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# FINAL REPORT

## *Workshop on Planning Rehabilitation of Degraded Industrial Areas in the Mediterranean by DSS*

*Tunis, Tunisia*
*29-31 May 2000*

*organized by*

***ICS-UNIDO***

*in collaboration with the*

***Tunis International Center for Environmental Technologies***
*Tunis, Tunisia*

***and***
*MED POL – UNEP*
*Athens, Greece*

***BACKGROUND***

1. The International Centre for Science and High Technology (ICS-UNIDO) has organised in collaboration with CITET and MED POL- UNEP a Workshop on "Planning Rehabilitation of Degraded Industrial Areas in the Mediterranean by Decision Support Systems" from 29 to 31 May 2000 in Tunisia.

2. This Workshop has been developed within the activities of the Area of Earth, Environmental and Marine Sciences and Technologies, under the Decision Support Systems (DSS) Subprogram, which supports the diffusion, integration and application of information technology (IT) for aiding decision making in developing countries. The integration of technologies (including the use of Geographic Information System (GIS) instruments and methods, Remote Sensing (RS) data integration and manipulation, Process Simulation (PS) techniques, Internet facilities, etc) is especially useful for presenting a common "interface" and "approach" to tackle problems through networking and technology transfer to developing countries. Based on this, activities including training in new techniques and demonstrations of practical case studies are being developed at local level and projects are being developed in close co-operation with national counterparts.

3. The aim of the Workshop is to define guidelines and contents directed to combine different technologies of Decision Support Systems for planning rehabilitation of Degraded Industrial Areas in the Mediterranean Basin. Moreover, in recognizing the importance of collaborating and interacting with all key actors involved at the IV MCSD meeting organized by MED-POL and thematic Group (Massa, 14-15 May 1999), ICS seeks to identify synergies with other international and national entities concerned with industry and sustainable development in the Mediterranean. As a consequence close cooperation among others has been established with UNEP Mediterranean Action Plan (MAP), through its MED POL Program.

***JUSTIFICATION***

4. Degradation of industrial Areas in the Mediterranean has a particular meaning related not only to environmental pollution around the industrial areas but also to the inadequate technologies used for the production process and loss of competitive capacity. The problem to couple cleaner production with competitive issues is very important for the rehabilitation of industries both from the productive and ecological points of view.

5. Within both industrial and natural systems, each process or network of process is viewed as an interrelated part of the whole system. In other words, it has to be considered that manufacturing processes are not performed in isolation from their surroundings but influenced by them and, in turn, have their own influence on the environment. This analogy forces to apply Ecological concepts in the industrial context. Ecology has shown that sustainable ecosystems present cyclic processes rather than linear models, in which materials are degraded, dispersed and lost. Industries are under pressure to abandon from this linear model towards cyclicity in order to achieve a sustainable development.

6. There is an urgent need to have an assessment of the industrial areas and a monitoring of the existing activities for developing a management plan to control and maintain the environment quality and to prevent the risk of pollution and contamination. For this we need to develop an integrated monitoring system, which produce useful data for decision-makers that have not only to deal with environmental protection but also the economical competition.

***PARTICIPATION***

7. The workshop was attended by 15 participants from Tunisia, Italy, Spain, Lebanon, Greece, Algeria and Syria, as well as from several international organisations active in planning and managing industrial areas ( ICS, CP/RAC, UNIDO and MED-POL - UNEP ). Although invited the representatives from Morocco and Egypt were unable to attend the workshop. The complete list of participants is attached in Annex I

***OPENING OF THE WORKSHOP***

8. Mrs Amel Jrad FANTAR welcomed and greeted the participants on behalf of Mrs Amel BENZARTI, the General Director of CITET. She emphasised the importance of sustainable development in industrial activities. She also raised hopes that the workshop would produce good results and wished the participants fruitful work and pleasant stay in Tunis.

***ADOPTION OF THE AGENDA***

9. The agenda was adopted as presented in Annex I

***OBJECTIVES OF THE WORKSHOP***

10. Mr E. Feoli, scientific consultant of ICS-UNIDO presented the objectives of the workshop. These objectives are to :

- ✓ Define the characterises and the roles of Degraded Industrial Areas in the Mediterranean;
- ✓ Localise the degraded industrial areas according to their spatial distribution

  ( Urban or peri –urban areas) and to detect hotspots;
- ✓ Identify risk and plan for mitigation and remediation ;
- ✓ Promote existing industrial technologies ;
- ✓ Develop an approach for creating new industry;
- ✓ Strengthen network connection of specialists and experts, concerned with issues of using Decision Support Systems for Planning rehabilitation of Degraded Industrial Areas .

- ✓ Examine the possibility of further collaboration with individual specialists, in the light of new projects and initiatives being undertaken by ICS-UNIDO;

- ✓ Reinforce UNIDO action and policy in the Mediterranean region

Mr E. Feoli also presented the Aide Memoire that was prepared in advance to the workshop.

## *EXPECTED OUTPUTS*

**11.** Mr.E. Feoli informed the participants that the expected outputs of the workshop were the following:

- Definition of the most urgent problems and relevant in the field intervention priorities in the Mediterranean developing countries.

- Identification of the most advanced technologies and software to implement DSS for industrial development.

- Identification of the most appropriate tools and strategies to transfer DSS technologies to developing countries.

- Identification of centres to be considered for inclusion as focal points in the ICS network.

- Review of national and international projects concerning the monitoring of industrial development in the Mediterranean region.

- Review of case studies related to the application of the technological framework of the decision domain.

- Provision of guidance for planning rehabilitation of degraded industrial areas in the Mediterranean region.

## *PRESENTATIONS AT THE WORKSHOP:*

**12.** The list of the presentations given by the participants is contained in Annex II

**13.** Mr. V. Macià, Director of CP/RAC of UNEP-MAP, pointed out the necessity for a cleaner technology and waste minimisation. He also stressed on the fact that cleaner production should be seen as a competitiveness tool, rather than an added cost, as it was generally seen in the past. Then he highlighted the advantages of the cleaner production options over the end-of-pipe measures. However, these two approaches are complementary and compatible. Incentives to pollution prevention can be economic, legislative/administrative, technical and organisational/corporative. Finally, he presented a case study of industrial enterprise that applied the CP approach. Mr. Macia also informed the participants that The CP Center in Barcelone developed a diagnosis tool called "Minimization Opportunities Environmental Diagnosis".

**14.** Mr. Fouad Abou Samra, MED POL Programme Officer, presented the Strategic Action Programme (SAP) and the way to address pollution from Land Based activities. He pointed out that the general objectives of the program are to (1 ) Improve the quality of the marine environment by better shared management of land based pollution and (2) Facilitate the implementation of the LBS protocol by the contracting parties. He also gave a brief overview regarding the agreed targets.

**15.** Mr. Alberto Bertucco, Professor at the University of Padua. Italy presented the process simulation approach as a tool to improve industrial sustainability. He also defended this thesis by presenting a number of industrial case studies. Finally, he talked about the possibilities of technical co-operation in this area.

**16.** Mr. M. N. Moore, of SES/PEM of UNIDO, gave a brief overview about the methodology of impact and risk assessment in integrated environmental management. He pointed out that a large portion of the world's population lives in close proximity to specific geographical locations such as the global coastal environment and the catchment basins of large river systems. The result of this situation is that most of the waste, both industrial and domestic, and various other types of habitat destruction occurs on those areas that are of greatest biological and economic significance. He also highlighted that one of the major difficulties in impact and risk assessment was to link harmful effects of chemical pollutants in individual animals and plants with the ecological consequences. Eco-toxicological tools, like "bio-markers" and immuno-chemical tests for contaminants, recently available, can help overcome this knowledge gap. He described the development and the use of process simulation models, which will further facilitate the development of a predictive capacity for future risks. The main thesis developed by Mr. Moors is that an integrated environmental management strategy must be truly cross disciplinary if an effective capability for risk assessment and prediction is to be developed. Therefore, collaboration needs to include remote/satellite surveillance, risk assessment, interpretation of complex information, predictive modeling and precautionary anticipation of novel environmental hazards. Finally, he stressed the importance of education of politicians, industrialists and environmental managers concerning the long-term consequences of pollution. Rising consumer awareness exerts pressure on industry to make the production and the products "environmentally friendly".

**17.** Messrs. E. Feoli and M. Ghribi from ICS - UNIDO pointed out the role that ICS can play in the promotion of sustainable industrial development through the creation of a network of Mediterranean institutions and specialists, the design and implementation of a pollution reduction program and the identification of synergies with other initiatives. In this regard, they stressed the importance of a flexible and accessible information system for planning the sustainable industrial development, co-ordination between different initiatives, and the integration of the field observations with results of remote sensing.

**18.** Mr. M. Ghribi also presented a set of case studies that have been elaborated by ICS-UNIDO. These case studies highlighted the use of GIS, remote sensing and decision support systems for landscape monitoring and environmental management of coastal areas through a case study. In the case study of Tunis-Bizerte Mr. Ghribi illustrated the technique of Multi-Criteria Evaluation for Urban Management and Industrial Siting as a contribution to decision-making. Having analysed the methodology of this process, he described its aims and concepts. In addition, he illustrated a hazardous waste analysis.

**19.** On the second day, Mr. Feoli opened the session and greeted all the participants. He gave a brief overview about the program of the day which consists mainly on:

1) countries presentations;
2) a field trip to two industrial zones in Tunisia.

**20.** Mr M. Jeljeli, from CITET, talked about the Tunisian plan to combat industrial pollution. Then Mr J Thlibi from the Tunisian Environmental Protection Agency focused on the EIA as a preventive tool to reduce industrial pollution. Ms Hili and Mr S Hamed from Industrial Land Planing Agency (AFI) presented the Tunisian program to rehabilitate degraded industrial areas in Tunisia. Finally, Mr. Felfoul from the National Office for Waste water Treatment (ONAS) gave a brief overview about the project of the "grouped" industrial waste water treatment plant in the industrial zone of Ben –Arous. He pointed out that this type of treatment plants is an optimum way of managing industrial effluents in industrial zones.

**21.** Mr. O. Aljundi, from the Syrian Ministry of State for Environmental Affairs, presented some statistics regarding industrial pollution in the main Syrian hot spots including Damascus, Banias, Homs, Hama and Aleppo. He also emphasised the need for cleaner production and environmental management systems as tools to combat industrial pollution.

**22.** Mr. Chaouram from Algeria gave a general overview about the industrial environment in Algeria. He attributed the rapid degradation of the Algerian urban areas to the concentration of major economic activities along the coastal lines. He then pointed out that the key issues are air and water pollution and the proliferation of unregulated hazardous waste disposal sites. Mr. Chaouram presented also the geographical distribution of the major Hot Spots in Algeria followed by an overview of the legal environmental framework that governs the industrial activities.

**23.** Mr. Boghos from MECTAT - Lebanon started his presentation by giving some statistical background on industrial development. He then briefly overviewed the geographical distribution of the industrial zones and the major Hot Spots in Lebanon. He also highlighted the necessity of BATNEC in combating industrial pollution. Finally Mr. Boghos stressed the role that can play regional environmental institutions such as ICS in transferring environmental technologies.

***GENERAL DISCUSSION AND RECOMMENDATION:***

**24.** The third day of the workshop was dedicated to a general discussion that culminated on the following recommendations.

1) Development of awareness raising programs in the area of Planning Rehabilitation of Degraded Industrial Zones.

2) Building capacity in risk management tools applied to environmental management of industrial zones.

3) Development of regional database (GIS) for Industrial Zones.

4) Promotion of industrial clustering for optimum use of natural resources.
This will minimise production cost and ameliorate industrial competitiveness .Special attention should be given to water management in industrial zones.

5) Establishment of MED Network for industrial zones' rehabilitation.

6) Elaboration of country –wise diagnostic studies related to the subject matter

7) Financial problems related to the management and rehabilitation of industrial zones should be investigated and practical solutions should be proposed.

8) Development of a pilot project in managing industrial zones ( eg, UNIDO/ICS-AFI).

9) More training workshops and expert meetings need to be organised by ICS.

10) A regional meeting at the decision level is highly requested.

***CLOSURE OF THE WORKSHOP:***

**25.** Mr. E .FEOLI, on behalf of ICS and UNIDO, expressed his satisfaction with the work and organisation. He stated that the joint work of the participants from different countries and institution made the workshop interesting.

**26.** Finally Mr. Jeljeli, on behalf of CITET, expressed his thanks to all the participants for their efforts and contributions to make this workshop a success . He also raised hopes that this workshop will be the starting point for future co-operation in the area of " Planning Rehabilitation of Degraded Industrial Areas in the Mediterranean by DSS.

# Annex I
# AGENDA

***Workshop on***
***"Planning Rehabilitation of Degraded Industrial Areas in the Mediterranean by DSS"***

***Tunis, Tunisia***
***29-31 May 2000***

Monday, 29 May 2000

| | |
|---|---|
| 09:00-09:30 | Registration |
| 09:30-09:45 | Opening and Welcome by the host<br>**Ms. Amel Jrad Fantar**<br>Centre International des Technologies de l'Environnement de Tunis (CITET), Tunis, Tunisia |
| 09:45-10:00 | ICS-UNIDO Presentation<br>Briefing on the scope of the Workshop<br>Presentation of the participants<br>**Mr. Enrico Feoli**<br>ICS-UNIDO, Trieste, Italy |
| 10.00-10.45 | Presentation of the Centre (CITET) |
| 10:45-11:15 | Coffee break |
| 11.15-12.00 | Evaluating the Technological Level of Production Systems and Developing Programmes for Cleaner Production<br>**Mr. Victor Maciá**<br>Cleaner Production/Regional Activity Centre, CP/RAC<br>Barcelona, Spain |
| 12.00-13.00 | Process Simulation as a Tool to Improve Industrial Sustainability<br>**Mr. Alberto Bertucco**<br>Istituto di Impianti Chimici, University of Padua, Italy |
| 13:00-14:30 | Lunch break |
| 14.30-15.15 | Strategic Action Programme to Address Pollution from Land Based Activities<br>**Mr. Fouad Abousamra**<br>MED POL Programme Officer, UNEP, Athens, Greece |
| 15.15-16.00 | Methodology for Impact and Risk Assessment in Integrated Environmental Management<br>**Mr. Michael N. Moore**<br>SES/PEM, UNIDO, Vienna, Austria |
| 16:00-16:15 | Coffee break |

| | |
|---|---|
| 16:15-17.00 | Geographic Information System for Industrial development<br>Presentation of ICS case studies<br>**Mr. Enrico Feoli and Mr. Mounir Ghribi**<br>ICS-INIDO, Trieste, Italy |

*Tuesday, 30 May 2000*

Analysis of the industrial component in the participant countries:
- Generally;
- Inventory of the industries;
- Physical planning of Industrial Activities;
- Legal framework-permits for industrial installations;
- Environment Impact Assessment of industries;
- Industrial waste management, etc.

| | |
|---|---|
| 09:30-10:15 | **Tunisia,** Mr. Mohamed Jeljeli, CITET<br>Ms. Naima Hili, Mr. Salah Hamed, Agence Foncière Industrielle (AFI) |
| 10:15-11:00 | **Algeria,** Mr. Rabeh Chaouram, DGE (General Direction of Environment) |
| 11:00-11:30 | Coffee break |
| 11:30-12:15 | **Lebanon,** Mr. Boghos Ghougassian, MECTAT |
| 12:15-13:00 | **Syria,** Mr. Jundi Ozaina, GCEA |
| 13:00-14:30 | Lunch |
| 14:30-17:00 | A visit to an industrial zone in Tunis |

*Wednesday, 31 May 2000*

| | |
|---|---|
| 09:30-13:00 | Round-table discussion - Recommendations<br>Conclusion and Closing<br>(11:00-11:15 Coffee break) |

# Annex II
# List of participants

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# Annex III
# List of presentations

**Mr Abousamra Fouad :** Strategic Action Programme to Address Pollution from Land .

**Mr Bertucco Alberto :** Process Simulation as a Tool to Improve Industrial Sustainability

**Mr. Chaouram Rabah:** Algerian case study

**Mr. Hamed Salah and Ms. Hili Naima**: Tunisian case study

**Mr. Gougassian Boghos:** Lebanese case study

**Mr Ghribi Mounir and Feoli Enrico:** Geographic Information System for Industrial development Presentation of ICS case studies .

**Mr. Jundi Ozaina:** Syrian case study

**Mr. Macia Victor :** Evaluating the technological Level of Production Systems and Developing programs for Cleaner Production .

**Mr. Michael N. Moore :** Methodology for Impact and Risk Assessment in Integrated Environmental Management .

# ANNEX IV
# Overheads, notes, and presentations

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# LAND-BASED SOURCES (LBS) PROTOCOL

AND

# STRATEGIC ACTION PROGRAMME (SAP)

by

**Fouad Abousamra**
MED POL Programme Officer

**Programme for the Assessment and Control of Pollution in the Mediterranean Region (MED POL)**

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# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## THE STRATEGIC ACTION PROGRAMME (SAP)

- Specifies the main land based pollution issues in the Mediterranean
- Indicates the desired targets to be reached to resolve these issues.
- Indicates the possible control measures that could be taken at the national and regional level, including their costs
- Establishes a general schedule and timeframe for their implementation.

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# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## GENERAL OBJECTIVES

- To improve the quality of the marine environment by better shared-management of land-based pollution
- To facilitate the implementation of the LBS Protocol by the Contracting Parties

## SPECIFIC OBJECTIVES

- Formulation of principles, approaches, measures, timetables and priorities for action
- Preparation of a priority list of hot spots for intervention and investments
- Analysis of expected baseline and additional actions needed to resolve transboundary priority problems
- Identification of the elements for the formulation of National Action Plans
- Identification of the role for NGOs in the implementation of the SAP

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# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## PRINCIPLES AND OBLIGATIONS

- To apply the precautionary principle
- To apply the polluter pays principle
- To use best available techniques (BAT), including clean production techniques
- To apply best environmental practice (BEP)
- To implement integrated pollution prevention and control
- To promote integrated coastal zone management
- To ensure public access to information
- To undertake environmental impact assessments for proposed activities
- To undertake routine reporting of toxic emissions to air water and land

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# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## TARGETS AND ACTIVITIES:

The agreed targets and activities are identified at the national and the regional level and are of legal, institutional or technical nature.

## THEY COVER:

- Urban environment
- Industrial development
- Physical alterations and destruction of habitats
- Monitoring
- Capacity Building
- Public Participation
- Reporting

The SAP also contains Guidelines for the preparation of National Action Plans and an Investment portfolio.

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# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## URBAN ENVIRONMENT

- Municipal sewage
- Urban solid waste
- Air pollution

## INDUSTRIAL DEVELOPMENT

- TPBs
- Other Organohalogen Compounds
- Other Heavy Metals
- Radioactive substances
- Nutrients and suspended solids
- Hazardous wastes

# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## INDUSTRIAL DEVELOPMENT

**General Targets:**

- By the year 2025, point source discharges and air emissions from industrial installations to be in conformity with the LBS Protocol and other agreed international and national provisions

- Over a period of 10 years to reduce by 50% discharges, emissions and accidental losses of substances that are toxic persistent and liable to bioaccumulate

- Over a period of 10 years to reduce by 50% discharges, emissions and accidental losses of polluting substances from industrial installations in hot spots and other areas of concern

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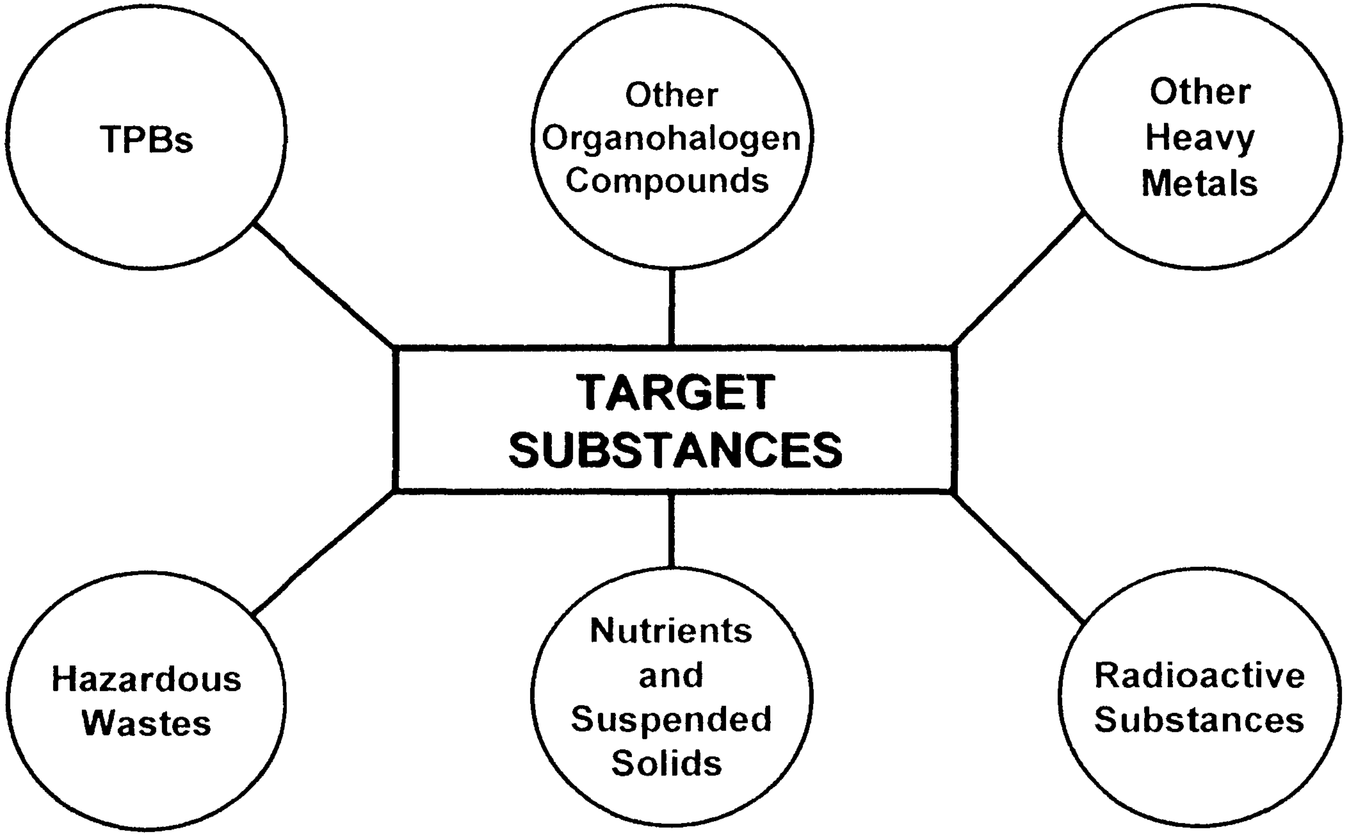
# STRATEGIC ACTION PROGRAMME - INDUSTRIAL DEVELOPMENT



# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## INDUSTRIAL DEVELOPMENT

### Regional Actions - General

- To prepare and adopt guidelines for industrial wastewater treatment and disposal and the application of BAT, BEP in industry
- To formulate and adopt environmental quality criteria and emissions limit values for point-source industrial discharges into water and air
- To promote capacity building on environmentally sound industrial wastewater treatment, including the production of technical information and training and the promotion of technology transfer among countries
- To promote research on environmentally sound industrial wastewater treatment
- To support the development and application of eco-auditing and accreditation schemes (EMAS and ISO 14000)

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# TPBs are:

- Toxic
- Persistent
- Liable to Bioaccumulate

## and they include:

- Persistent Organic Pollutants (POPs)
- Some heavy metals (Hg, Cd, Pb)
- Some organo-metallic compounds (organo-mercuric, organo-lead and organo-tin compounds)

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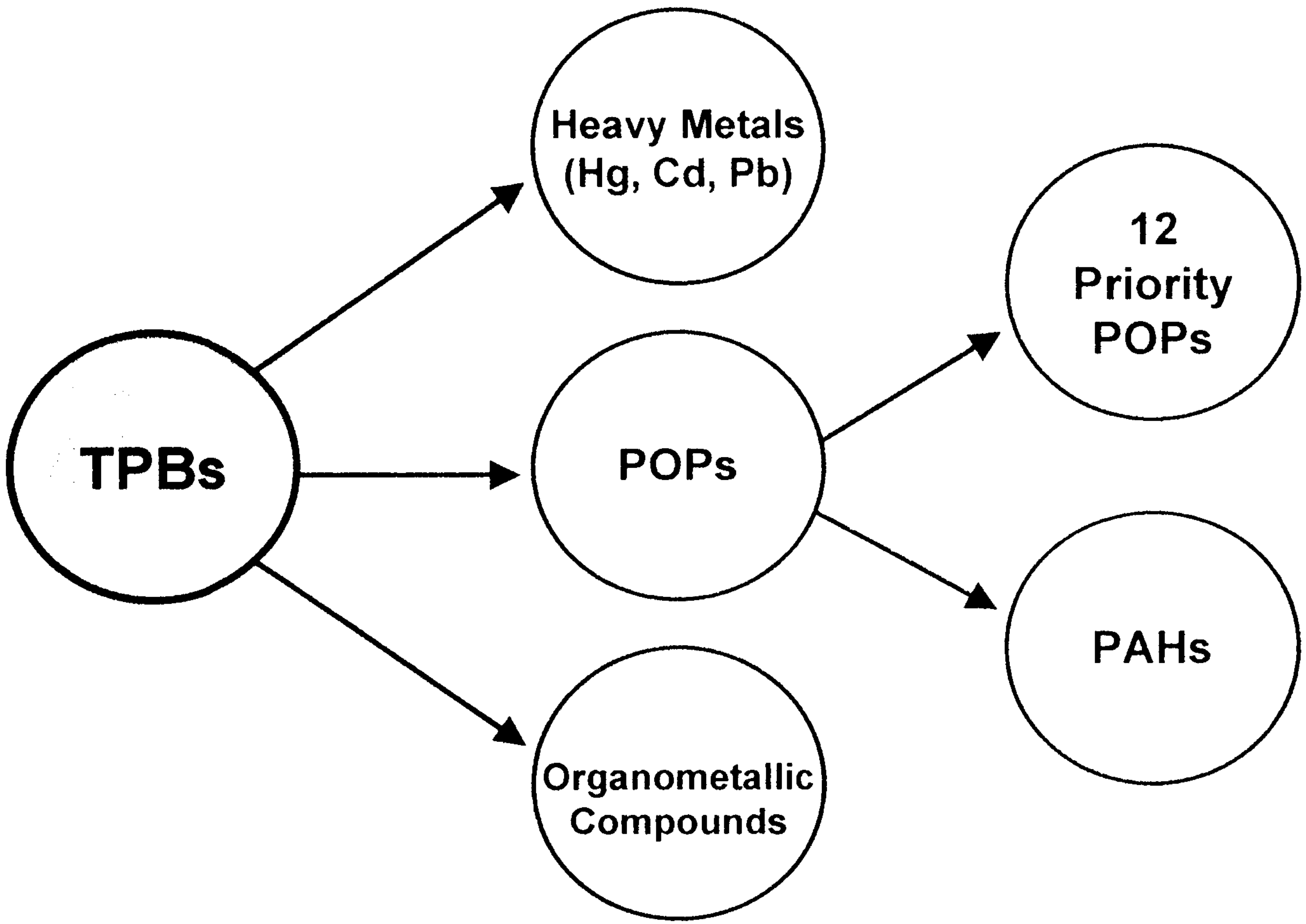
# SAP - INDUSTRIAL DEVELOPMENT

## BREAKDOWN OF TPBs



# TPBs - PERSISTENT ORGANIC POLLUTANTS (POPs)

## Properties in relation to the environment and human health:

- Adverse environmental and human health effects at locations near and far from their source
- Low water solubility and high fat solubility
- Once dispersed, clean-up rarely possible
- Long environmental half-lives
- Continued accumulation and ubiquitous presence in the global environment

## Target Substances:

- Priority 12 organochlorine POPs
- Other POPs (PAHs)

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# TPBs - POPs

## Twelve priority POPs:

The LBS Protocol identifies twelve priority organochlorine compounds which are divided into three groups:

- Pesticides: DDT, aldrin, dieldrin, endrin, chlordane, heptachlor, Mirex, Toxaphene, hexachlorobenzene
- Industrial chemicals: PCBs
- By-products and impurities: hexaclorobenzene, dioxins, furans

## Other POPs :

6 Borneff Polycyclic aromatic hydrocarbons (PAHs):

- fluoranthene
- benzo (a) pyrene
- benzo (b) fluoranthene
- benzo (k) fluoranthene
- indeno (1,2,3, cd) pyrene
- benzo (g,h,l) pyrilene

# TPBs - POPs

## Targets:

**by 2025:**

- To phase out inputs of PAHs

**by 2010:**

- To phase out inputs of the 9 priority pesticides and PCBs
- To reduce to the fullest possible extent inputs of by-products and impurities (hexachlorobenzene, dioxins and furans)
- To formulate and adopt emission limit values for point-source discharges and emissions of PAHs

**by 2005:**

- To reduce by 50% inputs of the Priority 12 POPs
- To collect and dispose all PCB waste in a safe and environmentally sound manner

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# TPBs - POPs

## Regional Actions:

**by 2000:**

- Preparation of guidelines for the application of BEP and, where possible, the use BAT in industrial installations producing dioxins, furans

**by 2005:**

- Capacity building on the environmentally sound substitution and environmentally sound disposal of the existing quantities of the priority 9 pesticides and PCBs, including the production of technical information and training and the promotion of technology transfer among countries
- Preparation of guidelines for the application of BEP and, where possible, the use BAT in industrial installations producing PAHs

**by 2010:**

- To formulate and adopt emission limit values for point source discharges and emissions of PAHs

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# TPBs - POPs

## National Actions (2000-2005):

**by 2000:**

- To phase out the use of the nine priority pesticides, except when WHO recommendations related to the safeguarding of human health suggest otherwise.
- To prohibit the manufacture, trade and new uses of PCBs
- To organise the collection and environmentally sound disposal of the existing quantities of the nine pesticides

**by 2001:**

- To prepare an inventory of quantities and uses of the nine pesticides and PCBs as well as of the industries which manufacture or condition them

**by 2005:**

- To prepare pilot programmes aimed at the safe disposal of PCBs, taking into consideration their progressive elimination, including the decontamination of equipment and containers

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# TPBs - POPs

## National Actions (2005-2025):

**by 2010:**

- To prohibit all existing uses of PCBs
- To reduce the emissions of HCBs, dioxins and furans as much as possible and, in order to do so to promote the implementation of environmental audits and apply BEP and BAT
- To promote the implementation of environmental audits in the industrial installations that are sources of PAHs, located in identified hot spots

**by 2025:**

- To reduce the emissions of PAHs as required in order to comply with the set regional emission limits for point source discharges and in order to do so, to apply BEP and if possible BAT to relevant industrial activities

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# TPBs - MERCURY, CADMIUM, LEAD

## Targets:

**by 2025:**

- To phase out discharges, emissions and accidental releases of Hg, Cd and Pb

**by 2005:**

- To reduce discharges, emissions and accidental releases of Hg, Cd and Pb by 50%

**by 2000:**

- To reduce discharges, emissions and accidental releases of Hg, Cd and Pb by 20%

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# TPBs - MERCURY, CADMIUM, LEAD

## Regional Actions:

by 2000:

- To prepare guidelines for the application of BEP and the use of BAT in the industrial installations that are sources of Hg, Cd and Pb

by 2010:

- To formulate and adopt environmental quality criteria and standards for point source discharges and emissions of mercury, cadmium and lead

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# TPBs - MERCURY, CADMIUM, LEAD

## National Actions:

### by 2000:

- To prepare National Programmes for the reduction and control of pollution by the heavy metals mercury, cadmium and lead in accordance with the provisions of the Protocol and other internationally agreed provisions

### by 2005:

- To adopt at the national level and apply the common measures for preventing mercury pollution adopted by the Parties in 1987 (releases into the sea max. conc. 0.050 mg/l)

- To adopt at the national level and apply the pollution prevention and control measures for cadmium and cadmium compounds adopted by the Parties in 1989 (releases into the sea max. conc. 0.2 mg/l)

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# TPBs - MERCURY, CADMIUM, LEAD

## National Actions (cont'd):

by 2010:

- To adopt and apply in the industries of the alkaline chloride electrolysis sector, the maximum value of 0.5gr of mercury in the water per tonne of chlorine production capacity (brine recirculation), 5 gr of mercury in the water per tonne (lost brine technology) and, 2 gr of mercury from total releases into water, air and products

- To promote the implementation of environmental audits and the application of BEP and BAT at the installations that are sources of heavy metals, giving priority to installations located in the selected hot spots, in order to reduce as much as possible the discharges and emissions of the heavy metals mercury, cadmium and lead

- To prepare environmental voluntary agreements to which authorities, producers and users are committed on the basis of a reduction plan

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# TPBs - ORGANOMETALLIC COMPOUNDS (ORGANOMERCURIC, ORGANOLEAD AND ORGANOTIN COMPOUNDS)

## Targets:

by 2010:

- To phase out discharges, emissions and losses of organomercuric compounds and reduce to the fullest possible extent those of organolead (particularly TML and TEL) and organotin (particularly TBT and TPT) compounds

by 2005:

- To reduce by 50% discharges, emissions and losses of organometallic compounds
- To phase out the use of organomercuric compounds

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# TPBs - ORGANOMETALLIC COMPOUNDS

## Regional Actions:

by 2000:

- To prepare guidelines for BAT and BEP for the control of the discharge, emissions and losses of organometallic compounds from relevant industrial installations

by 2010:

- To formulate and adopt, as appropriate, environmental quality criteria and standards for point source discharges and emissions of organometallic compounds

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# TPBs - ORGANOMETALLIC COMPOUNDS

## National Actions:

by 2000:

- To make an inventory of the uses and quantities of organomercuric compounds used

by 2005:

- To promote the use of lead free petrol
- To adopt at the national level and apply the common measures to control pollution from organotin compounds, adopted by the Contracting parties in 1989
- To phase out_the use of organotin compounds as anti-fouling agents in cooling systems

by 2010:

- To promote the implementation of environmental audits and apply BEP and BAT at installations that are sources of organometallic compounds, in order to reduce as much as possible discharges and emissions of organomettalic compounds

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# MEASURES FOR THE CONTROL OF POLLUTION BY ORGANOTIN COMPOUNDS

**A.** As from 1 July 1991 not to allow the use in the marine environment of preparations containing organotin compounds intended for the prevention of fouling by micro-organisms, plants or animals:

- on hulls of boats having an overall length (as defined by ISO standards No. 8666) of less than 25m;
- on all structures, equipment or apparatus used in mariculture.

This measure should not apply to any ships owned or operated by a state party to the LBS Protocol and used only on government non-commercial service.

**B.** To report to the Secretariat on measures taken in accordance with this decision.

**C.** That a code of practice be developed to minimise the contamination of the marine environment in the vicinity of boat-yards, dry-docks etc., where ships are cleaned of old anti-fouling paint and subsequently repainted.

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# OTHER HEAVY METALS (ZINC, COPPER, CHROMIUM)

Those causing negative environmental effects which require their reduction, control and monitoring

## Targets:

**by 2025:**

- To eliminate pollution of the Mediterrranean Sea caused by discharges, emissions and losses of zinc, copper and chromium

**by 2010:**

- To reduce discharges, emissions and losses of zinc, copper and chromium (by 50%)

# OTHER HEAVY METALS (ZINC, COPPER, CHROMIUM)

## Regional Actions:

by 2000:

- To prepare guidelines for the application of BAT and BEP to control discharges, emissions and losses of zinc, copper and chromium from relevant industrial installations

by 2010:

- To formulate and adopt, as appropriate, environmental quality criteria and standards for point source discharges and emissions of zinc, copper and chromium

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# OTHER HEAVY METALS (ZINC, COPPER, CHROMIUM)

## National Actions:

by 2005:

- To adopt at the national level and apply the common measures to control pollution caused by zinc, copper and their compounds adopted by the Parties in 1996 (releases into the sea, max. conc. 1.0 mg/l for zinc and 0.5 mg/l for copper)

by 2010:

- To promote the implementation of environmentral audits and apply BEP and BAT at industrial installations which are sources of zinc, copper and chromium, giving priority to installations located in the selected hot spots in order to reduce as much as possible discharges and emissions of zinc, copper and chromium

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# OTHER ORGANOHALOGEN COMPOUNDS

**Those causing negative environmental effects which require their reduction, control and monitoring:**

- Halogenated aliphatic hydrocarbons (chlorinated solvents, chlorinated paraffins)
- Other halogenated aromatic hydrocarbons (Chlorobenzenes, polychlorinated naphtalenes, polybrominated diphenyl ethers and polybrominated biphenyls)
- Other chlorinated phenolic compounds
- Other organohalogenated pesticides (lindane, chlorophenoxy acids)

# OTHER ORGANOHALOGEN COMPOUNDS

## Targets:

by 2025:

- To eliminate pollution of the Mediterranean Sea caused by discharges, emissions and losses of organohalogen compounds

by 2010:

- To reduce discharges, emissions and losses of other organohalogen compounds into the Mediterranean Sea, (by 50%)

# OTHER ORGANOHALOGEN COMPOUNDS

## Regional Actions:

by 2000:

- To prepare guidelines for the application of BAT and BEP to control the discharges, emissions and losses of organohalogen compounds from relevant industrial installations

by 2010:

- To formulate and adopt, as appropriate, environmental quality criteria and standards for point source discharges and emissions of organohalogen compounds

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# OTHER ORGANOHALOGEN COMPOUNDS

## National Actions (2000-2005):

### by 2000:

- To prepare National Programmes on the reduction and control of pollution by organohalogen compounds
- To make an inventory of the uses and quantities of pesticides

### by 2005:

- To make an inventory of the uses and quantities of chlorinated paraffins and to reduce the use of short-chained chlorinated paraffins.
- To adopt at the national level and apply the common measures for the control of pollution by organohalogen compounds adopted by the Parties.
- To participate in the programmes and activities of international organisations, especially FAO on the sustainable use of pesticides and to promote integrated pest management

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# MEASURES FOR THE CONTROL OF POLLUTION BY ORGANOHALOGEN COMPOUNDS

**A.** To adopt an environmental quality objective in coastal waters of 25 $ng.l^{-1}$ for total DDT

**B.** To use the International Code of Conduct on the distribution and use of pesticides as adopted by the FAO conference in 1985

**C.** To promote monitoring programmes wherever possible for:

- the establishment of trends and baseline concentrations of the organohalogen compounds
- the detection of "hot spot" areas

**D.** To provide the Secretariat with information on the present legal and administrative measures in force in each country for the production, use and disposal of organohalogen compounds and relevant monitoring data on (C) above.

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# OTHER ORGANOHALOGEN COMPOUNDS

## National Actions (2005-2010):

by 2010:

- To regulate releases of organochlorines by the paper and paper pulp industries by limiting discharges measured as AOX (adsorbable organic halogen) to 1 kg per tonne of paper pulp produced and by reducing it further through the promotion of BEP and BAT and the promotion of alternative bleaching to the use of molecular chlorine.
- To reduce and control the manufacture of PBDEs and PBBs
- To reduce and control the manufacture and use of certain pesticides, such as lindane, 2,4-D and 2,5-T herbicides, and tri- tetra- and penta-chlorophenols, used in the treatment of wood
- To promote the implementation of environmental audits and apply BEP and BAT at industrial installations that are sources of organohalogen compounds, giving priority to installations located in the selected hot spots, in order to reduce discharges and emissions of organohalogen compounds as much as possible
- To prepare environmental voluntary agreements to which authorities, manufacturers and users are committed on the basis of a reduction plan

# NUTRIENTS AND SUSPENDED SOLIDS IN INDUSTRIAL WASTE WATER

## Targets:

**by 2025:**

- **To dispose all wastewater from industrial installations which are sources of BOD, nutrients and suspended solids, in conformity with the provisions of the LBS Protocol**

**by 2010:**

- **To reduce by 50% inputs of BOD, nutrients and suspended solids from relevant industrial installations**

# NUTRIENTS AND SUSPENDED SOLIDS IN INDUSTRIAL WASTE WATER

## Regional Actions:

by 2000:

- To prepare guidelines for the application of BAT and BEP in industrial installations which are sources of BOD, nutrients and suspended solids

by 2010:

- To formulate and adopt, as appropriate, environmental quality criteria and standards for point source discharges of BOD, nutrients and suspended solids
- To formulate and adopt guidelines for wastewater treatment and waste disposal from industries which are sources of BOD, nutrients and suspended solids

# NUTRIENTS AND SUSPENDED SOLIDS IN INDUSTRIAL WASTE WATER

## National Actions:

by 2005:

- To develop National Programmes for the environmentally sound management of waste water and solid waste from industrial installations which are sources of BOD and to this end to ensure:

  - that at least industrial installations, which are sources of BOD, nutrients and suspended solids, located in areas of concern dispose all waste water in conformity with a national regulation system

  - that coastal outfalls are located so as to obtain or maintain agreed environmental quality criteria

  - the promotion of primary, secondary and where appropriate and feasible tertiary treatment of BOD waste water discharged into rivers, estuaries and the sea

  - the sound operation and proper maintenance of facilities

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# NUTRIENTS AND SUSPENDED SOLIDS IN INDUSTRIAL WASTE WATER

## National Actions:

by 2005 (cont 'd):

- The implementation of measures for the reduction and beneficial use of waste-water or other measures appropriate to specific sites such as no-water and low-water solutions
- The environmentally sound disposal and/or use (composting, landfilling etc.) of sludges and other wastes
- The preparation of environmental voluntary afgreements to which authorities, manufacturers and users are committed on the basis of a reduction plan

by 2010:

- To promote the implementation of environmental audits, BET and BAP at industrial installations which are sources of BOD, giving priority to installations located in hot spots, in order to reduce discharges of BOD, nutrients and suspended solids

# STRATEGIC ACTION PROGRAMME TO ADDRESS POLLUTION FROM LAND-BASED ACTIVITIES (SAP)

## INDUSTRIAL DEVELOPMENT

### Nutrients And Suspended Solids From Agriculture

**Targets:**

To reduce nutrient inputs from agriculture and aquaculture practices into areas where these inputs are likely to cause pollution.

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# HAZARDOUS WASTES (OBSOLETE CHEMICALS, USED LUBOIL, BATTERIES)

## Targets:

**by 2025:**

- To dispose all hazardous wastes in a safe and environmentally sound manner, and in conformity with the provisions of the LBS Protocol and other agreed international provisions

**by 2010:**

- To reduce by 20% the generation of hazardous waste from industrial installations

- To dispose 50% of the hazardous waste generated in a safe and environmentally sound manner and in conformity with the provisions of the LBS Protocol and other agreed international provisions.

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# HAZARDOUS WASTES

## Regional Actions:

by 2005:

- To prepare a Mediterranean Strategy for the Management of Hazardous Wastes, based on the principles of prevention, reduction and reuse and the application of Best Available Techniques and Best Environmental Practice for hazardous waste disposal ; to take into account the regulation of hazardous waste transport and remedial actions

- To formulate and adopt common pollution prevention and control measures for hazardous wastes

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# HAZARDOUS WASTES

## National Actions:

by 2000:

- To prepare national strategies for the managament of hazardous wastes, based on the principles of prevention, reduction and reuse, and the application of BEP and BAT on the disposal of hazardous waste ; the regulation of the tansport of hazardous waste and the remedial actions will be taken into account

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# HAZARDOUS WASTES

## National Actions (cont 'd):

by 2005:

- To prepare National Plans for the management of hazardous wastes, including an evaluation of the quantities of hazardous wastes produced and the financial resources necessary for their environmentally sound collection and disposal. National Plans may include national programmes for specific wastes, for military establishments, for the public industrial sector.
- To ratify and apply the Hazardous Wastes Protocol

by 2010:

- To establish facilities for the environmentally sound disposal of hazardous wastes

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# HAZARDOUS WASTES

## Obsolete chemicals

(stocks of banned organochlorine compounds
i.e. dieldrin and DDT and stocks of out-of-date chemicals)

## Target:

by 2005:

- To collect and dispose all obsolete chemicals in a safe and environmentally sound manner

## Regional Action

by 2000:

- To develop programmes for sharing and exchanging technical information and advice on the environmentally sound disposal of obsolete chemicals, taking into consideration their progressive elimination, including the decontamination of equipment and containers

# HAZARDOUS WASTES

## Obsolete chemicals

## National Actions:

by 2000:

- To formulate national inventories of stocks of obsolete chemicals
- To intensify training programmes for the identification, handling and disposal of obsolete chemicals
- To prepare pilot programmes aimed at the safe disposal of obsolete chemicals, taking into consideration their progressive elimination, including the decontamination of equipment and containers

# HAZARDOUS WASTES

## Used luboils

## Target:

by 2005:

- To collect and dispose 50% of used lubricating oil in a safe and environmentally sound manner.

## Regional Action:

by 2000:

- To formulate and adopt a standard on the maximum amount of PCB an oil contain before it is considered to be contaminated (i.e. 50 mg/kg)

by 2005:

- To develop programmes for sharing and exchanging technical information and advice on the environmentally sound disposal of used luboils, taking into consideration their progressive elimination, including the decontamination of equipment and containers

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# HAZARDOUS WASTES

## Used luboils

## <u>National Actions:</u>

**by 2000:**

- ➤ To create an inventory of the existing quantities of the three categories of luboil
- ➤ To prepare and adopt national programmes for the collection, recycling and disposal of used luboils including the public services sector (air, road and railway transport, energy transport and distribution) and military establishments
- ➤ To adopt at the national level and apply the common measures against pollution from used luboils, adopted by the Contracting Parties in 1989

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# MEASURES FOR THE CONTROL OF POLLUTION BY USED LUBRICATING OILS

**A.** Wastes containing used luboils should not be discharged directly into the Protocol area

**B.** Relevant national measures should be implemented by 1 January 1994

**C.** The various control measures available (i.e. regeneration for re-use, burning as fuel in an appropriate installation, or treatment and disposal in specially designed units) should be taken into account.

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# PREPARATION OF NATIONAL ACTION PLANS (NAPs)

## Institutional Aspects - Analysis of targets and activities

## General Objectives:

- To support the development and application of EMAS and/or ISO 14000 in the industrial sector
- To promote water conservation in industry
- To promote energy conservation in industry
- To support the development and introduction of energy-saving technologies and practices
- To develop a policy geared to incorporating the life-cycle of products and the development of cleaner products

# PREPARATION OF NATIONAL ACTION PLANS (NAPs)

## Institutional Aspects - Authorization or regulation

## <u>Targets:</u>

**by 2025:**

- All discharges of wastewater and air emissions from land-based sources and activities shall be in conformity with national and international regulations

**by 2010:**

- 50% of discharges of wastewater and air emissions from industrial and urban installations shall be in conformity with national and international regulations

**by 2000:**

- All point source discharges and emissions from new installations shall have prior authorisation by the competent authorities

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# CAPACITY BUILDING

## Targets:

- To support promote and facilitate programmes of assistance in the area of scientific, technical and human resources
- To support, promote and facilitate the capacity to apply, develop and manage access to cleaner production technologies, use of BAT and application of BEP

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# CAPACITY BUILDING

To support, promote and facilitate the capacity to apply, develop and manage access to cleaner production technologies, use of BAT and application of BEP

## Regional Actions:

- Access to new and innovative technologies
- New information technologies for the transfer of knowledge
- Manuals on clean production, clean materials, implementation of clean technologies
- Networks to improve the exchange and transfer of information on clean technologies among experts
- Access to and transfer of patent-protected clean technology to developing countries
- Collaborative arrangements for the development of clean production technologies
- Joint ventures between suppliers and recipients of technologies, taking into account the needs of developing countries
- Assistance and advice on environmental aspects of current technologies
- Assistance and advice on the preparation of reports

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# CAPACITY BUILDING

To support, promote and facilitate the capacity to apply, develop and manage access to cleaner production technologies, use of BAT and application of BEP

## National Actions:

- Training programmes of national administrators on access to clean technologies
- Partnerships between the scientific and technological community, industry and Government institutions to stimulate research, transfer and development of clean technologies
- Cooperation between private sector groups and NGOs to introduce clean, cost effective technologies
- Strengthening of national institutions to access, manage develop and apply clean technologies
- To facilitate access to sources of technical advice and assistance on clean technologies
- Training of industrial personnel in cleaner production techniques and practices
- Adoption of codes of good environmental practice in industry
- Support of voluntary schemes for the award of ecolable
- To promote programmes for energy efficiency and use of renewable energy sources in industry

# A Presentation on Industrial Activities and Hot spots In Algeria
## (RABAH CHAOURAR/ ALGERIA)

Algeria is confronted to a rapid degradation of its urban areas , land and water resources . This is the consequence of the concentration of the major economic activity and settlement along the coastal plains, coastal highlands and High plains .

There is no doubt that source control of industrial pollution is the priority issue for environmental protection .The key issues are air and water pollution and the proliferation of unregulated hazardous wastes disposal sites.

The major polluters are petrochemical, mineral processing, steel metal working, mechanical and electrical industries.

The greatest concentration of polluting industries is in the provinces (wilayates) of Annaba, Algiers, Oran, Constantine and skikda. These industries were built without taking into consideration environmental preoccupation. Control equipment is either inadequate or non functioning, because of shortage of spare parts, poor training and because pollution control equipment was considered as a supplementary finance for the companies.

Total hazardous waste production is more than 185.000T/y, including mineral wastes and petrochemicals by products. Major industries, include petrochemical complexes in Oran (Arzew), Algiers and skikda wich discharge chromium, mercury, waste oils, phenol, ammonia, chlorine, into the sea. The El Hadjar iron and steel plant in Annaba and the ASMIDAL fertilizer plant are major local polluters.

The principal impacts of industrial pollution on the basis of available information are:

- Severe air pollution in Skikda and Annaba from ammonia and sulfuric acid, resulting in high rates of respiratory diseases;
- Acute contamination of surface, ground and sea water in the provinces of Annaba, Skikda, Algiers and Oran (Arzew). Precise Information about pollution loads is not yet available, pollutants wich have been identified are, pesticides, chromium, zink, and solvents.

- Sever contamination of rivers and aquifers, in particular in the Kebir-Rhumel, Seybousse, Mekerra and Cheliff.
- The threat to public health from poorly managed hazardous waste and absence of facilities. Waste is disposed of in open dumps, none of wich have any environmental controls or management.

Industrial activities in Algeria is governed by several decrees issued under the environmental legislation, law 03-83 of 1983 on the protection of the environment, these decrees are:

- Decree 178-90 on environmental impact assessment.
- Decree 160-93 on wastewater discharge.
- And the decree 339-98, on the classified installations.

Although this legal framework, the lack of monitoring equipment and the absence of emission standards cause difficult to apply the legislation.

Finally, and according to the available information the environmental hotspot areas in Algeria are the cities and peripheries of Algiers, Annaba, Oran and Skikda. These areas have high population densities, poorly managed solid waste disposal and no hazardous waste sites as well as a concentration of the most important industries.

Principal sources of environmental degradation in these areas are:

- Oran/Arzew

Oil refinery, Ammonia, nitric acid, metal and textile, food industries.

- Algiers

Oil refinery, mining, tanneries, pulp and paper, power plant and metal industries.

- Annaba

Iron and steel, fertilizers, power plant.

- Skikda

Petrochemicals and oil refinery.

République Tunisienne

**Ministère de l'Industrie**

AGENCE FONCIERE INDUSTRIELLE

# ATELIER DE TRAVAIL SUR LA REHABILITATION DES ZONES INDUSTRIELLES DANS LE BASSIN MEDITERRANEEN

# REHABILITATION DES ZONES INDUSTRIELLES & NOUVELLE CONCEPTION DU ZONNING INDUSTRIEL EN TUNISIE

Mai 2000

## Présentation de l'AFI

L'Agence Foncière Industrielle, organisme public, s'est vu attribuer dès 1973 la mission de concevoir et de réaliser l'infrastructure de base nécessaire à l'implantation industrielle dans le pays comme c'est le cas pour le tourisme et pour l'habitat.

Dans le cadre de sa mission, l'AFI a pour objet de :

- Procéder aux études relatives à la détermination, à l'aménagement et à l'équipement des zones industrielles, artisanales, de petits métiers ou de services.
- Entreprendre des travaux d'infrastructures ou de superstructures lui permettant de créer des zones industrielles et de les aménager en vue de les céder aux promoteurs de projets.
- Entreprendre la construction de bâtiments industriels en vue de les vendre ou les louer à des promoteurs industriels.
- Elaborer des programmes d'aménagement de zones industrielles et d'artisanat, de services et de petits métiers, en coordination avec les autorités régionales et locales, compte tenu des objectifs et des potentialités économiques spécifiques à chaque région et en conformité avec les plans directeurs de développement urbain et territorial.

Par ces différentes actions qui lui sont assignées, l'AFI, joue un rôle primordial dans la dynamique de développement socio-économique grâce au service qu'elle fournit en faveur de la promotion des investissements et de la création d'emplois.

Après 27 ans d'activité, l'AFI présente un bilan largement satisfaisant. Il lui revient le mérite d'avoir facilité l'installation de quelques milliers d'industriels à l'intérieur de zones aménagées et d'avoir favorisé l'éclosion d'un secteur industriel aussi diversifié que performant.

La promulgation de la loi 72 portant développement des industries manufacturières et favorisant la promotion de l'investissement off-shore en Tunisie, a donné naissance à une demande accrue en terrains aménagés. L'AFI s'est trouvée dans l'obligation de répondre à ces besoins pressants dans les plus courts délais.

## Bilan de l'AFI

L'AFI a réalisé depuis sa création en 1973, ce qui suit :

- **55** zones industrielles sur tout le territoire national couvrant une superficie totale de **1800 ha** environ
- **60** bâtiments industriels couvrant une superficie de 80.000 m² et qui sont totalement vendus.

L'AFI était amenée à réaliser en moyenne et en un laps de temps très court, 5 zones / an à un rythme de **120 ha / an** environ.

Le bilan qui en a résulté était à la hauteur des objectifs escomptés puisque la Tunisie est parvenue à ériger un potentiel industriel assez important.

L'important à cette époque là, était de mettre à la disposition des promoteurs des terrains aménagés dans les meilleurs délais, d'assurer le développement de l'investissement pour la création de l'emploi, la promotion de l'exportation et l'incitation à la décentralisation et ce au détriment même de la qualité des infrastructures, chose qu'on peut la qualifier de légitime pour un pays qui cherche à développer l'investissement et à assurer une croissance économique rapide.

L'objectif primordial était, donc, de soutenir le développement de l'industrie, tout en ignorant la réglementation de l'exploitation de ces zones .

Or, l'absence d'entretien et de maintenance des zones industrielles créées et l'exploitation poussée et non réglementaire des équipements réalisés ont contribué à la détérioration des infrastructures et des viabilités réalisées et ont affecté le milieu environnemental.

Cette implantation industrielle réalisée selon un rythme soutenu, s'est effectuée souvent au détriment de la protection de l'environnement, question totalement ignorée à l'époque.

## Zones industrielles - Une approche novatrice

Pour assurer un développement soutenu de son industrie, la Tunisie a opté pour une approche novatrice, elle vise à promouvoir un développement durable, qui concilie entre les impératifs d'une croissance économique rapide et le besoin impérieux de préserver l'équilibre du milieu naturel.

Aussi, L'ouverture de l'économie Tunisienne sur l'extérieur, les implications des Accords l'Uruguay Round et l'institution d'une zone de libre échange avec l'Union Européenne conduisent à un ancrage de l'économie Tunisienne au marché international et à un accroissement de la pression concurrentielle sur les entreprises.

De ce fait, l'Entreprise Tunisienne se doit s'adapter à ce nouveau contexte d'ouverture afin d'affronter la concurrence extérieure sur son propre marché et de conquérir d'autres marchés.

A cet effet, le Gouvernement Tunisien a mis en place un programme de Mise à Niveau visant l'amélioration de la compétitivité de l'Entreprise par sa modernisation et par le développement de son environnement . Le programme a porté sur les actions suivantes :

* Réhabilitation des zones industrielles existantes

* Nouvelle conception du zonning industriel

**Réhabilitation des zones industrielles**

Le programme de réhabilitation et de modernisation des zones industrielles contribue à la restructuration, la modernisation et à la mise à niveau de l'environnement de l'Entreprise et par conséquent à l'amélioration de sa compétitivité.

En outre, l'amélioration de l'environnement industriel est devenue impérative en raison de l'ampleur des dégradations occasionnées à l'environnement par les rejets industriels non traités au préalable. Elle vise à protéger le milieu urbain contre toute nouvelle atteinte nuisible à son équilibre humain et écologique et à réconcilier les zones industrielles avec leur milieu environnant.

A cet effet, il est primordial d'accorder un intérêt particulier pour l'amélioration de la qualité des infrastructures des zones industrielles et de compléter les viabilités manquantes pour répondre ainsi aux normes de compétitivité internationales et aux exigences écologiques, représentant un facteur déterminant dans l'attrait de l'investissement direct étranger et le développement du partenariat.

Dans ce contexte, un programme de réhabilitation de l'ensemble des zones industrielles existantes a été arrêté.

La visite de Monsieur le Président de la République du 15 Décembre 1992 dans la zone industrielle de BEN AROUS, qui fût suivie d'un Conseil Ministériel Restreint a marqué le coup d'envoi de tout un processus en matière d'aménagement et de réhabilitation de la zone industrielles.

L'intérêt présidentiel pour les zones industrielles s'est encore manifesté le 12 Février et le 17 Mars 1993, dates auxquelles deux Conseils Ministériels Restreints ont de nouveau examiné ce dossier devenu au fil du temps prioritaire.

Le premier grand résultat de cet intérêt fût la mise au point par l'AFI d'un plan d'action ambitieux portant sur la réhabilitation et la régularisation de la situation foncière des anciennes zones industrielles et l'engagement d'un programme d'aménagement de nouvelles zones industrielles.

La réhabilitation des anciennes zones est devenue impérative en raison de l'ampleur des faits suivants :

-Détérioration des réseaux de voiries
-Dégradations occasionnées à l'environnement par les rejets industriels non traités au préalable.
-Colmatage des réseaux d'assainissement des eaux usées et des eaux pluviales.
-Déversement des eaux industrielles dans le milieu naturel.
-Manque de certaines viabilités.
-Absence des réseaux d'assainissement ONAS pour certaines zones.
-Rejet des eaux industrielles polluées directement dans les réseaux d'assainissement sans traitement .

**Objectifs des projets de réhabilitation**

La réhabilitation des zones industrielles vise essentiellement à :

-Doter les zones industrielles des équipements nécessaires aux investisseurs
-Protéger le milieu naturel et urbain contre toute nouvelle atteinte nuisible à son équilibre humain et écologique
- Réconcilier les zones industrielles avec leur milieu environnant
-Créer des conditions favorables à l'investissement

**Consistance des travaux de réhabilitation des zones industrielles**

Les travaux de réhabilitation des zones consistent à :

- Reprendre tous les réseaux d'infrastructure accusant d'importantes détériorations (voiries, réseaux d'assainissements, de drainage des eaux pluviales, d'éclairage public, réseaux anti-incendie, etc... )

- Doter les zones des infrastructures de base manquantes

- Intercepter le déversement des eaux usées industrielles non contrôlées dans le milieu naturel

**Programme de réhabilitation des zones industrielles**

Le programme de réhabilitation des zones industrielles porte sur la réhabilitation de 75 zones couvrant une superficie globale de **2750 ha** et pour un investissement de **84 MD**, dont **38** zones aménagées par l'AFI.

Dans le but de faciliter la réalisation du programme, l'AFI a procédé à la décomposition de l'ensemble des zones concernées en trois lots, en fonction des critères suivants :

- L'état de dégradation des infrastructures
-Le taux d'occupation de la zone
-L'importance économique de la zone
-Les effets néfastes de la zone sur l'environnement

Ainsi, les trois lots sont comme suit :

**-Lot N°1** :il comporte **18** zones couvrant une superficie de **1331 Ha**, représentant **48 %** de la superficie globale et pour un investissement de **33 MD**

**-Lot N°2** : il comporte **28** zones couvrant une superficie de **955 Ha**, représentant **35 %** de la superficie globale et pour un investissement de **32 MD**

**-Lot N°3** : il comporte **29** zones couvrant une superficie de **464 Ha**, représentant **17 %** de la superficie globale et pour un investissement de **19 MD**

**Réalisations**

A ce jour, le programme a marqué les réalisations suivantes:

-Achèvement des travaux de réhabilitation de **14** zones industrielles couvrant une superficie de **853 ha** ce qui représente **31 %** de la superficie globale

-Les travaux de réhabilitation sont en cours pour **4** zones industrielles couvrant une superficie de **477 ha** ce qui représente **17 %** de la superficie globale

-Achèvement des études de réhabilitation de 8 autres zones industrielles couvrant une superficie de **341 ha** ce qui représente **12 %** de la superficie globale

**Coût des travaux réalisés**

Le coût des travaux de réhabilitation des zones achevées s'élève à **20 MD**, répartis comme suit :

- Voiries : 10,5 MD
- Réseaux des eaux usées : 3 MD
- Réseaux des eaux pluviales : 4,46 MD
- Réseaux d'éclairage public : 0,7 MD
- Aménagement des espaces verts : 1,9 MD

Le coût des travaux de réhabilitation des zones en cours s'élève à **12,9 MD**, répartis comme suit :

- Voiries : 6 MD
- Réseaux des eaux usées : 2 MD
- Réseaux des eaux pluviales : 3 MD
- Réseaux d'éclairage public : 1,2 MD
- Aménagement des espaces verts : 0,7 MD

Les viabilités réalisées dans le cadre des travaux de réhabilitation des zones industrielles pré-citées se résument comme suit:

- Voiries : **40 Km** pour un coût de **16,5 MD**
- Réseaux des eaux usées : **42 Km** pour un coût de **5 MD**
- Réseaux des eaux pluviales : **67 Km** pour un coût de **7,5 MD**

Il s'agit bien là d'exemples concrets qui traduisent le caractère novateur de la démarche arrêtée en vue de concilier développement et équilibre écologique.

Dans ce cadre là, nous saluons la prise de conscience des industriels tunisiens et étrangers et leur disposition à contribuer à la réussite des opérations de réhabilitation de ces zones et nous soulignons l'importance de la mission dévolue aux Groupements de Maintenance et de Gestion dans la sauvegarde des zones industrielles.

**Cadre juridique**

ce programme a été engagé sur la base d'un cadre juridique ayant fixé les règles régissant la réhabilitation, la maintenance et la gestion des zones industrielles en prévoyant notamment la création dans chaque zone industrielle d'un groupement de maintenance et de gestion.

Il s'agit de la loi N°94 -16 du 31/01/94 relative à l'aménagement et à la maintenance des zones industrielles et de ses 3 décrets d'applications, ainsi que le décret N°94 - 1935 du 19/09/94 portant approbation du cahier des charges relatif à l'aménagement et à la maintenance des zones et des bâtiments industriels.

Cette loi constitue aujourd'hui, le cadre réglementaire susceptible de sauvegarder l'environnement .

Conformément à la loi N°94 - 16 du 31 Janvier 1994 relative à l'aménagement et à la maintenance des zones industrielles, des Groupements de Maintenance et de Gestion (GMG) ont été constitués. Jusqu'à aujourd'hui, **49 GMG** ont été déjà constitués.

**Suivi des projets de réhabilitation des zones industrielles**

Les projets de réhabilitation sont définis, programmés et exécutés sous la supervision d'un comité présidé par le Gouverneur de la région et constitué des GMG, des collectivités locales et des services publics concernés.

Le Groupement de Maintenance et de Gestion de la zone industrielle est le Maître de l'ouvrage.

Pour la majorité des projets réalisés, l'AFI a été désigné comme Maître d'ouvrage délégué dans le cadre d'une convention établie avec le GMG concerné.

Le suivi des études de réhabilitation, qui sont réalisés par des Bureaux d'études privés, est assuré par l'AFI conjointement avec les différents organismes et administrations concernés (ONAS, STEG, SONEDE, PTT, MEH, Municipalités, etc...)

Le suivi de l'exécution des travaux de réhabilitation, est assuré par l'AFI et le Bureau de contrôle conjointement avec les différents organismes et administrations concernés (ONAS, STEG, SONEDE, PTT, MEH, Municipalités, etc...).

Après l'achèvement des travaux de réhabilitation, l'AFI procédera à la rétrocession des viabilités réhabilités au GMG et aux organismes concernés afin de prendre en charge et d'assurer la maintenance des réseaux qui leurs reviennent. Et ce conformément aux dispositions de l'article 32 du décret N°94/1935 du 19 Septembre 1994 portant approbation du cahier des charges relatif à l'aménagement et à la maintenance des zones et des bâtiments industriels.

L'AFI a contribué à toutes les phases de l'opération de réhabilitation de la quasi-totalité de ces zones en tant que maître d'ouvrage délégué auprès des **GMG** (maître d'ouvrage).

**Financement des projets de réhabilitation des zones industrielles**

La loi 94/16 du 31 janvier 1994 a institué le cadre légal de la réhabilitation des zones industrielles.

En effet, un Groupement de Maintenance et de Gestion (GMG) sera constitué dans chaque zone industrielle auquel adhérent tous les occupants, exploitants et propriétaires d'immeubles.

Il s'agit d'une association d'intérêt collectif, à but non lucratif, chargée de la réhabilitation, de la maintenance et de la gestion de la zone industrielle dont elle appartient.

En cas de défaillance de la part des occupants, exploitants et propriétaires d'immeubles, dans le versement de leurs contributions aux opérateurs de réhabilitation de la zone industrielle, les sommes dues peuvent être recouvrées et liquidées définitivement par voie d'états de liquidation rendus exécutoires par le Ministre chargé de l'Industrie.

**Difficultés et contraintes**

L'expérience vécue, jusqu'à présent, dans les projets engagés a montré que le problème majeur rencontré dans la plupart des cas est celui relatif à la collecte des contributions des industriels pour diverses raisons et notamment au niveau des entreprises en difficulté, les lots non encore occupés, les bâtiments fermés et la réticence de certains industriels .

En effet, certains GMG ont rencontré des difficultés dans l'opération de collecte des contributions pour assurer la continuité des travaux et leur achèvement dans les délais et cela en l'absence d'une source de financement qui pourra aider les GMG et les industriels à honorer leurs engagements et à réaliser leurs projets dans de bonnes conditions et dans les délais requis.

## Nouvelle conception du zonning industriel

Pour que l'industrie tunisienne devienne compétitive au niveau international, plusieurs transformations structurelles doivent être engagées au niveau de l'environnement industriel.

Outre l'amélioration de la qualité du produit, la maîtrise technologique et la maîtrise des coûts, l'entreprise a besoin également, d'une infrastructure de qualité et d'un environnement accueillant et favorable à la production.

Ainsi, et compte tenu des lacunes relevées dans ses actions antérieures, l'AFI a conçu l'aménagement de nouvelles zones industrielles selon un concept nouveau.

Ces zones seront conçues en tant que parcs d'activités où seront installés des équipements de lutte contre la pollution (stations de prétraitement, d'épuration, etc...), des centres de vie, ainsi que des espaces verts pour rendre ces zones attractives.

Conformément au décret n° 91-362 du 31 Mars 1991, tout projet d'aménagement industriel ou de réalisation d'unité industrielle , agricole ou commerciale fait l'objet d'une étude d'impact reflétant l'incidence prévisible du projet sur l'environnement. Cette étude est soumise à l'ANPE pour approbation.

Toujours dans sa nouvelle conception du zonning industriel, l'AFI procède au classement de ses lotissements futurs selon leur faisabilité et leur spécificité d'affectation en:

-Zones d'activités non polluantes et de haute gamme avec apport technologique.

-Zones d'activités industrielles diverses et de services.

-Micro zones pour les petits métiers.

Au niveau de la vocation des lotissements futurs, l'AFI s'est engagée, également, dans une série de concertation avec plusieurs partenaires et intervenants à étudier en commun les perspectives de créer des espaces d'activités spécifiques tels que les technopôles et les pépinières d'entreprises ainsi que les mini zones pour l'artisanat, les petits métiers et les services.

Ces concertations constituent déjà une première ébauche pour la concrétisation de projets pilotes et ceci en assurant des viabilités de haute gamme susceptibles de préserver la qualité de vie et l'équilibre écologique et en permettant à l'infrastructure tunisienne de répondre aux exigences internationales et d'atteindre le niveau des performances européennes (cas des zones industrielles de M'ghira et de Thyna).

## Nouveau Programme d'aménagement de zones industrielles

Le programme d'aménagement de zones industrielles, durant la période du Ixème plan, porte sur la réalisation de **25** zones industrielles couvrant une superficie globale de **703,5 ha** et pour un investissement de **177 MD** environ répartis comme suit :

- 6 zones dans le Grand Tunis, couvrant une superficie de 364 ha

-11 zones dans le littoral, couvrant une superficie de 258 ha

-8 zones dans l'axe médian et intérieur, couvrant une superficie de 96 ha.

## Recommandations

Toutefois, le programme de réhabilitation des zones industrielles, la nouvelle conception d'aménagement industriel et la mise en oeuvre des nouvelles réglementations pour la sauvegarde de l'environnement nécessitent la multiplication des efforts de tous les intervenants afin d'assurer la réalisation des objectifs tracés.

A cet effet, il est recommandé d'axer les efforts sur :

- Le renforcement des campagnes de sensibilisation des industriels sur les problèmes environnementaux engendrés par leurs activités.

- L'incitation des industriels à respecter les normes des rejets :
l'obligation pour toute unité industrielle polluante (rejets toxiques) d'être équipée par une station de prétraitement avant le rejet dans le réseau public.

- L'établissement d'un programme de gestion et de collecte sélective des déchets solides des unités industrielles ou autres pour leur réutilisation ou leur recyclage.

- L'interdiction de toute nouvelle implantation industrielle hors zone spécialement aménagée pour l'industrie.

- L'amélioration de l'aspect esthétique des bâtiments industriels dont l'architecture et la configuration doivent être insérées dans le paysage urbain.

- La généralisation de la mise en place des Groupements de Maintenance et de Gestion dans les zones industrielles, afin que les industriels puissent mieux gérer leur espace commun.

- L'introduction de la composante environnementale dans le processus de production de l'entreprise, c.à.d l'entreprise doit prendre en charge les procédures et les moyens utiles permettant la protection de l'environnement.

Enfin, l'aménagement de nouvelles zones et la réhabilitation des zones industrielles existantes a pour objectif d'accroître le potentiel industriel du pays et de mettre en place une plate - forme propice à l'investissement et à la préservation de l'environnement.

**USE OF GIS, REMOTE SENSING AND DECISION SUPPORT SYSTEMS FOR LANDSCAPE MONITORING AND ENVIRONMENTAL MANAGEMENT OF COASTAL AREAS**
(CASE STUDIES PRESENTATION)

Area of Earth, Environmental and Marine Sciences and Technologies
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**Case Study for the Region of Tunis- Bizerte, Tunisia**

M. Ghribi

## INTRODUCTION

The Tunisian coastline has for years seemed infinite in its capacity to support human pressures, hosting a variety of activities including habitation, recreation, industrialization, tourism and shipping among others.

This concentration of resource-use, stemming from activities of socio-economic nature, is giving rise to a series of environmental problems linked to the extreme fragility of coastal ecosystems and non-rational resource use that are the main causes of environmental degradation.



High expectations are now required of an Integrated Information Technology (IT) including Geographic Information Systems (GIS), Remote Sensing, Networking and Internet facilities for developing a planning system, which aims to accommodate multiple and often conflicting activities on the coast.

As a contribution to decision-making, the present work provides a Multi-Criteria Evaluation for Urban Management and Industrial Siting in Tunisia.

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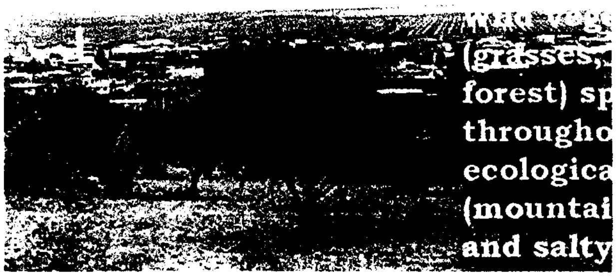



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## Multi-Criteria Evaluation for Industrial Siting

**Concept**
Decisions about the siting of industries typically involve the application of Multi-Criteria Algorithm based on logical PAIRWISE comparison.
GIS offers the opportunity to apply decision-making processes in a more enhanced and integrated context.

**Aim**
To design suitability map of industrial sensitivity of the coastal zone of the region Tunis-Bizerte.



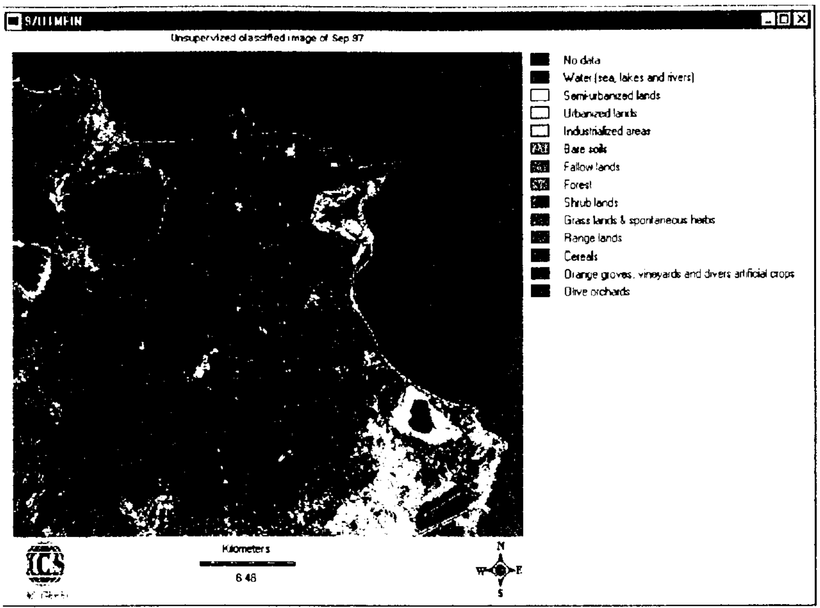
**Methodology**
Investigation of interactive effects by contributing factors and constraints that may enhance or decrease industrial susceptibility.

Factors contributing to the change of industrial susceptibility include:

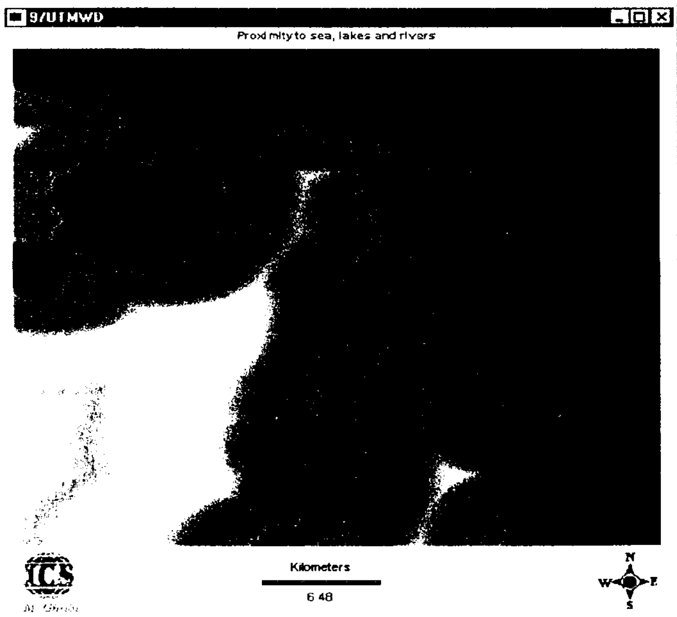
- **Proximity to main industrial sites**
- **Proximity to main residential sites**
- **Proximity to main roads**
- **Proximity to water (sea, lakes and rivers)**
- **Proximity to protected forest & national parks**
- **Proximity to bares lands**

The output will consist of a number of categories, each reflecting its susceptibility to the installation of new industries.

## Classified Landsat image of Sep-97




## Proximity to water (sea, lakes and rivers)



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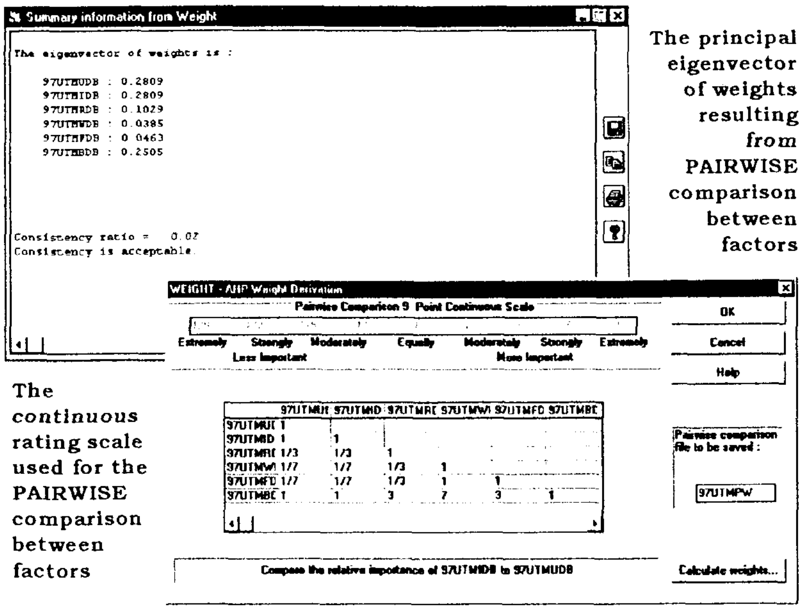


The principal eigenvector of weights resulting from PAIRWISE comparison between factors

The continuous rating scale used for the PAIRWISE comparison between factors

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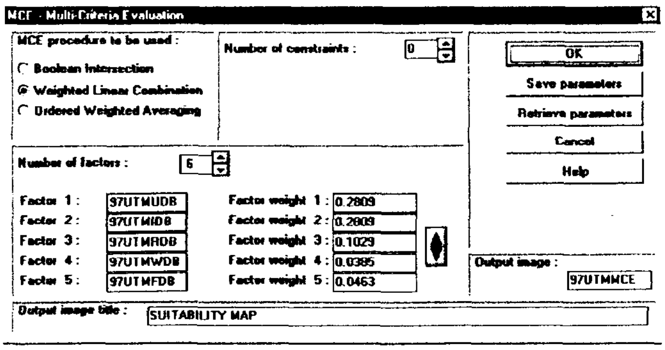
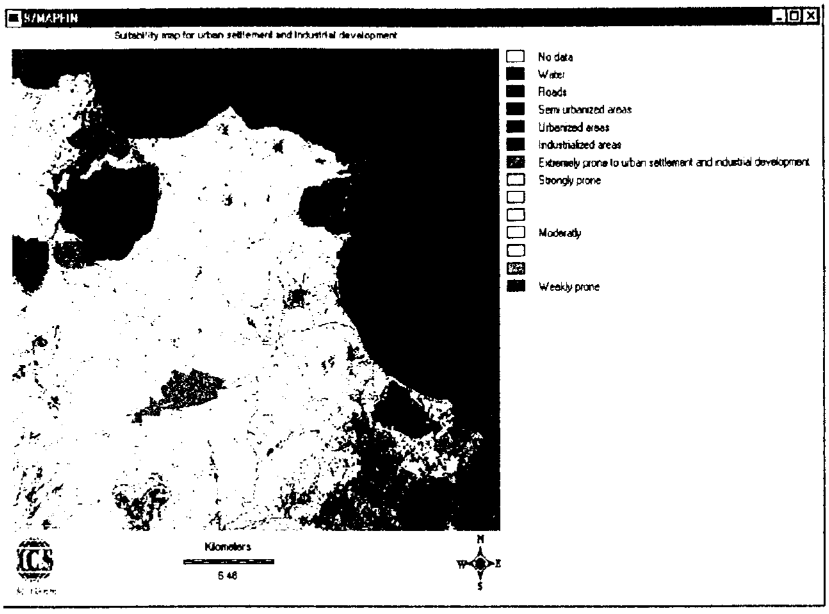
## Multi-Criteria Evaluation procedure



## Industrial siting suitability map

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## Multi-Criteria Evaluation for Urban settlement

The aim is to allocate prone lands for urbanization according to:

* **Some factors;**

1. Proximity to Residential sites (urban areas and commercial centers...)
2. Proximity to Industrial zones
3. Proximity to Main roads
4. Proximity to Rivers
5. Proximity to water points (lakes and sea)
6. Elevation

* **Some constraints;**

Reserved lands (Urban, beaches, Water and Salty lake) are excluded

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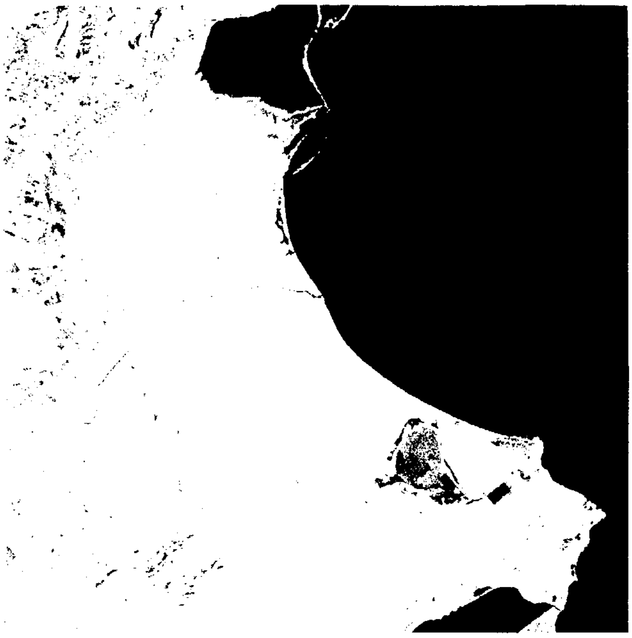

Landsat Thematic Mapper, September 1997

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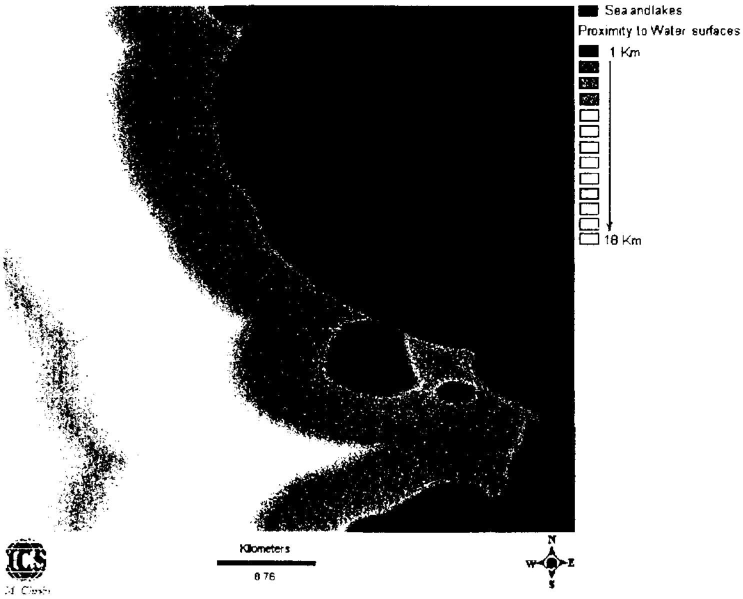
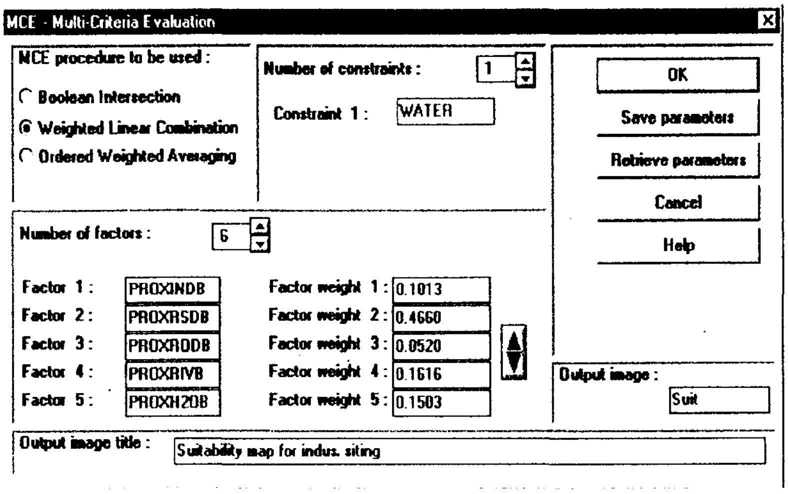
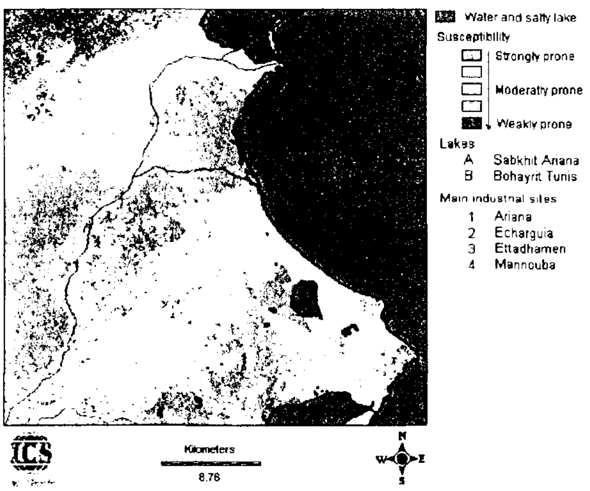
## Proximity to Coast

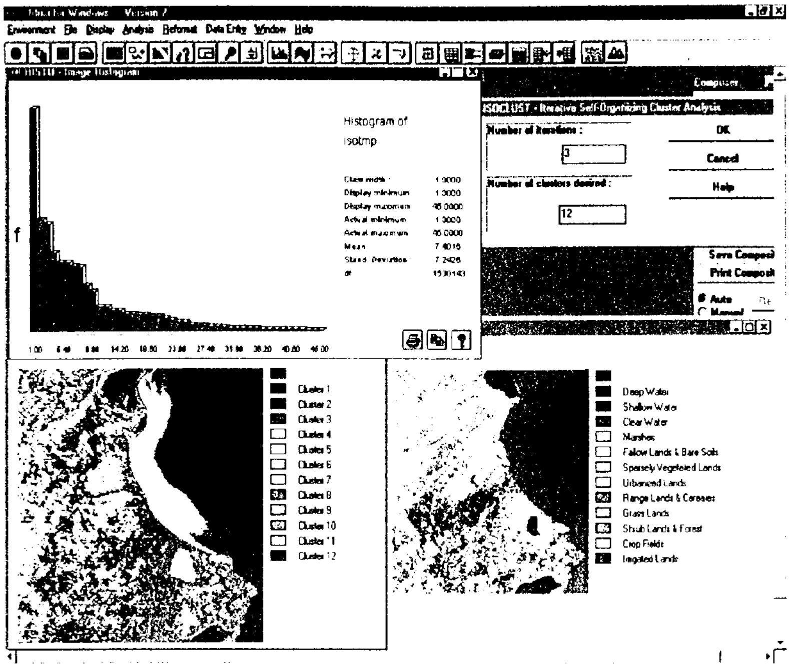




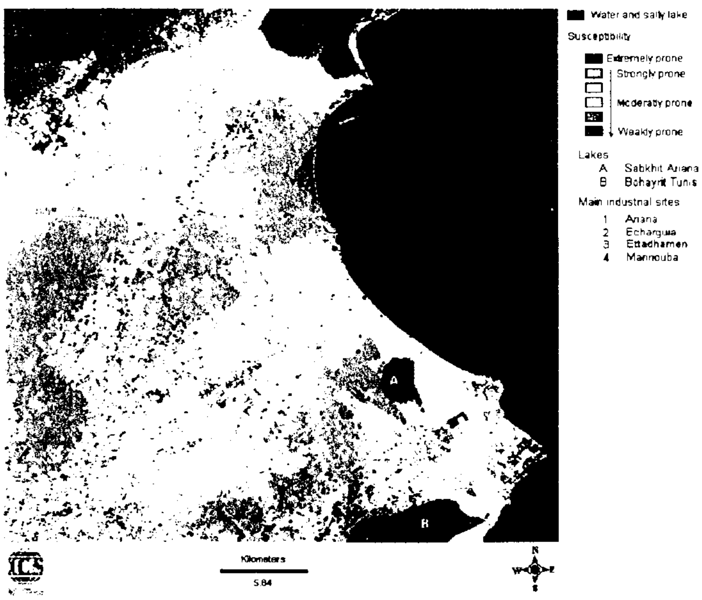

*Multi-Criteria Evaluation using Weighted Linear Combination*

## Preliminary Suitability Map






## Final Suitability Map



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## Hazardous waste analysis

**Purpose**

The aim is to improve the decisions concerning prioritization of sites for a remedial response to hazardous waste. In course to achieve this goal a cluster analysis was made to reflect the degree of similarity between the main industrial sites.

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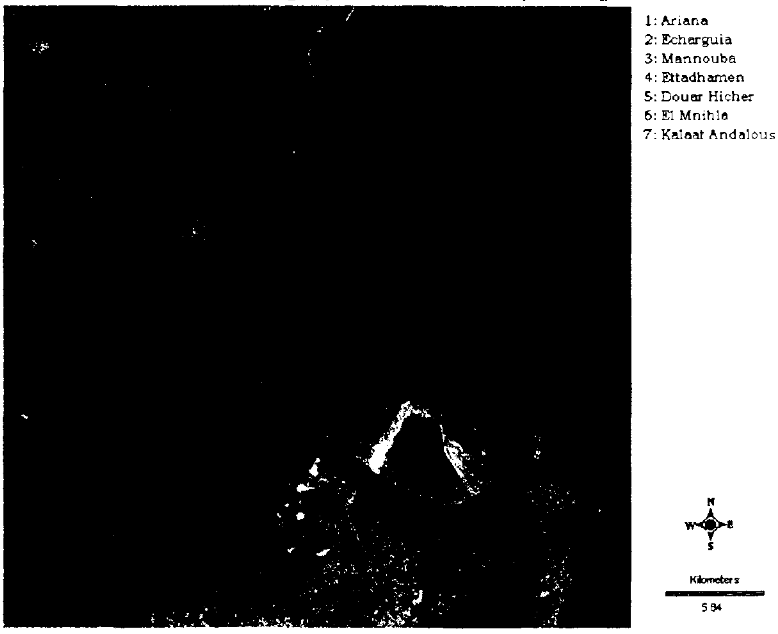
## Identification of Main Industrial Sites using satellite image (LANDSAT 5 TM) of September 1997



## Existing activities per main industrial sites

| | Activity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Miscellaneous | | | |
| | Textile & Garment / Leather & shoes | Agro-alimentary | Mechanical & Electrical | Construction materials / Glass & ceramics | Chemical | Pharmaceutical works | Hospital and medical clinics | Municipal or/& industrial landfills | Scientific laboratories etc... |
| **Industrial sites** | | | | | | | | | |
| Ariana | 29 | 16 | 10 | 3 | 2 | 13 | | | |
| Echarguia | 125 | 73 | 44 | 13 | 11 | 53 | | | |
| Mannouba | 30 | 17 | 11 | 4 | 3 | 13 | | | |
| Ettadhamen | 19 | 12 | 6 | 3 | 1 | 8 | | | |
| Douar Hicher | 43 | 26 | 15 | 5 | 4 | 19 | | | |
| El Mnihla | 10 | 6 | 3 | 1 | 1 | 5 | | | |
| Kalaat Andalous | 5 | 3 | 2 | 1 | 1 | 3 | | | |
| **Typical hazardous waste** | Sludge containing heavy metals | Pesticides & manure / contaminated filters | Sludge containing heavy metals | Building and soil material | Solvents/ halogenated residues/ sludge/ tars aqueous waste | Halogenous & halogen free solvents | Infectious waste, radioactive material | Domestic or industrial wastes | Wide range of hazardous materials usually in relatively small quantities |
| **Nature of hazards** | Pollution by toxic | Pollution by toxic/ infection | Pollution by toxic | Pollution by toxic & odorous substances | Fire/ explosion/ pollution by toxic | Pollution by toxic | Pollution by toxic/ micro-organisms/ radiation | Fire/ explosion/ pollution by toxic | Pollution by toxic/ infection/ radiation |
| **Potential impact** | Soil and water contamination | Soil and water contamination, bio-accumulation & persistence in environment | Soil and water contamination | Soil and water contamination | Soil, water & air contamination | Soil, water & air contamination | Soil and water contamination | Soil, water & air contamination | Soil, water & air contamination |
| **Potential health impacts** | Chronic & acute illnesses through intake of pollutants through water supply and food chain | Chronic & acute illnesses through inhalation and intake of pollutants through water supply and food chain | Chronic & acute illnesses through intake of pollutants through water supply and food chain | Chronic & acute illnesses through intake of pollutants through water supply and food chain | Chronic & acute illnesses through inhalation and intake of pollutants through water supply and food chain | Chronic & acute illnesses through intake of pollutants through water supply and food chain | acute illnesses through inhalation and intake of pollutants through water supply and food chain | Chronic & acute illnesses through inhalation and intake of pollutants through water supply and food chain | Chronic & acute illnesses through inhalation and intake of pollutants through water supply and food chain |

Tunisian Ministry of International Cooperation and External Investment (1998) Inventory.

IAEA (1996) Manual for the classification and prioritization of risks due to major accidents in process and related industries, International Atomic Energy Agency (IAEA).

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## Matrix A (Industrial sites, Activity)

| | | Activity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Textile & Garment / Leather & shoes | Agro-alimentary | Mechanical & Electrical | Construction materials / Glass & ceramics | Chemical | Miscellaneous |
| **Industrial Sites** | Ariana | 29 | 16 | 10 | 3 | 2 | 13 |
| | Echarguia | 125 | 73 | 44 | 13 | 11 | 53 |
| | Mannouba | 30 | 17 | 11 | 4 | 3 | 13 |
| | Ettadhamen | 19 | 12 | 6 | 3 | 1 | 8 |
| | Douar Hicher | 43 | 26 | 15 | 5 | 4 | 19 |
| | El Mnihla | 10 | 6 | 3 | 1 | 1 | 5 |
| | Kalaat Andalous | 5 | 3 | 2 | 1 | 1 | 3 |

## Matrix B (Activity, Potential Impact)

| | Sludge containing heavy metals | Pesticides & manure / contaminated filters | Building and soil material | Solvents/ halogenated residues/ sludge/ tars aqueous waste | Wide range of hazardous materials usually in relatively small quantities Domestic or industrial | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Textile & Garment / Leather & shoes | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Agro-alimentary | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| Mechanical & Electrical | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| Construction materials / Glass & ceramics | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Chemical | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Miscellaneous | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |

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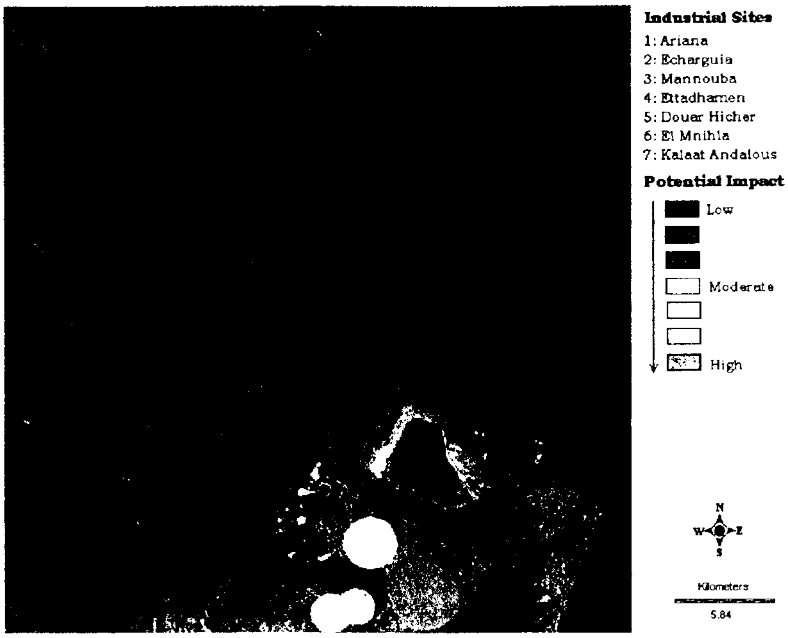
## Matrix AB = Matrix A x Matrix B

## (Industrial Sites, Potential Impact)

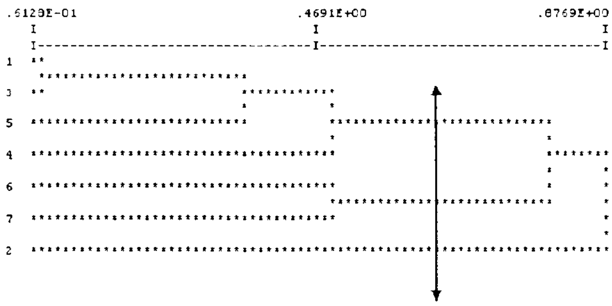
| | Sludge containing heavy metals | Pesticides & manure / contaminated filters | Building and soil material | Solvents/ halogenated residues/ sludge/ tars aqueous waste | Wide range of hazardous materials usually in relatively small quantities Domestic or | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ariana | 41 | 16 | 3 | 44 | 13 | 73 | 29 | 47 | 15 | 23 | 73 | 16 | 15 | 55 | 31 |
| Echarguia | 180 | 73 | 13 | 189 | 53 | 319 | 126 | 202 | 64 | 97 | 319 | 73 | 64 | 235 | 137 |
| Mannouba | 44 | 17 | 4 | 46 | 13 | 78 | 30 | 50 | 16 | 24 | 78 | 17 | 16 | 58 | 33 |
| Ettadhamen | 26 | 12 | 3 | 28 | 8 | 49 | 20 | 31 | 9 | 14 | 49 | 12 | 9 | 36 | 21 |
| Douar Hicher | 62 | 26 | 5 | 66 | 19 | 112 | 45 | 71 | 23 | 34 | 112 | 26 | 23 | 82 | 49 |
| El Mnihla | 14 | 6 | 1 | 16 | 5 | 26 | 11 | 17 | 6 | 8 | 26 | 6 | 6 | 19 | 12 |
| Kalaat Andalous | 8 | 3 | 1 | 9 | 3 | 15 | 6 | 10 | 4 | 5 | 15 | 3 | 4 | 11 | 7 |

## Potential impact for each industrial site



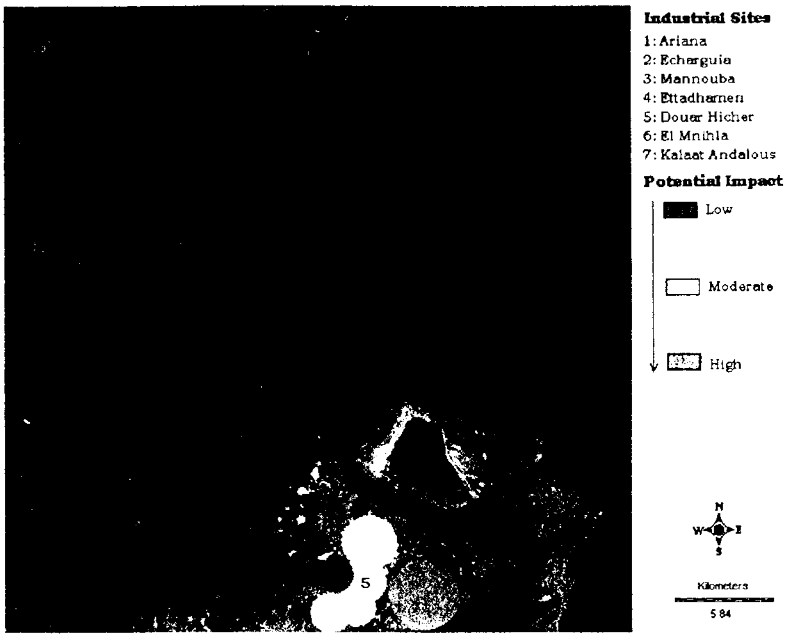

## Hierarchical clustering classification

Dendrogram of objects




1 Ariana
2 Echarguia
3 Mannouba
4 Douar Hicher
5 Ettadhamen
6 El Mnihla
7 kalaat Andalous

## Potential impact per each cluster

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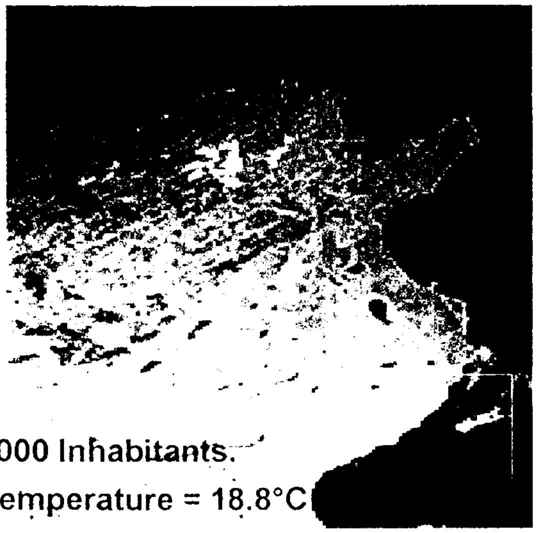
## Case Study for the Governorate of Sfax, Tunisia

M. A. Tlili

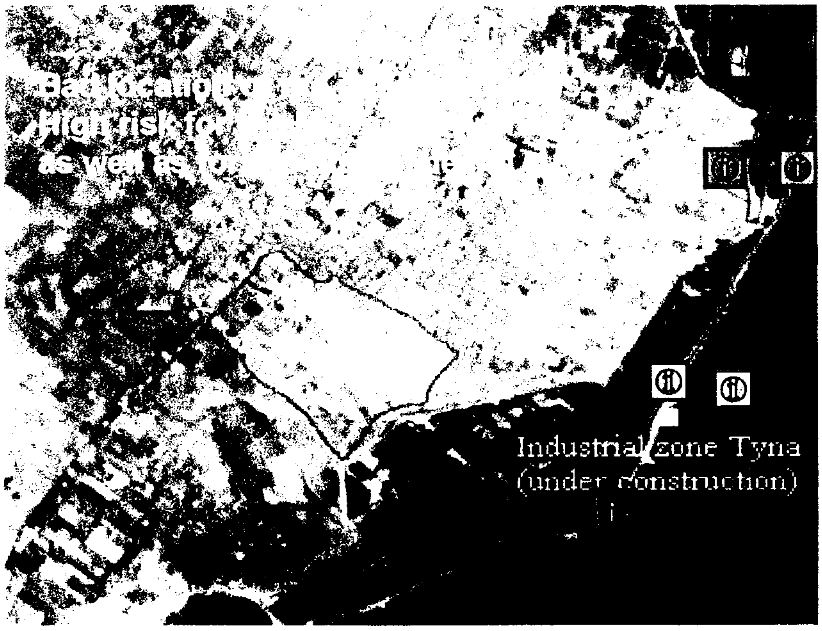
UNIDO ICS International Centre for Science and High Technology

## Study Area Presentation

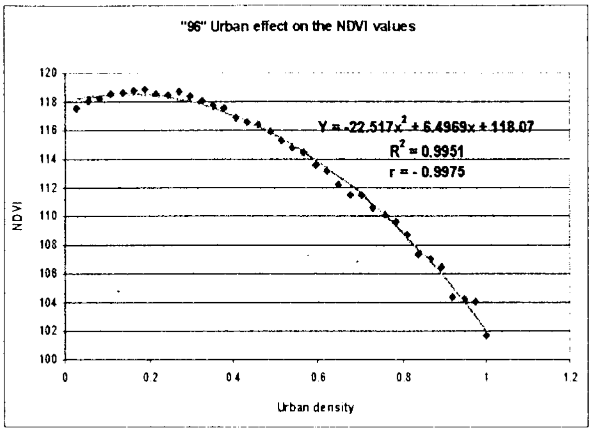


- Coastal zone
- More than 500.000 Inhabitants.
- Mean Annual Temperature = 18.8°C
- Mean Annual Precipitation = 200mm
- Semi- arid bioclimatic stage

## Industrial Space



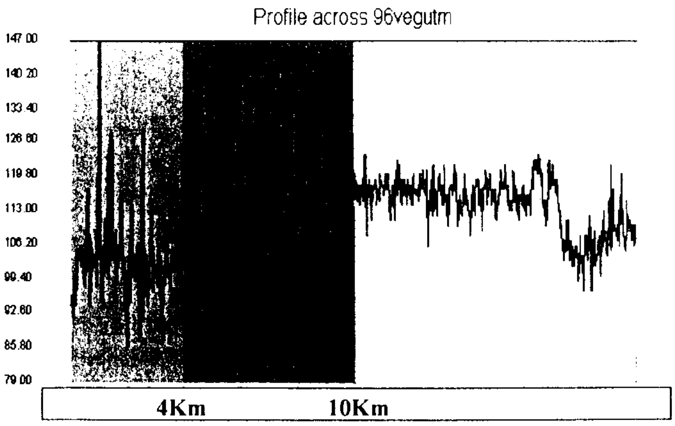
## Urban Impact on NDVI Values




The higher is the urban density the lower is the NDVI value

## East/West Spatial Profile of the NDVI

NDVI



## Urban Effect on Landscape Fragmentation

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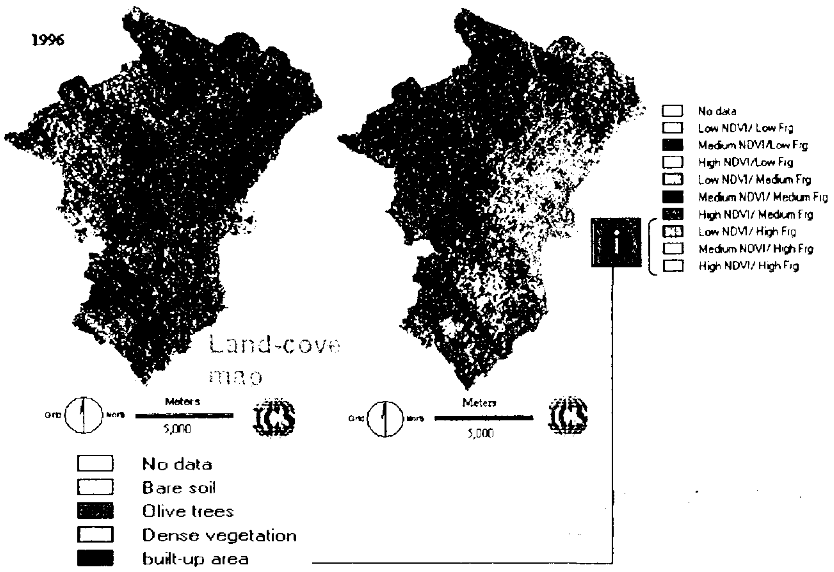
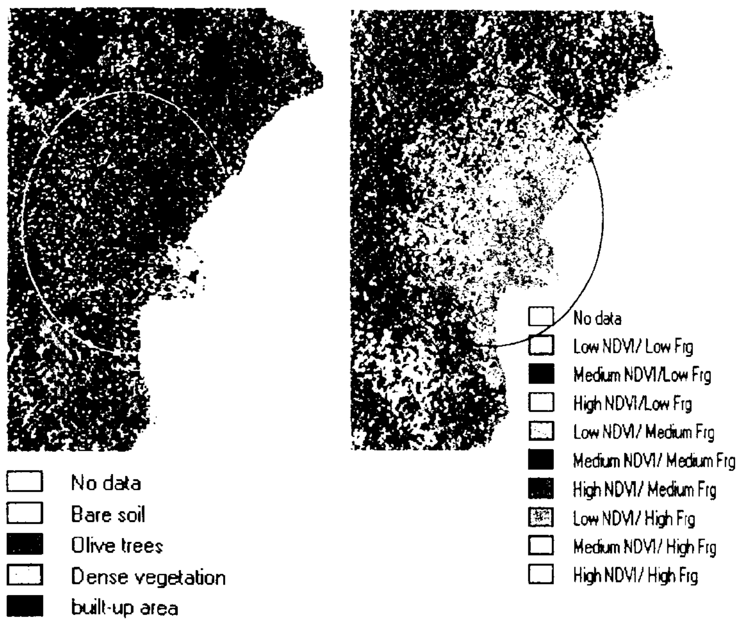



International Centre for Science and High Technology

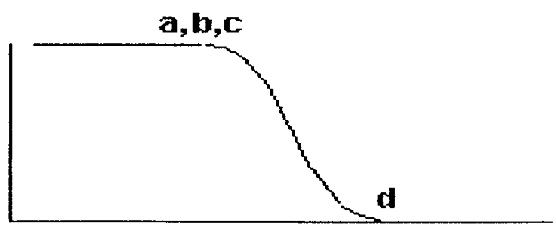
UNIDO



## Criteria Selection for Urban Siting

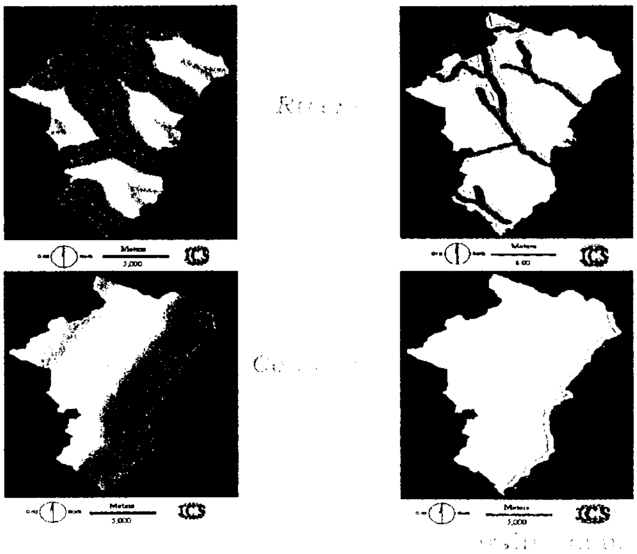
- Respect the proximity to the coast
- The transport accessibility (Roads)
- Far enough from the existing industrial zones
- Avoid the flood hazards (Rivers)
- Maintain a connected urban pattern

## Sigmoidal Function




**The Sigmoidal function used is:** $m = \cos^2 \alpha$
**Where, in the case of a monotonically decreasing function:**
$\alpha$ **is defined as:** $\alpha = (x - \text{point } a) / (\text{point } d - \text{point } a) * \Pi/2$
**When** $x < \text{point } a$, $m=1$.

## Factors Fuzzy Standardization



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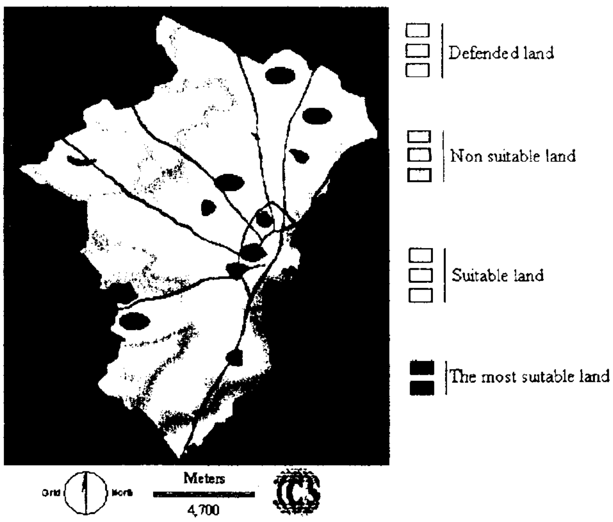
## Housing Suitability Map

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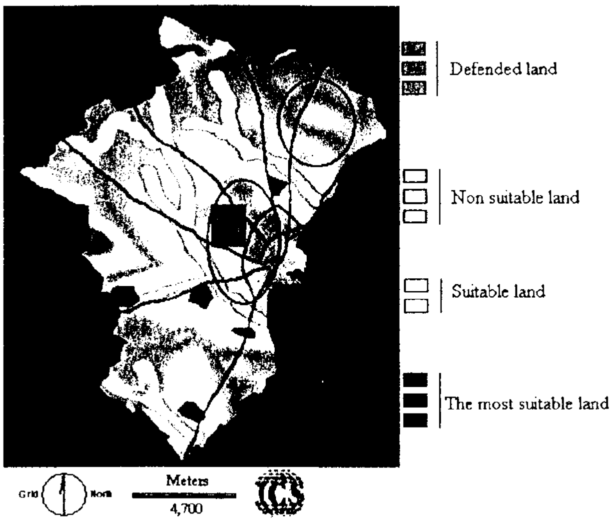
## Deciding for the New Industrial Sites

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## Case Study for Monfalcone, Italy

A. Altobelli

## A GIS application for industrial ecology

GIS and spatial pattern analysis methods can be used for facilitating industrial planning and environmental control.

The study area is located in Monfalcone (GO). A highly industrialized municipality in North East Italy. Central to the industrial development of the area are: an important shipyard, an engineering company specialized in the manufacture of electric motors and an oil and coal-fired power station. A considerable number of other factories contribute to the creation of a substantial source of potential pollution.

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## Study Area Presentation

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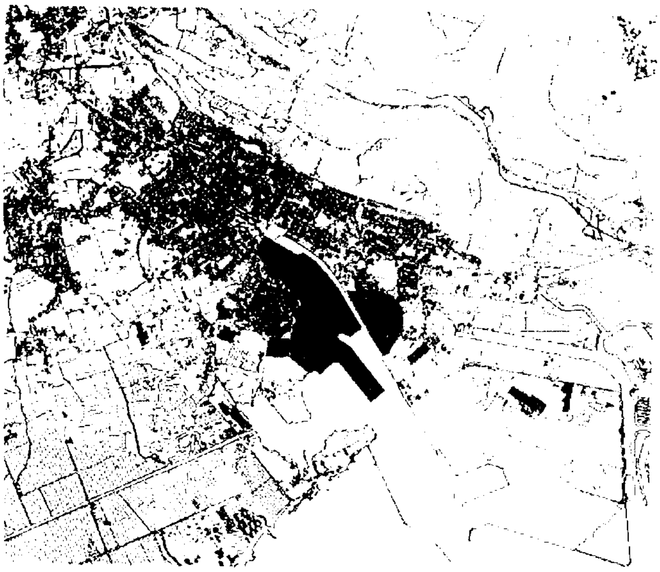
## Industrial Area of Monfalcone



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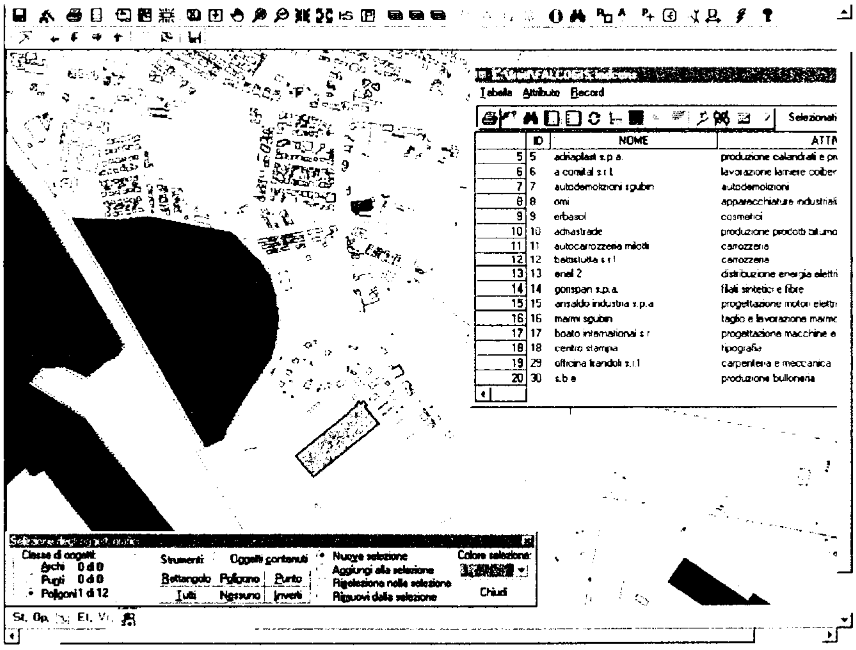
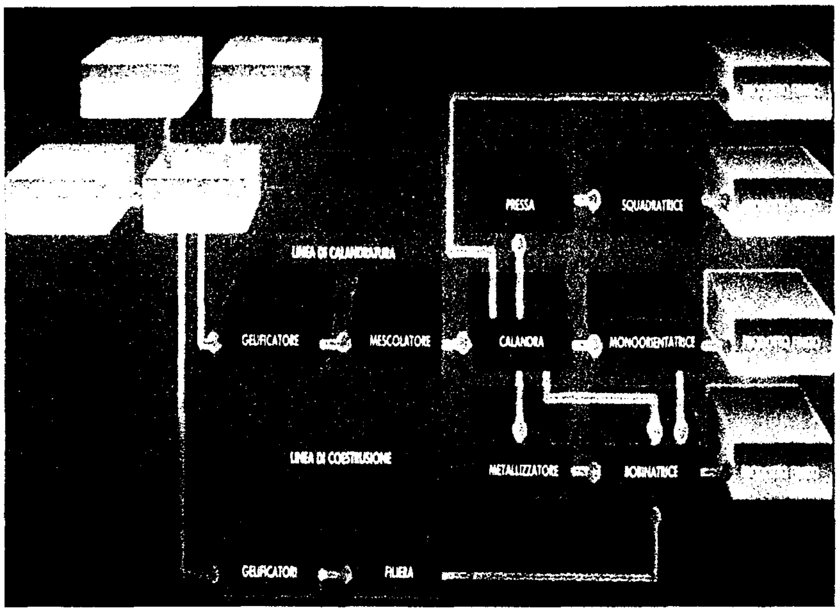
## Data base construction for the Industrial Area



## ADRIAPLAST Production System Plan

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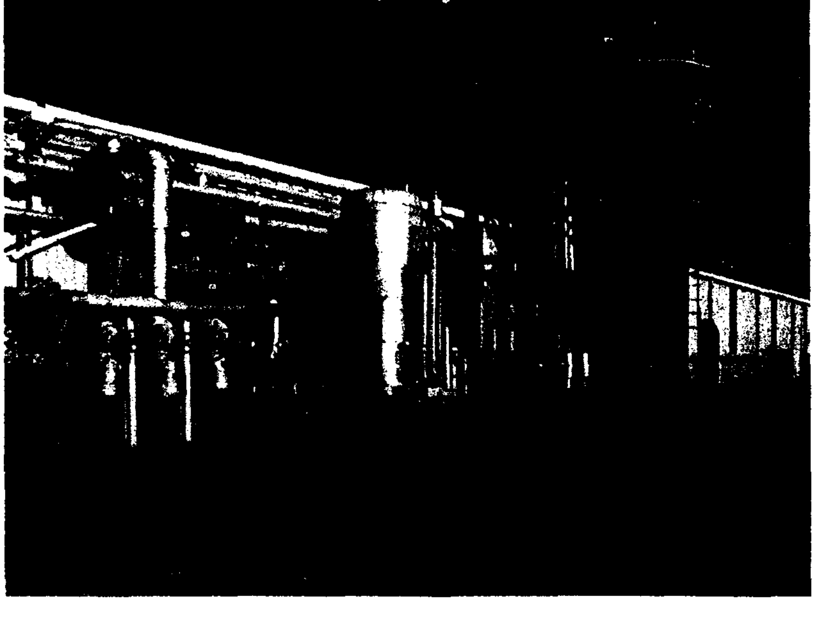
## ADRIAPLAST Monfalcone, Italy



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## Case Study for the municipality of Koper, Slovenia

M. Russi

UNIDO ICS International Centre for Science and High Technology

## INTRODUCTION

- Slovenia is mainly a continental state, **the total length of the coastline, all facing the Bay of Trieste, is only 46 km**. This small coastal area is of strategic economic and political importance for the whole country. Three towns *have developed there: Koper (administrative center of the area,* industry and harbour activities), Izola (tradition in the fishing industry (cannery)), Piran and neighbouring Portoroz (highly developed tourist center) and smaller settlements and tourist facilities between them, so the entire coast is one large urban area.

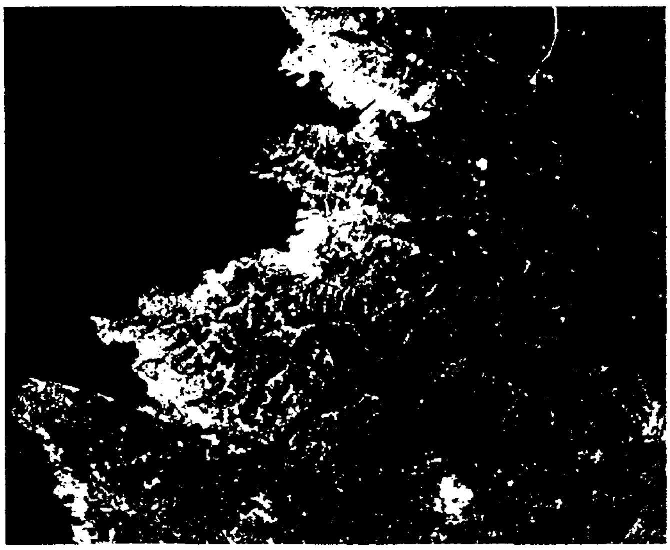
- *For this reasons competition* for the land use among housing, marine activities, tourism and industry is strenuous. However, close to this large urban area, environmentally valuable - unique - locations are located (ex. the Valley of Dragonja).

- As a result of these conflicts **seven hot spots** have been identified in the Slovenian coastal zone in the frame of the Mediterranean Action Plan (MED POL programme) survey. They are located in all the three municipalities.

- Surface flows, numerous urban wastewater outlets and one submarine outfall are the main sources of pollution of the coastal sea. Untreated industrial (three hot spots) and urban wastewater in the rivers are among the biggest problems.

- The contribution of land-based sources of pollution situated on the Slovenian coastal zone is much smaller than the overall value for the entire Bay of Trieste. The Italian side contribution must be -also- considered.

## Study Area Presentation



**The Study Area is opened to the northern Adriatic Sea in the west, connected with the inland Slovenia in the east and bordering with Italy and Croatia respectively in the north and in the south.**

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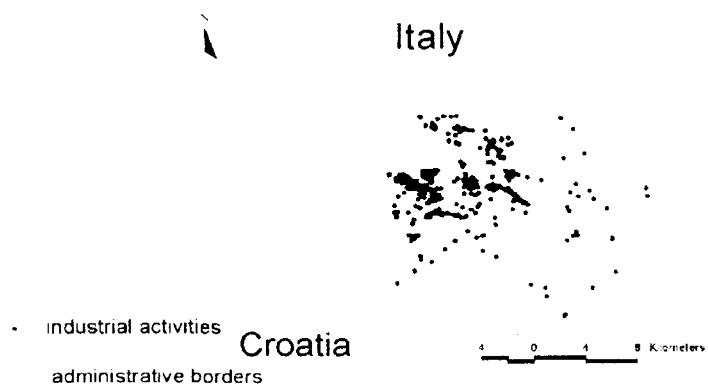
## Industrial Area

Inustrial activities in the municipality of Koper (Slovenia)

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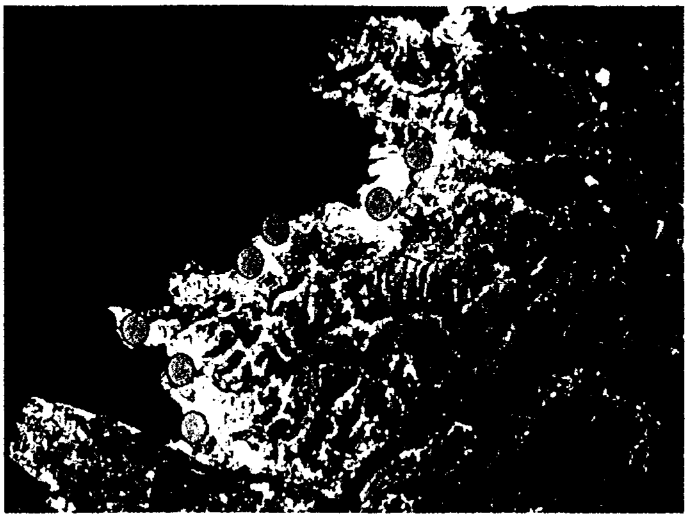
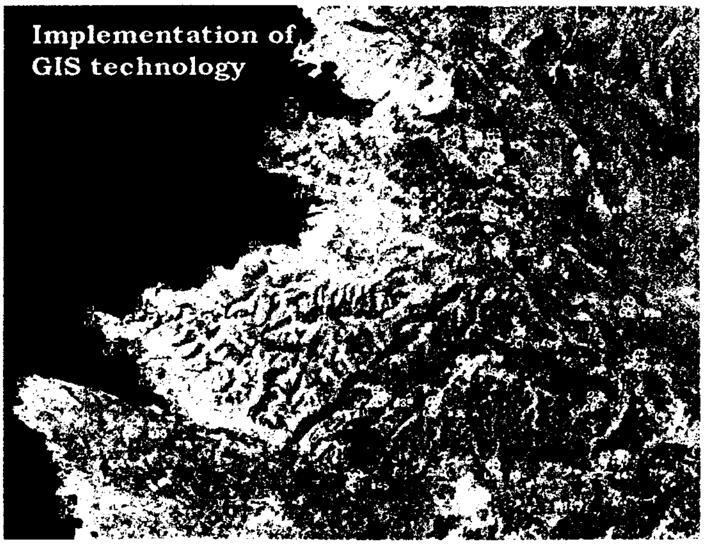
**7 hot spots/ 46 Km of coastline**



Hot spots in the Slovenian coastal areas
(source MAP/UNEP, 1999)




False color composite image of the Slovenian coastal zone
with ground control points (Landsat 5-TM image, summer 1997)

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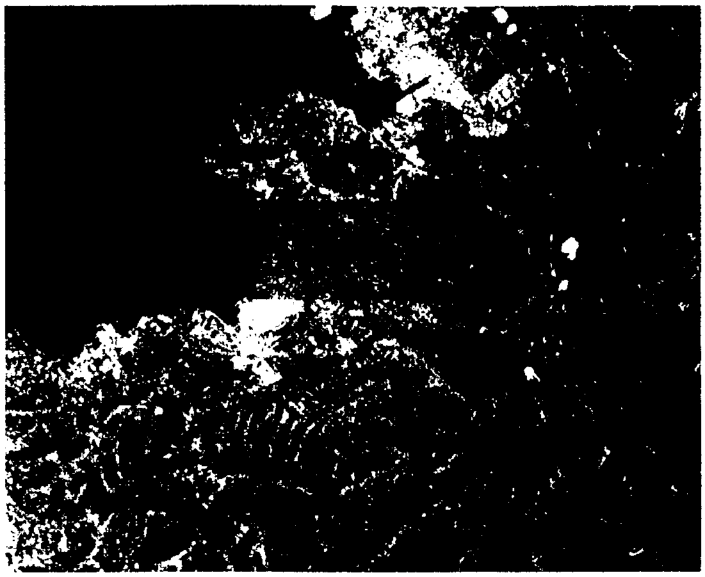

Layer 1: color composite image, Layer 2: ortophoto
(Georefereced Landsat 5-TM, summer 1997)

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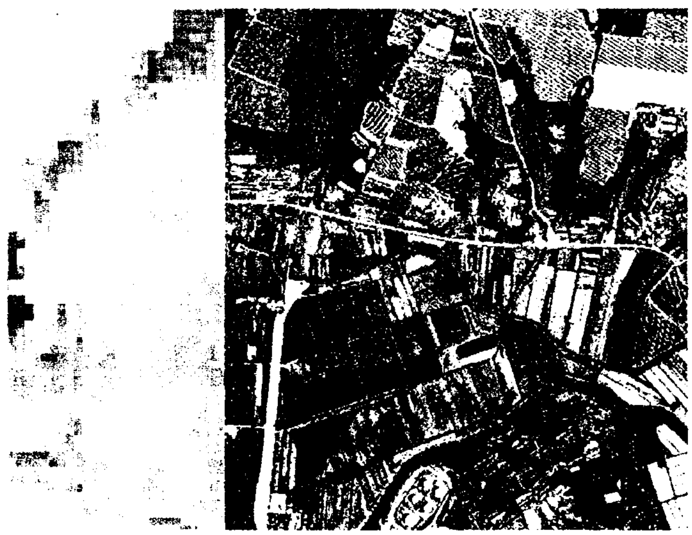

Layer 1: false color composite image; Layer 2: ortophoto
(Georeferenced Landsat 5-TM, summer 1997)

**Further applications of Geographic Information System:**

•Monitoring of areas, which are sustained by the industrial activities, and supporting industrial siting;

•Evaluation of the concentration of different industrial zones, their spatial distribution, their number, their infrastructure, their additional activities, etc;

•Definition of the homogenous areas to which specific concessions are assigned like degraded industrial areas;

•Economic evaluation of different degraded industrial areas and comparative analysis of industrial sites in alternative environments;

•Planning based on complete database of industrial concentration and distribution, labor density and specialization for Regions and Provinces.



**Industrial sustainable development**

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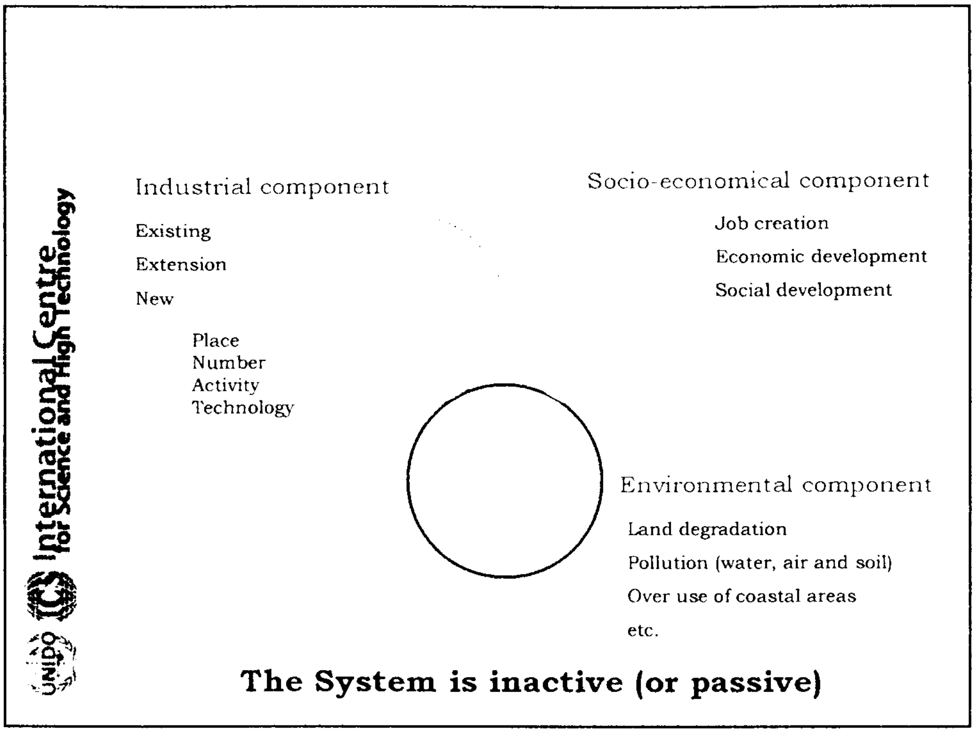
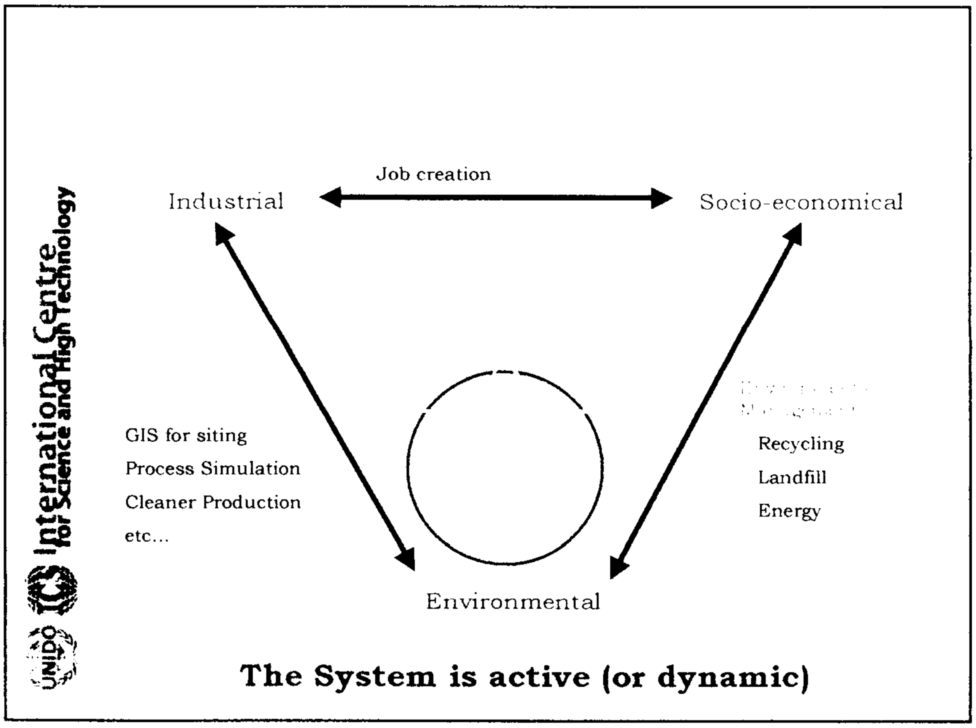
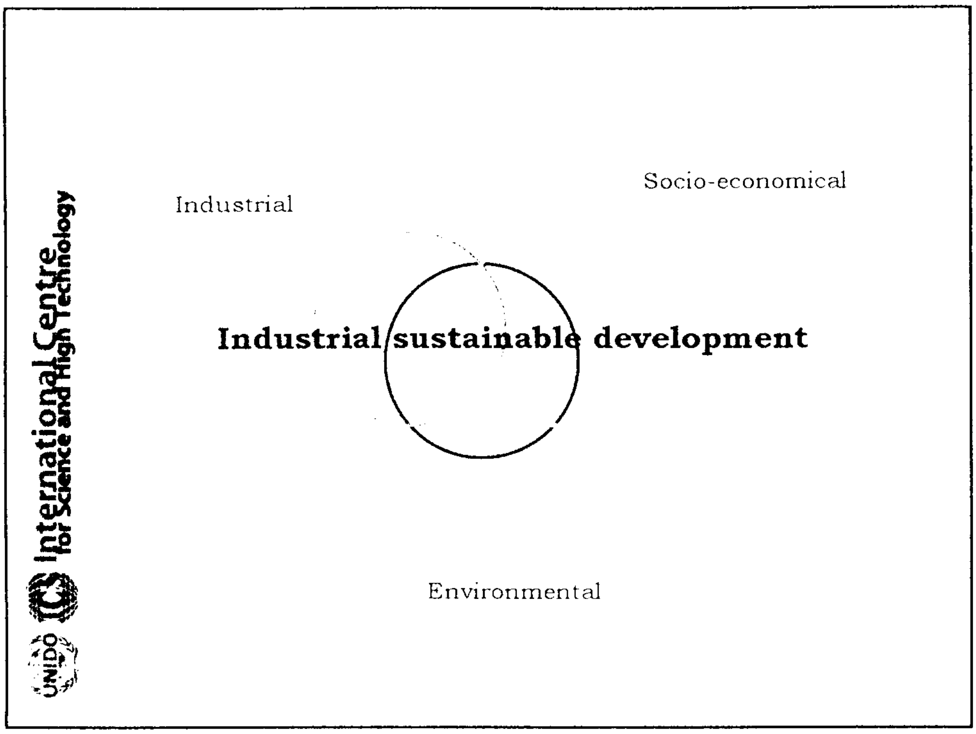

UNIDO ICS International Centre for Science and High Technology
Industrial component
Existing
Extension
New
Place
Number
Activity
Technology
Socio-economical component
Job creation
Economic development
Social development
Environmental component
Land degradation
Pollution (water, air and soil)
Over use of coastal areas
etc.
The System is inactive (or passive)


UNIDO ICS International Centre for Science and High Technology
Job creation
Industrial
Socio-economical
GIS for siting
Process Simulation
Cleaner Production
etc...
Recycling
Landfill
Energy
Environmental
The System is active (or dynamic)



Industrial
Socio-economical
Industrial sustainable development
Environmental
International Centre for Science and High Technology
UNIDO

Syrian Arab Republic
Ministry of State for Environmental Affairs

# A REPORT ON THE REHABILITATION OF DEGRADED INDUSTRIAL AREAS IN SYRIA

To be presented at the workshop of:
PLANNING REHABILITATION OF DEGRADED INDUSTRIAL AREAS IN THE MEDITERRANEAN

Tunis, 29-31 May 2000

Prepared by : Eng. Ozaina Aljundi
Damascus, 23 May 2000

Looking at the situation of the markets, one can see a need for electricity on the local level. Nationally, there is a market for most of the products produced at those industries such as: cement, petrol, electricity, sugar, textiles, and pharmaceuticals.
Internationally, the need is for: petrol, textile, and fertilizers.

There are some companies which have not been visited like: oil and fat factory, industrial chemicals factory, and a power station in Homs; a ceramic industry, a power station, and a cement factory in Hama; various tanneries, a yeast factory, and a dairy plant in Aleppo.

The technology used in general is somewhat old, with plans for improvement. There are some activities in this area like certain studies which have been undertaken to change the technology so that it will be more environmentally friendly.

Technical solutions are available for cleaner production ( such as changing the technology at power stations into gas-based ). However, the process is usually costly, which means that the availability of funds will play a big role in speeding up the process.

The introduction of environmental management systems in industry should take the highest priority. Development and implementation of these management systems should be in concert with programs to improve environmental awareness and introduce monitoring facilities and programs. Environmental reporting and responsibilities should be key issues of the management systems.

**Planning Rehabilitation of Degraded Industrial Areas in the Mediterranean**

# Industrial Areas in Syria

*Introduction:*
In the past industrial areas in Syria were constructed a little far from the cities. But later, due to the large growth in population and the horizontal expansion of the cities, people began to live closer to industrial areas. This situation created problems related to the health of these new inhabitants and the degradation of the surrounding environment resulting from polluting the water, the air, and the land.

*Industrial Areas of Syria:*
In 1997 five industrial regions in Syria were selected by the Syrian authorities to be subject to the "polluting sources inventory". These regions are: Damascus, Aleppo, Hama, Homs, Tartous.

Twenty nine companies were visited. They are, in general, public sector enterprises. The private industrial sector was largely ignored due to its small size. It should be noted that all large industrial companies in Syria are found in the public sector. Therefore, economic competition is somewhat little, which reflects positively on environmental performance The following Tables indicate the types of these industries, their annual production amounts, and their pollutant discharges.

| Damascus | | | | |
|---|---|---|---|---|
| Industry | Annual production /consumption | Air | Water | Solid waste |
| Damascus Power station | 660 MWe (gas and oil) | $SO_2$, dust, $NO_x$, CO, VOC | BOD, sus. solids, PAH, heavy metals [treated] | water treatment sludge |
| Canning industry | 3,100 t product | [combustion products] | BOD, sus. solids [untreated] | putrescent waste |
| General company for Tannery, and private companies | 32,000 t raw hides | $H_2S$, Ammonium sulphates, [combustion products] | chromium salts [treated] | animal by-products |
| Arab medical company (TAMECO) | 6,000 t medications | - | spilled medicines [untreated] | packaging waste |
| Sar general co. for chemical detergents | 10,550 t detergents | $SO_2$, dust, PAH | BOD [untreated] | - |
| National yeast factory | 1,755 t yeast | $H_2S$, $NH_3$, alcohol | BOD [untreated] | - |
| Dairy products | 15,000 t received milk | $SO_2$, CO, $NO_x$, VOC, dust [combustion products] | BOD, sus. solids, nitrates and ammonia [untreated] | packaging materials |
| Omayya paints factory | 3,400 t paints | dust, PAH [combustion products] | solvents, heavy metals, oils [untreated] | packaging materials, plastics, talc powder, paint |
| Al-Ahlieh co. for rubber & plastics | 7,300 t rubber & plastics products | $SO_2$, dust, [combustion products] | sus. solids, BOD [untreated] | pond sludge, rubber & plastics waste |
| U.C.I.C. textile co. | 2,000 t textile | dust, [combustion products] | BOD, oil, grease, dyes, fibres [untreated] | textile waste |

| Banias/Tartous | | | | |
|---|---|---|---|---|
| Industry | Annual production /consumption | Air | Water | Solid waste |
| Banias refinery co. | 6,370,000 t crude oil<br>45 MWe power (gas) | VOC, PAH, CO, $NO_x$, dust, $SO_2$ [direct emission/ combustion] | oil [treated] | water treatment sludge |
| Cement factory Tartous | 1,600,000 t cement | dust, CO, $NO_x$ | oil [untreated] | raw material waste |
| Power station Banias | 600 MWe [illegible] | $SO_2$, dust, $NO_x$, CO, VOC | BOD, sus. solids, PAH, heavy metals [treated] | water treatment sludge |
| Tartous oil terminal | 4,300,000 t crude oil | VOC, benzene, toluene | oil [untreated] | sludge |

## Homs

| Industry | Annual production /consumption | Air | Water | Solid waste |
|---|---|---|---|---|
| Sugar plant | 68,000 t white sugar | $SO_2$, soot, CO, dust, $NH_3$, $NO_x$ [boiler] | BOD, sus.solids, Cl2, nitrogen compounds [untreated] | combustion residue |
| Cotton plant | 280 t raw cotton, 690 textile threads and 620 t raw textile | CO, $NO_x$, VOC, dust, $SO_2$ [boiler] | BOD, sus.solids [treated] | waste water sludge |
| Dairy factory | 13,000 t milk, 100 t cheese | $SO_2$, CO, $NO_x$, VOC, dust [combustion] | BOD, sus.solids, nitrogen compounds [untreated] | package materials |
| Homs Refinery co. | 5,400 000 t crude oil | VOC, PAH, CO, $NO_x$, dust, $SO_2$ (direct emission/ combustion) | oil [treated] | cokes, oil sludge |
| Fertiliser | 300,000 t sulphuric acid, 100,000 t phosphoric acid, 210,000 t TSP, 195,000 t ammonia, 240,000 urea, 95,000 t nitric acid, 89,000 t CAN | $SO_2$, $NO_x$, HF, dust, $NH_3$, CO, VOC | BOD, oil, nitrogen compounds [treated] | phosphogypsum, spent catalyst |

## Hama

| Industry | Annual production /consumption | Air | Water | Solid waste |
|---|---|---|---|---|
| Wool factory | 2,000 t raw wool | $SO_2$, $NO_x$, CO | chemicals, sus. solids, BOD, fat [untreated] | wool waste |
| Rubber tires factory | 450,000 tires | VOC, benzene, trichloro-ethylene, $SO_2$, $NO_x$, CO, PAH, dust | FeCl, CaCl, MgCl, limestone [untreated] | tires waste, chemicals |
| Gecosteel | 184,000 t steel | dust, $SO_2$, $NO_x$, CO | metal oxides [treated]. | metal oxides, bricks, sinters, water treatment sludge |

## Aleppo

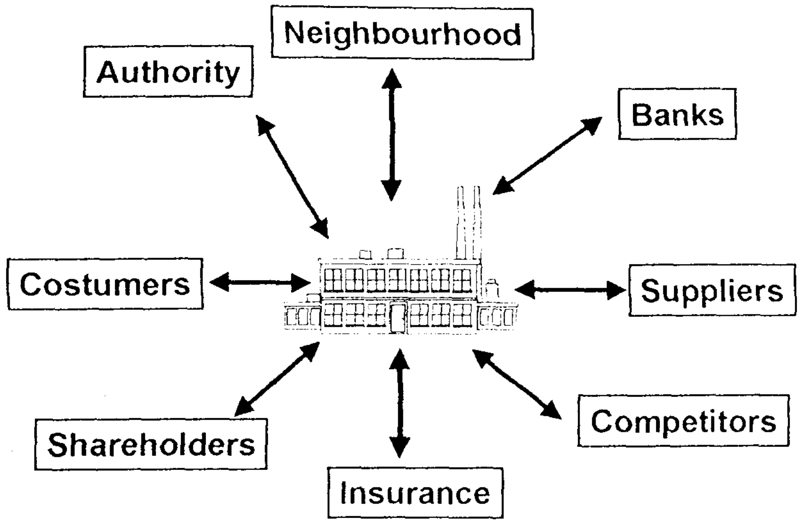
| Industry | Annual production /consumption | Air | Water | Solid waste |
|---|---|---|---|---|
| Arabian Cement and building materials company | 900,000 t cement | dust, NOx, $SO_2$ | oil [treated] | raw material waste |
| Syrian battery factory | 75,000 batteries | lead, CO, $H_2S$, dust, $SO_2$ | metal oxides [untreated] | ebonite |
| Aleppo power station (under construction) | 1062 MWe | $SO_2$, dust, $NO_x$, CO,VOC | BOD, sus. solids, PAH, heavy metals [treated] | water treatment sludge |

Workshop on Planning Rehabilitation of Degraded Industrial Areas in the Mediterranean

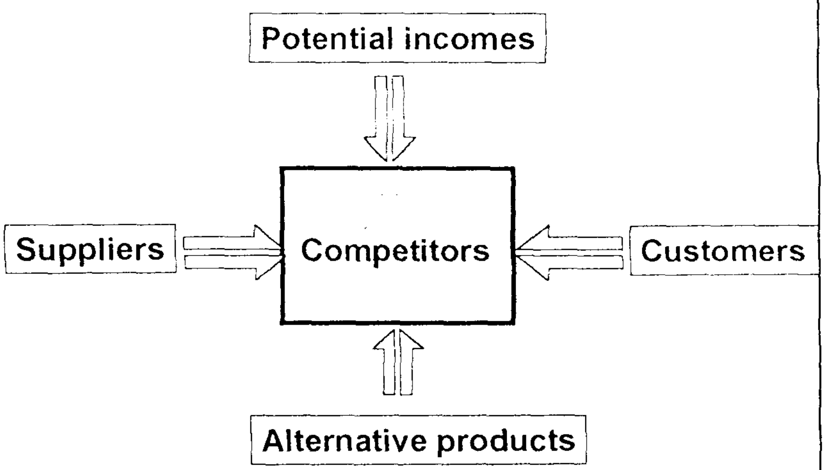
*Tunis, 29-31 May 2000*

# Evaluating the Technological Level of Production systems and Developing Programmes for Cleaner Production

# Why are cleaner technologies and waste minimisation necessary?




# The 5 market powers



# Reasons for the change of attitudes

- To facilitate the compliance of present legislation and foresee the future one
- To obtain net savings and to optimise the (growing) environmental management costs
- To answer market demands
- To improve company image and natural environment
- To take advantage of financial profits

# Opportunity - Cost

✓ Environmental management is an <u>opportunity management</u>

STOP Environmental management within the company is a <u>cost management</u>

## *Environmental Control* in a company or installation should NOT be considered as an isolate fact

- It has consequences for that company or installation
- It could have consequences "forwards"
- It could have consequences "backwards"

Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment.

(UNEP)

## Cleaner production means ....

- Processes
  - raw material preservation
  - water and energy preservation
  - hazardous products phase out
  - reduction in quantity and toxicity of waste
- Products
  - reduction of impacts among their life cycle
  - from raw materials to final waste

*Cleaner production needs knowledge use, technology improvements and* **change of attitudes**

## Cleaner production means ....

- "Rethinking" products, process and behaviour
- Applying it to prevention and treatment
- Thinking about impacts on previous and following stages
- Maintaining or increasing competitiveness
- Technical and economic feasibility
- Availability of technologies

# End of pipe

## means

added costs
growing with time
with *no* payback
fragile

# Main differences between eop and cleaner production *(Mebratu)*

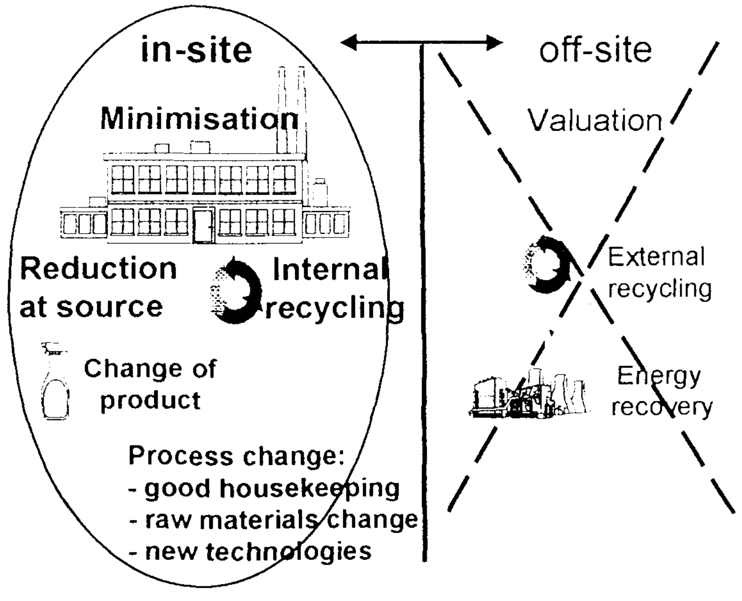
| | | |
|---|---|---|
| **Methodology** | reactive | proactive |
| **Reach** | not very systematic | integrated |
| **Solution** | specific for every medium | valid for all mediums |
| **Economy** | added cost | economic savings |
| **Engineering** | static | dynamic |

## One should distinguish between two complementary and non-incompatible approaches that should be taken into account in a consecutive way ....

- Reduction **at source** *(cleaner production, eco-efficiency, minimisation ....)*
  - is a voluntary **strategy (today)**
  - for PROCESSES (and *PRODUCTS*)
  - saves raw materials, energy and treatment costs
  - dynamic
  - not always needs inversions

- Pollution **Treatment**
  - is only technology
  - has not taken into account processes and products
  - has no added value
  - static and fragile
  - permanent and growing costs
  - needs always inversion

## Integrated Pollution Prevention



# Incentives to pollution prevention

- ☆ ECONOMIC
- ☆ LEGISLATIVE/ADMINISTRATIVE
- ☆ TECHNICAL
- ☆ ORGANIZATIVE/CORPORATIVE

# ECONOMIC

- ☆ Savings of raw materials
- ☆ Savings of waste treatment and management
- ☆ Savings of water and energy
- ☆ Quality improvement
- ☆ Easiness to obtain external financing
- ☆ Reduction in the insurance premium cost for environmental risk

## LEGISLATIVE/ADMINISTRATIVE

- ☆ Makes legislation compliance easy
- ☆ Less affected by legislative changes

## TECHNICAL

- ☆ Can be applied in most industry processes
- ☆ Can be applied in different steps of the process
- ☆ More flexibility for technical decision-making

## ORGANIZATIVE/CORPORATIVE

- ☆ Helps to organise work structure, rationalising it
- ☆ Increases technical level and training status of the company
- ☆ Increases participation and satisfaction of the working staff
- ☆ Reduces health and accident risks
- ☆ Obliges to rethink processes, procedures, stages, material flows, etc.
- ☆ Improves the public image of the company

## Conditions

- Expressed and demonstrated willingness of the Administrations
- Clear definition of what is understood as reduction at source
- Information level about pollution generation
- Capacity to identify opportunities and to analyse technical and economic feasibilities
- Existence of suitable instruments
- Standard of environmental culture

## Scenario

- Integrated approach

## Difficulties for changing

☆ Material and energy flows are not known
☆ Negative externalities are not internalised, and therefore the product's function is not well defined
☆ Feasible (economically and technically) alternatives are not known
☆ Companies have scarce technical resources to identify pollution prevention and source reduction opportunities
☆ Rigidity of acting Administrations
☆ Wilfulness (up to now) of the pollution prevention and source reduction opportunities
☆ Resistance to introduce changes within the process

# Steps

**Measure**

**Diagnosis**

**Alternatives**

**Feasibilities**

**Implementation**

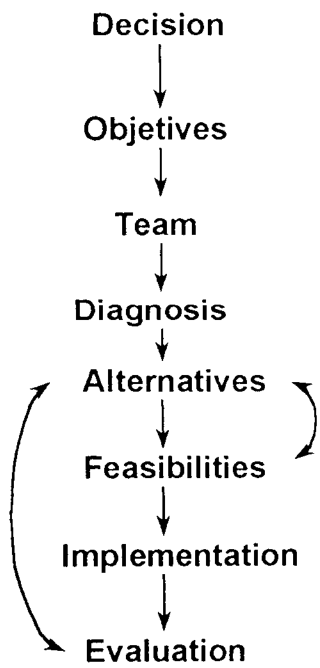
**Follow-up**

# Steps (1)

**Decission**

**Objectives' establishment and explanation**

- In a short
- In a medium
- In a long
- Process
- Product
- Certification



# Steps (2)

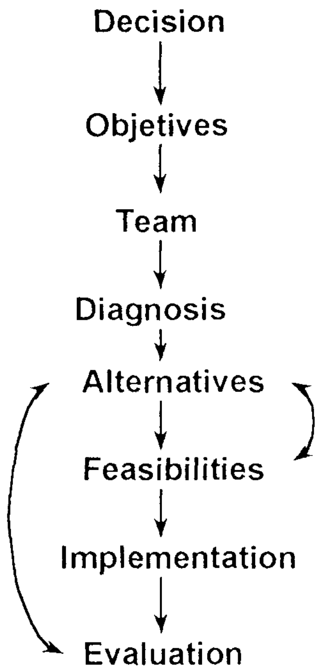
## Team(s)

### *Internal*

- routine *(changes in the parameters that measure process efficiency)*
- hierarchy

### *External*

- Advantages and inconveniences
- Reluctance that must be beaten

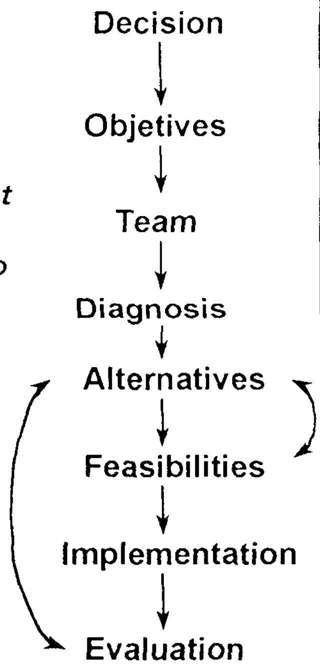



# Steps (3)

## Diagnosis

*A correct management of what is not known, is not correctly quantified or is not possible to be measured*

- Protocol
- Wasted opportunities
- Processes - sub-processes
  - material flows
  - process/product environmental costs



MINIMISATION OPPORTUNITIES
ENVIRONMENTAL DIAGNOSIS

(MOED)

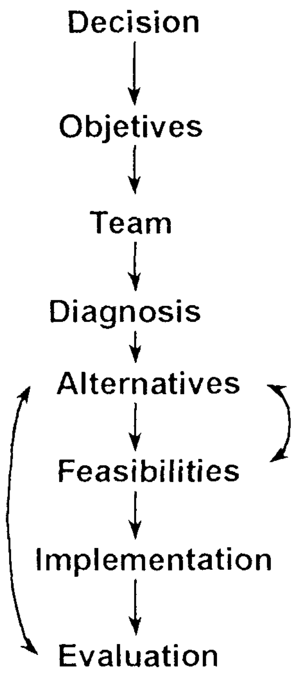
## WHAT IS MOED ?

Minimisation Opportunities

Environmental Diagnosis

*Expert evaluation* that allows identification of pollution prevention and source reduction opportunities, as well as, actions and steps heading towards technologies, techniques and practices that mean an effective reduction of pollution generated by an industrial activity

# Steps (4)



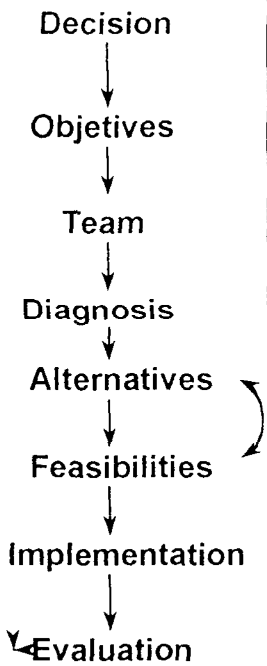

## Alternatives

- desired, expected and foreseeable results

## Feasibility

- technical
- economical
- time / duties
- training

# Steps (5)




## Implementation

- project
  - financing (grants)
- staff implication
  - motivation
  - training
  - integration (suggestions)

## Results' evaluation

- internal and external publicity
- process feedback and new objectives

## CONCLUSIONS AND RECOMMENDATIONS (I)

Eco-efficiency implementation needs:

A) mechanisms to internalise the negative external environmental effects

B) mechanisms to promote cleaner practices and technologies

C) mechanisms to identify pollution prevention opportunities

## CONCLUSIONS AND RECOMMENDATIONS (II)

D) a legal basis

E) voluntary agreements

F) full dissemination and easy access to environmental prevention and source reduction technologies

G) promotion through neutral and intervectorial institutions

H) confidentiality should be given to the companies

## CONCLUSIONS AND RECOMMENDATIONS (III)

I) main mechanism for promotion: inspection units should promote such issues

J) cleaner production should never be confused with environmental certification, they should be considered as complementary tools

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# ANNEX I

# A METHODOLOGY FOR IMPACT AND RISK ASSESSMENT IN INTEGRATED ENVIRONMENTAL MANAGEMENT

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**Abstract**

Most of the Earth's living resources are found in specific geographical locations such as the global coastal environment and the catchment basins of large river systems. Furthermore, a large proportion of the world's population lives in close proximity to these regions and is frequently dependent upon it for either part or much of its food supply and industrial raw materials. The consequence of this situation is that much of the waste, both industrial and domestic, and various other types of habitat destruction generated by the human population, occurs in those areas that are of greatest biological and economic significance. The overall problem is, how to develop effective procedures for environmental/ecological impact and risk assessment? One of the major difficulties in impact and risk assessment is to link harmful effects of chemical pollutants in individual animals and plants with the ecological consequences. Consequently, this obstacle has resulted in a "knowledge-gap" for those seeking to develop effective policies for sustainable use of resources and environmental protection. However, diagnostic "clinical-type" ecotoxicological tests or "biomarkers" and immunochemical tests for contaminants are now increasingly available; and there is a concerted international research effort to improve and extend this predictive capability. These ecotoxicological tools can provide information on the health-status of populations based on relatively small samples of individuals. Also, biomarkers can now be used to begin to link processes of molecular and cellular damage through to the higher levels (i.e., prognostic capability), where they can result in reduced performance and reproductive success. Research effort to meet this challenge is interdisciplinary in character, since the key questions mainly involve complex interfacial problems. These include the effects of physical chemical speciation of pollutant chemicals on uptake and toxicity and the toxicity of complex mixtures; as well as linking the impact of pollutants through the various hierarchical levels of biological organisation to ecosystem and human health. Finally, the development and use of process simulation models (i.e., "virtual" cells, organs and animals), illustrated here using an endosomal/lysosomal uptake and cell injury model, will further facilitate the development of a predictive capacity for estimating risk associated with the possibility of future environmental events.

In conclusion, an integrated environmental management strategy must be truly cross-disciplinary if an effective capability for risk assessment and prediction is to be developed in relation to resource sustainability. Areas of collaboration need to include, among others remote/satellite surveillance, risk assessment, interpretation of complex information and predictive modelling. There also needs to be increased focus on precautionary anticipation of novel environmental hazards (e.g., from Biotechnology & Molecular Nanotechnology). And last but not least, it is crucial to educate politicians, industrialists and environmental managers concerning the long-term consequences of pollution; and that increased consumer awareness of environmental problems is exerting pressure on industry to make its products "environmentally friendly" (i.e., eco-labelling), in order to maintain existing markets and to improve their penetration into new markets.

## INTRODUCTION

Riverine, coastal & shelf areas are the most heavily used yet vulnerable zones of the planet. They receive a multitude of man-made inputs from land-based sources (land drainage, rivers, municipal & industrial outfalls), as well as contaminants introduced through combustion and atmospheric inputs. Consequently, this results in deterioration in water quality of groundwater, lakes, rivers, estuaries & coastal marine environments. The problem arises from a variety of reasons including:- economic failure; inadequate governance & non-enforcement of existing environmental protection laws; haphazard industrialisation and urbanisation results in runoff of polluted wastewater and contamination of land, rivers and coastal waters; poor public education and understanding of the problems; and the strongly sectoral structure of government bodies frequently presents a barrier to integrated solutions.

River basins, deltas and estuaries are often characterised by a rich diversity of plants and animals, that are, unfortunately, often environmentally sensitive and susceptible to human interference. Consequently, this can lead to conflict over resource rights and deprive the indigenous human population of major sources of food (e.g., fish as a major source of dietary protein). However, there is now increasing awareness of the global importance of specific geographical domains, such as the coastal land-sea interface, as major resources and concern for maintaining the diversity of life on our planet. This was a major focus for Agenda 21 of the UNCED, Earth Summit Conference in Rio de Janiero (Quarrie, 1992).

The scale of the problem is indicated by the findings of a recent economic study. These placed a value of US$ 12.6 Trillion/year for Coastal Zones & US$ 6.6 Trillion/year on Wetlands, Rivers & Lakes, out of a Global Total of US$ 33.3 Trillion/year (Costanza *et al.*, 1998).

Pollutant impact on ecosystem and human health is an urgent and international issue, since there is an ever-increasing number of examples of environmental disturbance, likely to affect the biota and humans, by both natural and anthropogenic stress. Important stressors include toxic industrial chemical contaminants, increased UV-radiation, nutrient enhancement or deprivation, hypoxia, habitat disturbance and pathogen-induced disease. In fact, environmental disturbance will frequently comprise various combinations of such stresses. Furthermore, it is increasingly recognised that assessment of the impact of environmental disturbance on organisms requires understanding of stress effects throughout the hierarchy of biological organisation, from the molecular and cellular to the organism and population levels, as well as the community and ecosystem level. In the past, damage to the environment has largely been identified retrospectively and in response to acute events such as major disasters (e.g., industrial accidents like Seveso and Bhopal; and oil spills (Amoco Cadiz & Exxon Valdez) and chemical pollution of the Great Lakes). Generally, these have been measured in terms of human health impacts and visible changes resulting from the loss of particular populations or communities. However, long term and chronic exposure to environmental stress, including chemical pollutants or other anthropogenic factors, will seldom result in rapid and catastrophic change. Rather, the impact will be gradual, subtle and frequently difficult to disentangle from the process and effects of natural environmental change. This latter problem has been a major stumbling block in assessing environmental impact since such investigations began, mainly in the 1960s.

The major issues of concern include the role of "Industry" as a major source of pollution; the fact that pollution does not respect national boundaries; the loss of living resources and biodiversity; damage to human health; and support for sustainable financing and banking in order to support developing economies. The environmental objectives of sustainable industrial development include the sound management of natural resources, effective transfer of environmentally sound technologies in order to reduce, reuse and recycle waste, investment promotion for sustainable industry, environmental monitoring and control of investments for environmental industry projects.

Environmental Components for Sustainable Industrial Development need to include:-

- an effective environmental policy framework
- cleaner industrial production and pollution prevention
- environmental emission and discharge standards
- enforceable pollution control and waste management
- ecotoxicology for assessing environmental impact of pollution and overuse of resources

- environmental modelling for policy decisions
- risk assessment and risk reduction
- the integrating process with socio-economic conditions and governance issues.

In this context, UNIDO provides knowledge-based expertise on environmental policy, cleaner production, waste management and pollution control, through its service modules, in order to achieve sustainability. It also provides expert diagnostic and predictive software to link existing models with industrial information and knowledge of the environment. In addition, UNIDO supports the development and use of indicators, which show effectiveness in moving towards sustainable development, that link environmental, social and economic measures.

Environmental Stress can be caused by a number of factors including:- natural forces such as sea level rise, climate change and soil erosion; poorly planned development, such as haphazard urbanisation and industrialisation; depletion of resources through over-fishing, deforestation and poor use of agricultural land; unregulated discharges of municipal sewage and industrial waste; and illegal practices,such as disposal of dangerous toxic wastes.

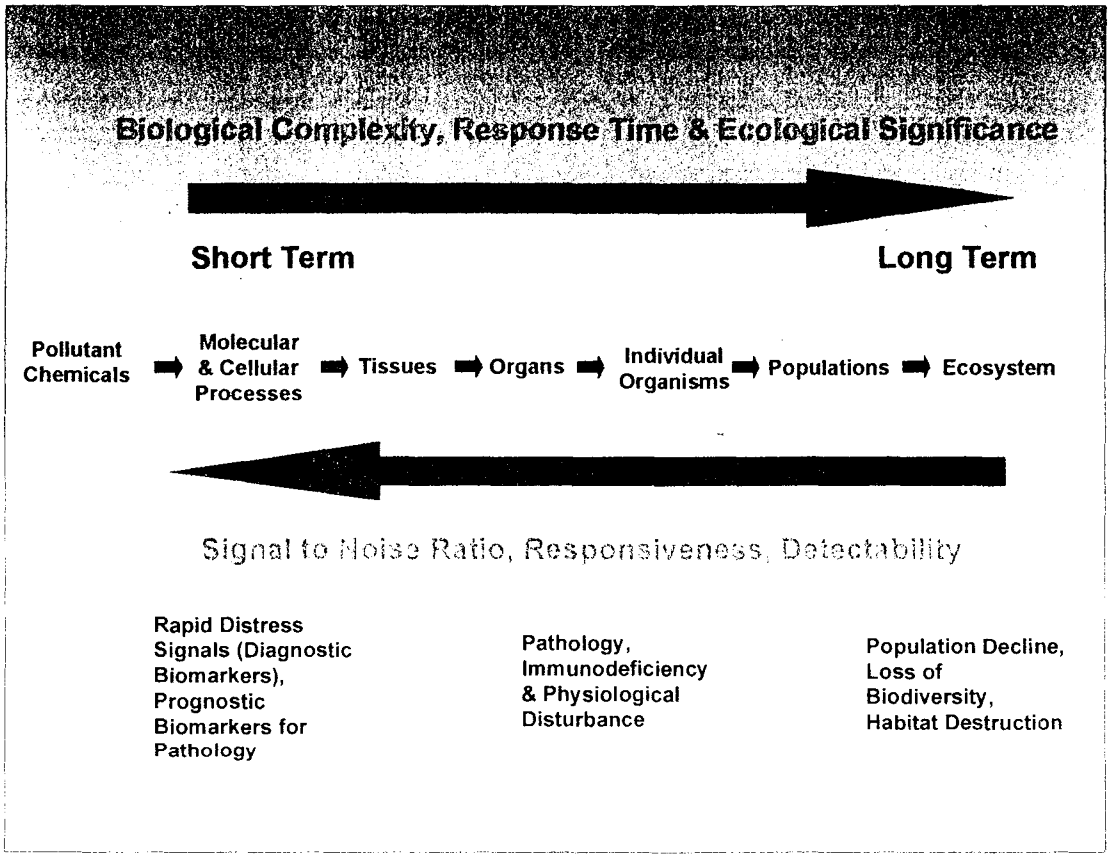


Fig. 1. Diagrammatic representation of the relationship between environmental distress signal detectability and ecological relevance (Bayne *et al.*, 1985; Moore & Simpson, 1992; Moore *et al.*, 1994; Moore, 2000).

While it is clearly recognised that stress-induced changes at the population / community / ecosystem / human health levels of biological organisation are the ultimate concern, they are generally too complex and far removed from the causative events to be of much use in developing tools for the early detection and prediction of the consequences of environmental stress (Fig. 1; Depledge *et al.*, 1993). Rapid resolution of this link to health is essential if environmental management is to have a sound scientific basis for the regulation of the release of toxic substances, nutrients and habitat disturbance. The basis of such regulation, where it exists at present, is often at best sketchy with a heavy reliance on empirical observations and laboratory based toxicity tests using organisms that have limited relevance to the real environmental context.

A probable solution to this problem lies in the effective detection of **"distress signals"** at the molecular and cellular levels of organisation and linking these latter to the higher level consequences (Fig. 1; Bayne *et al.*, 1985; Depledge *et al.*, 1993; Moore, 1990; Moore and Simpson, 1992). It is only at these lower levels that we will have the reasonable expectation of developing a reasonable basis of mechanistic understanding of how different environmental conditions can modulate organismal function, which in turn will ultimately help in linking causality with predictability of response. This is in part due to our ability to make certain generalisations about biological organisation and function at the molecular and cellular level which rapidly disappear as we ascend the hierarchical ladder. Hence, distress signals at the molecular, cellular and physiological levels of organisation should be capable of providing "early warning prognostic biomarkers (molecular, cellular, physiological and behavioural)" of reduced performance, impending pathology and damage to health (Depledge *et al.*, 1993; Hinton and Lauren, 1990; McCarthy and Shugart, 1990). In fact, there is a direct analogy here with the use of clinical tests (biomarkers) in human and veterinary medicine (Moore and Simpson, 1992).

The derivation of potential prognostic tests for "distress signals" will only arise out of an understanding of the mechanistic basis of the cellular and physiological processes that contribute to uptake, biotransformation, molecular damage and cell injury, impairment of protective systems and, ultimately, to degenerative change and the consequences for reproduction and survival (Moore, 1990; Moore *et al.*, 1994; Fig. 2). For this way forward to be fully effective it requires an integrated multi-tiered approach combining both reductionist and synthesist components. The tools to implement this are now becoming increasingly available.

Briefly, these include mechanisms of pollutant uptake, biotransformation and radical generation, molecular damage and consequent cell injury, as well as antioxidant protection and repair. These in turn need to be linked with cellular and physiological processes of vesicular transport of proteins, protein turnover, and interactions of the nervous and endocrine systems with effective immune defence function. At the higher organisational levels, differential sensitivity needs to be assessed according to individual genotype, life-history stage, and natural seasonal changes in physiological and/or reproductive status. Finally, this information then needs to be used to develop process simulation models of the type increasingly used in quantitative cell biology and cellular bioengineering (Biganzoli *et al.*, 1998; Düchting *et al.*, 1996; Koo, 1999; Lauffenburger & Linderman, 1993; Noble *et al.*, 1999). Mathematical simulation models can provide insights into the links between molecular properties and cell and organ behaviour; and the predictive power of such models can be harnessed to develop tools for risk assessment of toxic chemicals.

Research effort to meet this challenge must be interdisciplinary in character, since the key questions mainly involve interfacial problems. These questions include the effect of physico-chemical speciation on uptake and toxicity, the toxicity of complex mixtures (Howard, 1997; Kanzawa *et al.*, 1997), and linking the impact of pollutants at the various hierarchical levels of biological organisation from the supra-molecular and cellular to the population and ecological community (Figs. 1 & 2).

Major aims include the development of conceptual frameworks based on a mechanistic understanding of contaminant geochemistry and uptake, metabolic biotransformation, toxicity and impact within the biological organisational hierarchy. Large scale tasks include predicting the toxicity of contaminant mixtures (Howard, 1997); and modelling environmental pollution and impact as a complex adaptive system, which will encompass contaminant geochemistry, biochemical toxicology, cellular pathology, ecological consequences and human risk (Fig. 2; Moore, 2000).

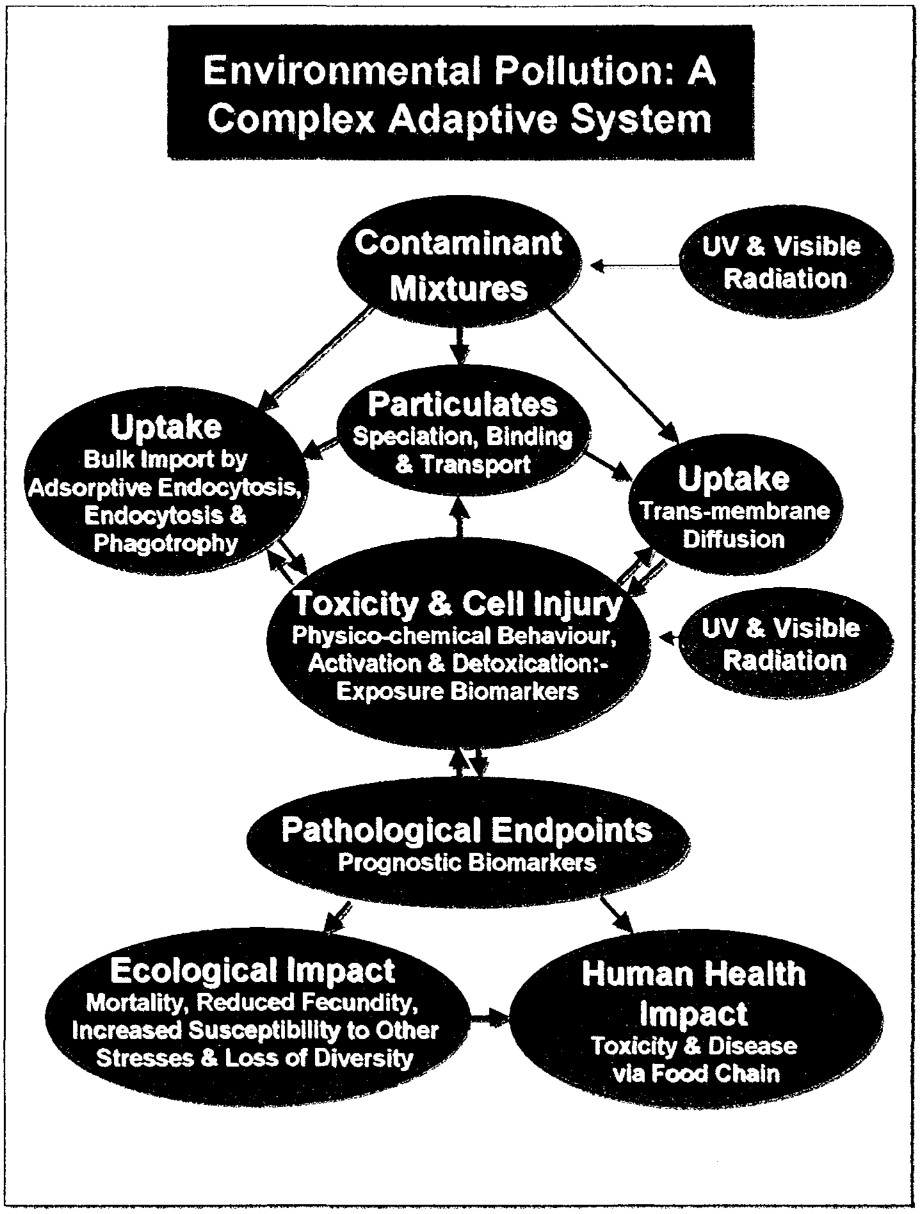


Fig. 2. A conceptual framework showing the interconnectedness of environmental pollutant-related processes and their harmful effects as components of a Complex Adaptive System (taken from Moore, 2000).

Finally, the major challenges for ecotoxicologists and environmental scientists are to aim for "real mechanistic understanding", which must also include the linkages between levels of organization in the biological hierarchy. This is essential if the question of biocomplexity is to be effectively addressed through the development of computational simulation models, based on multiple molecular interactions (Schaff *et al.*, 1997). These cellular models must be capable of experimental validation, which should also include genetic manipulation of key processes. Visualisation of cellular processes *in silico* will facilitate the identification of complex subcellular strategies for adaptation to altered environmental conditions.

## ENVIRONMENTAL RISK & INTEGRATED ENVIRONMENTAL MANAGEMENT

First, we must consider what is at risk in the coastal zone: clearly these are land use and environmental resources, such as water and fisheries; biodiversity and environmental quality; environmental and human health (in some countries, such as Ghana, up to 70% of the health costs are directly related to environmental causes); and finally aesthetics, which can be particularly important in relation to the tourist industry.

The acceptability of risk in Integrated Environmental Management is not an issue for scientific research alone. It involves economic, social and political issues, which all need to be integrated in order to develop prognostic risk models. There are also important economic components that are directly related to the value of the resources to be protected and the costs of increasing safety margins.

We can forecast and reduce Environmental Risks through the implementation of innovative environmental monitoring and surveillance techniques to understand the extent of the problems (new rapid low cost immunochemical tests for contaminants, health tests (biomarkers) for animals, plants and humans, satellite monitoring). These require supporting research into understanding physical, chemical, biological and ecological processes. We also need to develop decision support (expert) systems to link existing models with our experience and knowledge of the environment; as well as to develop and use indicators of sustainability to show effectiveness in moving towards sustainable development, where there is a need to link environmental, social and economic measures.

The Objectives of Integrated Environmental Management (IEM) are as follows:

- prevent, reduce and control degradation of the total environment thereby maintaining and improving its life support and productivity capacities
- develop and increase the potential of living resources to meet human nutritional needs, as well as social, economic and development goals
- promote the integrated management and sustainable development of terrestrial, freshwater and coastal marine environments.

IEM holistically assesses the changing states of ecosystems based on information from five operational modules:-

1) ecosystem productivity;
2) water, fisheries, agricultural and forestry resources;
3) pollution and health (ecosystem & human);
4) socio-economic conditions;
5) and governance protocols.

These modules link science-based information to socio-economic benefits for countries sharing boundaries for international waters; and are used in an integrated interdisciplinary mode to address the consequences of ecosystem change (e.g., GEF-Large Marine Ecosystem Projects).

The methodology of IEM brings together elements for dealing with the complex interactions of the many demands placed on the environment. The methods are implemented through training, technology transfer and capacity building, that are firmly grounded on strategic science-based assessments and monitoring and linked to standard internationally agreed QA protocols.

Programme components for Integrated Environmental Management should include:-

- biogeochemical and physical processes
- bioavailability of toxic chemical pollutants, uptake into plants, fish and animals and the subsequent transfer to humans through the food chain
- ecotoxicology and environmental impact of pollution and overuse of resources (e.g., land, water, rivers, forests and fisheries)
- models for integrated environmental management
- human health risks
- risk assessment - a cross-disciplinary issue
- the integrating process for environmental data and predictions, together with economic and social aspects.

## BIOAVAILABILITY AND UPTAKE OF CONTAMINANTS

The uptake and accumulation of organic micropollutants and metals by aquatic organisms is governed by their physical chemical speciation. Lipophilic pollutants are largely associated with particulates and colloidal organic carbon (Murdoch *et al.*, 1994; Smedes, 1994; Readman *et al.*, 1984). It is becoming increasingly clear, however, that the mechanisms of binding vary from that simply described by the traditional $K_d$. In considering bioavailability and uptake, this factor needs to be addressed. In addition, it is probable that contaminant entry into cells is directly related to the extracellular and intracellular behaviour of particulates/colloids with adsorbed chemicals (Fig. 3; Moore & Willows, 1998).

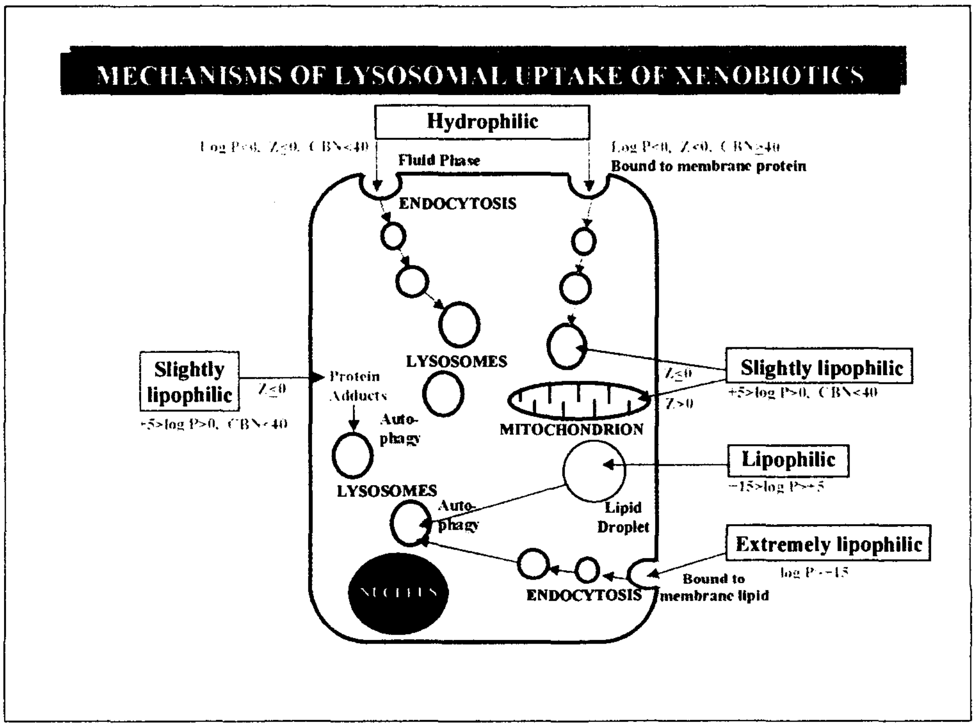


Fig. 3. Diagrammatic representation of the various routes of uptake (diffusion and endocytotic) of contaminant xenobiotic chemicals into the cell that result in their accumulation in the lysosomal compartment, based on their physical chemical characteristics (Rashid & Horobin, 1990; Rashid *et al.*, 1991; Moore *et al*, 1996).

Contaminants are seldom present as a single chemical and usually comprise a complex mixture (Howard, 1997; Kanzawa *et al.*, 1997). Uptake of xenobiotics from such mixtures is poorly understood and questions of whether components of the mixture influence the uptake and biotransformation of other components have not been seriously addressed (Kortenkamp & Altenburger, 1998). Uptake is often viewed as taking place from solution with the contaminant crossing cellular membranes by diffusion (Moore & Willows, 1998). However, as stated above, most contaminant chemicals are bound to particulates and so, are seldom in true solution (Smedes, 1994; Moore & Willows, 1998; Readman *et al.*, 1984). This is probably of considerable importance in explaining the known compartmentation of many micropollutants and metals within cells and tissues of plants and animals, so it is essential that an appropriate mechanistic understanding of the intracellular transport processes, intracellular chemistry and associated biotransformations is developed in the future (Moore, 2000; Moore & Willows, 1998). This type of knowledge is essential if we are going to be able to attempt to predict the kinds of organisms at risk and, also, whether particular life stages are more vulnerable than others.

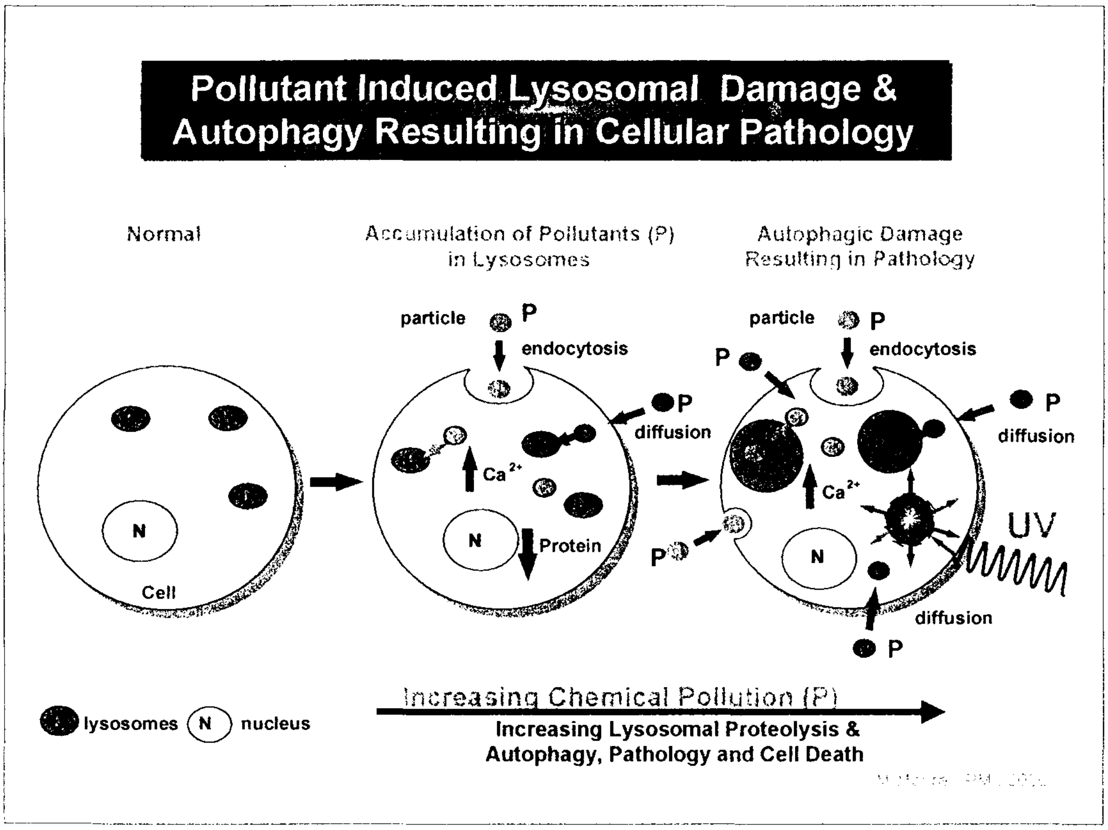


Fig. 4 Diagrammatical representation of the processes of cellular uptake of xenobiotics; their lysosomal accumulation and harmful effects, including induced lysosomal proteolysis, augmented autophagy and the interactive effects of UV radiation in cell injury (Benchimol, 1999; Bonifaciano & Weissman, 1998; Calle *et al.*, 1999; Franke, 1990; Halliwell, 1997; Hawkins & Day, 1999; Hein *et al.*, 1990; Hutchins *et al.*, 1999; Luzikov, 1999; Moore, 1990, 1991, 2000; Moore & Willows, 1998; Moore *et al.*, 1994, 1996, 1997; Mortimore & Poso, 1987; Rashid *et al.*, 1991; Seglen, 1997; Thevenod & Friedmann, 1999; Viarengo *et al.*, 1994; Winston *et al.*, 1996).

There is also a clear need for new rapid analytical methods for routine application, such as the use of immunochemical detection of organic micropollutants (Aga & Thurman, 1997; Sherry, 1997). Clinical chemists have utilised immunoassay (IA) techniques to detect and quantify proteins, hormones, and drugs for decades. The most common version of environmental IA is called ELISA (Enzyme Linked Immunosorbent Assay; Aga & Thurman, 1997). ELISA is an immunoassay method that uses antibodies and enzyme conjugates to detect and quantify target compounds, otherwise known as compounds of interest (COIs), in field samples. Therefore, with appropriate calibration, IA can be used for rapid low cost pollutant determination in soil, sediment, water and body fluids (Aga & Thurman, 1997; Sherry, 1997).

In studies of bioavaiability, there has only been very limited use of modelling procedures to simulate intracellular behaviour of pollutants. Here, process simulation modelling will be particularly important in helping to define the problems and in developing hypotheses in this highly complex area. One such preliminary mathematical model has been developed that defines the component processes in endocytosis, lysosomal compartmentation, toxicity and pathology (Figs. 3 & 4; Moore & Willows, 1998). This model focuses on ligand-binding sites associated with endocytosed particulates and the role of the endosomal-lysosomal system in pollutant uptake, toxicity and cell injury (Cheung *et al.*, 1998; Hauton *et al.*, 1998; Lowe *et al.*, 1995; Moore *et al.*, 1994, 1996 & 1997; Rashid *et al.*, 1991; Ringwood *et al.*, 1998; Svendseb & Weeks, 1995; Wedderburn *et al.*, 1998; and Figs. 3 & 4). This model has provided a conceptual framework for pollutant uptake and biotransformation, lysosomal accumulation, protein degradation, cellular autophagy and cell injury, as well as excretion of pollutants and bioavailability. It also highlights key hypotheses for experimental testing and validation of the model (Moore & Willows, 1998).

## BIOMARKERS OF EXPOSURE & EFFECT

Ecosystem Risk can be assessed using "Clinical-type Health Tests" or Biomarkers: these often simple and rapid tests are frequently based on molecular and cellular reactions that help to identify exposure to pollutants, their harmful effects and the causative processes involved.

Understanding the molecular mechanisms by which the cells of animals and plants protect themselves against pollutants is necessary for predicting the impact of such chemicals on ecosystems, and for designing tests (biomarkers) that can be used to monitor the health of the environment and its biota (Depledge *et al.*, 1993; Moore & Simpson, 1992). This will necessitate characterising the membrane protein pumps of the multidrug resistance system that directly remove xenobiotics from cells (MDR/MXR), as well as biotransformation processes by which the enzymes of cells either detoxify pollutants to harmless, excretable products, or activate them to more toxic forms ( Kurelec & Pivcevic, 1991; Minier & Moore, 1997; Stegeman & Lech, 1991) .

Many natural and pollutant organic xenobiotics are detoxified by biotransformation enzymes of phase I and II metabolism (Stegeman & Lech, 1991). Of central importance in the former is the multi-gene, multi-functional cytochrome P450 (CYP450) family of inducible isoenzymes of which particular forms (e.g., CYP1A) can activate xenobiotics to form covalent adducts with nucleic acid and protein ( Livingstone, 1991). Interacting with xenobiotic metabolism are pro-oxidant and antioxidant processes involving the production of oxyradicals and their removal by antioxidant defences (Livingstone, 1993; Livingstone *et al.*, 1990; Winston *et al.*, 1996). Oxyradical production can be increased by interaction with transition metals (Fe, Cu, Cr, Ni, Co, Va) and redox cycling organics (nitroaromatics, quinones), and also by induction of particular components of the biotransformation system, causing oxidative damage to cellular constituents (Mason, 1990; Premereur *et al.*, 1986). The consequences of xenobiotic activation and enhanced oxyradical production include impaired cellular function, cancer and certain disease processes. Aspects of the defences may be integrated at the gene level, *viz.* enzymes of the mammalian [*Ah*]-gene battery, including CYP1A and the antioxidant enzymes DT-diaphorase (DTD) and aldehyde dehydrogenase (ALDH), can be co-induced by organic xenobiotics (Nebert *et al.*, 1990).

Cellular reactions to chemical pollutants can provide early-warning distress signals of injurious change in plants and animals (Bannasch *et al.*, 1989; Hinton & Lauren, 1990; Köhler, 1989;

Köhler *et al.*, 1992; Moore *et al*, 1994; Moore *et al*, 1999). Such reactions will be of particular use if they can be shown to be precursors of pathology, since this will relate directly to the risk potential (Figs. 4 & 5). Cellular changes are used as indicators of toxic impact in testing new chemical products in laboratory rodents, and have also been increasingly used in environmental assessment of toxic risk. A further advantage of using cellular reactions is that isolated cells can be exposed to chemicals or complex mixtures of toxicants *in vitro*, which facilitates rapid testing of many samples. Additionally, at a time when the general public is becoming aware and alarmed at animal suffering in the name of science an *in vitro* approach requires the sacrifice of very few animals (Lowe *et al.*, 1992; Moore, 1992; Moore *et al*, 1994). Once disaggregated, a tissue biopsy or sample of body fluids (coelomic or blood cells) or eggs can provide sufficient cells to undertake many exposure experiments in the knowledge that genetic heterogeneity has been removed as a confounding factor; which is in sharp contrast to traditional *in vivo* exposure studies where it is necessary to treat different animals with a compound.

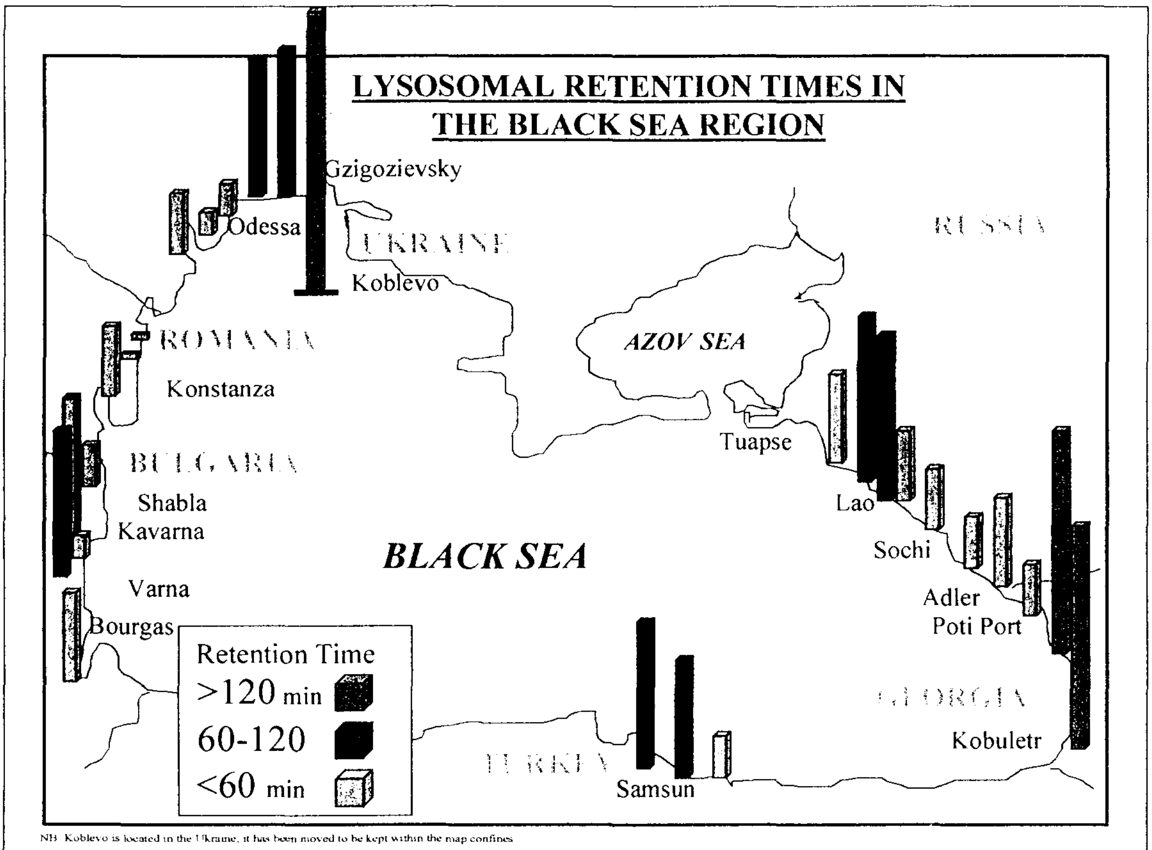


Fig. 5. Lysosomal dye retention times for the IOC-UNESCO Black Sea Mussel Watch: retention values of less than 60 minutes indicate severely impaired health (Moore *et al.*, 1999).

An attainable objective is the development of a holistic approach to environmental toxicological pathology (Fig. 2). Biomarkers are also needed which will accurately indicate the health status of the organism (Fig. 5; Lowe *et al.*, 1995; Moore, 2000). As such, this will require an integration of different tools, including molecular and cellular toxicology (including greater use of available cell lines), quantitative structure-activity relationships (QSARs), modelling the processes of cell injury and linking the models to data from flow cytometry and multiparameter fluorescent imaging of cells, coupled with cellular and tissue pathology (De Biasio *et al.*, 1987; Lowe *et al.*, 1992; Moore, 1992; Moore & Willows, 1998; Rashid *et al.*, 1991).

## ECOLOGICAL RELEVANCE & RISK ASSESSMENT

A key aim of environmental science is to derive robust, practical and relatively low cost procedures for assessing risk to the health of the biosphere and to use this capability to predict the likely consequences of exposure to potentially harmful toxic pollutants. Until relatively recently, risk assessment procedures have been oriented towards protecting human health. Now, it is widely acknowledged that such procedures must also ensure that complex biotic communities in natural ecosystems are protected if the quality of the environment in which we live is to be maintained. Environmental risk assessments are currently based on a suite of information derived from studies on the physical chemical characteristics of compounds (the QSAR approach), and from laboratory-based toxicity tests (Depledge *et al.*, 1993; Rashid *et al.*, 1991). Although these procedures constitute a low cost, pragmatic means of ranking the toxicity of potentially hazardous chemicals, they do not directly evaluate the sublethal toxicity, or other adverse effects (e.g., disturbance of ecological relationships) on organisms exposed to complex mixtures of pollutants in the highly fluctuating conditions that prevail in the environment (Howard, 1997; Kanzawa *et al.*, 1997; Kortenkamp & Altenburger, 1998).

There is therefore, a priority requirement to implement the use of robust but simple, easy to learn, cost-effective test systems that can identify early diagnostic changes in biota, that can be linked to ecologically relevant endpoints. These latter must be capable of facilitating a predictive ranking of the condition of particular ecosystems, thus highlighting environmental situations where a more detailed analysis is justified (Depledge *et al.*, 1993; Moore, 1990; Moore & Simpson, 1992; and Fig. 6).

Environmental toxicologists have also to try to anticipate the potential impacts of novel products and unwanted by-products of industry (Moore *et al.*, 1997). This includes future developments in the chemical and pharmaceutical industries as well as industries using biotechnology and the anticipated arrival of a new "molecular nanotechnology" industry (Drexler, 1992; Gross, 1999; Perrin, 1997). Harmful products are likely to include: new targeted drugs and pesticides, particularly those for use in concert with genetically modified crops; natural pesticides resulting from gene transfer into crops; and novel pathogens used for biological control (Darmency, 1994; Dunwell & Paul, 1990; Perrin, 1997).

The exponential increase in published papers in the area of nanotechnology since 1990 is a strong indicator that shortly there will be a new industry based on engineering molecules for multiple applications (Drexler, 1994; Gross, 1999). Without strong international controls on such production there could be serious environmental risks, since it is likely that the first practical developments towards nanotechnological application will rely on modified biological molecules and assemblages (Gross, 1999; Kitov *et al.*, 2000). The purpose here is primarily to raise awareness of developments and possible environmental risks in the field of nanotechnology, since it is still in the research phase.

The overall problem is, in essence: how to develop effective procedures for environmental/ecological impact and risk assessment? The use of biomarkers and biological effects indices has proven useful in establishing evidence of exposure to pollutant chemicals and damage to the health of sentinel organisms (Figs. 1, 2 & 5; Depledge *et al.*, 1993). This is obviously of great value in helping to establish causal relationships. However, for impact and risk assessment tools to be effective they must be capable of providing data that relates to ecologically significant processes (Depledge *et al.*, 1993; Moore *et al.*, 1994). This requires a better understanding of particular biomarkers, as they relate to health status (Figs. 2 & 5), in order to improve their interpretative value in monitoring (Fig. 6; Moore, 2000; Moore & Simpson, 1992; Moore *et al.*, 1994). Monitoring, itself, must be made more effective through rational interaction between chemists, ecotoxicologists and environmental managers: a framework for this type of interaction is outlined in Figure 6.

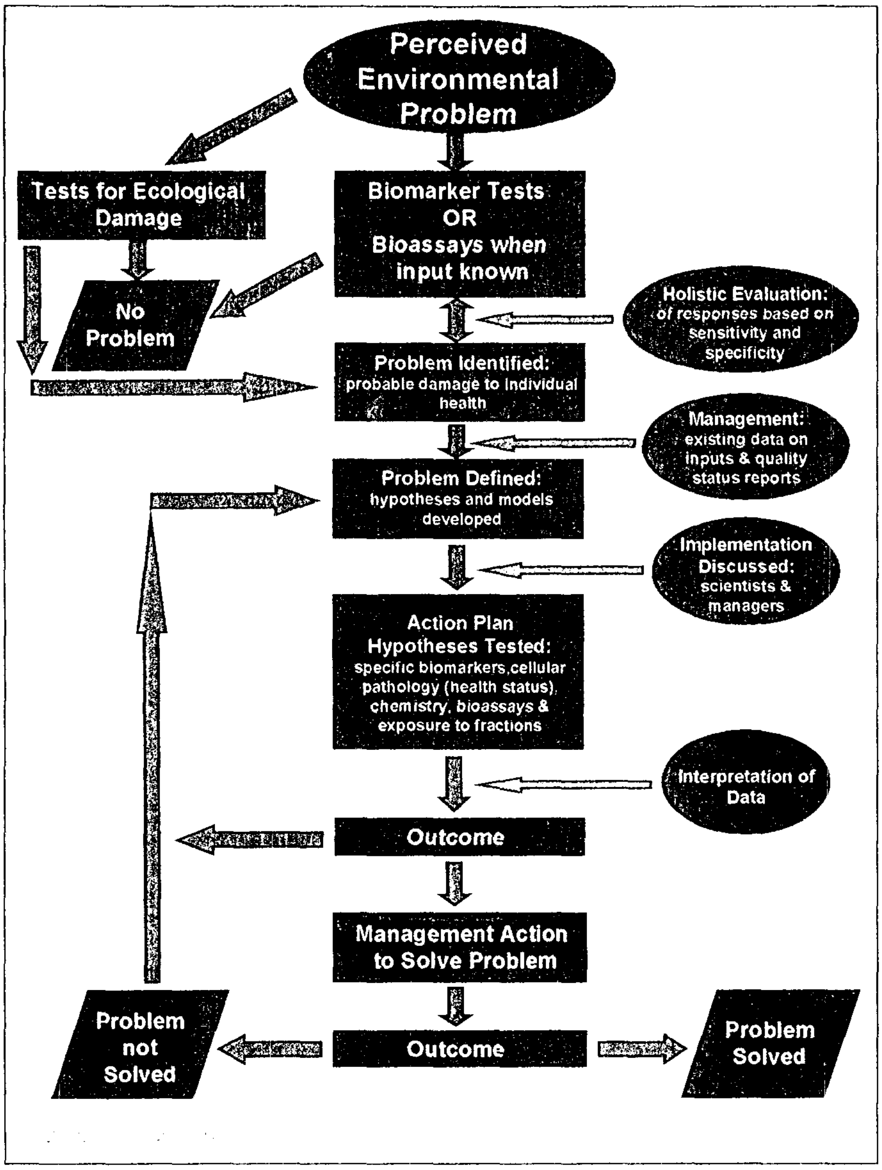


Fig. 6. Conceptual framework for an interactive monitoring programme for the assessment of environmental impact of pollutant chemicals (Adapted from the ICES-WGBEC Report, 1997 and Moore *et al.*, 2000).

In order to achieve the above aim, the science must also address the question of linkages between effects at different levels of biological organisation (Bayne & Moore, 1998; Grundy *et al.*, 1996a & b; Kauffman, 1993; Livingstone *et al.*, 2000; Moore, 2000). Establishing these linkages is essential, not only for understanding the current status of the environment, but also to provide a rational basis for prognosis for future improvement or deterioration in environmental quality (Fig. 2).

## CONCLUSIONS

This broad approach to the complex problem of assessing the health of ecosystems will facilitate the validation, and further the essential new development of robust and rapid tools for assessment (Depledge *et al.*, 1993; Ferson & Long, 1995; Moore & Simpson, 1992; Moore *et al.*, 1994). Future efforts must focus on an integrated approach to the validation of biomarkers that are prognostic for population and community endpoints (Depledge *et al.*, 1993; Moore *et al.*, 1994). As with bioavailability and uptake, exposure to pollutant mixtures must also be considered with the possibility of complex synergistic interactions resulting in emergent and novel toxicities and pathologies (Moore & Willows, 1998; Warne & Hawker, 1995).). Other environmental factors such as intense visible and UV-radiation (Fig. 2) and hypoxia also need to be considered, since these are likely to be important in terms of potentially harmful interactions with contaminants (Mason, 1990). This includes xenobiotics acting as photosensitisers and the facilitation of cascades of harmful radical production on reoxygenation following a hypoxic interlude, such as that induced by eutrophication (Fig. 2).

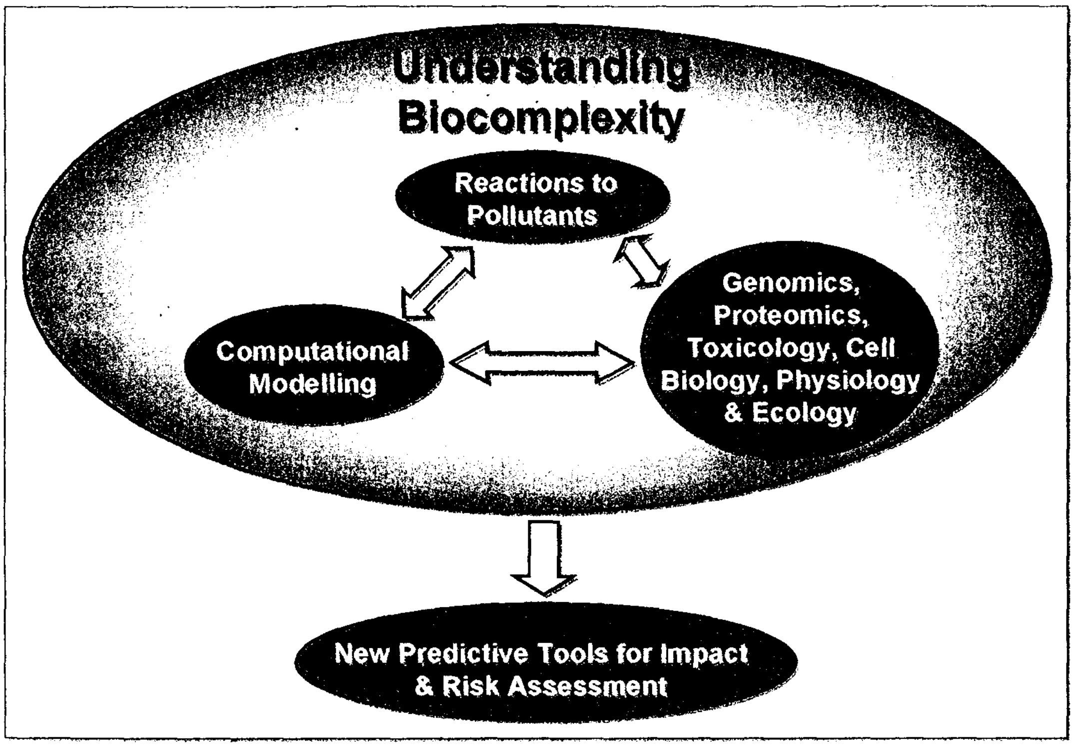


Fig. 7. Conceptual framework for developing new predictive ecotoxicological tools to address future needs for environmental impact and risk assessment (Moore, 2000).

A major reason for the development of complexity science, and its use in ecotoxicology, is to gain a realistic insight into the limits of reductionism as a very successful universal problem-solving approach (Casti, 1994; Kauffman, 1993; and Fig. 2). Complex biological and ecological processes generate counter-intuitive, seemingly acausal behaviour that is full of novelty (Howard, 1997; Kanzawa *et al.*, 1997; Kauffman, 1993). Trying to understand the behaviour of a complex adaptive (or dynamic) system, such as an organism, population, ecosystem or biogeochemical cycle, by a reductionist approach often irretrievably destroys the inherent nature of the problem (Kauffman, 1993). Recognition that a system is complex is specifically subjective, not an objective property of an isolated system. However, it can become objective, once the investigative formalism takes into account the larger system with which the target system interacts (Casti, 1994; Kauffman, 1993). In fact, complexity science is really a subset of the more general and much larger scale objective of creating a theory of models (Casti, 1994).

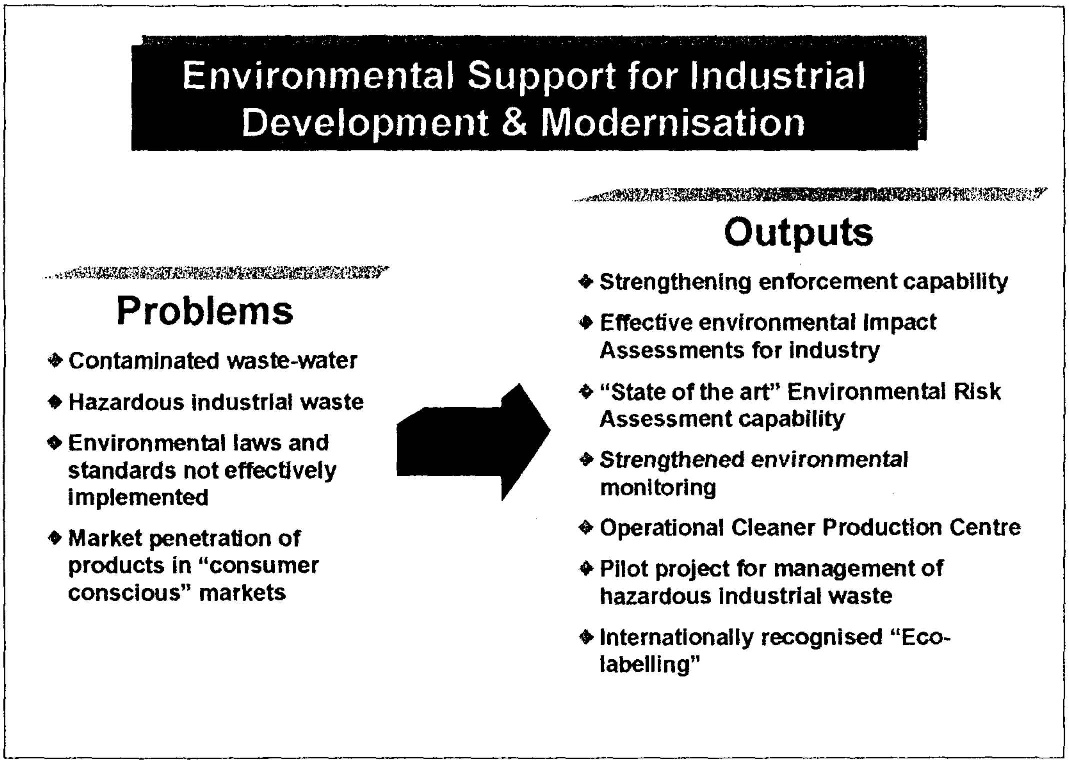


Fig. 8. Diagrammatic representation of environmental problems related to sustainable industrial development and their proposed solutions through the application of IEM.

There must also be a wider recognition that IEM and ecotoxicology/environmental toxicology is dealing with complex adaptive systems (Kauffman, 1993; Moore, 2000; and Fig. 2). Consequently, there needs to be a rapid acquisition of the new methods of "complexity science" and implementation of these into the scientific components of Integrated Environmental Management programmes (Fig. 8). Therefore, a rational way forward can be conceived, if an integrated multidisciplinary approach to the environmental impact of industrial chemical inputs is adopted as follows:

- development of conceptual frameworks and process simulation models based on an improved mechanistic understanding of contaminant uptake, biotransformation, toxicity and impact within the biological organisational hierarchy (Düchting et al., 1996; Koo, 1999; Lauffenburger & Linderman, 1993; Maddox, 1998; Moore, 2000; Moore & Willows, 1998; Noble *et al.*, 1999; Figs. 2-4 & 7);

- meet the interdisciplinary challenge of mathematically modelling processes in environmental pollution and impact as a complex adaptive system (Kauffman, 1993; Figs. 2 & 7), encompassing contaminant geochemistry, mode of uptake and intracellular behaviour, biochemical toxicology (including proteomics), cellular injury and pathology (e.g., using "virtual" organs and animals; Fig. 4), ecological consequences and human risk;
- take a broad view of the current and predicted future problems in environmental management, that incorporates both moderate reductionist and synthesist approaches Figs. 3, 4 & 7);

- areas of collaboration need to include, among others remote/satellite surveillance, risk assessment, interpretation of complex information and predictive modelling (Fig., 8);

- precautionary anticipation of novel environmental hazards (e.g., from Biotechnology & Molecular Nanotechnology);

- education of politicians, industrialists and environmental managers concerning the long-term consequences of pollution; and that increased consumer awareness of environmental problems is already exerting pressure on "Industry" to make its products "environmentally friendly" (i.e., eco-labelling), in order to maintain existing markets and to improve their penetration into new markets (Fig. 8).

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# An Overview on Industrial Sector in Lebanon

ICS – UNIDO/CITET Workshop on
Planning Rehabilitation of Degraded Industrial Areas
In the Mediterranean by Decision Support Systems
29-31 May 2000, Tunis

By: Boghos Ghougassian
MECTAT – Lebanon

## 1- INTRODUCTION

After some 17 years of destructive civil strive, which ended in early 1990s, Lebanon's authorities and people are engaged in efforts to rebuild a nation. They are reconstructing and rehabilitating the physical infrastructure, reconstitute the educational, health and social service system, create an enabling environment for economic growth, industrial development, job creation, and implement a long-term development strategy and policics to prepare the country for the challenges of the 21st century.

Lebanon's economy is dominated by the services sector (financial, commercial, public administration, tourism, etc.), which accounts for an estimated 60% of GDP, followed by manufacturing and construction with 18% and 10% respectively, and agriculture with 12-15%.

There are about 22,000 industrial units in Lebanon, out of which 88% is typified as small and medium size enterprise (SME) and each one of them employing less than 9 people. SMEs dominate the labor intensive sectors such as food processing, leather and footwear, textile and clothing, woodworking and crafts, construction materials, fisheries, recycling (paper, batteries, plastics, etc.) and light metal working. These small firms provide employment to 55% of the workforce in the industrial sector.

The industrial sector was hard hit during the war years of 1970s and 1980s. Many firms were damaged and skilled labor has out migrated or was displaced in another part of the country. On the other hand little and cautious investments were made for adopting new and more adequate technologies. These factors along with others severely hampered the growth of the industrial sector in Lebanon.

Now efforts are being made for the revitalization of the industrial sector, but the process is slow, due to lack of resources and lack of competent staff in public services.

## 2- INVENTORY OF INDUSTRIES

According to the 1994 statistical survey of Ministry of Industry, there are about 22,000 operating industrial units in Lebanon (out of 23,500 registered). It is estimated that over 70% of those are concentrated in Beirut and its suburbs. About 10% located in Tripoli area, 5% in Zahle area, 5% in Saida and 10% in other regions. Attached map gives an indication of distribution of industrial areas in Lebanon.

The results of the industrial census of 1994 indicates the following:

- The total number of the operational firms in Lebanon is estimated at 22,107 units. Those firms are distributed among the different geographical regions of the country and are spread out between the different branches of activities. This total does not include the water and power generation activities, which are entirely handled by the public sector.
- The census had taken into account all the units that meet with the four following criteria: a machine, a worker, an input and a finished product.
- The Lebanese industrial units are small-sized since 87.7% of the listed enterprises employ less than 9 wagers.
- More than 96% of the industrial units' number is concentrated in the manufacturing industry, the construction representing 2.3% of the total industrial units, and the mines and quarries a little more than 1.1%.
- 30% of the listed units have been set up between 1990 and the first half of 1994.
- The foreign capital invested in the Lebanese industry remains very low, since only 56 units, out of the 23,500 listed ones, have a foreign majority, and 89 units have a capital equally shared out between nationals and foreigners.
- The industrial units, which are active in Lebanon, are employing more than 150,000 employees. The listing of the employees takes into account the employers and the relatives working in the company, but it does not take into account the seasonal workers.
- The average number of employee per firm is 6.52 persons.
- The total turnover of this sector is 3.72 billion US dollars. The average turnover per company is approximately 165,700 USD. When related to the number of workers in the company, the turnover is approximately 25,700 USD per worker.

Tables 1 and 2 provide additional statistics on the status of industries in Lebanon.

**Table–1: Structure of the industrial firms**– as a percentage of the total

| Number of worker | Number of firms | Workforce | Out put | Added value | G.F.C.F.* | Salary charges |
|---|---|---|---|---|---|---|
| 1 to 9 | 87.7% | 55.3% | 37.0% | 40.3% | 35.3% | 36.9% |
| 10 to 49 | 8.5% | 21.7% | 29.5% | 29.0% | 22.1% | 24.4% |
| 50 to 249 | 0.7% | 9.3% | 17.4% | 15.1% | 22.5% | 15.1% |
| Over 250 | 0.2% | 10.9% | 14.7% | 13.8% | 17.2% | 20.9% |
| Total | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

* Gross Fixed Capital Formation

Table – 2: Distribution of Existing Industrial Establishments in The republic of Lebanon

| INDUSTRY | | WORK FORCE | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| CODE | LIBELLE | 1 – 4 | 5 – 9 | 10 – 19 | 20 – 34 | 35 – 49 | 50 – 99 | 100 – 249 | >250 | |
| 1 | Agriculture and Hunting | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 |
| 14 | Mining and Quarrying | 117 | 81 | 30 | 4 | 5 | 2 | 1 | 0 | 240 |
| 15 | Food Products and Beverages | 3300 | 786 | 288 | 94 | 22 | 35 | 10 | 7 | 4542 |
| 16 | Tobacco Products | 3 | 4 | 2 | 0 | 0 | 0 | 0 | 1 | 10 |
| 17 | Textiles | 407 | 86 | 56 | 31 | 9 | 14 | 6 | 1 | 610 |
| 18 | Wearing Apparels,Fur | 2284 | 379 | 226 | 96 | 26 | 25 | 5 | 3 | 3044 |
| 19 | Leather and Leather Products | 444 | 198 | 153 | 45 | 10 | 7 | 0 | 1 | 858 |
| 20 | Wood and Wood Products | 1203 | 176 | 41 | 14 | 1 | 2 | 3 | 1 | 1441 |
| 21 | Pulp and Paper Products | 113 | 52 | 22 | 10 | 6 | 7 | 4 | 3 | 217 |
| 22 | Printed Matter and Recorded Media | 206 | 103 | 52 | 27 | 11 | 8 | 3 | 3 | 413 |
| 23 | Coke and Petroleum Products | 5 | 5 | 2 | 2 | 3 | 1 | 0 | 1 | 19 |
| 24 | Chemical Products and Man-Made Fibres | 123 | 43 | 37 | 13 | 11 | 10 | 1 | 1 | 239 |
| 25 | Rubber and Plastic Products | 242 | 89 | 41 | 16 | 10 | 5 | 3 | 0 | 406 |
| 26 | Non-Metallic Mineral Products | 952 | 479 | 178 | 38 | 11 | 7 | 6 | 7 | 1678 |
| 27 | Basic Metals | 161 | 47 | 14 | 7 | 3 | 6 | 3 | 1 | 242 |
| 28 | Fabricated Metal Products | 2541 | 415 | 84 | 20 | 16 | 9 | 2 | 1 | 3088 |
| 29 | Machinery and Equipment | 227 | 67 | 38 | 19 | 6 | 3 | 3 | 0 | 363 |
| 31 | Electric Machinery and Products | 242 | 23 | 9 | 5 | 5 | 2 | 1 | 3 | 290 |
| 32 | Radio and communication Equipment | 15 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 17 |
| 33 | Medical, Optical, Watches, and clocks | 13 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 15 |
| 34 | Motor Vehicles and trailer | 288 | 35 | 4 | 2 | 1 | 0 | 0 | 1 | 331 |
| 35 | Other Transport Vehicles | 9 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 15 |
| 36 | Furnitures and other Goods | 2797 | 562 | 179 | 48 | 18 | 11 | 3 | 2 | 3620 |
| 45 | Construction Work | 243 | 136 | 83 | 28 | 4 | 6 | 2 | 3 | 505 |
| | TOTAL | 15935 | 3770 | 1544 | 521 | 178 | 161 | 56 | 40 | 22205 |

## Constraints for Revitalization of Industrial Enterprises in Lebanon

The main constraints for slow rate progress in the industrial sector is summarized as follows:

(a) The lack of medium-and long-term financing facilities for local companies. which remains a serious obstruction to the development of small-scale industries;

(b) Low productivity and lack of quality standards. This would require measures to raise the efficiency and productivity of enterprises, including quality enhancement and standards certification (ISO 9000) to boost export-oriented industries and international competitiveness;

(c) The need for improvements in the administrative. legal and regulatory framework for business operations;

(d) The fact that industry-related support services and information systems and networks remain inadequate, or do not exist. This represents a major handicap for industrial expansion and competitiveness;

(e) The need for management training as well as training to upgrade the skills of the workforce.

## Pollution Created by Industries

The pollutants (effluents, emissions and solid wastes) of the industrial activities are usually discharged into the environment, without pretreatment. Brief descriptions of pollutants related to industrial subsectors are presented here below.

### *Processing Industries:*

The following industries generate wastes and discharge them in the environment without any treatment.

- **Chemical and pharmaceutical:** Large variety of chemical wastes.
- **Paper, pulp and wood:** Suspended solids alkaline products, color, soda, sulfates, sulfites, dyes, fat, acids, sulfur, calcium, solid wastes, etc.
- **Food industries:** Organic nitrogen, ammonia, sodium, calcium, mercury, phosphate, potassium, ash, suspended solids, fat, sulfates, etc.
- **Textile and apparel industries:** Chrome, mono-chloro-benzene, oils, soda, sulfuric acid, acetic acid, mineral oil, etc.
- **Agricultural fertilizers and pesticides:** Wide range of organic and inorganic matter, toxic wastes, etc.
- **Cement factories:** Dusts, asbestos, sulfur dioxide, nitrogen oxides, petroleum, industrial effluents, suspended solids, etc.
- **Paint factories**: Large variety of alkaline materials, fats, chemicals, solids, acids, color, organic and inorganic matter, etc.

- **Metallurgical, ceramics, fiberglass, surface treatment and plating:** Phenol, cyanides, nitrogen compounds, organic and non organic matter, suspended solids, sodium carbonate, acids, ferrous sulfate, ferrous chloride, cyanide, aluminum, copper, chrome, zinc, caustic soda, silicon oxide, chlorine, cadmium, silver.
- **Batteries:** Lead compounds, sulfuric acid, suspended solids and plastics.
- **Plastics:** Large variety of polyesters, vinyls, chlorides, alkyls, methane, pigments, color, solids, dust, etc.

*Hospitals and Laboratories:*

The following wastes are produced by over 130 hospitals with **preliminary waste treatment.** Less than 10% of the hospitals treat their solid wastes by incineration.

Solid waste that are generated in Hospitals include the following

- Wastes that are similar to household solid waste
- Infectious waste
- Sharp objects
- Anatomic waste
- Pharmaceuticals
- Chemicals
- Radioactive waste

An estimate of 5 kgs of waste per occupied bed is generated. It is expected that waste generation will increase with the increased use of disposables.

*Petroleum Industries:*

The petroleum sector involves the following activities with **no waste treatment facilities:**

- 21 private oil terminals
- 6 power stations
- 2 refineries (non-operational)
- 4 main seaports + 23 open sea berths for petroleum tankers.
- Oil blending / filling facilities (30,000 MT / year).
- Chemical blending / filling facilities (60.000 MT / year).
- Petroleum delivery stations, oil sumps, garages, and over 2500 gas stations.

- **The total storage capacities of fossil fuels in Lebanon are:**

  - Liquefied propane/butane mixtures: 100,000m$^3$, mostly in Greater Beirut area.

- Liquid products (gasoline, jet fuel, fuel oil, diesel oil, kerosene, petrochemicals), 1,800.000 m3, more than half at the Tripoli and Zahrani refineries.

***Power Generation:***

There are **no waste treatment facilities** for power generation except the minimal import of unleaded gasoline:

- 6 thermal power generating stations with about 2,300 megawatts. The industrial effluents are: hot water, sulfur dioxide, sulfuric acid, carbon monoxide, nitrogen oxides, particulate.
- Internal combustion engines: over 1.5 million vehicles and 100.000 generators including private cars, busses and trucks generating pollutants such as: carbon monoxide, nitrogen oxides, sulfur dioxide, lead, and hydrocarbons.

## 3- PHYSICAL PLANNING OF INDUSTRIAL ACTIVITIES

Since the early 90's Lebanon witnessed an impressive economic revival. The country, with its traditionally free market economy and no exchange controls, is in the process of completely rebuilding its infrastructure.

In this context, the new policy for the location of industrial zones and town planning measures guarantees attractive conditions for investors.

Its success relies on a healthy business environment that favors investments.

The existing industrial zones are being revitalized through improvements in infrastructure and landscaping. On the other hand, the new industrial zones are being equipped and landscaped according to international standards. These new zones are strategically located throughout Lebanon.

### Classification of Industries and Zoning

A revision of laws regarding the classification of different industries is currently underway. As a result of the evolution of production techniques and pollution control, many modern industries no longer present a threat to the environment. In order to keep up with the evolution of industrial technology, the government has carried out a study proposing to replace the three existing industrial categories with five new categories for a more detailed and comprehensive classification.

The industrial zones will be classified according to the industrial category they are authorized to accommodate to prevent inappropriate industrial location. Each major region of Lebanon will have at least one zone of category 1.

The three existing industrial categories are marked according to the quantity of pollution they produce. These categories are the following:

*Category 1* – those industries generating wastes more than 1,000 kg/year.

*Category 2* – industries generating waste at the rate of 100 kg to 1,000 kg/year.

*Category 3* – less than 100 kg of waste per year.

Industries belonging to categories 1 and 2 must provide detailed information regarding raw materials used, water consumption, waste treatment and health measures adopted.

## 4- LEGAL FRAMEWORK: Permits for Industrial Installations

The revival of the Lebanese industry needs a comprehensive policy concerning investments, production, financing and promotion as well.

### 4.1 The Existing Measures

In the past, the Lebanese government took measures to help the industrial sector. But often the solutions have not gone beyond first aid actions.

The measures that have been taken so far are summed up as follows:

- Tax exemptions for some new industrial investments,
- Customs protection for the locally manufactured products;
- Customs exemptions on industrial equipment, spare parts and raw material.
- The creation of special credit institutions, which are supposed to grant credits at preferential rates and with favorable terms.
- Subsidies for the energy prices, especially for fuel oil, diesel oil and electricity.
- A cautious policy of professional training, through the development of technical and professional training; and on the research level, the establishment of the Industrial Research Institute, which resumed its operation recently.
- An investments protection against the non-commercial risks; through the National Institute of Investments Guarantee.
- A promotion of the industrial exports, through trading agreements signed with the Arab countries, and with the European Union.

**Government priorities for industrial policy**

Lebanon's main government strategies, objectives and policy direction is to rebuild the country after 17 years of civil war and to prepare it for the challenges of the twenty-first century. Government priorities for industrial policy formulation and implementation is designed to develop Lebanon's manufacturing industries and improve their international competitiveness.

Therefore, for the Government of Lebanon, the creation of an enabling environment for industrial development includes the following major measures:

(a) Adjusting the legal and regulatory framework of the country.

(b) The development of financial intermediation.

(c) Providing vocational, technical and professional training facilities.

(d) Developing the provision of industrial information and support services.

(e) Providing technical assistance and support services to improve the quality of products, services and management.

(f) Providing incentives for regional and rural industrial development (e.g. through the establishment of industrial estates, industrial free zones, industrial incubators);

(g) Promoting agro-industries and small- and medium- size industries (SMIs);

(h) Providing incentives and training for technology absorption and adaptation to raise the efficiency, productivity and export capacity of the industrial sector;

(i) Implementing policies that protect the environment while securing sustainable industrial development (energy conservation, pollution abatement, cleaner production centres, reducing health and safety risks).

## 4.2 Need for an Integrated Industrial Policy

Measures listed above have helped the industry to start off, but these can hardly be termed as an industrial policy.

An integrated industrial policy implies a coupling between tax exemption, customs protection, low-interest credit, the possible subsidies and the prospecting of foreign markets.

An industrial policy implies a series of objectives, which are decided in the light of the real needs of the country and the sector, and the market potentialities, which are supported by realistic and appropriate measures, through efficient and controllable instruments.

The required strategic objectives should aim at creating and encouraging the development of a series of activities, or on the contrary, aim at freeing from a product series of little benefit or without any substantial advantage for Lebanon.

### Specific Incentives for Promoting the Development of Industries

The speed at which a manufacturing company is set up is a measure of its success. To reduce government bureaucracy, a committee has been formed comprising IDAL

(Investment Development Authority of Lebanon), Ministry of Environment (MOE), the General Directorate of Town Planning, and presided over by the Ministry of Industry and Petroleum.

This committee facilitates procedures issuing permits (industrial licenses, construction permits) and responds to all requests concerning the formation of business and the setting up or expansion of industrial firms.

Companies will be notified of committee decisions within thirty days and permits will be delivered within the following fifteen days.

Consultations carried out by the committee with all the relevant authorities will be made on a case-by-case basis.

On the other hand, an EU funded project "Strengthening the Permitting and Auditing System for Industries" was launched recently at MOE Lebanon.

## 5- E.I.A. and INDUSTRIES

In 1995 the EIA tool was introduced in Lebanon, at Ministry of Environment. Two training sessions were organized for experts and decision-makers and then the EIA Manual (Environmental Impact Assessment Manual- Basic Procedures for EIA in Lebanon) was drafted in 1997. Until now the EIA process has not started at Ministry of Environment.

After several revisions and studies during the last couple of years, now a program is set at MOE, financed by GEF, to implement the EIA process. The main obstacle is that there is no comprehensive environmental law or an environmental code in Lebanon, which supports the implementation of the EIA process.

Another constraint is how to deal with the SMIs or SMEs which are the most polluting enterprises. It is anticipated that those small firms will be allowed to prepare brief EIA statements.

Meanwhile, when applying for a permit, proponents should prepare a technical study. This must be submitted to Ministry of Environment and include measures regarding solid and liquid waste management, controlling air pollution, evaluation of anticipated noise levels, transport/storage methods and processing of raw material.

## 6- INDUSTRIAL WASTE MANAGEMENT

The majority of industries, discharge their wastes into watercourses. The volume and strength of these wastes has not been surveyed so far. More specifically, industries located in sewered areas discharge their untreated wastes along with municipal sewage. Those located in suburban or rural areas tend to practice direct discharge of untreated effluents into freshwater streams or valleys and into the sea, and in some instances on land. Usually the industrial solid wastes are dumped at municipal solid waste dumping sites, where open dumping is the general practice.

Wastes from chemical industries are the most problematic and hazardous for the Lebanese environment. The most polluting ones, in this category, are the small-scale industries. They throw their wastes carelessly. For instance, solid wastes from paint manufacturing industries, organic effluents from food processing units, toxic chemical residues from tanning and textile dying operations, effluents from paper making industries all end up in the environment, without treatment.

**Disposal of Solid Waste:**

It is estimated that total **solid waste** arising from industry is around 326,000 tons/year. Most of industrial waste could be regarded as non-hazardous. A survey of current disposal practices indicates that, some industrial waste is being disposed of through the municipalities, but other disposal routes include informal on-site incineration and informal dumping. The extent of both types of waste disposal is obvious on the western slopes and foothills of Mount Lebanon, giving rise to a risk of contamination of ground and surface water. Nonetheless, the lack of surveillance over the practice of the industrial waste discharged adds further to the deterioration of the quality of water resource.

All of the industries open dump their wastes into rivers or dumped on land without prior treatment. The observed pollutant loads resulting therefrom are extremely significant and contain a wide range of contaminants such as heavy metals, phosphate, sulfide, halogens, dyes, hydrocarbons, and others.

**Disposal of Effluents:**

There is virtually no treatment of **liquid wastes** from industry, which are mostly discharged into surface and coastal waters. These pollutant loads impose serious environmental stress on surface water and groundwater resources.

In some cases, effluents are discharged into seasonal wadis rather than rivers. The concentrations of effluents in wadis change seasonally as water flow is substantially reduced in the summer months.

In general, the key issues associated with industrial activities and industrial waste on the environment may be highlighted as follows:

- the geographical concentration of industry in the coastal zone and west of the mountains, allows discharge of effluents into the Mediterranean Sea, directly or through flow in the valleys;
- Industries damaged or destroyed during the war may have left a legacy of contaminated land and ground water;
- Small enterprises are hard to monitor and control than larger units;
- The identification of proposed industrial estates has not been subjected to environmental impact analysis;
- Most industries have no effluent treatment facilities, and water is frequently supplied from private wells, most of them illegally constructed;

- Surface and ground water is contaminated through direct dumping of industrial liquid effluents in water courses, leaching from uncontrolled dumps on land, disposal of wastes to disused bore-holes and wells;
- Informal incineration of industrial solid waste, causes harmful atmospheric emissions;
- Waste oils are frequently disposed of directly to the sewer network and then to the rivers or to the sea.

**Efforts for Controlling Pollution**

During 1996/97 the National Industrial Waste Management Plan was developed by MOE. This plan concentrates on end-of-the-pipe solutions for existing industrial units. It does not indicate waste minimization and clean production measures. It is doubtful how effectively this plan will be implemented.

In this Plan, SMEs are usually left to their destinies and very little is planned for improving their situation. Huge efforts are needed to enable SMEs to close their technological gaps, to enable them to comply with environmental standards that are planned to be forced.

Actually the owners of factories do not know what to do with their wastes. Training of engineers and technicians is highly needed in order to achieve abatement of pollutants and apply the low waste and clean production (CP) concepts at factories. End-of-the-pipe remedial actions are not enough for solving the pollution problem of industries. Preventive measures and environmental management systems should be adopted. On the other hand, care should be taken not to bring in the polluting and outdating technologies that are being provided by industrialized countries.

**Difficulties Faced by Small and Medium Industries**

General difficulties faced by SMEs can be broken down into categories of information, training, guarantees, taxation and resources.

Usually SMEs lack financial, technical and managerial resources; they are starved of technical information. They do not have the means to deal with the administrative and legal difficulties in new operational environments.

The technical solutions for alleviating some of these difficulties may include the following elements:

- training of specialized advisers to be placed at the disposal of SMEs;
- establishment of units for providing pooled services;
- insurance covering the identification of modes of technology transfer;
- introduction of investment guarantees;
- financing of studies and the introduction of legislation on SMEs for governing investments.

## Typical Industrial Waste Management Program Needed for Lebanon

A typical industrial waste management program for the treatment of industrial effluents in Lebanon would encompass the following:

- Development of comprehensive environmental legislation and standards,
- Implementation of international agreements and conventions,
- Statistical data compilation on continuous basis,
- Analysis of the present situation,
- Development of Waste Management programs in cooperation between the Industries and Authorities,
- Identification of environmentally sound technologies (ESTs) and their transfer to Lebanon,
- Identification of Cleaner Production procedures for each industry or group of industries,
- Promotion of primary and secondary level treatment of industrial wastewater at the site,
- Dissemination of economic viability studies to encourage in situ waste treatment.

## Cooperation of UNIDO with Ministry of Industry

During the first half of May 2000, an experts' team from UNIDO Headquarters visited Lebanon and discussed with authorities the priority projects that UNIDO is going to implement during the next couple of years.

UNIDO's field mission has come up with a four-pronged program to assist Lebanon: effective governance, partnership and market access, improving enterprises' performance, and clean environment.

Lebanese authorities have agreed with UNIDO in establishing a Clean Production Centre, which would play an advisory role and catalyze waste minimization at industrial units. Small and medium industries of Lebanon urgently need such a service. But in the absence of capable public institutions that can shoulder such a task, it is quite difficult to go ahead. One approach would be the involvement of the private sector, as consultants.

Other areas of cooperation with UNIDO will include themes such as: environment, renewable energy, and development of cottage industries (local crop processing) for rural women.

Good intentions are there, but the lack of funds and skilled manpower is the main obstacle which need to be overcome.

**Institutional Framework**

The main public bodies that are involved in the matters of industrial development in Lebanon are the following:

- Ministry of Industry and Petroleum
- Council for Development and Reconstruction (CDR)
- Ministry of Environment
- Investment Development Authority of Lebanon (IDAL)

By: Boghos Ghougassian
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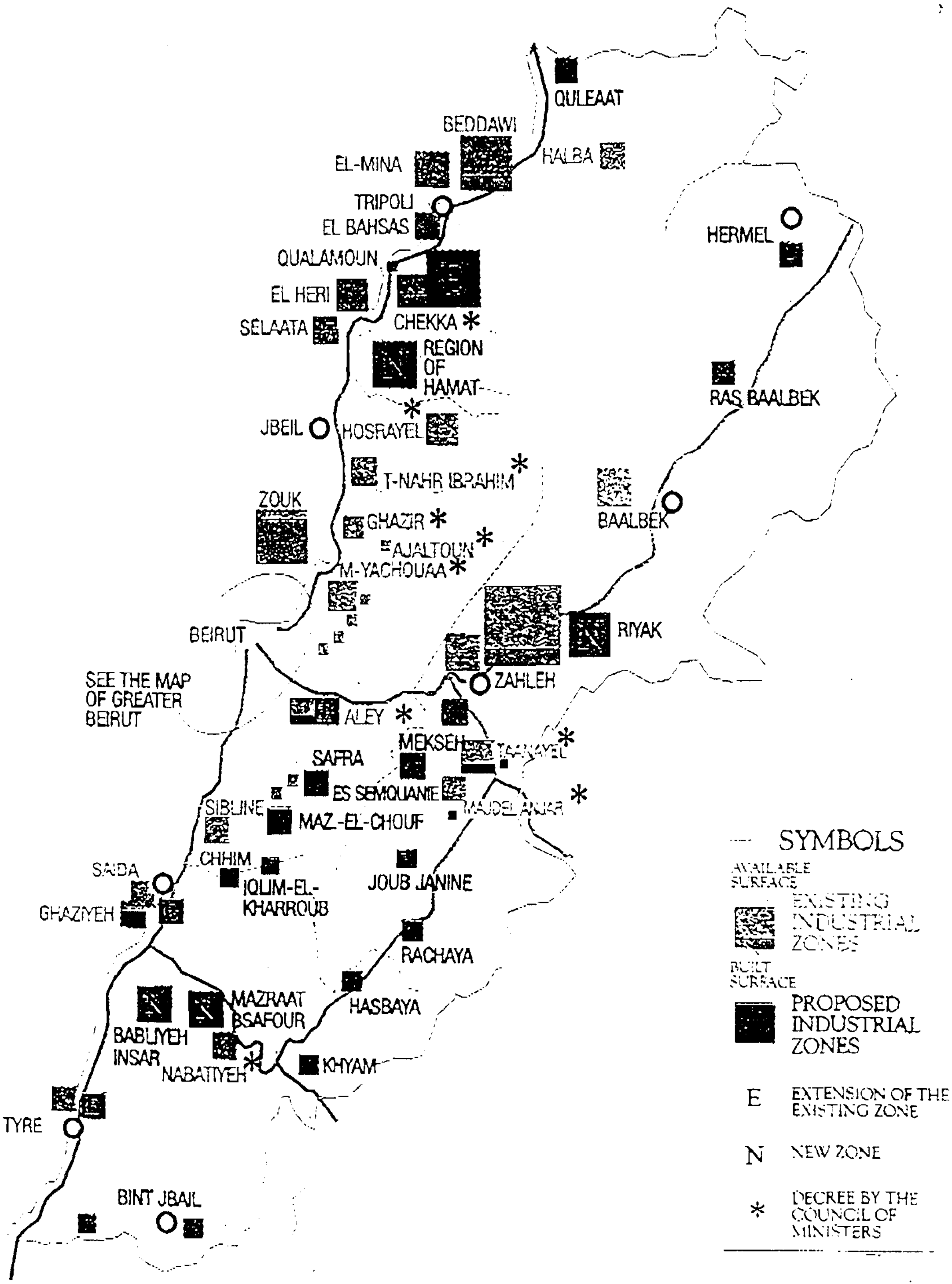
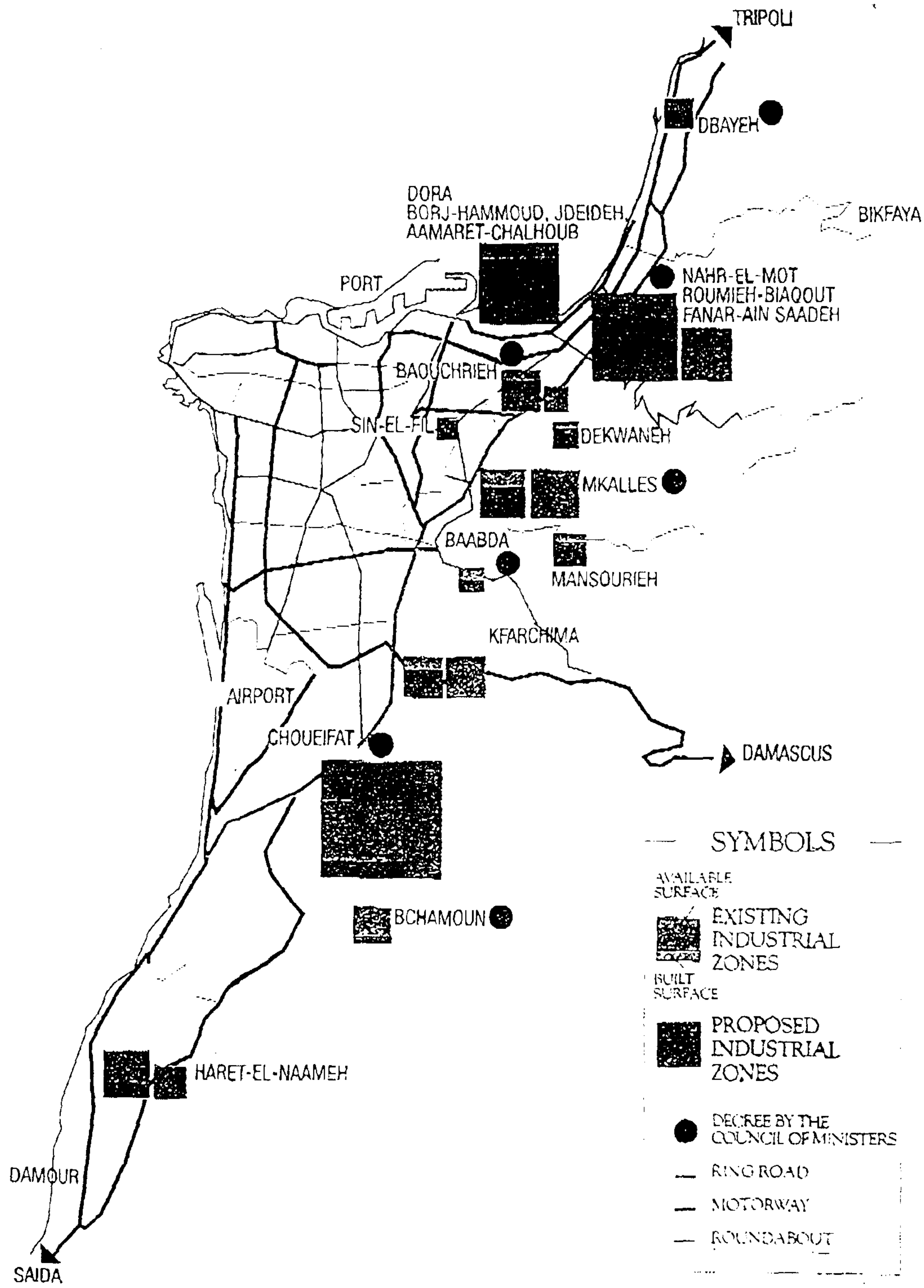
P.O. Box: 113-5474
Beirut, Lebanon
E-Mail: boghos@mectat.com.lb

25 May 2000

# LOCATION OF THE INDUSTRIAL ZONES IN LEBANON



# LOCATION OF THE INDUSTRIAL ZONES IN GREATER BEIRUT



..ka voyages
..el: 892 775- 846 985-783471-849265
Fax: 797826

Tunis, le 29 Mai 2000

Bon de Commande N°

FACTURE N° 12078

COPIE

DOIT: LA C.I.T.E.T

| NATURE DES SERVICES RENDUS | P. U | QTE | MONTANT |
|---|---|---|---|
| 1 BILLET PREPAID BEIRUT/ISTANBUL/TUNIS/ISTANBUL/BE FAVEUR MR BOGHOS/GHOUGASSIAN N° 235-6617581928 | 1,133,500 | 1 | 1,133,500 |
| 1 BILLET PREPAID VENICE/MILAN/TUNIS/ROME/VENICE FAVEUR MR BERTUCCO/ALBERTO N° 055-6617581930 | 698,500 | 1 | 698,500 |
| 1 BILLET PREPAID DAMAS/TUNIS/DAMAS FAVEUR OUDINA/J ET SOUHA/N N° 0704020194724 | 3,532,000 | 1 | 3,532,000 |
| 1 BILLET PREPAID ALGER/TUNIS/ALGER FAVEUR GHAURAR/RABAH N° 124-4020591020 | 378,000 | 1 | 378,000 |
| CITET 2 6 JUIN 2000 ARRIVEE N° 290 COMPTABILISÉE | | | 5,742,000 |

Arrêté la p. la presente facture à la somme de : CINQ MILLE SEPT CENT QUARANTE DEUX DINARS ,/,

Valeur en votre aimable règlement.

Banque du Sud Agence le Belvédère Tunis
CCB N° 04 105 0444047004033 73

PRISE EN CHARGE
Le soussigné certifie que le matériel et les services, objet de la présente ... exécutés et reconnus bo...
Nom : ...
Qualité : ...
Signature : ...

MINISTERE DE L'ENVIRONNEMENT
ET DE L'AMENAGEMENT DU TERRITOIRE
Centre International des Technologies
de l'Environnement de Tunis

وزارة البيئة والتهيئة الترابية
مركز تونس الدولي
لتكنلوجيا البيئة

Tunis, le 28 juin 2000

***Invoice N° /2000***

Subject : Workshop on Planning Rehabilitation of degraded Industrial Areas in the Mediterranean.
29-31 May 2000

**Client: ICS/ UNIDO**

| N° | DESIGNATION | Amount in US$ |
|---|---|---|
| 1 | Air Tickets | 4,417 |
| 2 | Perdiem | 4,488 |
| 3 | Field trip and local transportation | 880 |
| 4 | Stationery ( folders and badges, pens, block notes, markers, flip charts and black board | 320 |
| 5 | Photocopies , faxes, communication | 1,000 |
| 6 | Rental of equipment | 300 |
| 7 | Elaboration of final report | 1,000 |
| | Total | 12,405 |

**Total amount of twelve thousand four hundred and five dollars and no cent**

Rate: 1US$ = 1,3 Tunisian Dinar

La Directrice Générale
du Centre International des Technologies
de l'Environnement de Tunis

Mme [illegible] BENZARTI

شارع البيئة - 1080 تونس الهاتف : 216 1) 770.285 / 770.998 فاكس : 216 1) 772.255
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MINISTERE DE L'ENVIRONNEMENT
ET DE L'AMENAGEMENT DU TERITOIRE

Centre International des Technologies
de l'Environnement de Tunis

## ICS- UNIDO Workshop on degraded industrial areas

from 29 to 31 May

**Perdiem Expenditure**

| N° | Pays | Nom et Prénom | é.mail | Tél | Fax | Perdiem (dollars) |
|---|---|---|---|---|---|---|
| 1 | ITALY | GHRIBI Mounir | ghribi@ics.triese.it | 39-040-9228-105 | 040-9228-136 | |
| 2 | SPAIN | IRAKI Gili | cleanpro@cipn.es | 93 415 11 12 | 93 237 02 86 | |
| 3 | TUNISIA | HILI Naima | - | 794 618 | 782 330 | 544 |
| 4 | TUNISIA | HAMED Salah | - | 794 618 | 782 303 | 544 |
| 5 | AUSTRIA | MOORE Michael | mmoore@unido.org | 43-1-26026-33 63 | 43-1-26026 68 19 | |
| 6 | GREECE | ABOUSAMRA Fouad | Fouad@.unep map or | 72 73 116 | 72 35 196/7 | |
| 7 | ITALY | FEOLI Enrico | feoli@ics.trieste.it | 39 040 9228 109 | 39 040 9228 136 | |
| 8 | TUNISIA | FELFOUL Ahmed | - | 344 700 | 350 411 | 544 |
| 9 | ITALY | BERTUCCO Alberto | bebo@ux1.unipd.it | 0039 049 827 5457 | 0039 049 827 5461 | 136 |
| 10 | ALGERIA | CHAOURAR Rabah | - | 69 28 37 | - | 544 |
| 11 | SYRIA | JUNDI Ozaina | - | 333 05 10 | 333 56 45 | 544 |
| 12 | LEBANON | GHOUGASSIAN Boghos | boghos@mectat.com.lb | 961-1-341 323 | 961-1-346 465 | 544 |
| 13 | TUNISIE | THLIBI Jamel | - | 847 292 | 848 069 | 544 |
| 14 | TUNISIA | JELJELI Mohamed | - | 770 285 | 772 255 | 544 |
| | | | | | TOTAL | 4488 |