod06.pdf

[2]   ALEXANDRIS, D*., "Report and information on disaster reduction for Greece for the World Conference on Disaster Reduction,"*Kobe-Hyogo, Japan, 18-22 January, 2005,10

[3]   AYRAL P-A., "*Contribution à la spatialisation du modèle opérationnel de prévision des crues éclair ALHTAÏR – Approches spatiale et expérimentale –Application au bassin versant du Gardon d'Anduze*", Thèse de Doctorat, Université de Provence, Aix-Marseille 1 – LGEI, Ecole des Mines d'Alès, 2005, 300p.

[4]   AYRAL P-A., SAUVAGNARGUES-LESAGE S., "*Elaboration par SIG d'une couche d'information sur les capacités d'infiltration d'eau dans le sol permettant l'établissement d'un indicateur pour l'annonce des crues*", Rapport Final, Ecole des Mines d'Alès, 2004, 250p.

[5]   AYRAL P-A, SAUVAGNARGUES-LESAGE S., BRESSAND F., GAY S., "*Forecasting flash floods with an operational model: application in the South-East of France (Gard)* ", Flood risk management in Europe: Innovation in Policy and practice". Advances in Natural and Technological hazards research, vol. 25. Begum S., Stive Marcel JF, James W (Eds.), Springer 2006, 600p.

[6]   BALBIS L., GAETANI F., MINCIARDI R., PORTELLA G., SACILE R., AND TRASFORINI E.), "*A decisional model for dynamic allocation of resources in natural disasters management*".3rd International Conference on Computer Simulation in Risk Analysis and Hazard Mitigation. June 2002, Sintra (P) P. 243-250. ISBN 1853128309.

[7]   BRESSAND F., "*Le projet ALHTAÏR du service d'annonce des crues du Gard ", Colloque imagerie satellitaire et radar au service de l'eau*", La Houille Blanche, Revue Internationale de l'eau, n°2, 2002, pp. 64-68.

[8]   CUOMO V., M. LANFREDI, R. LASAPONARA, M. F. MACCHIATO and T.SIMONIELLO, (2001). "*Detection of inter-annual variation of vegetation in middle and southern Italy during 1985-1999 with 1 km NOAA AVHRR,*" Journal of Geophysical Research, vol. 106, No.D16, ISBN 17,863-17, 876, 2001.

[9]   DAUPHINE, A., "*Risques et catastrophes: observer, spatialiser, comprendre, gérer*". A. Colin, 288 p. 2001.

[10]   DANDOULAKI, M., "*Some comments related to the country report of Greece, Scientific Colloquium"*, 4-5 April, 2005, University of Dortmund, 12 p.

[11]   DAUTUN C., TIXIER J., CHAPELAIN J., FONTAINE F., DUSSERRE G., "*Crisis management: improvement of knowledge and development of a decision aid process*", Conference of Loss Prevention, Edinburgh, 22-24 May 2007, 10 p.

[12]   DIRECCAO - DIRECÇÃO-GERAL RECURSOS Florestais, "*Plano Nacional de Defesa da Floresta Contra Incêndios*" - Ministério de Agricultura, Portugal, 2006, 85 p.

[13]   DOZIER, J, "*Spectral signature of alpine snow cover from the Landsat Thematic Mapper, Remole Sensing of Environment*", v28, 1989, pp9-22.

[14]   **FIORUCCI P., GAETANI F., MINCIARDI R., TRASFORINI E.**, *"Natural risk assessment and decision planning for disaster mitigation*". Advances in Geosciences, 2, P. 161–165, SRef-ID: 1680-7359/adgeo/2005-2-161, 2005. European Geosciences Union.

[15]   **FIORUCCI P., GAETANI F., MINCIARDI R.** *"Dynamic models and Optimal   control techniques for forest fire risk assessment and management*". IFAC Workshop   on Modelling and Control in Environmental Issues, August 2001,Yokohama (J). P 273-278. ISBN 0-08-04-3909-8.

[16]   **FIORUCCI P., GAETANI F., MINCIARDI R., AND TRASFORINI E.**, "*A DSS for The evaluation of the consequences of natural hazards on a complex Territorial system*". IEMSs 2002, Integrated Assessment and Decision Support, 1st Biennial Meeting of the International Environmental Modelling and Software Society, June 2002, Lugano (CH) P. 25-29. ISBN 88-900787-0-7.

[17]   **FIORUCCI P., GAETANI F., MINCIARDI R.**, "*Dynamic models for preventive management and real time control of forest fires*". 15th IFAC World Congress In Automatic Control. July 2002 Barcelona (E) ISBN 0-08-044295-1.

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[23]   **FIORUCCI P., GAETANI F., MINCIARDI R., SACILE R., AND TRASFORINI E.**, "*Real time optimal resource allocation for natural hazard "*in Pahl, C., Schmidt, S. and Jakeman, T. (eds.) iEMSs 2004 International Congress: "Complexity and Integrated Resources Management" International Environmental Modelling and Software Society June 2004, Osnabrueck (D) ISBN 88-900787-1-5.

[24]   **FIORUCCI P., GAETANI F., MINCIARDI R., TRASFORINI E, AND SACILE R.**, *"Dynamic Resource Allocation For Forest Fire Risk Management".* DEXA 15th, International Workshop on Database and Expert Systems Applications. September 2004, Zaragoza (SP).

[25]   **FIORUCCI P., GAETANI F., MINCIARDI R., "***Combined use of historical forest fire data and risk assessment evaluations for optimal planning of the firefihting system over a given region*". EGU European Geosciences Union – 2nd General Assembly, April 2005, Wien (A). Geophysical research abstracts. Sref-ID 1607-7962/gra/EGU04-A- 04298 ISSN 1029-7006. 2005

[26]   **FIORUCCI P., GAETANI F., LANORTE A., LASAPONARA R.**, "*Remote Sensing technology coupled with meteorological forecast data for wildland fire danger assessment* ", in De La Riva J., Pérez-Cabello, F. and Chuvieco, E. (eds.) 5th International Workshop on Remote Sensing and GIS Applications to Forest Fire Management: Fire Effects Assessment. pp. 119-123. June 2005 Zaragoza (SP) ISBN 84-96214-52-4.

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