THE GIIDA PROJECT: A SPATIAL INFORMATION INFRASTRUCTURE FOR ENVIRONMENTAL DATA SHARING

Nativi S. [a,b,*], Mazzetti P. [a,b], F.Guzzetti [c], A. Oggioni [d], N. Pirrone [e], R. Santoleri [f], G. Tartari [g], A. Viola [f], M. Santoro [a]

[a] IMAA of the Italian National Research Council - (nativi,mazzetti,santoro)@imaa.cnr.it
[b] University of Florence at Prato - (stefano.nativi,paolo.mazzetti)@pin.unifi.it
[c] IRPI of the Italian National Research Council - fausto.guzzetti@irpi.cnr.it
[d] ISE of the Italian National Research Council – a.oggioni@ise.cnr.it
[e] IIA of the Italian National Research Council – pirrone@iia.cnr.it
[f] ISAC of the Italian National Research Council – (rosalia.santoleri,a.viola)@isac.cnr.it
[g] IRSA of the Italian National Research Council – tartari@irsa.cnr.it

KEY WORDS: SDI, System of Systems, Multidisciplinary Interoperability, GEOSS, GMES, SEIS

ABSTRACT:

The GIIDA initiative of the Italian National Research Council (CNR) was launched in 2008 as an inter-departmental project which aims to design and develop a multidisciplinary e-infrastructure (cyber-infrastructure) for the management, processing, and evaluation of Earth and Environmental resources –i.e. data, services, model and sensors.
The mission of GIIDA is to *implement the CNR Spatial Information Infrastructure (SII) for Environmental and Earth Sciences resources* which conforms with the main international initiatives in this context (GEOSS, GMES, SEIS, INSPIRE). To achieve this, the GIIDA Project sets the following goals: to create a Network of CNR institutes for a common information framework, to re-engineer the CNR environmental Observation, Modeling and Processing infrastructure and to develop mediation solutions for inter-disciplinary interoperability in national and international frameworks.
GIIDA adopts a System of Systems architectural approach in order to federate the identified Thematic Areas Systems. A Call For Participation was issued and high-level projects providing contributions were to GIIDA were selected.
GIIDA is a contribution to Research&Development infrastructures in the context of a more general national digital infrastructure. Therefore, CNR is activating collaborations with other relevant actors in the context of national digital infrastructures for environment in order to establish synergies for a long-term sustainability.

1. INTRODUCTION

GIIDA[**] (Gestione Integrata e Interoperativa dei Dati Ambientali) is an initiative of the Italian National Research Council (CNR). It has been launched in 2008 as an inter-departmental project aiming to design and develop a multidisciplinary e-infrastructure (cyber-infrastructure) for the discovery, access, processing and publishing of CNR Earth and Environmental resources –i.e. data, services, models and sensors, best practices.
GIIDA will develop a System of Systems building on existing resources applying well-accepted interoperability standards.
Such an infrastructure will contribute to develop multidisciplinary teams studying the global Earth Systems in order to address the needs coming from important Societal Benefit Areas (SBAs) –e.g. Civil Protection and Risk Management.
GIIDA will strengthen the CNR and National presence in important international programmes dealing with Spatial Data Infrastructures (SDI), Mega-Science, and multi-disciplinary Science & Technology. In fact, GIIDA partners have been involved in the following significant initiatives: the European Directive Infrastructure for Spatial Information in the European Community (INSPIRE) (European Parliament, 2009), the EU European Earth Observation Programme (GMES) (European Commission, 2005), the international GEO/GEOSS (Group on Earth Observations/Global Earth Observation System of Systems) programme (GEO, 2005), the European Shared Environmental Information System (SEIS) (European commission, 2008).

2. GIIDA MISSION AND PRINCIPLES

The mission of the GIIDA initiative is to implement the CNR Spatial Information Infrastructure (SII) (Woolf A., Nativi S., 2008) for Environmental and Earth Sciences resources.
To achieve such an overarching goal, GIIDA introduced a set of guidance principles:
- To shift from a "traditional" data centric approach to a more advanced service-based solution for Earth System Science and Environmental information.
- To shift the focus from Data to Information Spatial Infrastructures in order to support decision-making.
- To be interoperable with analogous National (e.g. SINAnet, and the INSPIRE National Infrastructure) and international initiatives (e.g. INSPIRE, GMES, SEIS, and GEOSS).
- To reinforce the Italian presence in the European and international programmes concerning digital infrastructures, geospatial information, and the Mega-Science approach.
- To apply the National and International Information Technology (IT) standards for achieving multi-disciplinary interoperability in the Earth and Space Sciences (e.g. ISO, OGC, CEN, CNIPA).

---

[*] Corresponding Author
[**] http://www.dta.cnr.it/content/view/2735/2735/lang,en/

2.1 Project Operative Goals

GIIDA will pursue its overarching goal by achieving five main operational goals:

- *Networking*. To create a network of CNR Institutes (and other national organizations, where possible) for a common information framework.
- *Observation*. To re-engineer the CNR environmental observing infrastructures
- *Modeling*. To re-engineer the CNR environmental modeling infrastructures
- *Processing*. To re-engineer the CNR environmental processing infrastructures
- *Mediation*. To develop mediation solutions for inter-disciplinary interoperability, in significant national and international frameworks.

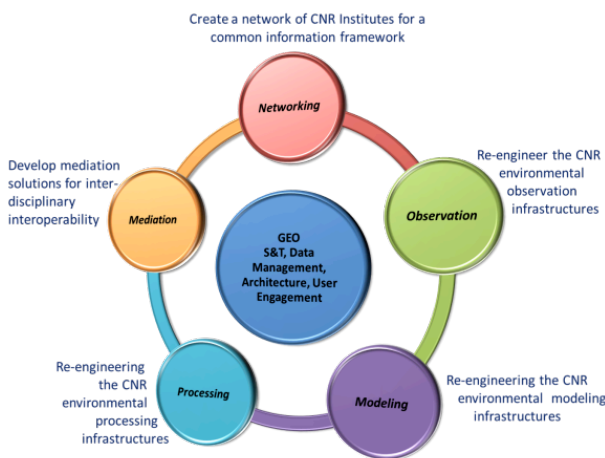Figure 1 depicts the GIIDA objectives context.

Figure 1 - GIIDA Objectives Context

3. GIIDA IMPLEMENTATION PROCESS

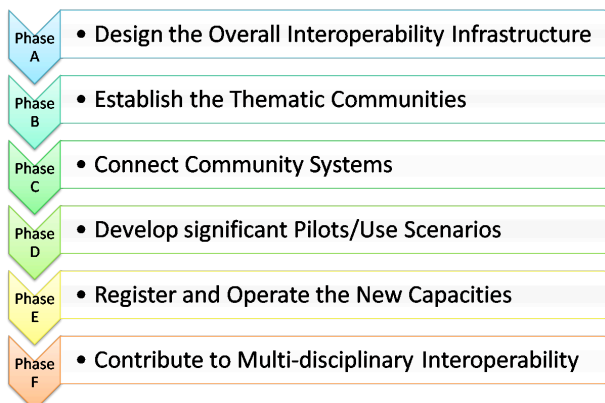The implementation process adopted by GIIDA is depicted in Figure 2.

Figure 2 - GIIDA Implementation Process

3.1 GIIDA Infrastructure Architecture

GIIDA architecture realizes a "System of Systems" approach. Thus, GIIDA federates existing, and hopefully future, system resources across different disciplinary domains.

Typically, in a System of System approach two service levels are considered: a) local (autonomous) systems services, e.g. local disciplinary resources; b) overall system services which should provide a consistent facade for the System of Systems and *brokering&mediating* local system services – this level of services should be kept as loosely coupled as possible.

Although all GIIDA local systems continue to operate within their own mandates, interoperability arrangements of GIIDA allow subsystems to leverage each other so that the overall GIIDA infrastructure becomes much more than the sum of its component systems.

Interoperability between the local systems and the overall system services is achieved by the compliance of the individual systems to a set of interoperability rules specified in the GIIDA architecture document (Nativi S., Bigagli L., Mazzetti P., 2008). For the interoperability rules specification, GIIDA adopted the international best practices under development by the most significant European and international initiatives (e.g. GEO/GEOSS, GMES, INSPIRE), based on international and community standards for geospatial information (e.g. ISO, OGC, CEN, etc.). Figure 3 shows the architecture design context.
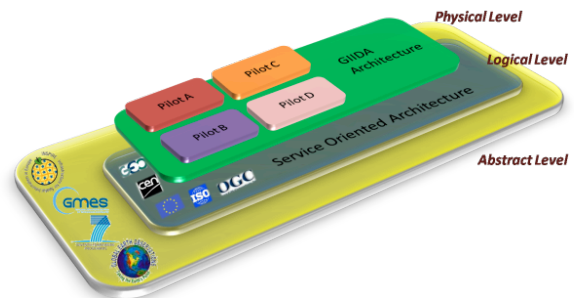

Figure 3 - GIIDA in the International Context

3.2 Thematic Areas

The second phase of the project consisted in the recognition of seven significant thematic areas for the initial GIIDA community of practice:

- Biodiversity and Ecosystems
- Climate Changes
- Air Quality
- Soil and Water Quality
- Risks
- Sea and Marine Resources
- Joint Research and Public Administration (PA) Infrastructures

According to the GIIDA architecture specified in (Nativi S., Bigagli L., Mazzetti P., 2008) the following technological areas were initially identified:

- Discovery Resources
- Thesauri
- Data Resources
- Sensors
- Workflow and Processing Resources
- Clients and Portals

In fact, GIIDA applies a mediation framework to federate sub-systems which are supposed to serve their own Thematic Areas. These sub-systems (or infrastructures) are called the GIIDA thematic systems. Resources are actually managed and provided at this level.

Keeping on with the System of Systems approach, GIIDA infrastructure is comprised of three interoperability levels: the local systems level, the thematic areas level and the overall system level (see Figure 4).

As far as disaster management is concerned all the recognized thematic areas can provide valuable contributions. Two of them are particularly focused on disaster management application: *Risks* and *Joint Research and PA infrastructures*.
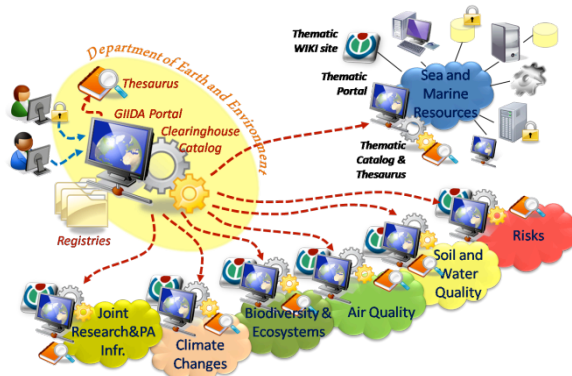

Figure 4 – The GIIDA System of Systems

The *Risks* thematic area concerns natural and man-made risks and it includes collaborative interoperability scenarios based on remote and in-situ sensors covering, but not limited to: hydro-geological risk, floods and landslides, civil protection, volcanic eruptions, geological risk mitigation, tsunami risk mitigation.

The *Joint Research and PA infrastructures* thematic area includes collaborative interoperability scenarios for Research and PA shared SDIs in the context of the European INSPIRE directive covering the following topics: socio-economical models, civil protection, thematic geological maps, cartographic maps, technology transfer from research to the regional PA, regional process integration, urban and industrial protected areas, land use planning.

3.3 Call For Participation

Best practices for implementing a System of Systems approach includes both top-down and bottom-up actions. Therefore, to complement the common GIIDA interoperability architecture action, a Call For Participation (CFP) was published with the intent of mobilizing resources from the CNR institutes and other national organizations (Nativi S., 2008b).

This action is the main step in order to achieve the other implementation process phases (i.e. Connect Community systems, Develop Significant Pilots/Use Scenarios, Register and Operate the new Capacities, Contribute to Multi-disciplinary interoperability). In fact, the CFP aims to:

- Identify and propose components and software services (e.g. Web Portals, Data resources, Catalogues, Processing Systems, etc.);
- Contribute to the interoperability tests of the components/services using international standards and specific interoperability arrangements;
- Contribute to the development of Use Scenarios of interest for the specific SBAs

3.3.1 Results from the CFP

GIIDA selected 23 responses to the issued CFP, proposing high-level components and Pilots contributions.

The response consortia are comprised of: 17 CNR Institutes affiliated to 5 different departments, the EV-K2 Institute and 18 external bodies:

- 3 Italian Regional Administrations (Lombardy, Puglia and Basilicata)
- 1 National Agency (Corpo Forestale dello Stato)
- 4 Other Research Centers (ENEA, INAF, INOGS, ICIMOD)
- 5 Universities (University of Pavia, University of Turin, University of Milan - Bicocca, University of Messina, Pol. of Milan - Como)
- 5 SMEs

Figure 5 depicts the geographic distribution of main GIIDA partners.

Figure 5 - Distribution of Main GIIDA Partners

3.4 The GIIDA Initial Operating Capacity

The first GIIDA operational phase will deliver the GIIDA Initial Operating Capacity (IOC).
This capacity consists of the systems and pilots developed by the previously described process.
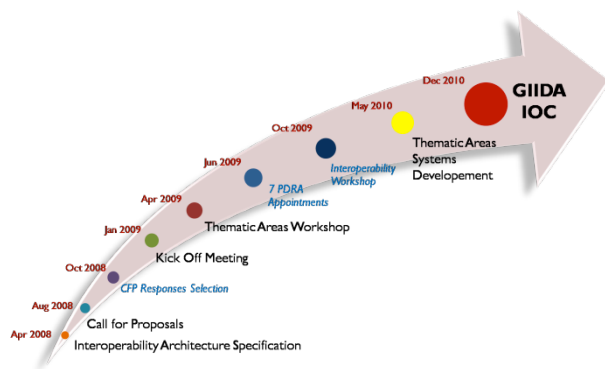Figure 6 shows the IOC development timeline.

Figure 6 - GIIDA IOC Development Timeline

4. GIIDA CONTRIBUTION TO THE INTERNATIONAL CONTEXT

International scientific community is spending great effort in order to create common digital infrastructures for the

management of environmental resources. Following is an overview of the international initiatives to which GIIDA contributes.

4.1 GEOSS

The Group on Earth Observations (GEO) is coordinating efforts to build the Global Earth Observation System of Systems or GEOSS. This system will provide decision-support tools to a wide variety of users. As with the Internet, GEOSS will be a global and flexible network of content providers allowing decision makers to access an extraordinary range of information at their desk (GEO, 2008).

GIIDA partners have contributed to the GEO Architecture and Data Committee (ADC) and the Science&Technology Committee (STC).

4.2 GMES

GMES is a joint initiative of the European Commission (EC) and European Space Agency (ESA) for the implementation of an European capacity for Earth observation. In fact, GMES provides data useful in a range of issues including climate change and citizen's security. Land, sea and atmosphere – each Earth component is observed through GMES, helping to make our lives safer. The GMES services are structured around 'Core' and 'Downstream' service layers.

GIIDA participants have contributed to the development of both GMES Core and Downstream Services through several FP7 projects.

4.3 SEIS

SEIS is a collaborative initiative of the European Commission and the European Environment Agency (EEA) to establish together with the Member States an integrated and shared EU-wide environmental information system. This system would tie in better all existing data gathering and information flows related to EU environmental policies and legislation.

GIIDA can certainly contribute to the future SEIS activities in close collaboration with SINAnet (see § 5.1.1) in the framework of the CNR-ISPRA Memorandum of Understanding.

4.4 INSPIRE

The INSPIRE Directive establishes the legal framework for setting up and operating a European Spatial Data Infrastructure based on the infrastructures for spatial information of the Member States of the European Union. The INSPIRE Directive entered into force on the 15th May 2007 .

GIIDA recently became an INSPIRE Spatial Data Interest Community (SDIC) covering most of the spatial data themes listed in the directive annexes. Moreover, GIIDA partners contribute to the INSPIRE Drafting Team activities.

5. GIIDA CONTRIBUTION TO THE NATIONAL INFRASTRUCTURE FOR ENVIRONMENT

A national digital infrastructure for environment aims to interconnect national wide systems dealing with the environment (see Figure 7).

In this context, GIIDA implements one the possible national research infrastructures for the environment and Earth Science information. These research infrastructures must be interconnected with the analogous digital infrastructures developed by other important stakeholders, such as public users and private companies.

The long-term sustainability of such a national digital infrastructure for the environment requires synergies among all the involved stakeholders' domains: Users, Governance, Capacity provision and Research&Development (see Figure 8). Therefore, in order to increase the GIIDA effectiveness, CNR established collaborations and liaisons with relevant actors of the other stakeholders' domains.
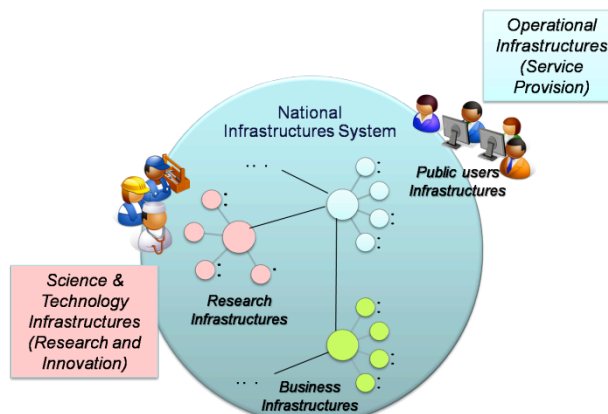

Figure 7 - National Infrastructures System

5.1 National Synergies

5.1.1 ISPRA - SINAnet

The National Environmental Information System (SINAnet[*]) is a system of national cooperation between the main national organizations which have competence in the management of environmental information. SINAnet aims to promote the integration of environmental component with policy, that is sustainable develop.

In the framework of a Memorandum of Understanding signed by CNR and ISPRA (the Italian Institute for Environmental Protection and Research), GIIDA and SINAnet collaborate to develop and apply common interoperability solutions sharing research and operational resources. This liaison will particularly address SEIS recommendations –applying the INSPIRE best practices.

Figure 8 - Stakeholders' Domains in a National Infrastructure Context

5.1.2 CNIPA

The CNIPA[**] (Italian National Centre for Informatics in Public Administration) hosts the Committee for the Technical Rules of

---

[*] http://www.sinanet.apat.it/it

[**] http://www.cnipa.gov.it/site/it-IT

Geographic Data of the Italian National Repository of Environmental Data.

CNIPA and CNR have been working on a Memorandum of Understanding for fruitful collaborations on several common areas of interest.

In this framework GIIDA might contribute to the activity of the Committee for the Technical Rules of Geographic Data.

5.1.3 Italian Grid Infrastructure

The Italian Grid Infrastructure (IGI[*]) is the Italian NGI (National Grid Initiative) and is part of the European Grid Infrastructure (EGI). IGI is the national coordinating body for all aspects of the Italian Grid infrastructure.

CNR is member of IGI. In this context, GIIDA aims to achieve interoperability between the CNR infrastructure and the Italian Grid infrastructure for the Earth Science and Civil Protection domains.

6. CONCLUSIONS

GIIDA project started in the first half of 2008 releasing its System of Systems architecture. Interoperability with international initiatives for geoinformation interoperability is one of the main GIIDA objectives.

After the recognition of the seven Thematic Areas, a Call for Participation was issued and 23 high-level projects were selected to provide contributions to GIIDA. The projects consortia are comprised of: 17 CNR Institutes affiliated to 5 different departments, the EV-K2 Institute and 18 external bodies (3 Italian Regional Administrations, 1 National Agency, 4 Other Research Centers, 5 Universities and 5 SMEs).

CNR/GIIDA established liaisons and collaborations with other relevant national agencies for contributing to the National Infrastructure for the Environment.

REFERENCES

References from Books:
Woolf A., Nativi S., 2008. "How Earth Science can Contribute to, and Benefit From, the SII", published in the book: "Creating Spatial Information Infrastructures towards the spatial semantic web" Taylor & Francis. ISBN: 1420070681.

References from websites:
GEO, 2008. "What is GEOSS?: The Global Earth Observation System of Systems" http://www.earthobservations.org/geoss.shtml (accessed 30 Nov. 2009)

References from Other Literature:
Group on Earth Observations, 2005. "Global Earth Observation System of Systems GEOSS 10-Year Implementation Plan Reference Document"

European Parliament, 2009. "Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)"

European Commission, 2005. "COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT - Global Monitoring for Environment and Security (GMES): From Concept to Reality - {SEC(2005)1432}"

European Commission, 2008. "COMMUNICATION FROM THE COMMISSION TO THE COUNCIL, THE EUROPEAN PARLIAMENT, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF REGIONS – Towards a Shared Environmental Information System (SEIS) - {SEC(2008)111}{SEC(2008)112}"

Nativi S., 2008a. "GIIDA: Work Plan", document of CNR - Department of Earth and Environment.

Nativi S., Bigagli L., Mazzetti P., 2008. "GIIDA: Architettura per l'Interoperabilita' ver. 1.1", document of CNR - Department of Earth and Environment.

Nativi S., 2008b. "GIIDA: Call for Participation (CFP)", document of CNR - Department of Earth and Environment.

Nativi S., 2008c. "GIIDA –Architecture Implementation Pilot: Call for Participation (CFP) responses", document of CNR - Department of Earth and Environment.

Guzzetti F., Balducci V., "PORTALE TEMATICO SUL DISSESTO GEO-IDROLOGICO, Interfaccia al sistema informativo distribuito su$f$l dissesto geo-idrologico in Italia", GIIDA CFP response, Sept 2008.

Cinnirella S., "Sistema Integrato per la Gestione dei Dati sull'Inquinamento Atmosferico", GIIDA CFP response, Sept 2008.

Plini P., S. Di Franco, V. De Santis, F. Mazzocchi, B. De Santis, "Il thesaurus per l'ambiente come strumento per l'organizzazione di dati e metadati geografici", GIIDA CFP response, Sept 2008.

Hedgecock I.M., "Air Quality Forecasts for Italy", GIIDA CFP response, Sept 2008.

Santoleri R., Manzella G., Mazzetti P., "Sviluppo di un sistema di gestione di prodotti satellitari ed in-situ marini per il Mar Mediterraneo", GIIDA CFP response, Sept 2008.

Viola A.P., Gobbi G., Congeduti F. "Costituzione di una banca dati ambientali per lo studio delle caratteristiche e dei processi nell'atmosfera dell'area della bassa valle del Tevere", GIIDA CFP response, Sept 2008.

Martano P., Cava D., Contini D., Donateo A., Elefante C., Grasso F., "Costruzione di un portale Web con aggiornamento real-time per visualizzazione/accesso alla banca dati climatologici e di qualità dell'aria in acquisizione presso i siti sperimentali della unità operativa ISAC CNR di Lecce.", GIIDA CFP response, Sept 2008.

Rafanelli C., Poscolieri M., Benedetti E., Damiani A., De Simone S., Diego P., "EarthData Project", GIIDA CFP response, Sept 2008.

Cavinato G.P., Messina P., Sposato A., "Geologia ambientale e rischio geologico", GIIDA CFP response, Sept 2008.

Chiocci F.L., Ridente D., Bosman A., Sposato A., "Geologia Marina", GIIDA CFP response, Sept 2008.

---

[*] http://www.italiangrid.org/

Brilli M., Petitta M., Voltaggio M., "Geochimica Ambientale", GIIDA CFP response, Sept 2008.

Tartari G., Uricchio V.F., Marchetto A., Erba S., Buffagni A., Barca E., "Banche dati sullo stato ecologico ed ecotossicologico del suolo e delle acque superficiali italiane", GIIDA CFP response, Sept 2008.

Spalla P., Baronti S., "Tecniche di Elaborazione per la Fusione di Dati Multidimensionali di Telerilevamento e per l'Individuazione di Feature Ambientali", GIIDA CFP response, Sept 2008.

Piana F., Balestro G., "Geoportale WMS MAGGIS", GIIDA CFP response, Sept 2008.

Carrara P., Bordogna G., Zucca F., De Amicis M., Brovelli M.A., A. Piccin, D. Dal Puppo, "R2R Lombardia: scenari di interoperabilità tra infrastrutture di dati con riferimento geografico prodotti dalla Ricerca lombarda e Regione Lombardia", GIIDA CFP response, Sept 2008.

Bortoluzzi G., Foglini F., Sarretta A., Ravaioli M., Aliani S., Boldrin A., Bastianini M., Langone L., Paschini E., Carniel S., Francavilla M., Gasparini G., Catalano G., Guerzoni S., Trincardi F., Spagnoli F., "Sistema integrato di banche dati sul tema mare e risorse marine", GIIDA CFP response, Sept 2008.

Lami A., Salerno F., "Ecosistemi di montagna: protezione e sviluppo", GIIDA CFP response, Sept 2008.

Maurizi A., Pappalardo G., "Sviluppo di un servizio web per l'integrazione di dati lidar tramite un modello di circolazione atmosferica", GIIDA CFP response, Sept 2008.

Scarascia Mugnozza G., Romano C., Matteucci G., "Infrastruttura per la condivisione di dati geospaziali di carattere ambientale", GIIDA CFP response, Sept 2008.

De Feis I., "Condivisione ed analisi di dati telerilevati", GIIDA CFP response, Sept 2008.

Mazzetti P., Bigagli L., "Infrastruttura condivisa tra CNR e Regione Basilicata per il supporto alle decisioni", GIIDA CFP response, Sept 2008.

Matteucci G., Ravaioli M., Bertoni R., "Dati ecologici, di biodiversità e di risposta ai cambiamenti climatici da siti di ricerca ecologica a lungo termine (LTER) del CNR in ambienti terrestri, lagunari, marini e di acque interne", GIIDA CFP response, Sept 2008.

Oggioni A., Manca D., "Biodiversità degli Ecosistemi", GIIDA CFP response, Sept 2008.

ACKNOWLEDGMENTS