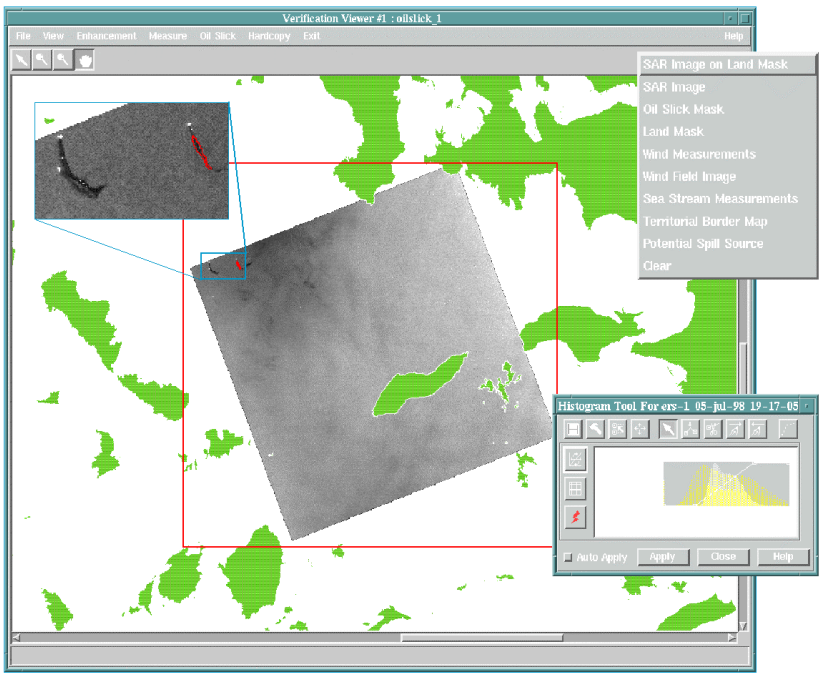
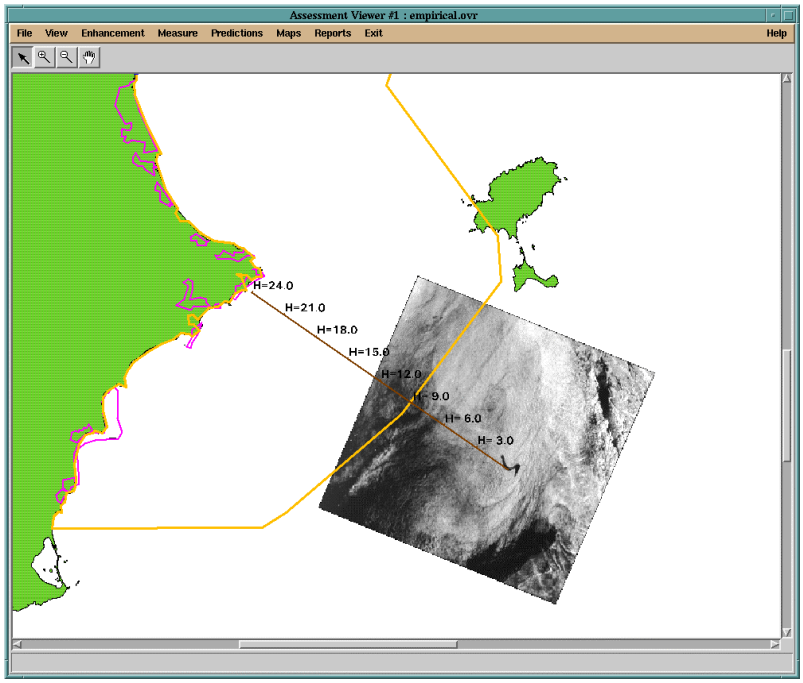
ENVISYS

Environmental Monitoring, Warning and Emergency Management System

Final Report





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Sammendrag/Abstract:

ENVISYS was a CEC R&D project within the Telematics Application Programme's sector for environment, developed by a team of Greek, Norwegian and Spanish institutes and companies. The project started in 1996 and was finished in 1999.

ENVISYS is a complete, integrated management system concept for environmental emergencies in general (marine oil spills, forest fires, floods, earthquakes, volcanic eruptions etc.). A prototype for the case of sea monitoring, including fully automatic detection of oil spills using radar satellite images, has been developed and demonstrated. The use of earth observation (satellite remote sensing) data is a central part of the concept. The main capabilities of the system are:

- Automatic transfer of remote sensing images and monitoring.
- Alarm when a possible oil slick is detected.
- Routines for manual verification by the operator.
- Simulation of the behaviour of the oil slick.
- Assistance in the counter-action management (clean-up operations).

The report gives a presentation of the ENVISYS project. The ENVISYS system is described and the results of the evaluation and future plans are commented.

Emneord/Keywords: remote sensing, marine oil pollution, oil spill, radar satellite images, environmental emergencies, automatic detection

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Preface

The editors of this report are grateful to all the people that have contributed to the report and the success of the ENVISYS project by taking part in the management, user-needs investigation, system design, implementation, verification, and demonstration of the ENVISYS system. In particular we wish to thank our project partner organisations:

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Rune Solberg Espen Volden Hans Koren

FINAL REPORT

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Part I Executive Summary

ENVISYS

Environmental Monitoring, Warning and Emergency Management System

ENVISYS WILL PROTECT THE MEDITERRANEAN SEA

ENVISYS is a complete, integrated management system for environmental emergencies in general (marine oil spills, forest fires, floods, earthquakes, volcanic eruptions etc.). A prototype for the case of sea monitoring, including fully automatic detection of oil spills using radar satellite images, has been developed and demonstrated.

Setting the Scene

Environmental emergencies yearly cause loss of lives and important damage to the environment throughout the world. In Europe forest fires, floods and marine oil spills have been particularly devastating in the last years. Such emergency situations are characterised by a sudden appearance, geographical extension and the potential of rapid evolution. Remote sensing based monitoring constitutes an interesting approach to meet the challenges posed by these characteristics. Satellite images have begun to be used as a supplement to other information in some cases; e.g., visual inspection of radar satellite images allows detecting oil spill from ships and oil rigs. However, there has been no complete emergency management system featuring satellite-image based detection of oil spills. Furthermore, no system has provided fully automatic detection, which is important because a continuous monitoring requires huge data amounts, and manual inspection, therefore, becomes too costly. The challenge of ENVISYS has been to provide an answer to this, by developing a prototype system to be demonstrated in the Mediterranean Sea, which is both particularly sensitive to oil pollution and highly exposed to such risks.

Approach

ENVISYS' approach is to have a monitoring centre supported by powerful remote sensing, telematics and information technology. The centre retrieves data and extracts relevant information, which is distributed to the users, who are regional, national and international authorities responsible for enforcing national and international law for marine environment. Secondary users are organisa-

tions and industry taking part in verification, assessment, and cleanup activities. ENVISYS is focused on providing assistance directly to the involved environmental authorities, enterprises and institutions related to environment protection.

Results and Achievements

A prototype system has been developed for the case of marine pollution caused by oil spills. The main capabilities of the system are:

- Automatic downloading of remote sensing images and oil spill detection
- Alarm when there is an oil slick
- Routines and tools for manual investigation by the operator
- GIS integration of images and maps of areas sensitive to oil pollution
- Simulation of the behaviour of the oil slick
- Assistance in the resource management (using a database) during the cleanup operations

The system has four modes of operations, which also demonstrates the general concept: detection, verification, assessment and operations. The core system is comprised of the four corresponding main modules Detection, Verification, Assessment and Operations - whereas numerous support modules make the system more effective and user friendly. ENVISYS has been developed and implemented as a prototype system for environmental emergency management of marine oil spill. The overall design of the system is as generic as possible in order to be able to cover other emergency types at a later stage of system development.

Conclusions and Plans for the Future

The verification and evaluation work packages have shown the good technical performance of the ENVISYS prototype system and the positive evaluation by the users. There are, therefore, great expectations for the commercialisation of ENVISYS, in which three partners will be involved: IN&DI, INTELLSERVE and EPSILON. NR will support this commercialisation, especially in the adaptation to user-specific needs and providing technical support. It is also desirable to join a major IT distributor in order to establish a co-operating framework with synergies in product portfolio on one hand and access to a worldwide network on the other hand. A search for such a partner is now taking place. It is planned to develop the prototype into a sales product before the end of the year 2000.

Contact Details

Project Name:

ENVISYS - Environmental Monitoring, Warning and Emergency Management System

Research Area:

TAP - Environment

Timescale:

01.02.96 - 31.05.99

Budget:

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European Commission contribution: EUR 800,000

Keywords:

Environmental emergency management; Remote sensing; Marine oil spill; Automatic detection; Radar satellite images (SAR); Automatic data retrieval; GIS; Simulation; Assessment of situation; Support to cleanup operations.

Key Project Participants:

NR	(NO)
IMPAE	(GR)
EPSILON	(GR)
SPACETEC	(NO)
INTELLSERVE	(GR)
ANETKY	(GR)
INDI	(ES)
ISDEFE	(ES)
STQ-URV	(ES)
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Part II Final Report

1. Setting the scene

1.1. Emergency management and remote sensing

Environmental emergencies yearly cause loss of lives and important damage to the environment throughout the world. In Europe forest fires, floods and marine oil spills have been particularly devastating in the last years. The common characteristics of such environmental emergency situations are the following:

Potentially serious to people and environment
It is therefore imperative to take action in order to manage the situation in a way that avoids or minimises the damages. However, up to now no efficient tools for this purpose have been available.

Sudden appearance and geographically extended
This has until recently made it difficult to efficiently detect and monitor such phenomena. The advent of high spatial resolution satellite remote sensing has made this possible

Potential of rapid development
Therefore, it is necessary also to monitor the phenomenon frequently. The same remote sensing technology makes this possible. However, to make the remote sensing data useful, fast data transfer is needed as well as automatic or semi-automatic processing because of the huge data amounts.

In order to reduce the impact of such disasters, and to prevent those that are man-made from happening at all, efficient management systems are required. From the brief characterisation above, one can draw the conclusion that remote sensing is a promising approach, because of the possibility of continuos monitoring of large and remote areas. However, additional technology is strictly required in order to be able to use the approach. What is needed are efficient information technology solutions.

1.2. Marine oil pollution - An important environmental problem

Marine Pollution from hydrocarbons is an environmental issue with magnitude, extend and implications not very well known due to the difficulties in detecting such phenomena, the effects on the environment itself in the cleaning process and the scarcity of validated data on their impact. However, it is a problem with considerable political, economical and environmental repercussions. The main sources of marine oil pollution are (intentional and accidental) releases from ships, natural slicks and pollution from land. The first source is the most important.

Inevitably not all of the estimated 100,000,000 tonnes of oil loaded into tankers each day worldwide ends up being delivered to the consumer at the other end. Some is lost in large, dramatic, accidental spills, but even more important are non-accidental releases. For example, of the 200,000 tonnes that a tanker might carry, 700 tonnes will

remain stuck to the sides of the storage tanks after delivery of the oil. This oil must be disposed of before the next load can be taken on board and one of the easiest and cheapest ways of doing this is simply to dump it at sea on the return journey.

The ENVISYS project has demonstrated its prototype in the Mediterranean Sea. This is an area of important tanker traffic and it is estimated that 600,000 tonnes of oil (three times the Amoco-Cadiz pollution) end up in this sea each year as a result of rinsing of tankers and "natural" losses. The gravity of this pollution problem is magnified by the fact that the Mediterranean Sea is a semi-closed basin, which means that its water is exchanged very slowly. This pollution, therefore, constitutes a considerable threat to the marine and coastal environment as well as to two of the most important economical activities of the region: tourism and fishing.

1.3. The ENVISYS project

The above outlined needs for efficient emergency management systems to cope with emergency situations in general and with marine oil spills in particular, motivated the European Commission's decision to co-finance the ENVISYS project from 1st February 1996. The project had the following partners from Norway, Spain and Greece:

The Norwegian Computing Center (NR) is an independent research foundation working in the fields of information technology, scientific computing and applied statistics. NR co-ordinated the project and contributed with knowledge of user needs in the area of oil spill detection, overall system design, image analysis algorithms for automatic emergency detection, and dissemination of results.

Kongsberg Spacetec (SPACETEC) is a company that provides Earth Observation ground systems and related technology and software. SPACETEC was an associated partner of ENVISYS from November 1996 and was responsible for the development of the Verification Module.

The Institute of Meteorology and Physics of the Atmospheric Environment (IMPAE) at the National Observatory of Athens (NOA) deals with meteorology, climatology, physics of the atmospheric environment, and solar and wind energy. Within the ENVISYS project IMPAE was responsible for the collection, processing and adaptation of wind data and sea current data for the Greek demonstration area.

Epsilon International SA (EPSILON is a science & research consulting company providing services within various sectors including environmental management, coastal zone management, mapping, GIS and remote sensing. EPSILON provided digital maps for the Greek demonstration site.

INTELLSERVE SA is a high-tech company specialised in the area of informatics with emphasis in telematics applications. In ENVISYS INTELLSERVE contributed to the network design and was responsible for the development of the Background Command Sequencer and the External Communications Module. They were also in charge of the Greek demonstration.

Regional Agency of Cyclades S.A. (ANETKY) is a subsidiary company of the Prefecture of Cyclades and of main municipalities of the region. ANETKY provided map information and was responsible for the local co-ordination during the Greek demonstration.

ISDEFE is an independent Spanish systems engineering firm, whose capital is state-owned. It performs scientific, technical, and management activities for the public benefit under contract of official and private agencies. ISDEFE was involved in many parts of the project, and in particular in the elaboration of user requirements and in the evaluation of the project.

SASEMAR is an agency that supports the Spanish maritime administration in complying with the obligation to safeguard human life at sea and promote any actions aimed at increasing safety at sea. SASEMAR was a user and a sponsoring partner in the project.

IN&DI is a sea fishing research centre. It is a private organisation specialising in the development and use of information to study the sea. IN&DI was responsible for the development of the Toolkit and the Operations Module as well as for the Spanish demonstration. The European Workshop on Detection of Environmental Emergency Situations with Main Focus on Marine Oil Spill was hosted by IN&DI.

The Chemical Technology Service (STQ) of the University Rovira i Virgili (URV) was founded in 1995 to fulfil the need for Chemical Engineering education and research in the immediate geographical area of Tarragona - that hosts one of the largest petrochemical and chemical production sites in the south of Europe. STQ-URV provided a physical simulator for oil spill evolution, which was integrated in ENVISYS.

2. Approach

2.1. The objectives

The main objectives of the ENVISYS Project were the following:

- To integrate into a fully operational system existing remote sensing, communication and software intensive technologies, as well as existing public infrastructure, for the sea monitoring, detection of oil spills due to human activities, issue warning to responsible public authorities, and provide decision support to the said authorities during clean up operations. As a measurable result, the project aims to detect a very high percentage of slicks created during demonstration time, constrained only by satellite coverage of the area in question (in terms of time). Achievement of these results with current satellite coverage, implies the systems viability as a very powerful tool for public agencies responsible for such disasters, on a day by day basis, as 24 hours coverage from satellites is anticipated in the imminent future.
- To investigate the cost effectiveness of similar techniques in other disaster areas, most notably forest fires and floods.
- To demonstrate the applicability of concepts and technology to the potential user organisations as well the cost effectiveness of chosen solutions. This shall be carried out at three distinct operation sites.

2.2. The ENVISYS concept

ENVISYS demonstrates the capability of a remote sensing and telematics based system to handle environmental emergency situations in a much more efficient way than has been possible with traditional techniques. The ENVISYS project has established a platform for a system for environmental management in general.

ENVISYS' approach is to have a monitoring centre supported by powerful information technology. The centre retrieves data and extracts relevant information, which is distributed to the users.

The users of the ENVISYS technology will be regional, national and international authorities responsible for enforcing national and international law for marine environment. Secondary users are organisations and industry taking part in verification, assessment, and cleanup activities.

The ENVISYS project is focused on providing assistance directly to the involved environmental authorities, enterprises and institutions related to environment protection.

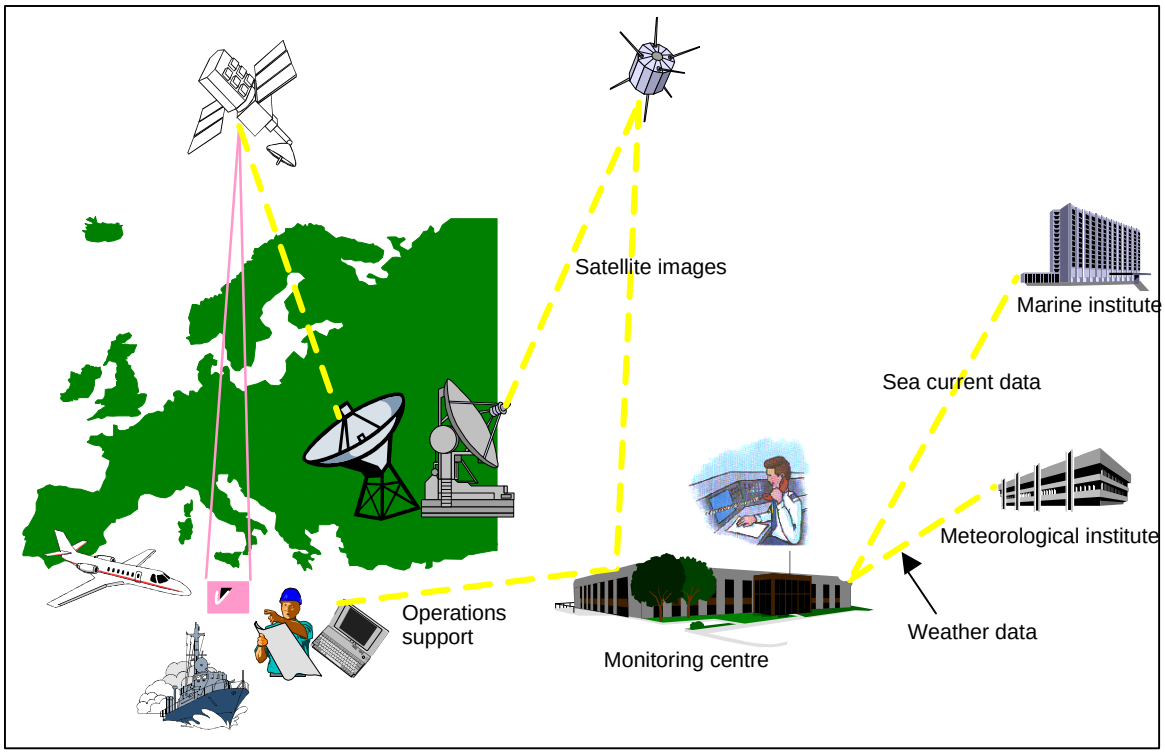

Figure 1 - The ENVISYS approach

2.3. Demonstration

The purpose of the demonstration was to test the functionality and usefulness of ENVISYS by running it in a real world environment in two different sites in parallel: Greece and Spain. The ENVISYS systems in the two sites were identical apart from local geographical maps, local meteorological and sea current data, and the format of the user reports, which had been adapted to the specific needs of the local users.

For both sites radar images from the European ERS-2 satellite were received one or two weeks after acquisition. In parallel, low-radiometric-resolution products were generated at the satellite station and sent directly by FTP to ESA-ESRIN. They were available for ENVISYS approximately three hours after acquisition. Unfortunately, these images are not suited for automatic detection, but were used for real-time tests of the other parts of ENVISYS.

From the year 2001, radar images that are suitable for ENVISYS will be available from the European ENVISAT satellite in near real time. By combining these with images from the Canadian Radarsat the entire Mediterranean will be covered almost daily.

The Spanish demonstration covered an area of approximately 50,000 km^2 delimited by Barcelona, the Ebro Delta, Valencia and the Balearic Islands. In this region there are many environmentally sensitive coastal areas and both tourism and fishing are at

the same time important for the economy and very sensitive to oil pollution. Three major ports, in addition to an oil refinery and other potential contaminant factories, imply a high risk of oil pollution.

The ENVISYS control centre was situated in the office of INDI (ENVISYS partner). Cartographic data were provided by the National Cartographic Institute of Spain, and wind and sea current data by the Public Company of State Ports. Other involved institutions were SASEMAR, which is part of the Directorate General of Marine Merchant (Ministry of public works) and is responsible for cleanup operations in all Spanish territorial waters, and different regional and provincial administrations, authorities and emergency centres.

The test site in Greece was the Cycladic Region of the South Aegean Sea. This region includes numerous islands with beautiful beaches, small fishing villages and preserved and protected areas. The tanker traffic is very important to and from ports of the region as well as passing by, like the famous traffic route of the tankers coming out from Bosporous with destination either a port in a Mediterranean country, Suez or Gibraltar.

INTELLSERVE (co-ordinating ENVISYS contractor for Greece) provided both the ENVISYS control centre and its operators. Sea current data to the demonstrator were provided by the Institute of Physics in Athens (IMPAE) with the collaboration of the National Marine Institute (EKTHE). Wind data were provided by the National Observatory of Athens (NOA), and maps of the Greek islands by EPSILON SA (ENVISYS partner). Furthermore, ANETKY (ENVISYS partner) co-ordinated the follow-up activities of the demonstration. The Prefecture of Cyclades, the Coast Guard and other regional and national authorities and emergency centres were also involved.

Out of 109 processed satellite images, two were found to contain very probable oil spills. Since these images were received more than a week after acquisition, an on-site verification was not possible. However, five different experts in visual interpretation of SAR images all agree that these images undoubtedly show oil spills. In two occasions, one in each demonstration site, an alarm report was sent to the users in the morning after the detection of medium probable oil spills in satellite images acquired during the night. In Greece a ship from the Coast Guard went out to the reported area, but observed no oil spill. In Spain, the pilot of a helicopter from SASEMAR recognised an area of the reported shape and location. He judged it not be oil, but water of a darker colour than the surroundings. The visible darker colour and the dampened waves (dark in the SAR image) of this area may be explained by some organic material, e.g. algae or pollution caused by some viscous chemical substance.

2.4. Evaluation

The rational behind ENVISYS' system design, development and demonstration was not primarily to prove the technical realisation of the proposed applications, but to demonstrate that these applications are accepted by the respective user groups and thus are feasible, viable and marketable. The criteria that were developed for the

quantification of the ENVISYS objectives, fall into the following assessment categories:

- technical assessment defining the adequate physical functioning of the system and its usability
- user acceptance assessment
- impact assessment
- socio-economic assessment
- market assessment

These criteria were grouped according to nine indicators (e.g., ecological impact, willingness to pay and net present value). There was a questionnaire to be filled out by the users after the demonstration and a procedure to evaluate the results. The most representative users were interviewed to complete the evaluations. On the other hand, there was a logbook where comments and incidents were recorded for every processed image in both demonstration sites.

We defined a European Added Value (EAV) as the global addition for each demonstration site of the present value of the theoretical incomes generated during a period of 5 years by the ENVISYS system.

With the set of user questionnaires, interviews and logbooks for every processed image, the global evolution indicators described above were obtained. The value obtained for the European Added Value (EAV) based on the results of the demonstration was very close to the total costs of the ENVISYS project, and twice the contribution from the Commission of the European Union. The value obtained for the demonstration could have been doubled if an administrative problem had been resolved in order to obtain satellite images directly from the provider.

The results of the evaluation show that most of the systems characteristics are positively considered by the users (location and time accuracy, early warning and near real time detection, large geographic coverage, telecommunications support, user friendliness, system expandability, cartographic support, etc.). On the other hand, most users are very reserved in terms of coverage frequency, culprit identification and some aspects of event evolution (only partially presented to them). The satellite coverage presented to the users was the one obtained during the demonstration where only ERS-2 images were used. Of course, the combined use of RADARSAT and ENVISAT will increase the coverage frequency dramatically. It should also be noted that most users are not familiar with remote sensing techniques and applications and do not have any comparative basis.

Unfortunately, the users did not have enough information about financial aspects in order to compare ENVISYS costs to other detection and surveillance methods and express a clear opinion on all aspects of the cost effectiveness of the system. However, the estimation of acceptable investment cost for ENVISYS (at least for the approximate price considered in the Business Plan) has to be taken into account for the future ENVISYS commercialisation policy. Also it has to be noted that users are reserved concerning satellite images costs. However, such costs are expected to decrease significantly in the near future.

3. Results and achievements

3.1. Results versus objectives

The first of the main objectives recalled in Ch. 2.1 describes the system that should be developed for the detection and management of marine oil spill emergencies. The completed prototype system fulfils this objective totally. Of course, the few oil slicks reported by other sources and the few slicks present in the SAR images during the demonstration are not sufficient to claim that ENVISYS detects a very high percentage of slicks. However, NR has worked with archived SAR images from Northern Europe and obtained a very high percentage of slick detection on a statistically significant number of images, and nothing seems to indicate that this will not be the case in the Mediterranean.

Deliverable 6.3, Report on Other Emergencies and parts of deliverable D1, User Requirements, investigate the use of remote sensing to the detection and management of floods and forest fires, and in particular how the ENVISYS system may be adapted to those types of emergency situations. The second of the three main objectives (recalled in Ch. 2.1) is, therefore, fulfilled.

Finally, the last main objective was fulfilled during the demonstration apart from the fact that the demonstration took place in two different sites instead of three.

3.2. The ENVISYS system

ENVISYS is a complete system for detection, verification, monitoring and assessment of an environmental emergency situation in addition to support of a possible counteraction operation. The use of earth observation (satellite remote sensing) data is a central part of the concept. It may to some degree be similar to a defence command, control and communication system. The system provides a graphical user interface supported by image analysis, as well as by Geographical Information System (GIS) and database (DBMS) tools.

ENVISYS is a software system aiming at the validation of numerous applications/services to support counteractions in case of environmental emergencies. ENVISYS functional design provides an open, stable, flexible, scaleable and expandable basis for developing systems for different environmental emergency situations according to the requirements posed by the concerned users.

A prototype system has been developed for the case of marine pollution caused by oil spills. The main capabilities of the system are:

- Automatic monitoring of the sea with respect to oil spills
- Automatic retrieval of remote sensing data and meteorological data
- Alarm when an oil slick is automatically detected
- Routines and tools for manual verification by the operator

- Simulation of the evolution of the oil slick
- Assistance in resources management (using a database) for the planning of and during the cleanup operations
- GIS interface

This is the only complete emergency system for marine oil spills in the world that allows an automatic monitoring. Furthermore, it is unique in its orientation to the users' needs, providing an integrated set of tools that allows the user to manage the oil spill detection, measurement and cleanup operations.

ENVISYS has been developed and implemented as a prototype system for environmental emergency management of marine oil spill. The overall design of the system is as generic as possible in order to be able to cover other emergency types at a later stage of system development. The system has **four** modes of operations, which also demonstrates the general concept. The four modes, namely **detection, verification, assessment and operations**, are described below.

A simplified system design description is given in Figure 2. As the figure indicates, the four system modes have each got its own module - **Detection** Module, **Verification** Module, **Assessment** Module and **Operations** Module - whereas numerous support modules make the system more effective and user friendly. All the modules are linked to a Geographical Information System (GIS) and a Relational Database Management System (RDBMS), each with a related storage system. The External Communications Module retrieves SAR (Synthetic Aperture Radar) satellite image data and meteorological data from external data sources.

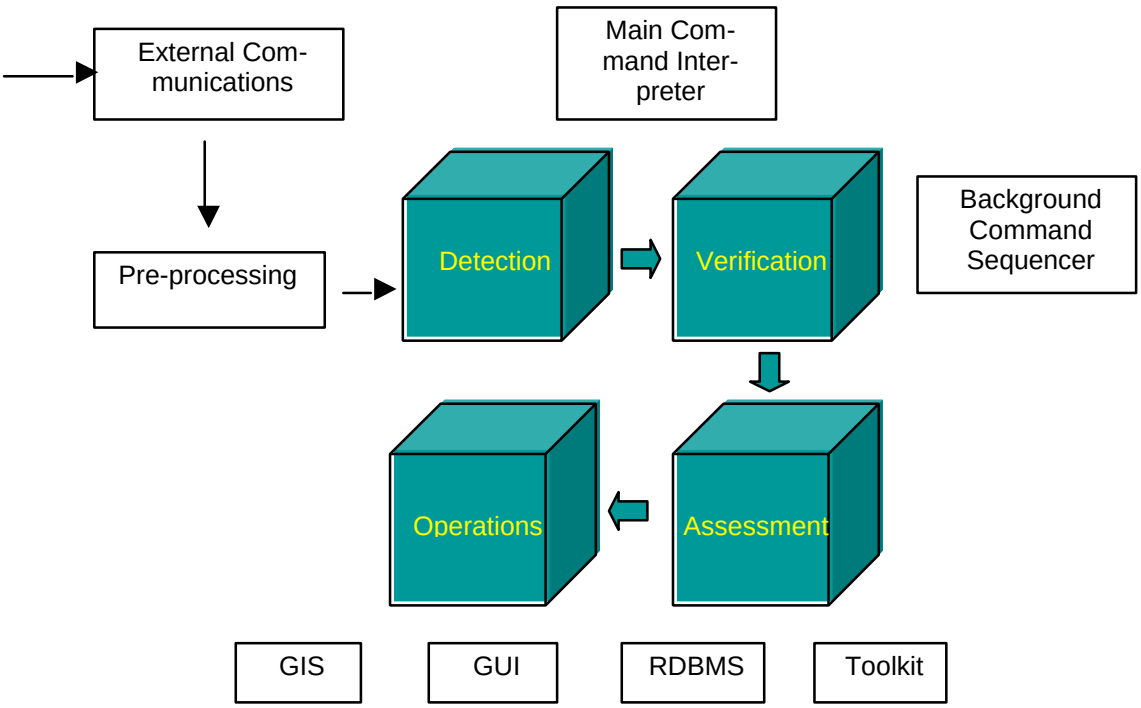

Figure 2 - The ENVISYS conceptual model for the oil-spill case.

The commercial software ERDAS IMAGINE is used for GIS functionality and for the graphical user interface. ERDAS own programming language, EML, has been used for the implementation, in addition to the main programming language for ENVISYS, C++. Perl has been used for some of the communication routines. The database management system is Oracle. The interface to Oracle has been developed by using embedded SQL in the C++-code. The prototype has been developed on UNIX, and an important factor for the commercialisation process will be the porting to Windows NT, which is not expected to be difficult. The present prototype must run on a UNIX workstation. Other hardware required are a fax machine and a modem for connection to the Internet. A part from ERDAS IMAGINE and Oracle, only common, free software is needed (GNU C++-compiler, Perl and the fax software HylaFax).

3.3. How ENVISYS works

When a satellite image is available at the satellite ground station, a message will be received as an e-mail by the system. It will automatically read and interpret the e-mail, and then locate and retrieve the corresponding SAR image by FTP. The image will be converted to an internal image format and pre-processed. The pre-processing includes a radiometric range calibration and a geometrical transformation to the chosen map projection. The image is then transferred to the Detection module for fully **automatic** oil slick detection.

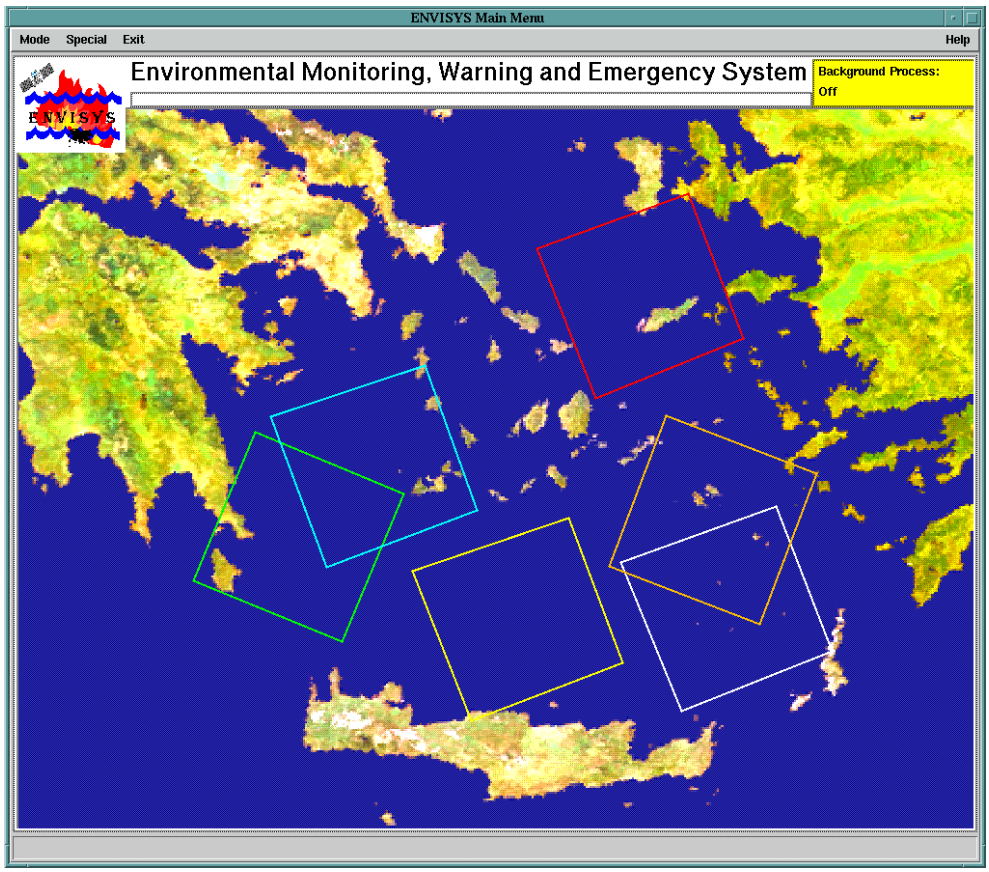

Figure 3 - Main window of the ENVISYS prototype for Greece. Different colours of satellite image frames correspond to different states and results of processing.

Under normal conditions, ENVISYS is running unattended by the operator in Automatic Monitoring Mode. The retrieved SAR image is processed by the automatic oil slick detection algorithm. If an oil slick is detected, an alarm sounds calling the attention of the operator. In the alarm situation, the system will turn to the Verification Mode. This and the following modes require the presence of an operator. The Verification Mode provides tools to help him to investigate the SAR image in order to determine whether this is a false alarm or a real oil slick, based on his experience and possibly other data. Wind information derived from the image is available, and possibly wind field forecasts or measurements provided by a meteorological institute. The operator will also see some map data showing the coastline and territorial borders. With interactive image processing tools he is able to investigate the image data very thoroughly. If the operator can confirm the alarm to represent a fairly probable oil slick, and the slick is of considerable size, he would normally contact surveillance authorities in order to direct an aircraft to the location. The aircraft will report back to the operator whether the case was confirmed.

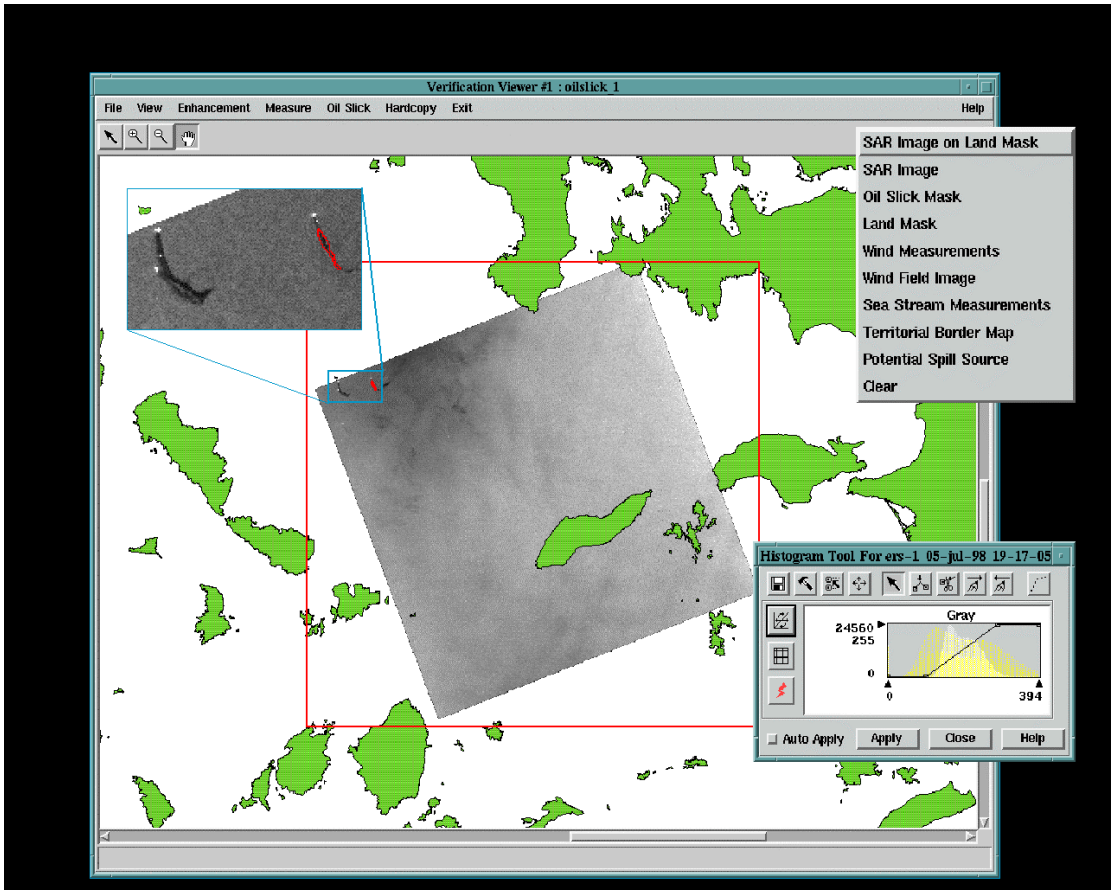

Figure 4 - The Verification mode provides tools for investigating the radar image.

The operator would turn over to the Assessment Mode if the alarm was verified and the slick was judged not to be harmless. The Assessment Mode could also be started before a possible aircraft verification in order to determine if resources should be spent on aircraft verification. This mode allows the operator to place the oil slick in a complete geographic context. Various map overlays are shown on top of the image, e.g. maps showing fishing areas, sea farms, recreational areas and environmental fragile areas. The operator may also add wind information in order to better determine the possible development of the situation. The module includes oil slick development simulators. There are two simulators. One is based on an empirical relationship between the oil slick, wind and sea currents. The other is a comprehensive physical model. The result of the modelling is a map showing the probable oil slick trajectory in the area covered. If the situation is threatening commercial, touristic or environmental resources, the operator may choose to switch to the next mode.

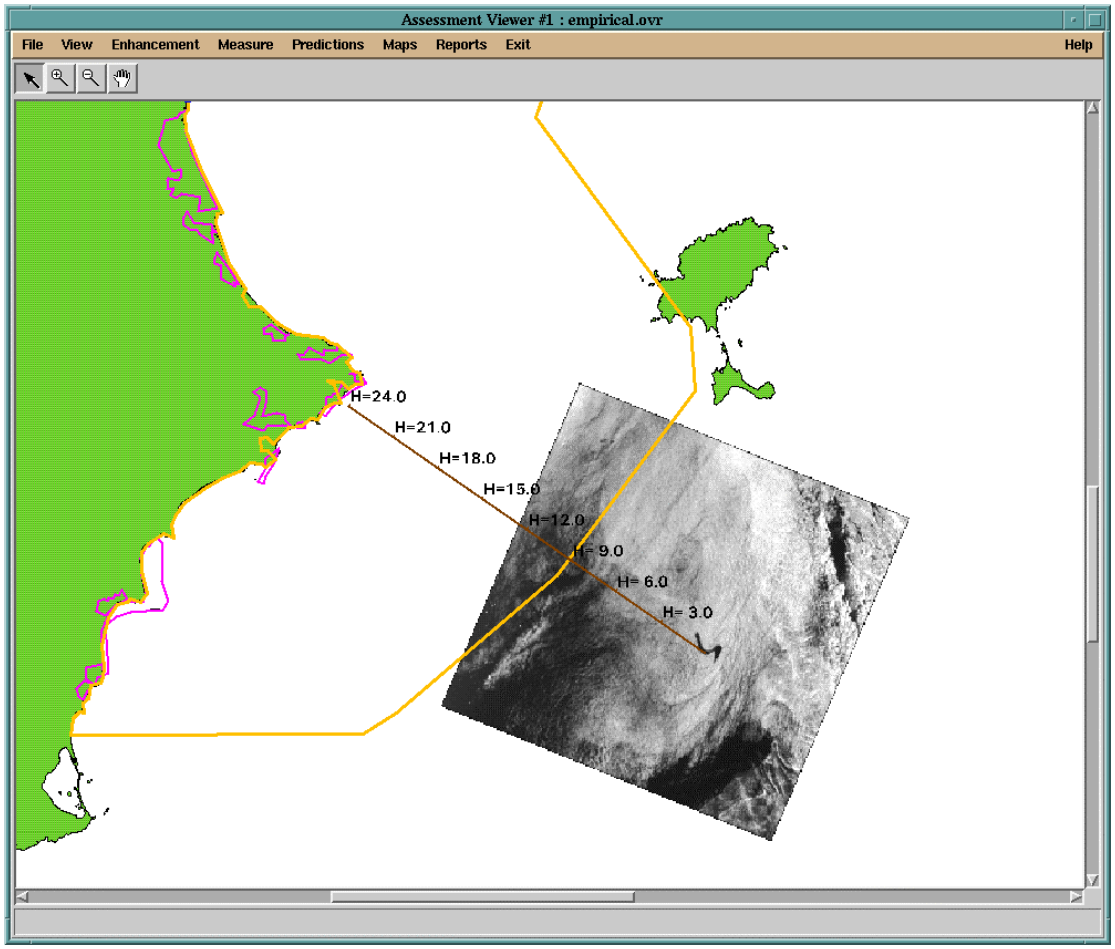

Figure 5 - The Assessment mode provides simulations of the future movement of the oil spill. Commercial beaches in blue, important fishing resources inside yellow polygon, natural reserves inside pink polygons.

The Operations Mode supports a possible cleanup operation. The module includes an equipment database and tools to archive the development of the oil slick. The equipment database is used to determine which resources are available in the region for a cleanup operation and to set up an equipment plan for the operation. If the situation lasts for some time, several SAR images covering the emergency area may be acquired from the satellite. The interpreted SAR images and field data are handled by the module.

3.4. ENVISYS - A general solution for emergency management

ENVISYS has currently been implemented in a prototype for marine oil spill detection. However, ENVISYS also represents a generic approach to environmental emergency management. Therefore, we foresee several other application types in the future. Deliverable D6.3, Report on other Emergencies, describes the necessary modifications to the ENVISYS prototype for different types of emergencies. Conceptual models have been proposed for each of the following cases:

3.4.1. Forest fire detection

Forest fires may be detected from satellites and from land-based cameras. ENVISYS proposes to automatically retrieve and integrate data from both sources in order to obtain a very reliable surveillance system. Furthermore, ENVISYS will not wait passively until a fire occurs, but will, based on remote sensing and meteorological data, give an early warning by providing maps showing the risk of forest fires. Other features of the system are tools for the assessment of the situation, support to the fire combat action and a post-assessment of the fire consequences.

3.4.2. Floods

Floods may be detected and monitored by remote sensing by detecting changes of a water-body's border. Early warnings are possible, e.g., by remote sensing of snow properties or by meteorological predictions of heavy rainfalls. Remote sensing also allows the evaluation of the extent of damages to roads, buildings and other constructions, agricultural areas, forests and the environment. ENVISYS proposes a system that integrates these functions and tools for support to counter-actions.

Figure 6 - From left to right: Forest fire, burnt forest and flood.

3.4.3. Earthquakes

Remote sensing allows measuring changes of the terrain surface shape down to the centimetre level. Hence, it can be used to detect small earth crust movements that may be an early warning of an earthquake. In addition, the damages caused by an earthquake may be determined using remote sensing data. ENVISYS proposes an integrated system with these two features and fully automatic retrieval of data.

3.5. Evaluation

The value obtained for the European Added Value (EAV) based on the results of the demonstration was very close to the total costs of the ENVISYS project, and twice the contribution from the Commission of the European Union. The value obtained for the demonstration could have been doubled if an administrative problem had been resolved in order to obtain satellite images directly from the provider.

It should also be noted that ENVISYS' most important contribution to cleaner oceans and seas will probably be the preventive effect. Knowing that your ship is monitored day and night makes it less tempting to release oil illegally. The impact of this has not been taken into account in the computation of the European Added Value.

The demonstration of the ENVISYS system gave in general positive results, according to the opinions expressed by the users directly or indirectly involved in the demonstration phase. There is a great interest in the continuation of ENVISYS amongst the involved users.

3.6. Commercialisation

Several meetings took place in order to plan the commercialisation of the ENVISYS system and to reach an agreement on the legal aspects. A business plan (deliverable D03.2 Business Plan) has been elaborated, which analyses the market, shows the commercial potential of ENVISYS and defines how the commercialisation process should be performed and the responsibility of each partner in this process. Obligations and rights to the financial outcome have been defined in a consortium agreement document (D03.1 Intellectual Property Right doc.). The commercial partners of the consortium, supported by NR, will be in charge of the commercialisation process. It is planned to have a product ready for sale within one year.

4. Conclusions and future plans

4.1. Conclusions

The evaluation results show that most of the systems characteristics are positively considered by the users (location and time accuracy, early warning and near real time detection, large geographic coverage, telecommunications support, user friendliness, system expandability, cartographic support, etc.). On the other hand, most users are very reserved in terms of coverage frequency, culprit identification and some aspects of event evolution (only partially presented to them). The satellite coverage presented to the users was the one obtained during the demonstration where only ERS-2 images were used. Of course, the combined use of RADARSAT and ENVISAT will increase the coverage frequency dramatically. It should also be noted that most users are not familiar with remote sensing techniques and applications and do not have any comparative basis.

Unfortunately, the users did not have enough information about financial aspects in order to compare ENVISYS costs to other detection and surveillance methods and express a clear opinion on all aspects of the cost effectiveness of the system. However, the estimation of acceptable investment cost for ENVISYS (at least for the approximate price considered in the Business Plan) has to be taken into account for the future ENVISYS commercialisation policy. Also it has to be noted that users are reserved concerning satellite images costs. However, such costs are expected to decrease significantly in the near future.

The demonstration of the ENVISYS system gave in general positive results, according to the opinions expressed by the users directly or indirectly involved in the demonstration phase. However, there were some restrictions that limited the potential impact of the ENVISYS demonstration to local users and potential customers.

The main positive result consists in the proven possibility to automatically detect oil spills. It has to be underlined that the fully automatic detection with alarm by the ENVISYS system, when working with the appropriate image format, has extremely impressed the users. Other important outcomes of the user acceptance of the system are related to:

- The fully automatic data retrieval (satellite images, wind data and sea current data)
- The fast processing: It takes only minutes from the moment when the satellite image is available at the image provider's FTP site until the image has been retrieved and processed, the operator has verified it manually and an alarm report has been created, sent and received by the users.
- The near real time operation of the whole concept when SARC images are used
- The effective and user-friendly interfaces of the system, in spite of use of complicated software tools
- The accurate location and area estimation of the potential oil spill
- The possibility of extended geographical coverage, especially when compared with traditional monitoring means (patrols etc)

- The possibility of day and night monitoring under most weather conditions

On the other hand, some operational aspects that created a scepticism by the users are linked to the frequency of satellite coverage by ERS and the long time needed for provision of high resolution ERS-2 images that allow a real time automatic detection. This aspect, as explained before is linked to the actual products available by ESA, and the future exploitation of ENVISAT products will considerably improve both these aspects. Points of concern for the users are also related to the high cost of the satellite images and the overall operational cost of the system. Even though satellite image costs are expected to decrease significantly in the next years, these points have to be taken into account in the planning of a price policy for the ENVISYS product.

4.2. Future plans

There are great expectations for the commercialisation of ENVISYS, in which three partners will be involved (IN&DI, INTELLSERVE and EPSILON). NR will support this commercialisation, especially in the adaptation to user-specific needs and providing technical support. It is also desirable to join a major IT distributor in order to establish a co-operating framework with synergies in product portfolio on one hand and access to a worldwide network on the other hand.

There are low entrance barriers in this industry. The main competitive advantage is to have a new, innovative product and establish it in the market, providing the necessary improvements earlier than the competitors. However, at this moment there is no similar system for the management of oil spill emergencies.

One of the goals of the commercialisation of ENVISYS is to acquire 30% of the global market, and obtain 40% of these sales in the first three years of its period of commercial exploitation. The revenues will in this case pay the commercialisation costs, and 50% of the basic product cost will pay the gross part of the investment done in the R&D project.

There are two options for promoting and selling the ENVISYS product: In the most favourable case through a strategic alliance with a big distributor, or promoting by the three commercial partners.

There is no major software or hardware distributor with an established worldwide distribution network for oil spills emergency management systems. However, there are some large companies that are providers of other information technologies based products for a wide profile of customers. This kind of companies will be good potential partners for ENVISYS because they are always searching for innovations in order to extend their portfolio of products. Furthermore, there is some hardware and software that is needed for running the ENVISYS system. Selling this basic information technology infrastructure (hardware & software) together with ENVISYS will allow increasing the sales of the core-products of the distributor to new users. Also, it facilitates sales to the environmental emergency agencies that are current customers of the distributor, because the agencies could extend new utilities for the hardware and software already bought. From the point of view of ENVISYS partners, a strategic

agreement with a major distributor will allow to get access to a world-wide market, with its already established sales network and experience and to guarantee marketing facility, sales-support, training, etc. This kind of top-down market approach will mean synergy effects for both sides with a kind of “win-win” agreement.

In the case of failure to achieve any agreement with a major distributor, the commercialisation will be done directly by the partners of the consortium. IN&DI, INTELLSERVE and EPSILON, supported by NR, will commercialise the product to the final users. In the beginning, the commercial areas will be west Mediterranean for IN&DI and east Mediterranean and Middle East for INTELLSERVE and EPSILON, respectively. In the ENVISYS business plan (deliverable D03.2) it is shown that even in this less favourable case the commercialisation of ENVISYS should reach the return of investment within three years.

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ENVISYS Web pages:
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