

Lebanon is acknowledged as one of the world's 18 major biological hot spots, and one of the richest in terms of natural capital – with Mediterranean ecosystems characterised by unique landscape structures of forest and natural zones intersecting matrices of manmade landscapes. It can be considered a very vulnerable country in terms of geological, hydro-geological and biological components as well as, over the past few decades, rapid urban development and coastal encroachment. Aiming to transform the CNRS into a regional centre of excellence for dealing with important environmental concerns deriving from anthropological impacts on natural resources: soil, water, biodiversity, and coastal zone management, monitoring, testing and research, INCAM project was launched in 2011.

◇ **Project's portal**

The project started by the creation of a portal for dissemination its results to ensure a close collaboration and further follow-up links between the CNRS staff, INCAM project partners and the larger regional participants involved in all INCAM activities. The portal system is available on www.incam-cnrs.eu (figure 1) and contains all information related to the project. The website serves also as a dissemination tool for all conferences material (reports, presentations, pictures, participants contact list) delivered after any activity prepared within the project.



Figure 1 Home page of INCAM website (www.incam-cnrs.eu)

◇ **INCAM database**

During the first year of the project, a thorough assessment of the present status of natural resources in Lebanon was done with a main focus on the coastal zone of the country that has experienced drastic changes over the last two decades. Data of existing research results and literature review in Lebanon were collected for the last 5 years including a selection of important publications pre-2007,

addressing seven main topics: Water; Marine Ecosystem; Soil; Vegetation; Natural risks; Manmade risks; Human development index. Around 1000 metadata-sheets were introduced in the INCAM Web based catalogue that had been set up within the CNRS IT department in June/July (<http://incam.cnrs.edu.lb/geonetwork>) following all the instructions given through the training conducted in collaboration with IRD researchers (figure 2) on how to use standardised approaches to describe datasets, scientific reports, and publications.



Figure 2 CNRS researchers during the training conducted on the technical aspects of creating a database

◇ INCAM book

CNRS Researchers also gathered the collected data in a 328-pages book highlighting the state of the art of natural resources in the country focussing on the coastal area with a critical analyse on the management of these resources as well the recommendations identifying gaps for each topic, feeding the activities foreseen in the other work packages. INCAM book entitled “Review and Perspectives of Environmental studies in Lebanon” (figure 3) includes fourteen chapters covering most of the critical issues that Lebanon is facing from biodiversity loss, degradation of soil and water quality, loss of the coastal zones to aggressive development and urbanization, land loss & erosion. Each chapter reviews and sheds light on the development of scientific appreciation of a specific environmental topic with a focus on the coastal area in order to identify knowledge gaps and priorities for future work. At the end of the book, a recommendation chapter (available also in Arabic) highlights generic recommendations for a sustainable environmental management.

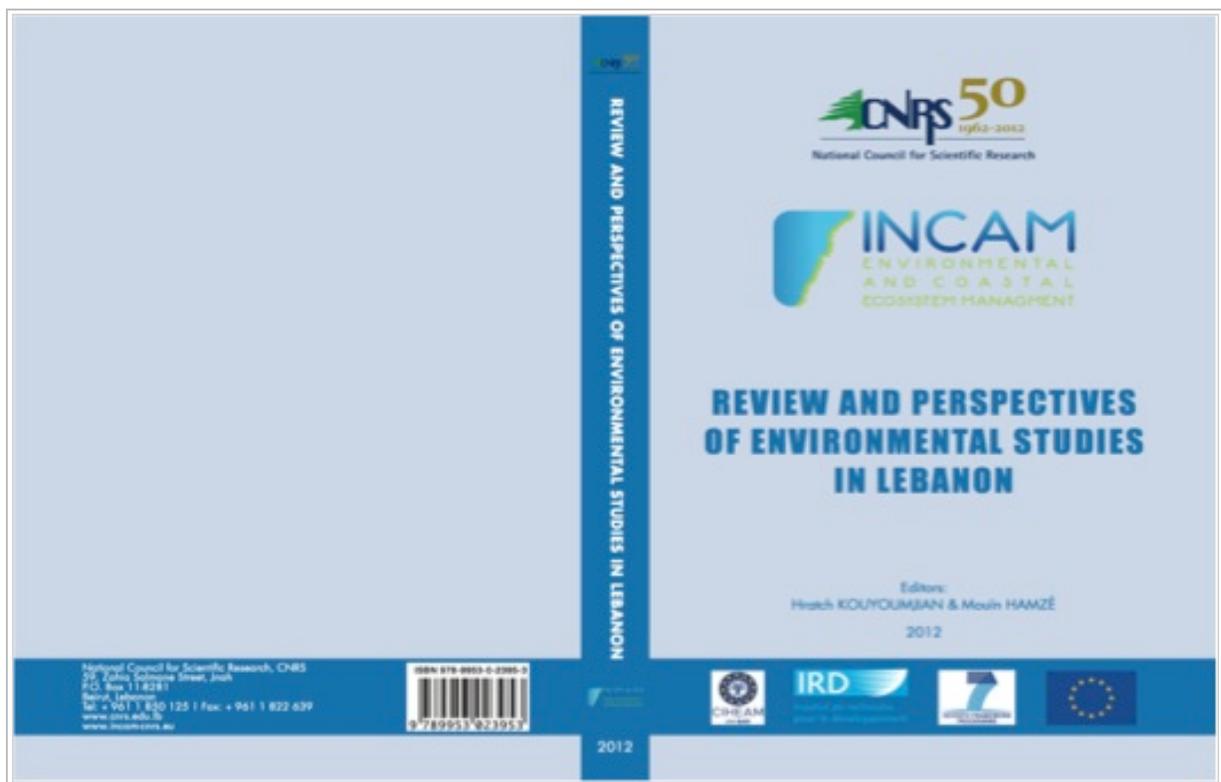


Figure 3 INCAM Book cover

◇ Peer-reviewed papers

In light of state of the art and all the analyses prepared, peer reviewed papers could be published on (i) Vulnerability to Desertification in Lebanon Based on Geo-information and Socioeconomic Conditions, published in Journal of Environmental Science and Engineering B 1 (2012) 851-864, (figure 4) (ii) Distribution of Lead, Cadmium, and Vanadium in Lebanese Coastal Sediments and Mussels, Journal of Coastal Research (in press), (figure 5) and (iii) La Composition Et La

Distribution Du Peuplement Des Poissons Marins Migrateurs Dans Quelques Rivieres Libanaises Et L'impact Des Amenagements Sur La Migration De Ces Poissons, proceeding during INOC-CNRS, International Conference on "Land-Sea Interactions in the Coastal Zone" Jounieh - LEBANON, 06-08 November – 2012 (figure 6).

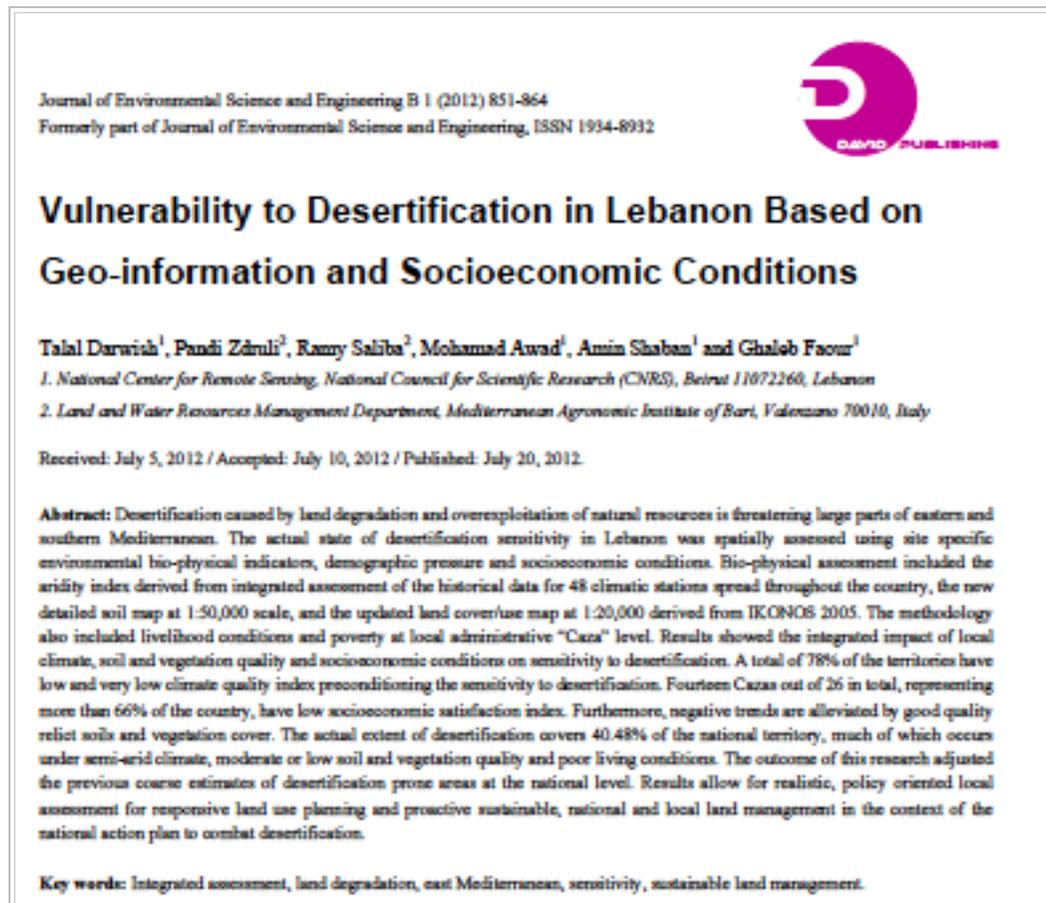


Figure 4 First peer reviewed paper published within INCAM in Journal of Environmental Science and Engineering

**LA COMPOSITION ET LA DISTRIBUTION DU PEUPEMENT DES
POISSONS MARINS MIGRATEURS DANS QUELQUES RIVIERES
LIBANAISES ET L'IMPACT DES AMENAGEMENTS SUR LA
MIGRATION DE CES POISSONS**

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RESUME

*Trois espèces de poissons d'origine marine ou estuarienne ont été pêchées dans plusieurs localités des rivières libanaises qui se jettent dans la Méditerranée, *Anguilla anguilla* (Linné, 1758), *Mugil cephalus* (Linné, 1758) et *Chelon labrosus* (Risso, 1826).*

Ces trois espèces sont des poissons euryhalins répandues dans la Méditerranée orientale, vivant généralement dans les eaux côtières et pénétrant dans les estuaires, les lagunes saumâtres et les eaux douces des rivières côtières libanaises pour se nourrir.

Les résultats de l'inventaire et la distribution des poissons dans ces différentes rivières sont présentés et quelques données biologiques de ces espèces sont dressées.

Cette étude est menée dans le but d'estimer un éventuel impact des activités humaines sur ces poissons marins migrateurs.

Les aménagements de différents types (construction des ponts, des barrages, assèchement dû au pompage intensif...) dans ces rivières côtières avec une urbanisation incontrôlée, sont très marquées.

L'effet de ces aménagements a entraîné des perturbations du fonctionnement naturel du biotope de ces poissons migrateurs. Des constructions ont gêné et même arrêté la migration des poissons vers l'amont des rivières.

Mots clés : poissons migrateurs, biologie, aménagement, activités anthropiques

Figure 6 Proceeding within INCAM in the INOC-CNRS, International Conference on "Land-Sea Interactions in the Coastal Zone"

◇ Local workshops

Following the print out of INCAM book which is considered to be a major achievement towards increasing the CNRS national role on the road to a continual environmental assessment and since it is considered to be a major source of information for decision makers, stake holders, academics, students and the public at large, the project management unit suggested to hold local workshops: the first one on environmental remediation of Upper Litani Watershed at the Lebanese Parliament, Beirut February 28, 2013. The workshop involved NGOs, ministries, environmental experts, decision makers to discuss the environmental pollution of the river and discuss technical, administrative and legislative solutions toward a proper management for the protection of the Litani river, the second one on the linkage between INCAM project and the OREME observatory (Observatoire des Sciences de l'Univers dédié à l'étude des Aléas et de la Vulnérabilité des Milieux Méditerranéens : risques naturels, et impact des changements globaux et anthropiques sur l'espace méditerranéen vivant et inerte) on March 12, 2013 at the CNRS, Lebanon (figure 8) while the third

one (May 28 & 29, 2013, CNRS-Lebanon) addressed the database created within INCAM to share with participants involved in OREME (called O-Life in Lebanon) the methodology used within INCAM Project towards feeding the established natural database during O-Life.



Figure 7 Litani Watershed depollution workshop, Lebanese Parliament, February 28, 2013



The local workshops gave the CNRS a good opportunity to actively participate in other national (Litani River Decontamination) and Euro-Mediterranean (OREME observatory) projects towards enhancing the role of the council and ensuring a continuity of INCAM beyond the project's duration.



Figure 8 INCAM-OREME workshop

◇ Critical sites visits

Towards promoting and enhancing the sharing of experience and know-how, two critical sites visits were undertaken with regional experts at Selaata chemical plant and different quarries in the country (figure 9).



Figure 9 critical sites visits, on the left the Selaata chemical plant visit; on the right experts visiting the Qartaba site relocated to karting

The visits were preceded by CNRS centers visits and meetings where experts presented the main studies carried out by the researchers of the centers related to the critical site visit in particular to (i) the monitoring and the observation of the Lebanese coastal zone and focusing on the main sources of chemical and bacteriological pollution and (ii) the impact of degraded quarries on natural resources and the negative effect of practices -before 2005- on the water, soil resources and vegetation cover as well as on air and water quality and terrain stability. Four regional experts and 13 local experts from the CNRS centers, the Lebanese institutions and universities, the ministry of environment and main stakeholders identified for each critical site visit shared/exchanged experience and know-how on the identified critical sites.

◇ **Lebanese participation in European trainings and conferences**

Four Researchers from the CNRS also participated in European workshops and conferences addressing man and biosphere management; (2) open days for the PhD students on biodiversity and ecology; (3) ecological impact of biological control; (4) Marine Ecosystems Responses to climatic and anthropogenic forcing in the Mediterranean. Researchers were eager to share and exchange experience and know-how and disseminate the outputs of the project.

One of the main objectives of INCAM is to enhance the capacity of the CNRS to plan and manage natural resources and the coast efficiently and effectively. This implies addressing capacity building on a long-term, strategic level to ensure that the CNRS will be adequately equipped to deal with any emerging implementation challenges beyond INCAM project. Throughout INCAM Project, the improvement of CNRS capacity building was assessed through the transfer of knowledge which is a

key activity done within INCAM using, among other means, six CNRS researchers were trained in EU countries on Integrated Coastal Zone Management and Environmental challenges. These trainings could strengthen the required institutional and organizational capacity to manage different source of information mainly through acquiring new skills on: (i) Drought monitoring using climatic and remote sensing indicators; (ii) Planning, capturing and processing of hyper spectral images; (iii) Training and meeting concerning floods and mass movements; (iv) Learn new analytical extraction procedures for trace metal speciation in marine sediments; (v) the speciation program Hyss, its role and applications; (vi) learn new methodology for marine taxonomy; (vii) new methods for studying currents in the sea surface; (viii) how to use the CTD; (ix) statistical applications used in marine hydrology; (x) how to use space sensors to manage multidisciplinary projects with local national institutions and multinational teams and carrying advanced studies and analyzes. All the trainings conducted will allow the CNRS staff to assess and monitor the coastal changes and hazards serving the integrated coastal zone management in order to create future early warning systems.

◇ **MsC and PhD students granted within INCAM**

INCAM project gave also the opportunity for two Lebanese students to pursue their studies in European Countries in order to improve scientific knowledge and technological know-how in water use efficiency, land conservation and environmental issues through the completion of specific research themes and experimental works. The first student was selected by INCAM management team to continue his studies in IAM-Bari AMB to work towards the elaboration and completion of his Master of Science thesis. The MSc theme will be decided in close collaboration between the IAMB and CNRS staff in 2014 following the objectives of INCAM project put forward in the Road Map Action Plan for the modernisation of CNRS. Based on previous excellent experience and cooperation, all thesis will be co-advised by senior researchers based both at IAMB and CNRS. According to the academic requirements of the CIHEAM-IAMB, students are foreseen to defend their MSc thesis in October 2014. Answering the priorities identified in the INCAM review (biodiversity chapter) on the need to support and encourage research on biodiversity related topics, a second student has been granted a PhD fellowship (since September-October 2012) from CNRS-L for a PhD conducted between Lebanon and University of Marseille on biodiversity and socio economic indicator for integrated ecosystem management and biodiversity conservation in Lebanon.

◇ **FP7 training to increase Lebanese participation in EU projects**

INCAM project aims to increase FP7 participation capacities for Lebanese researchers; in this framework, an FP7 training workshop was held in Beirut, Lebanon on the 16th of March 2012. The training workshop was organized by the Project coordinator, the National Council for Scientific

Research (CNRS) with the participation of the Institut Agronomique Méditerranéen de Bari (IAM-Bari) represented by Dr. Pandi Zdruli and Dr. Saverio De Santis. The training was attended by researchers, research assistants and administration officers from various institutions in Lebanon (CNRS, USEK, USJ, UL, AUB). The main objectives of the workshop were to train participants on FP7 rules, regulations, funding schemes, project management, project proposal guidelines with a particular focus on how to select the scientific and/or technical aspects relevant to the topics of the Call, how to describe the potential impacts of the proposal as well as how to implement it successfully following the financial rules of the FP7.



Figure 10 Participants during the FP7 training workshop, March 16, 2012, Lebanon

During the workshop, researchers were trained on how to successfully prepare a proposal, fill the Part A (Administrative part) and the Part B (scientific relevance, management, budget, impact), write the potential impact of the proposal and the project implementation, submit electronically the proposal (the EPSS system), negotiations and signing of the grant agreement, project Management, fill the form C (financial Statement and financial schemes), costs reporting and payment, main problems to be faced and the Evaluation summary report. Additional issues were also presented and discussed during the workshop such as the role of the financial audit, the players in the financial audit, the European court of audit website, how an audit operates, common issues in financial audits and how to submit a claim. INCAM project was given as an example for a coordination and support action-funding scheme within FP7.

◇ **First Regional Workshop training**

Under the Patronage of H.E. the Minister of Environment, Nazem El Khoury, the National Council for Scientific Research – CNRS in Beirut, Lebanon held in its head quarter INCAM first regional training workshop on January 25th and 26th 2012. Almost sixty trainees, lecturers and INCAM

partners' members attended the workshop from Lebanon, Syria, Egypt, Jordan, Algeria, Tunisia, Palestine, France and Italy. Of the trainees, five have ERA-WIDE projects and the remaining are researchers or PhD students involved in natural resources management (soil and land management, coastal zone management, etc.) either in Lebanon or in the region. Lecturers were selected among INCAM partners, representing the CNRS; CIHEAM, IAM-Bari and IRD. During INCAM two-day workshop, consortium partners – CNRS-Lebanon, the Mediterranean Agronomic Institute of Bari (IAM-B), Italy and Institut de Recherche pour le Développement (IRD) of Toulouse, France- shared INCAM methodology with local and regional partners deepening on environmental institutional capacity building aspects toward increasing the leading scientific role of CNRS as well as its centres and establishing networking between Lebanon, the region and the EU. The last session of the workshop was dedicated to sharing experiences and exchange of information between participants and previous identified volunteers presented their projects (EU or others) focusing on the outputs and suggestions for future collaboration with INCAM, the National Council for Scientific Research in Lebanon and its centers.

**ورشة لتحسين إدارة الموارد الطبيعية
في مجلس الوطني للبحوث العلمية**

نظم المجلس الوطني للبحوث العلمية ورشة عمل تدريبية، في مقره في النجّاح، بعبسان، «تحسين التقييم الوطني وقدرات الرصد مع أجل الإدارة المتكاملة للأنظمة البيئية البحرية»، ضمن برنامج INCAM المدعوم من الاتحاد الأوروبي، في حضور ممثل وزير البيئة وتناظم الخوري مستشاره غسان صياح، ومشاركة المؤسسة الزراعية المتوسطة في باري-إيطاليا ومعهد البحوث من أجل التنمية في فرنسا، الأمين العام للمجلس الوطني للبحوث العلمية الدكتور معين حمزة وممثلين وخبراء من دول مصر وسوريا وفلسطين والأردن والجزائر وتونس وإيطاليا.

افتتح الدكتور حمزة الورشة بالتهنئة بـ «دور المجلس المتنامي في المشاريع الأوروبية»، مؤكدا «أهمية التعاون القائم بين مراكز المجلس وياخذه من جهة والمشاريع التنموية التي تشرف عليها وزارة البيئة، مستفيدا لأقصى حد من الخبرات الأوروبية والمتوسطة ذات الخلق...»

تحدث ممثل وزير البيئة صياح أشار فيها إلى أهمية الورشة، «كونها تفتح طرق إلى صلب الاهتمامات البيئية والتحديات والتغيرات التي قد يواجهها العالم أجمع».

وقال: «إن لبنان كسائر بلدان العالم المتقدمة أو النامية عرضة لاستنزاف موارده الطبيعية لأن زيادة تعداد سكان الأرض وتضاعف احتياجاتهم للموارد شكل ضغطا متزايدا على المياه والتربة والتنوع البيولوجي»، مشيرا إلى «أن لبنان ليس بمنأى عن هذه الضغوط: فلبنان - أسوة

بمثالته من دول المتوسط - يعاني من تدهور بيئي سنوي قدر بحوالي ٨٠٠ مليون دولارا أميركيا- أي ما يقدر بـ ٧٪ من الدخل القومي. هذا ورغم أن التدهور البيئي ترك بصماته الأكبر على الموارد المائية والهواء والمناطق الساحلية، إلا أننا لا نستطيع أن ننكر أن للتدهور آثارا سلبية على التنوع البيولوجي».

وأعلن أن الدولة اللبنانية «وعت أهمية التخطيط والعمل من أجل حماية البيئة، فعمدت إلى المشاركة والمصادقة على كل الاتفاقيات والمعاهدات الإقليمية والعالمية الهادفة إلى استدامة الموارد البيئية وتمييزها».

وأشار إلى «أن وزارة البيئة تعمل حاليا ضمن خطة عمل ثلاثية ٢٠١٠-٢٠١٢ تركز على تفعيل الإدارة الرشيدة للموارد الوطنية الطبيعية لحمايتها من الاستنزاف واستدامتها».

وأوضح أن المشروعين المنفذيين حاليا في وزارة البيئة والمرتبطين مباشرة بورشة العمل هذه هما: مشروع «تطوير مراقبة ورصد الموارد البيئية في لبنان».

مشروع «دعم إدارة الموانئ البحرية في لبنان، وختم بالقول: «إن المهمة أمامنا صعبة وتحمل الكثير من التحديات في دولنا النامية المنهكة والمنهكة في أمورها الطارئة، إلا أن ذلك لا يعني أن نتنصل من مسؤولياتنا أو نهمل التزاماتنا. أننا ندرك بأنه علينا أن نبني اقتصادنا من منطلق تنمية مواردها الطبيعية لا استنزافها من أجل حماية حقوق وتوعية حياة الأجيال المقبلة».

Figure 11 Press release in Arabic of the first regional workshop in a local journal (Al Diar)



Figure 12 Participants during the first regional workshop, January 25&26, 2012, Lebanon

◇ **INCAM Final conference**

The final conference of the project was held in Izmir, Turkey in collaboration with the Inter-Islamic Science Technology Network on Oceanography, Izmir and the Institute of Marine Sciences & Technology, Dökuz Eylül University, Izmir on May 15-17, 2013 with the aims to share INCAM success story and disseminate its lessons learned with regional partners and establish a network between marine research centers in the Mediterranean region to endorse Integrated Coastal Zone Management principles and environmental objectives in the Mediterranean. The conference was marked by the presence of Dr. Vedat Mirmahmutogullari, the Undersecretary of the Turkish Ministry of Food, Agriculture and Livestock and H.E. Mr. Mansour Abdallah, Ambassador of Lebanon to Turkey as well as representatives from eleven Mediterranean countries (from Lebanon; Jordan; Egypt; Tunisia; Turkey; Spain; France; Italy; Greece; Turkey; Cyprus) dealing with coastal zone management, environmental protection, land use planning, policy and decision making, research and education, NGOs, civil society. The first session of the conference included presentations on (i) INCAM Project outcomes, accomplishments and perspectives, (ii) Seventh Framework Programme: Cooperation with the Mediterranean Neighbourhood Countries in Research and Innovation, (iii) INCAM experience and prospects for the future collaboration from the CIHEAM point of view and (iv) INCAM natural resources database. The second session included Country reports from the MENA region in particular from Lebanon, Jordan, Egypt and Tunisia. All participants presented the status of environmental protection in the country with a special focus on coastal zones. Participants also presented their Institutions (Mission and Purpose, Major Activities, Major Objectives), Status of environmental management in their country (Highlighting the main

challenges that can concern the remaining Mediterranean countries as well), stressing on how can their institution collaborate in the ICZM Mediterranean network and what are their expectations from the Networking. The 3rd session addressed country reports from the EU and candidate countries in particular from Spain, France, Greece, Turkey, Ankara and Cyprus. During the second day of the conference, INCAM legacy and International collaboration and future perspectives were discussed. The working day started by the Human and socio-economic aspects presentation towards an integrated coastal zone management in the Mediterranean Countries followed by presentations on the assessment of coastal Environment using Remote Sensing & GIS techniques: example of Lebanon and the CNRSL Strategic action plan prepared within INCAM for the period of 2014–2019 .The last session of the conference opened discussions between all participants to give ideas and suggestions for future collaboration on ICZM and environmental protection in the Mediterranean.



Figure 13 Participants in the final conference of the project Izmir, May 15-17, 2013

◇ **Roadmap and action plan for the CNRS beyond INCAM life**

Towards strengthening the role of the CNRS to improve excellence in relevant research areas, and within INCAM project, an action plan striving towards strengthening the role of the CNRS was prepared to improve excellence in relevant research areas. This plan will contribute better to the use and management of limited natural resources and to support sustainable development in the country in a time when Lebanon itself and the countries of the region are particularly facing not only financial and energy crises, but also environmental challenges.

These actions aim at achieving external objectives of a strategy or objectives of a management plan.

The action plan strives towards the modernization of the CNRS towards becoming a center of excellence for research, innovation, good governance and management as a possible model for the region. It aims as well to assure continued follow-up and implementations of this strategic action plan even after the lifetime of the INCAM project. In INCAM project, the strategic action plan differs from the action plan by the fact that it contains more guidelines than in action plan. This is why many people call the strategic action plan a road-map.

Good Governance and Quality Control Management refers to the means by which the institution is formally organized and managed; in other words, it is the way CNRS is operated. Good Governance is defined as a system through which the performance of the institution (CNRS) is guided and supervised so as to achieve the required objectives and ensure quality control. The governance of the CNRS is fully explained in a comprehensive document prepared within the project structured in ten sub chapters including an introduction, a review of existing CNRS strategy, the CNRS Presentation, the Assessment of the Science, Technology and Innovation policy in Environment, the CNRS human resources, the analysis of the State of the art of the CNRS, the strategic action plan prepared within INCAM, the national geospatial strategy and implementation plan, the actions to achieve objectives of the road-map and the procedure to be conducted in order to implement this strategic action plan. At the end of the document, a follow-up planning document is produced to provide every person involved in the implementation with a common understanding of the motivation and the actions and activities to be followed up towards contributing to the upgrade of the CNRS to be a Center of Excellence for Lebanon and the Region.

◇ **Leaflets**

The first leaflet printed out by the project contained the context and main objectives of the project (figures 14). This brochure was disseminated during the main activities of the project, of the CNRS as well as during EU and international conferences in particular during the CNRS Golden Jubilee Ceremony, all local and regional INCAM activities and other EU meetings such as, “Strategy for internationalization and research valorization” workshop in Marseille on October 2011 and ERA-WIDE Projects – 3rd Week of coordination “Governance, Human capital and RDI management skills: accompanying success stories in the Mediterranean research centers on July 2012 in Brussels, the International Conference on Land-Sea Interactions in the Coastal Zone on November 2012 in Lebanon, International Workshop MERMEX in Zagreb, Croatia on June 2013. Moreover CNRS distributed the leaflet with the newsletter to local stakeholders and decision makers in Lebanon from Universities and Ministries;



Figure 14 First leaflet design

The second leaflet (see figures 15) was recently designed in collaboration with the International Innovation research journal together with a 3-page article with images and graphics dedicated to INCAM project and published within the International Innovation report that focus on research, education, sharing of resources and information and access to data and infrastructure within many sub-topics of ocean and marine management, policy, monitoring research. The International Innovation report looks at a number of different areas including: marine, coastal and ocean climate and environmental monitoring and modeling, access to marine research infrastructures and services, managing ocean and coastal resources, environmental collaboration and collaborative marine policy development, climate change prediction impact, management, reduction and policy, marine and coastal research ecosystem and environment research, resource allocation, land use and rural development, impact assessment, biodiversity, large scale data modeling, sharing and coding, collection and sharing of data for stakeholders and education, environmental technologies, sustainable program development, water and maritime issues, collaboration in addressing environment and climate issues, modeling interoperability and standards, decision support tools, joint action plan development, policy recommendations, driving the science, policy., stakeholder interface and engagement etc.

This leaflet is addressed (through email and hard copies) to local stakeholders (all universities in Lebanon, all researchers included in the database of the CNRS and all ministries related to natural resource management, NGOs) and regional stakeholders (see list of potential end users, deliverable 4.2).

The International Innovation Report adheres to open access to accelerate the barrier-free dissemination of scientific knowledge. Through the open access, INCAM project will benefit from a higher visibility and increased citation rate of its papers. Readers and stakeholders benefit from immediate access to high quality research information and dissemination.

The report will be sent to over 30'000 key stakeholder readers carefully selected and highly targeted audience of key researchers, policy makers, government and decision makers across both the private & public sectors across all member states in the European Union and INCO countries (please see below list). CNRS, IAM-Bari and IRD will also receive additional copies to be used for any future dissemination.

The report is also made available online in a digital publication format on a dedicated web page for a period of twelve months, the report is also distributed worldwide to enable international dissemination and communication of scientific and policy results. INCAM website as well as the CNRS website will also add an electronic version of the report and leaflet.

information implying technology, standards, and policies to acquire, process, distribute, and increase use of geospatial datasets. Among the tools available for accurate and timely updates, earth observation techniques play a central role. This project SDI contributes to shared environmental monitoring systems. Built upon a complete stack of open source software, including GeoNetwork, GeoServer, OpenLayers, GeoWebCache, PostGIS, and EasySDI it provides full OGC web services with extensive digital rights managements controls. EasySDI is a comprehensive framework for implementing and managing spatial data infrastructures and to fulfil the European INSPIRE directive requirements. The solution is based on a service orientated architecture (SOA) conceived with a modular design to set up services of discovery, visualization and download in a secure and multilingual environment. It acts as aggregating technologies to offer an interoperable solution allowing orchestrations of OGC compliant web services. The complete platform, enabling dissemination and interoperable processes to organize, edit, process and publish spatial through standardized services (WFS, WMS, WCS and SOS) is presented. The INCAM SDI was designed as a stepping stone for CNRS National Spatial Data Infrastructure (NSDI). It offers access to geospatial data, publications and all related information's. INCAM SDI will confidently increase information sharing across the department of CNRS, allowing for the reuse and adaptation of geospatial datasets. This availability is cost-savings, and offers wider use of crucial datasets by offering access to datasets elaborated only once but (re) used many times. INCAM SDI main objective is to establish a network on geographical Information for nature conservation (i) to share experiences and good practices, (ii) to stimulate the community of nature conservation stakeholders at improving the harmonisation and (iii) for the exploitation and the access to their datasets. The SDI priorities with respect to common data, services and applications include (i) discovery of spatial data, services and applications, (ii) inventory and selection of geospatial data and services, (iii) enforcement of standards, (iv) identify priorities for new common data, services and applications, (v) More “Pro-Active Engagements” with the Research community much earlier in the project timeline, (vi) researchers to complete a “Data Management Plan”, (vii) explore incentives to increase Researcher interest in Data Management and make more metadata public. The INCAM SDI is based on a modular approach that allows to upgrade its various component. It is designed for setting up discovery, view and download services in a secured environment (rights management and multilingual support) and act as aggregating technologies to offer an interoperable and OGC compliant solution (collaboration with Geoserver, MapServer, Geonetwork, Openlayers,...) and can be installed in technical environment already in place, without change (if OGC compliant).

- **Geoserver**

Geoserver is an open source cartographic server able to store and manage geo-referred data and to make them available through the Web (figure 16). It thus makes it possible to manage a large panel of formats raster and vector. It is able to interact with various databases (Oracle Space,

ArcSDE, PostGIS, etc), it implements standards OGC, protocols (WFS-T, WMS, etc). GeoServer is thus the implementation of reference of Open Geospatial Consortium (OGC) for the standards Web Feature Service (WFS) and Web Coverage Service (WCS), as well as a certified performance conforms to Web Map Service (WMS). GeoServer forms one of the essential components of the Spatial Web.

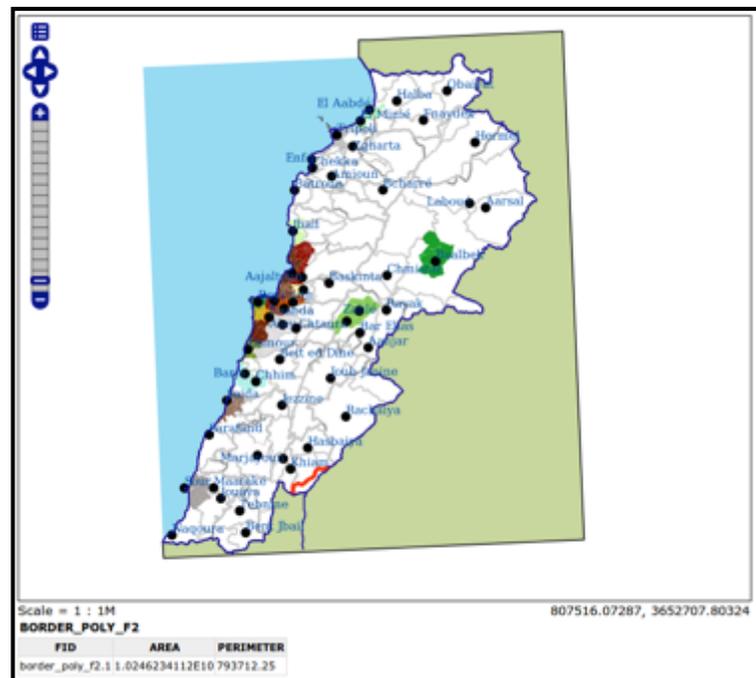
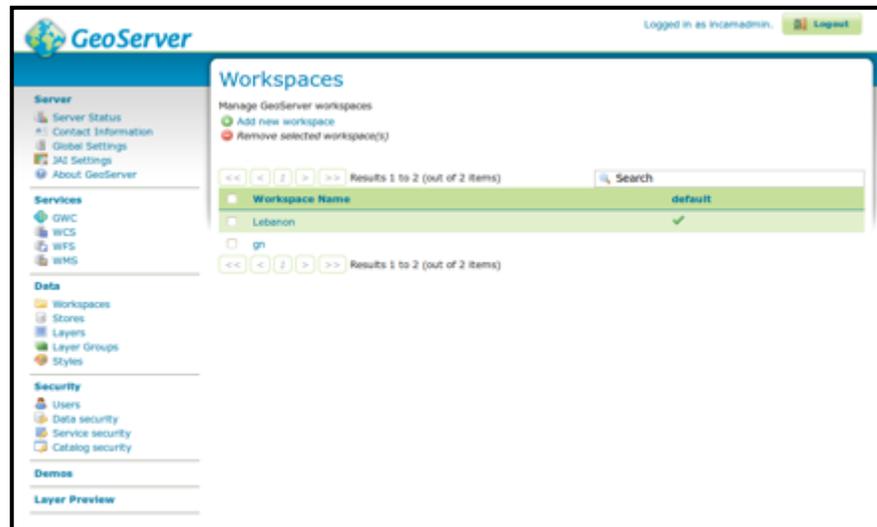


Figure 16 Geoserver for storing and managing geo-referred data and make them available through the Web.

- **Geonetwork**

GeoNetwork is an information management framework for decentralized spatial data conceived to ease the access to geospatial databases, cartographic products and related metadata of varied sources, improving the exchange of spatial information. The main aim of GeoNetwork is to improve accessibility with a large variety of data and related information, on different scale and multidisciplinary sources, organized and documented in accordance with the standard.

- **GeoCat Bridge**

GeoCat Bridge is a paying module under ArcGis. It makes it possible to publish OGC data from ArcGis Desktop towards Geoserver and Geonetwork. The interest of this module is in its capacity to publish the whole of the layers present in a ArcMap project as well as the symbology applied and the associated metadata.

- **OpenLayer**

OpenLayer is free software, released under the BSD license. It is a library of JavaScript functions providing core functionality-oriented development of fluids client applications Web mapping. OpenLayers can display map as well as markers from a wide variety of data sources such as GeoServer in our case. Part of this library allows to manage the proposed user ergonomics, but this is not the main goal.

- **GeoExt**

Born from the fusion of OpenLayers and Ext, GeoExt is a javascript library to easily create rich mapping interfaces. It offers the ultimate completely new custom objects (figure 17).

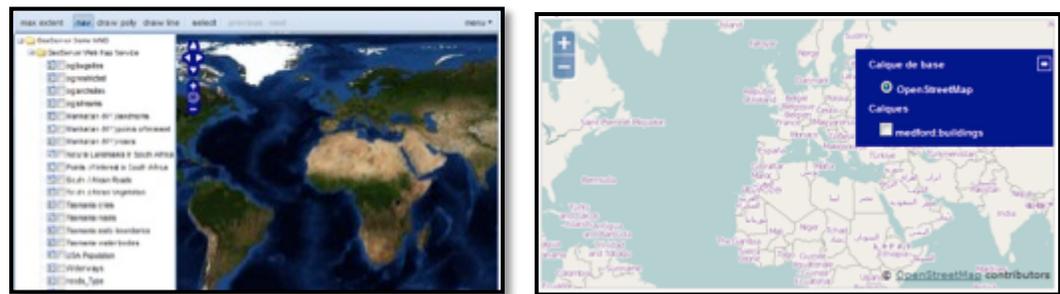


Figure 17 GeoExt for mapping interfaces

Although value of geospatial data is recognised but its effective use is inhibited by lack of knowledge of its existence, poorly documented information datasets. Knowing the dynamic nature of data in a networked environment, metadata is therefore an essential requirement for locating and evaluating available data. The INCAM SDI offers a catalog based on geonetwork to ease data mining on three levels of metadata (figures 18, 19, 20)

- ✓ Discovery metadata: What data sets hold the sort of researchers are interested in?
- ✓ Exploration metadata: Is the data sets sufficient for the analysis
- ✓ Exploitation metadata: How can researchers can access the data.

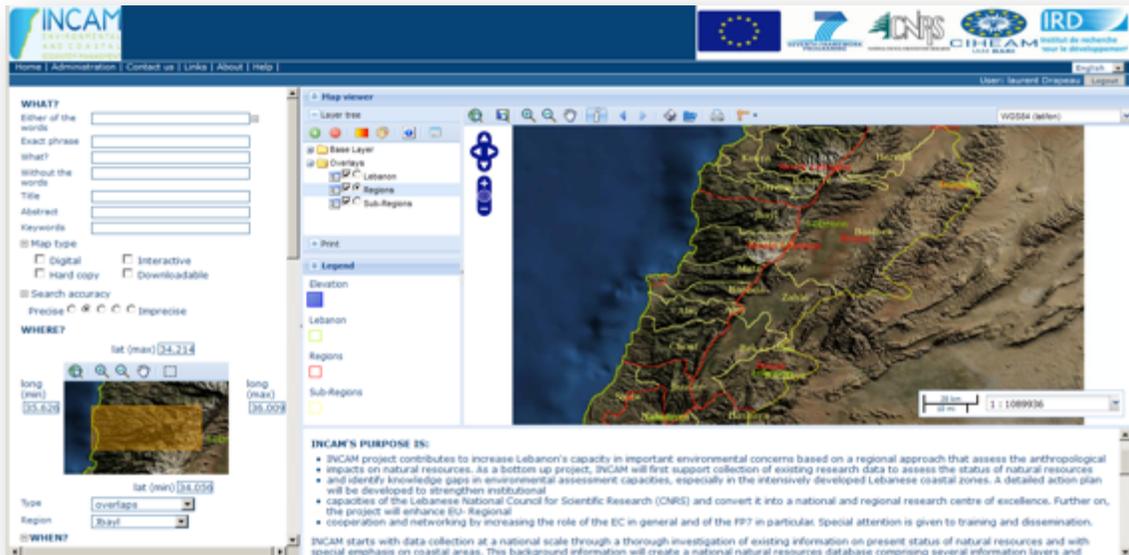


Figure 18 : Incam Geoportal access (<http://incam.cnrs.edu.lb/geonetwork>)

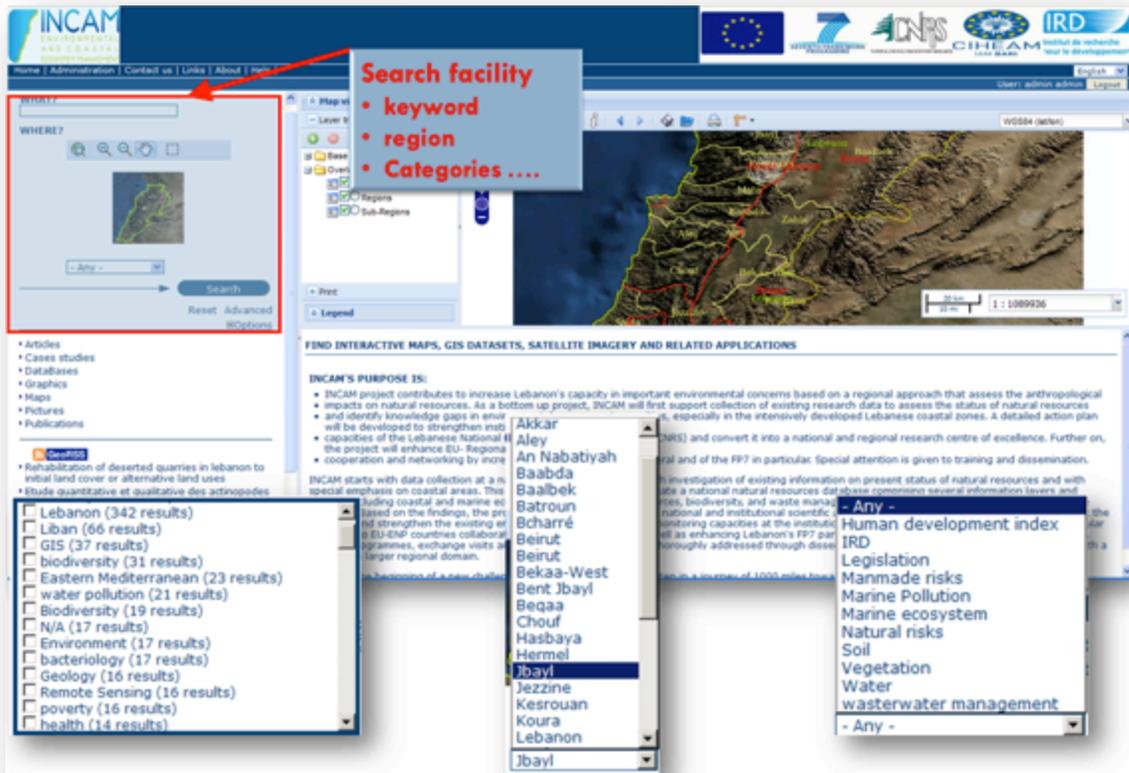


Figure 19 : Multi criteria research (key words, area of interest, categories)

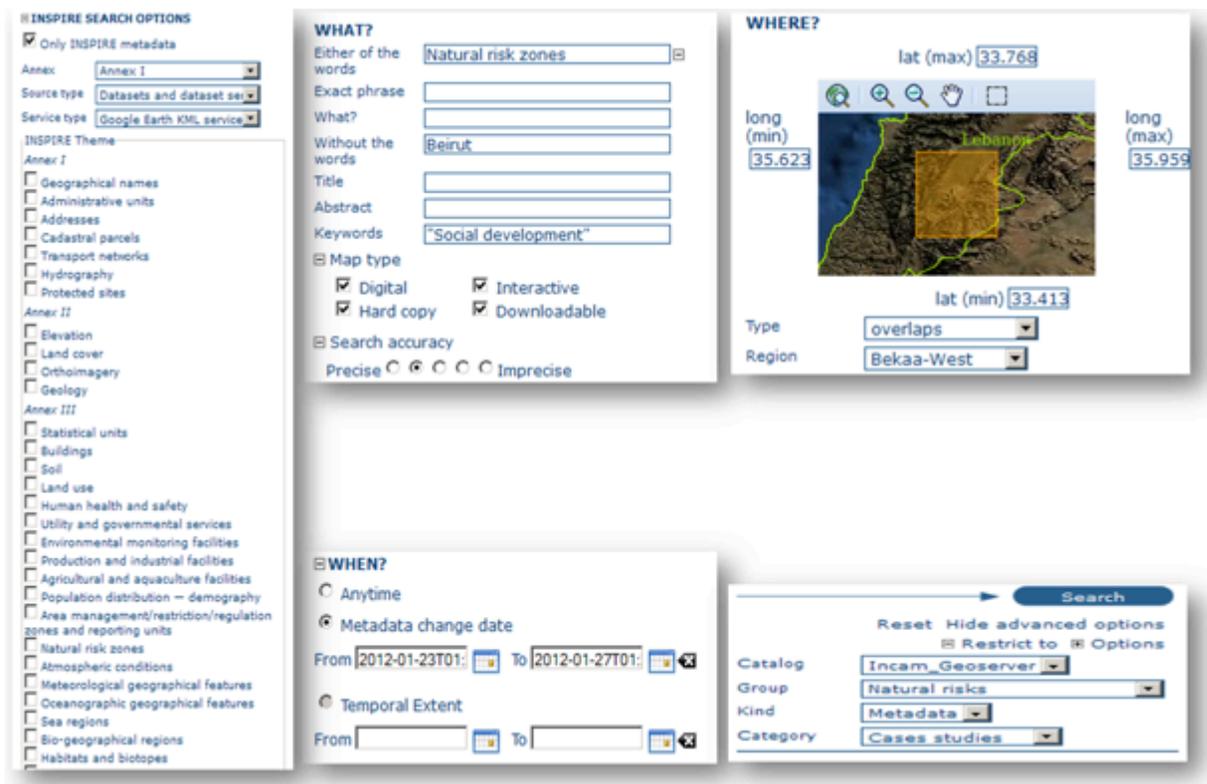


Figure 20 : Multi criteria research (spatial, temporal, autors, INSPIRE)

The platform offers interactive web mapping facilities. The Web Mapping Services (WMS,WFS,WCS) enables interactive overlay of distributed geographic information simultaneously. It offers as well the sharing of geoprocessing services (coordinate transformation). An end users can therefore makes requests to the catalogue of services to discover URLs containing desired information (figures 21 &22). Service Registries return URLs and also information about methods by which the discovered information at each URL can be accessed. The client locates one or more servers containing the desired information, and integrates them. As directed by the Client, each Map Server accesses the information requested from it, and renders it suitable for displaying as one or more layers in a map composed of many layers.

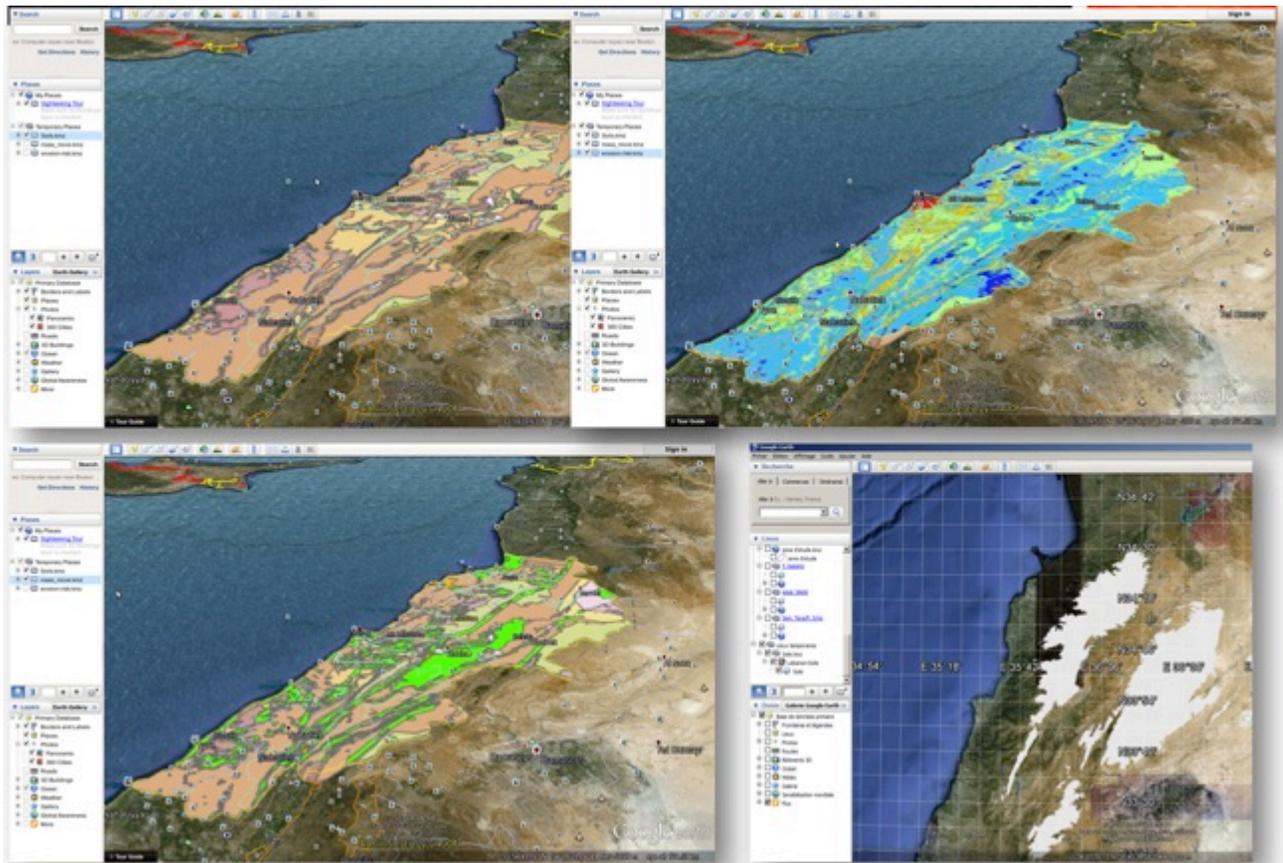


Figure 21 : Simple web mapping facilities enabling interactive display of geographical information with OpenLayers and Google Earth



Figure 22 : Complex interactive web tools (Mapshup CNES France) enabling 2D-3D display

- * The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results (not exceeding 10 pages).

The Lebanese coastal areas are under intense environmental changes with extensive feedback loops and co-evolution processes between natural environmental systems and anthropological driven ones. Natural resources and natural habitats in the region are under high pressure due to high demands from an increasing population. Natural habitats conservation is therefore a key element especially when looking at the proper balancing of environmental protection and socio-economic development objectives. INCAM main topic being to address the sustainable development of the coastal zones, in order to achieve this priority, long-term economic, environmental and social considerations have to be analysed for designing decisions, and exhaustive environmental information has to be collected and translated into convenient units of information to be useful in the decision-making processes. Basic data needs have been assessed at national level based on the experience of the respective technical partner community. An inventory of required and already available basic data have been produced by the INCAM project and include low, medium to high, very high resolution imagery, data from meteorological stations, ancillary data of different nature and field data (agricultural and socio-economic, crop/biomass production data, etc). This task has been backed up with regional workshops and meetings.

Indeed, it is one evolving system that required to be studied and managed. Understanding interactions between coastal zone and the environmental changes cannot be achieved by observational studies alone. Monitoring key environmental and socio-economic processes is crucial and requires enhancing capacity buildings for coastal management institutions and practices. As mentioned (Olsen 2002) integrated coastal environmental management is facing three requirements, it must be sustainable over long periods, must be adaptable to conditions that change rapidly and must provide mechanisms that encourage or require particular forms of resource use and collaborative behaviour among institutions and user groups.

The most important human-induced indirect factors to ecosystem changes include human population dynamics, socio-economic activities and use of technology. Most important is that demand for ecosystem products and services grow with population. The critical direct factors that change the Lebanese coastal ecosystem include pressure that directly cause habitat change, climate change (frequent, longer and severe droughts), invasive species, resource overexploitation (deforestation, wildlife decimation), and pollution (use of fertilizers, industrial, domestic and municipal effluents). Land degradation is caused mainly by man's excessive demand of ecosystem goods and services mainly due to high and dynamic populations and their demand for socio-economic growth.

The main variables that describe environmental and coastal habitats degradation are changes in productivity and standing biomass; changes in use/cover and of biodiversity; and changes in intensity and spatial (area) extent of the biomass and use. Monitoring such variables is of main importance to measure degradation statuses of landscapes. The project collected such variables/factors : Human Population (Population densities, Population structure, Population changes and trends), Human Development Index (HDI) (Income and poverty status and trends, Educational indices status and trends, Health status and trends indices), Land use/ economic (Land use type units, Land use systems changes, Use extent changes, Technology & productivity), Energy consumption (Energy sources, Biofuel use trends, Extraction pressure indices on units)

One of the important socio-economic outcomes for Coastal ecosystem Management is greater equity and social welfare. Integrated Coastal Management induced changes in behaviour can increase the standard of living of coastal residents by improving food security and improving opportunities to generate income through traditional and alternative employment. Properly managed, alternative income generating activities that improve economic welfare can be related to improvements in the condition of the environment.

Improvements in some societal qualities :

Increases in indices of quality of life, such as the Human Development Index.

Reduced poverty, greater life expectancy, better employment opportunities.

Greater equity in access to coastal resources and the distribution of benefits from their use.

Greater order, transparency and accountability in how planning and decision making processes occur.

Greater security, including food security.

Aiming to make most deliverables of the project (except financial reports) accessible by the public, the project used different tools to disseminate activities in particular:

- (i) Portal website for knowledge sharing and management to disseminate any activity foreseen and prepared by the project available on www.incam-cnrs.eu where any visitor can access reports, presentations and any document uploaded on the website.
- (ii) First regional workshop to disseminate the project's main outputs and lessons learned from critical environmental sites in Lebanon to local and regional partners deepening on environmental institutional capacity building aspects toward increasing the leading scientific role of CNRS as well as its centres and establishing networking between Lebanon, the region and the EU. The last session of the workshop was dedicated to sharing experiences and exchange of information between participants and previous

identified volunteers presented their projects (EU or others) focusing on the outputs and suggestions for future collaboration with INCAM, the National Council for Scientific Research in Lebanon and its centers

- (iii) Two critical sites visits were undertaken with regional experts at Selaata chemical plant and different quarries in the country towards promoting and enhancing the sharing of experience and know-how.
- (iv) FP7 training workshop to support EU and national policies, disseminate FP7 outcomes and increase FP7 participation capacities for Lebanese researchers
- (v) Trainings and participation in European conferences to share/exchange of experience and know-how and disseminate information using the main outcomes of INCAM Project, with a particular focus on the book published within the project.
- (vi) Two leaflets: one in the beginning containing the context and main objectives of the disseminated during the main activities of the project, of the CNRS as well as during EU and international conferences; the second one at the end of the project designed in collaboration with the International Innovation research journal together with a 3-page article with images and graphics dedicated to INCAM project and published within International Innovation report that focus on research, education, sharing of resources and information and access to data and infrastructure within many sub-topics of ocean and marine management, policy, monitoring research. This leaflet is addressed (through email and hard copies) to local stakeholders (all universities in Lebanon, all researchers included in the database of the CNRS and all ministries related to natural resource management, NGOs), regional stakeholders) and more than 3000 stakeholder readers carefully selected and highly targeted audience of key researchers, policy makers, government and decision makers across both the private & public sectors across all member states in the European Union and INCO countries
- (vii) INCAM poster including the main objectives and outcomes of the project and exposed during different events out of which we cite the CNRS Golden Jubilee Ceremony organized at the Grand Serail Under the Patronage of H.E. the President of the Council of Ministers Mr. Nagib Mikati on June 2012
- (viii) Final regional workshop to share INCAM success story and disseminate its lessons learned with regional partners & establish a network between marine research centers in the Mediterranean region to endorse Integrated Coastal Zone Management principles and environmental objectives
- (ix) Dissemination of final regional workshop through the CNRS newsletter to be published on August-September 2013 that will be distributed to more than 1000 local stakeholders (researchers at the universities in Lebanon, ministries, NGOs, etc.). All information

related to this event are also added on CNRS and INCAM websites for all INCAM and CNRS websites visitors.

- (x) Sharing of INCAM news on CNRS website: Information about the project and activities on CNRS website available on www.cnrs.edu.lb (figure 23) and in the newsletter of the CNRS (figure 24&25).



Figure 23 Information about INCAM on CNRS website (www.cnrs.edu.lb)

