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**STRENGTHENING CAPABILITIES OF ENVIRONMENTAL
LABORATORIES IN THE ESCWA REGION**

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STRENGTHENING CAPABILITIES OF ENVIRONMENTAL LABORATORIES
IN THE ESCWA REGION

EXECUTIVE SUMMARY

Countries of the ESCWA region have taken various legislative and institutional measures to improve their capacity in protecting their environment from pollution and degradation. Among such measures were the establishment of environmental laboratories to provide services needed for environmental protection. Services rendered by such laboratories include monitoring and assessing the state of the environment and recommending appropriate protection measures. All in all, there are at least 40 laboratories engaged in activities related to environment protection in the region. More such laboratories are planned.

In recognition of the importance of environmental laboratories in providing essential services to countries of the region, ESCWA has undertaken this study with the objective of identifying ways and means to strengthen capabilities of such laboratories. The study included field visits to environmental protection institutions in six countries of the region, namely Egypt, Iraq, Jordan, Saudi Arabia, Syria and the United Arab Emirates. The study included:

- (a) Review of number, level and training needs of manpower;
- (b) Evaluation of equipment performance with special reference to maintenance of equipment;
- (c) Degree in which information is being exchanged among environmental institutions in the region.

The study revealed that there is a strong need for regional co-operation among environmental protection agencies of member countries. The study also makes a strong case for the development of a plan of action to strengthen the capabilities of environmental laboratories. It is proposed that ESCWA, together with regional and international organizations initiate efforts to produce financial and administrative support for the implementation of such a plan. The plan of action has three components:

- The first is the establishment of a Maintenance Regional centre designed to provide maintenance services to equipment of the environmental laboratories. The mode of operation, costs and institutional base of such a centre are outlined.
- The second is the development and implementation of a training programme to strengthen the capacity of manpower working in environmental laboratories of the region. The outlines of three types of such training courses were suggested.

The third is the setting up of an information network and the publication of a newsletter. The total cost of the action plan was estimated at 900,000 U.S. dollars for an operation of three years.

The study also suggests that ESCWA take the initiative to hold a regional meeting to discuss the plan of action and to comment on the ways and means of how to implement the plan.

I. INTRODUCTION

This report is based on a regional study of issues involved in the structure, functions, and performance of laboratories dealing with environment in the ESCWA region. Field visits were made to six countries of the region, namely Egypt, Iraq, Jordan, Saudi Arabia, Syria and the United Arab Emirates. In addition, published materials and reports on environmental activities of the other seven countries of the region were reviewed. Special emphasis was given to environmental laboratory capabilities.

II. OVERVIEW

Countries of the ESCWA region have now recognized the importance of maintaining a balanced, clean, safe and productive environment. Many, if not all, of the countries have also recognized the negative impacts of economic development on to the main elements of the environment. Such elements include inland water resources, marine waters, marine life, soil, air, plants, animal life and man himself. The threat to environmental quality caused by poorly managed or poorly planned economic activities has been documented in many countries of the region. Examples of such threats are: pollution of inland and sea water; pollution of air; deterioration of soil productivity; the extinction and diminishing of many wild life species and ecosystems; and the deterioration of the living and working ambience of man himself.

In response to such present and potential threats to the environment, countries of the region have taken various measures to protect the environment, to plan economic activities better in order to minimize or stop hazards to environment, and eventually to maintain a safe and productive environment. Such measures vary from one country to another both in type and effectiveness. All countries have established units or institutions to deal with the problem. Many have established laws for the protection and conservation of the environment and nature. Many also have established operational institutions to implement environmental quality regulations, to monitor changes in the state of the environment, and to take measures to check sources or activities that pose threats to environmental quality. The strength of implementation institutions varies from one country to another in scope, manpower, equipment and programmes. Many of these institutions have established environmental laboratories. Such laboratories are specially designed to assess chemical and biological pollutants in water, air, soil and workers environment. They are also designed to monitor changes that take place in such vital elements of environment, interpret such changes and their impact on the quality of environment and recommend corrective measures that will minimize or stop deleterious effects of pollutants and hazardous materials or actions.

While all countries recognize the important role of environmental laboratories, many suffer from a lack of one or more of the elements needed to manage, operate or maintain such laboratories. The intermediate objective of this study is to assess present and potential capacity of countries of the region in these areas. It is to look into the strengths and weaknesses of

such capacity to determine gaps and needs of the countries in the areas in order to ensure properly operating environmental laboratories. Areas to be looked into include scope and type of manpower training courses, maintenance of equipment, methodology of interpreting results of analysis of environmental elements and standards of environmental quality. The final objective of this study is to define areas and vehicles through which countries can co-operate for their mutual benefit. Once these areas and vehicles are identified, a plan of action will be formulated in order to ensure support for its implementation and operation of such co-operative vehicles. The action plan will focus on the inputs of each country in the co-operative efforts, the inputs of regional and international organizations concerned with environment protection, the working mechanisms of the plan, and the output and benefits expected from it.

III. STATUS OF ENVIRONMENTAL LABORATORIES IN THE ESCWA REGION

There are over 30 laboratories in countries of ESCWA region that are engaged in one way or another in the study and analysis of environmental elements. The status of a selected number of these laboratories in terms of structure, function, operational activities, strengths, gaps and needed improvements will be discussed in the following headings. The laboratories will be discussed under selected countries in order to present a cross-section needed to formulate a plan of action.

A. Egypt

Over the years, Egypt has established a large variety of laboratories that engaged in environmental monitoring, assessment and research. In recent years, Egyptian authorities recognized the need to consolidate the responsibility of regular monitoring and assessment of the quality of water, air, soil and occupational health on a national scale. The Ministry of Health has taken steps to implement such a policy and has gone ahead and taken the leading role in establishing a centre for environmental and occupational health. Because of the important role that other institutions have been playing in environmental monitoring, research and development, a brief review of the laboratories in such institutions will be made.

1. Environmental and Occupational Health Centre of the Ministry of Health

Established and in the process of being developed by the Ministry of Health, the Centre may become the national focal point for monitoring air, water and soil in Egypt. The Centre will co-operate with other existing institutions in formulating environmental assessment of national standards. Eventually, the Centre will take national responsibility for providing services in environmental and occupational health. It is presently engaged in the expansion and development of its laboratory and field facilities needed to cope with its national mandate. The Centre has also a responsibility to develop and train manpower to work in the special fields of environmental and occupational health. It remains to be seen how the expanded activities of the Ministry of Health, to include regular environmental monitoring will develop. However officials were optimistic that the newly established centre will shoulder its responsibilities in the near future. The facilities as well as manpower of the Centre are in their formative stage.

2. Environmental Health Department (EHD) of the University of Alexandria

Established in 1956, and linked to the High Institute of Public Health of the University of Alexandria EHD has played a major role in carrying out research and development activities in marine water pollution; management of industrial wastes; stream sanitation. The staff and laboratories of EHD are part of the University of Alexandria system and hence should be looked at in any co-operative effort accordingly. EHD could be a valuable member in an information network, especially in the area of health engineering. In addition, the staff who are highly qualified may participate in any future training courses in the area of industrial waste management.

3. Environmental Research Unit (ERU) of the National Research Centre:

(a) Structure and function. ERU is one of 12 research units organized under the National Research Centre. The National Research Centre is the largest in the family of research centres organized under the Academy of Scientific Research and Technology. ERU has three large laboratories fully equipped to carry out research and other environmental services. The laboratory for water pollution is the largest and has been carrying out an extensive programme of research and development in waste water treatment, effluent water recycling, water pollution, water chemistry and microbiology. The laboratory on air pollution has been also carrying out assessment studies for air quality inside industrial buildings and in cities. In addition, studies on sources of air pollutants and control methods have been undertaken. The occupational health laboratory has carried out periodic check ups for industrial workers, as well as research on effects of occupational environment pollutants on experimental animals.

The ERU has a working technical staff of 168 out of which 42 hold Ph.D degrees in fields like chemistry, biochemistry, microbiology physics, industrial wastes and occupational health. The equipment in the laboratories is varied and elaborate. Some gets serviced by the maintenance unit of the centre. However, more complicated equipment needs service and maintenance.

ERU has a long history of research experience on environmental problems. Therefore the senior manpower may be valuable in regional training courses. The unit has been producing sizable output about environmental conditions in Egypt, methodology of how to assess environmental quality and technology of how to minimize pollutant threats. Naturally, a unit like this may be a valuable partner in any regional information network on various subjects related to environment.

4. Institute of Oceanography and Fisheries (IOF)

(a) Structure and function. Established in 1931, IOF is another institution organized to operate under the decentralized administration of the Academy for Scientific Research and Technology. IOF has an elaborate organization of marine research stations distributed throughout Egypt and located to serve various water bodies inside the country and in its borders. The IOF has three main branches one for inland waters, the other for the Mediterranean and the third for the Red Sea. The IOF has 10 research stations distributed throughout Egypt whose location and main function are as follows:

(i) Alexandria Branch which includes three stations:

- Al-Max : Mediterranean Sea, fully operational and has several laboratories for monitoring pollution;
- Materialah: On Lake Manzala, mainly fish culture;
- Balteem : On Lake Baralis, mainly fish culture.

(ii) Inland Waters Branch which includes five stations:

- Al-Qanater: in the formative stage;
- Zamalik : in the formative stage and established to serve the fish garden in Zamalik;
- Shakshouk: on Lake Aaroun;
- Aswan : on Lake Nasser (Aswan High Dam), fish culture;
- Sariw : fish culture.

(iii) Red Sea Branch which includes two major research stations:

- Ghardaqa : Located on the Red Sea and has a long history of marine and pollution research. Has several laboratories for water analysis and marine life research;
- Suez : considered to be the main station and is almost finished. It has 21 laboratories and other library facilities. Once it is finished, it will be the largest research facility on the Gulf of Suez and Red Sea.

It is clear from the above structure and facilities that IOF is the largest marine and fish culture institution in the region. It is organized into 15 divisions of which one is for pollution. The other divisions contribute to analysis of water as well as the effects of pollutants on marine life and fish culture.

IOF has a staff of over 200 of which 37 hold Ph.Ds in various disciplines of marine life, fish culture and oceanography. IOF has a large number of laboratories equipped for the implementation of oceanographic research, monitoring of pollution and fish culture. The issue of equipment maintenance was mentioned as one of the main problems, especially with the extensive spread of facilities.

IOF participated in the Mediterranean Pollution programme (Med. Pol.) and has received equipment from the programme. One of the major difficulties in the implementation of Med.Pol. was the fact that non-operating equipment had to be sent to places in Europe for repair.

IOF will continue to play a major role in monitoring and studying pollution and its sources. The institution has many training facilities and well trained manpower. It also has co-operated with respective departments of Egyptian universities to train a large number of MS. and Ph.D candidates in marine sciences. IOF will be a valuable resource in any regional co-operative effort whether it is training or exchange of information. The volume of needs for equipment maintenance require special consideration.

5. Other laboratories distributed over various institutions

There is a variety of laboratories distributed over ministries and universities in Egypt. The following is a summary of the main ones:

<u>Institution</u>	<u>Main function(s) related to environment</u>
- Water Research Centre of the Ministry of irrigation	Pollution problems of water used in irrigation (research);
- Land, soil and water Research Institute of the Agricultural Research Centre, Ministry of Agriculture.	Pollution nad degradation problems of soil (research and some monitoring)
- National Research Centre for Industrial Safety	Research and training in occupational health hazards in industry and its effects on productivity of labour.

B. Iraq

There are at least four major groups of laboratories that are engaged in the study, monitoring and assessment of quality of water, air, food and soil in Iraq.

1. Division of Environmental Laboratories of the Ministry of Health

(a) Structure and function. The environmental laboratories are organized in one of three divisions of the Department of Preventive Medicine and Environmental Services (Department). The other two divisions are Environmental Engineering and Environmental Education and Awareness. The Department is part of the structure of the State Organization of Health Services organized under the Ministry of Health. The organization of environmental services are presently under review to give it more independence and support. It is envisaged that such services will be seperated from preventive medicine services but perhaps remain under the Ministry of Health. Structurally the Division of environmental laboratories is composed of two laboratories, one chemical and the other is biological and microbiological.

Two laboratories are operational in each of the cities of Baghdad, Mousel and Basra. Smaller laboratory units are operative in Irbeel and Karkouk. There are plans to strengthen present laboratories and to expand such services to other cities.

Functionally, the laboratories are engaged in monitoring chemical and biological pollutants in air, inland waters and food.

(b) Manpower. The total working force in all laboratories is about 34 analysts. Many such analysts hold B.Sc degrees in either chemistry or biology. The training they received in the university was the classical type constituting a good base for general analysis but far from being consistent with methodology and know-how needed for proper environmental analysis.

(c) Equipment and instrumentation. There is no apparent lack of support to acquire materials, instruments or equipment needed for the work of laboratories. Some of the available equipment is sophisticated such as gas chromatographs and spectrophotometers. However, there is definite need to maintain such equipment in operation and to service them as needed. The staff are not qualified to service or repair any of the equipment. Other maintenance services available in Iraq are not always at hand to help.

(d) Programmes. Iraq is moving ahead in expanding its programmes to assess the state of the environment and to monitor changes in the quality of water, air and food. Some of the more urgently needed work or studies are carried out by other research laboratories in the country (see below). Certainly, such expanded programmes will require more competent manpower. Competency in sampling techniques, interpretation of data and evaluation of information is needed. It will also require equipment that are properly operated, serviced and maintained.

2. Division of Environmental Pollution of the Scientific Research Council

(a) Structure and function. The Division of Environmental Pollution is one of six organized under the Biological Sciences Research Centre of the Scientific Research Council (SRC). SRC is the national institution in Iraq responsible for the planning and co-ordination of research as well as the implementation of major research activities in several fields including biological sciences.

The Division has three units (subdivisions) each concerned with carrying out research at the national level. These are pesticides pollution, industrial and chemical pollution and microbiological pollution. The Division has been active in implementing a number of surveys and other research programmes to assess the state of pollutants in the waters, air, soils and foods in Iraq. Although the division is not concerned with regular monitoring of pollutants in the Iraqi environment, it does respond actively to study and report any trouble-spot in environmental pollution. It is clear that the establishment of such facilities reflects the fact of how seriously Iraq views environmental pollution.

(b) Manpower, equipment and other facilities. The Biological Sciences Research Centre will soon move to new and modern building constructed to house its expanding work. The manpower in the Division of Environmental Pollution is highly qualified in basic fields of sciences and is quite competent in handling research problems. A number of Ph.D holders assisted by a team of assistants and technicians are carrying out the research programme. The

laboratories are well equipped with sophisticated gas chromatographs, samplers, spectrophotometers and various other qualitative and quantitative analysers. The facilities present are suitable for holding training courses for technicians as well as for senior analysts. The Division may be party to a network of information exchange in the region.

3. The Marine Science Centre of the University of Basra.

The University of Basra, which is close to Shatt Al-Arab and the Gulf waters, has established the Marine Science Centre to carry out an integrated programme of marine research and monitoring activities of marine water pollutants. The Marine Science Centre is the Iraqi national focal points in ROPME activities.

It has a staff and laboratory facilities that are expanding to deal with monitoring pollution problems as well as other research activities in fish culture, other forms of marine life, biochemistry, uptake and degradation of petroleum by marine organisms. The Centre may become an important member in a regional network for exchange of information on effects of oil pollutants on marine waters and marine life.

4. Other laboratories

Iraqi universities and in particular the University of Baghdad have a number of research laboratories dealing with chemical and biological pollutants of the environment. In addition, the Ministry of Irrigation as well as the Agricultural Water Resources Research Centre of the Council of Scientific Research have laboratory facilities and staff engaged in the study of degradation and/or reclamation of soils. The studies include soil salinity, fertilizer effects and sand dune management.

C. Jordan

There are four institutions that have laboratories engaged in environmental research and/or monitoring of environment. In addition, Jordan is among the few countries that developed its national capacity for service and maintenance of equipment. The following is a brief review of the Jordanian scene.

1. The Royal Scientific Society (RSS)

(a) Structure and functions. RSS is a research and development institution that operates independently of the Government. It has a Board of Trustees chaired by his Royal Highness Crown Prince Hassan. Because of this unique organizational feature, RSS has become well known for its flexible and efficient operational procedures. RSS implements large number of research, development and technical service projects. Almost all projects are implemented through contracts concluded between RSS and clients (users). The main income of RSS comes from funds generated through such contracts. Over the years, RSS has become increasingly involved in contractual arrangements with Government institutions concerned with environmental problems. Among such institutions were the Jordan Valley Authority, Water Authority and the

Department of Environment of the Ministry of Municipabilities, Rural Affairs and Environment. In the past eight years, RSS implemented several projects monitoring pollution in air and water as well as the determination of pollutant sources. RSS is at present in charge of major monitoring projects of air and water on a continuous basis. RSS may be considered the most active institution in environmental monitoring of air and water. RSS is organized into centres or departments. Each has a number of well equipped and maintained laboratories. Among such structures are:

- Industrial Chemistry Department: One of six departments or centres, the Industrial Chemistry Department has several units, each with research and service laboratories. The Department laboratories are well equipped for water, air and soil analysis. The Department can carry out about 150 tests needed for air and water analysis. It has a staff of over 50 including several Ph.D and M.Sc. holders. Some have degrees in environmental analysis and management.
- Electronic Service and Training Centre: This centre will be reviewed in some detail because of its unique facilities and functions.

2. Electronic Service and Training Centre (ESTC)

In response to the acute and expanding need of scientific equipment testing and maintenance, RSS established ESTC, which became operational in 1979. ESTC is housed in an ultra-modern building constructed at a cost of 4 million US dollars and was equipped especially for electronic equipment maintenance at a cost of 2 million US dollars. ESTC operates through four sections, namely:

- Maintenance of scientific equipment section, which was a computerized inventory of over 200,000 electronic components and spare parts for various scientific equipment;
- Test and quality control of electronic equipment section;
- Electronic standards and calibration laboratory with primary and secondary standards. This section is certified by the Civil Aviation Authority according to international criteria and standards of civil aviation services;
- Electronic design laboratory section.

Over the past six years ESTC has implemented several maintenance and quality testing contracts of scientific equipment. The contracts included all medical equipment of the Ministry of Health, various hospitals, Royal Jordanian Airlines, Iraq Airlines, Jordanian universities and several equipment units in local industries. It is manned by a technical staff of 45 of which 17 are engineers. ESTC is an excellent facility to be considered as a regional focal point for training and maintenance of environmental laboratory laboratory equipment.

3. The Water Research Centre and other laboratories of the University of Jordan

There are three types of laboratories in the University of Jordan that are engaged in environmental research and monitoring. First, the chemistry laboratories, which are engaged in monitoring health hazards of labourers working in local industries. The monitoring is done in co-operation with the University hospital and in contractual arrangement with the Ministry of labour. Second is the biological laboratory, which co-operates with RSS in implementing some microbiological aspects of air and water monitoring. Third are the facilities of the Water Research Centre the functions of which include the study of water pollutants and their sources in surface and underground water. All three facilities are located in the Faculty of Science, which also has a service and maintenance workshop for electronic equipment.

4. The Marine Biological Station (MBS)

(a) Structure and function. MBS was established in Aqaba, the only sea exit in Jordan. MBS is jointly supported and administered by the University of Jordan and the University of Yarmouk. MBS implements a programme of research in oceanography, marine pollutants and their sources and marine life. It also monitors changes that take place in the Aqaba Gulf waters next to Jordan and is used as a training centre for both graduate and undergraduate students of the two universities. MBS is the Jordanian focal point in the implementation of the regional environmental programme of the Red Sea and the Gulf of Aden. The programme includes Saudi Arabia, the Yemen Arab Republic and the People's Democratic Republic of Yemen in addition to Jordan. The Sudan and Somalia, which are not ESCWA members, are also party to the programme. The programme is a regional co-operative activity designed as a vehicle through which member countries co-ordinate their environmental protection activities in the Red Sea and Gulf of Aden waters.

(b) Manpower, equipment and other schemes. MBS has a modest but competent cadre of 12 who operate a modern and well equipped laboratory. MBS has been co-operating with the University of Nice in France in the implementation of a research and training programme of oceanography. The facilities in MBS are serviced by the University of Jordan.

5. Department of Environmental Health of the Ministry of Health

This is the oldest department in the country concerned traditionally with monitoring the quality and standards of household water. Its laboratories have been strengthened in recent years to deal with problems of occupational health and public health engineering, especially sewage engineering. The laboratories have a competent staff of over 45. The Department is a good base to become the national focal point for environmental monitoring of water, air and occupational health.

D. Kuwait

The State of Kuwait is among the leading countries of the region in the organization of institutions that implement environmental monitoring. It is

also among the first countries to establish a department whose main function and concern is the monitoring and management of environmental health. The following is a review of its laboratory capacity.

1. The Department of Environment Protection (DEP) of the Ministry of Health

(a) Structure and function. DEP has an elaborate structure designed to serve the protection of the environment in Kuwait. DEP has been developing both manpower and physical and focal laboratory facilities in order to implement its functions. DEP implements a regular programme of air and coastal water monitoring service in order to determine changes in quality and recommend measures. It has several laboratories organized under five sections distributed functionally as follows:

- Air pollution control section;
- Soil and water pollution section;
- Environmental impact assessment section;
- Occupational health section;
- Work environment section.

DEP is also the national focal point for ROPME. In implementing its work, DEP co-operates with other scientific and production institutions in the country.

(b) Manpower and equipment. The technical capacity of manpower of DEP has been improving but still leaves much to be desired. Acquiring equipment has not been a problem for DEP but to operate such equipment in the proper way requires further strengthening of technical capacity.

2. Kuwait Institute for Scientific Research (KISR)

KISR is the national research institution in Kuwait. KISR has been involved in several studies dealing with pollution and pollutants of marine waters, oceanographic research and fisheries culture. KISR may be a valuable party in any training programme in the use of analysis instruments, methodology of analysis and data interpretation.

E. Saudi Arabia

There are two main groups of laboratories in terms of organization. The first is the group operating under the Meteorology and Environmental Protection Administration and the second is that number of laboratories operating in marine stations, universities and research institutes.

1. Meteorology and Environmental Protection Administration (MEPA) of the Ministry of Defence and Aviation

MEPA is the central and national focal point for environmental monitoring and protection in Saudi Arabia. Organized under the Ministry of

Defence and Aviation, MEPA has an elaborate structure that has been planned to take charge of human and natural environment protection. Because of the lack of trained manpower and in response to the urgency with which authorities view environmental protection issues, MEPA has gone ahead to implement its programme in two parallel lines. The first was to co-operate with other institutions inside and outside the Kingdom in carrying out several surveys on the state of the environment as well as in formulating standards and legislative acts to be enforced for environmental protection. Most work has been done on a contractual basis. The second was to build manpower, laboratories and other field stations with the objective of attaining a strong national capacity capable of monitoring, assessing and protecting the environment. MEPA has concentrated in its implementation plans on building meteorological facilities throughout the Kingdom but has been slow in completing all laboratory facilities needed to monitor air, industrial wastes and inland and coastal waters. In brief, Saudi Arabia represents one of the cases where gaps exist between plans, legislative acts and availability of financial resources on the one hand and scarcity of competent and trained manpower to implement available plans on the other. MEPA is the national focal point in the implementation of the Regional Programme of the Red Sea and Gulf of Aden and co-operates for ROPME with the University of Petroleum and Minerals.

In spite of the constraint in availability of trained manpower, MEPA has gone ahead in recent years and acquired two sophisticated mobile environmental laboratories: one for air and the second for water. The mobile air laboratory is fully operational. It complements other stationary air monitoring units around Jeddah. The water mobile laboratory has recently been acquired and is awaiting materials needed for its operation. The laboratory has most of the more expensive and sophisticated pieces of equipment but requires some of the more simple equipment needed to complete water analysis. The two laboratories have been planned to serve Jeddah and its vicinity. However, there are plans to acquire similar laboratories for the eastern region of the Kingdom. More ambitious plans call for the establishment of laboratories housed in buildings to serve Jeddah, Riyadh and the eastern region.

MEPA has taken major steps in building its manpower capacity. The General Directorate of Environmental Protection has three Ph.D. holders, two M.Sc. and about 30 B.Sc. graduates in various disciplines. Six of the B.Sc. holders are studying for their M.Sc. in various aspects of more specialized environmental protection. Most of the manpower is working in the information and administration of environmental standards application. The mobile environmental laboratories are manned by both Saudi nationals and expatriate technicians.

2. Laboratories in other institutions

A number of other laboratories are engaged in environmental research and surveys of pollution in air, water and work environments. Notable among these are the laboratories of the Marine Station of the Faculty of Marine Science of King Abdul-Aziz University in Jeddah and the water, air and soil pollution laboratories of the Faculty of Meteorology and Environmental Studies of the same university, those of the Research Institute of the University of

Petroleum and Minerals in Dhahran, and the chemical and biological laboratories of King Saud University in Riyadh. All of these laboratories were well equipped and are used in research work related to assessment of environment, oceanography and monitoring and analysis of oil pollutants in the Gulf and the Red Sea. In more recent years MEPA has co-operated with the laboratories of the Ministry of Agriculture and Water in Jeddah. MEPA either co-operates or contracts staff working in these laboratories to carry out some of the activities needed.

F. Syria

Syria is another country of the region where implemented programmes of environmental protection do not match Government plans and ambitions. Over the past 10 years several facilities have been established to monitor and assess the environment but they lacked the organizational framework to make them fully operational. Last year, a Minister of State for Environmental Affairs was included in the present Cabinet of Ministers in order to consolidate and co-ordinate Syrian efforts in environmental protection and has been working hard in achieving that goal. The following is a brief review of environmental laboratories.

1. Department of Pollution Control of Public Waters of the Ministry of Irrigation

The Department is organized under the Ministry of Irrigation and has six branches of which four are fully operational. Each of the four branches has sampling and laboratory facilities to monitor pollutants in water basins and to recommend measures of how to minimize pollution. The four branches are as follows: Barada and Aawaj river basins, Euphrates river basin, Khabour river basin, and Al-Aasi river basin. Monitoring of waters in such basins is not systematic and requires strengthening both in staff and in physical facilities. Sources of pollution are studied and periodic checks are made on levels of pollutants in the waters present in these basins.

2. Scientific Research and Studies Centre (SRSC)

SRSC is an autonomous scientific institution whose activities include carrying out studies in pollution especially that of air in cities. It has operational laboratories and has a nucleus of competent staff in environmental chemistry.

3. Marine Research Centre (MRC)

Located in Latakia on the Mediterranean coast, MRC is administered by the Higher Council of Sciences. At present MRC is directed by a scientist from SRSC and its final administrative linkage is under review. MRC has excellent facilities and its laboratories are fully equipped. However, MRC has not been functioning at its fullest capacity because of lack of trained manpower. The mandate of MRC includes monitoring pollutants in the coastal waters of Syria and carrying out oceanographic studies. MRC will be an excellent member in any co-operative work of marine water monitoring and environmental management.

G. United Arab Emirates

Environmental laboratories in the Emirates are decentralized and are organized under municipalities of major cities. Such laboratories are engaged in monitoring and assessing environmental state in air, water and food. There are three major laboratories: one is located in Abu Dhabi, the second in Dubai and the third in Al-Ain. Each laboratory serves the city and its vicinity. During the past eight years, the Emirates have been attempting to consolidate efforts, especially in the area of marine water protection. Environmental affairs in the Emirates are co-ordinated at present by the Ministry of Health through the Department of Environment located in Dubai. The most recent development is the establishment of a central laboratory facility in Dubai in co-operation with ROPME. The new laboratory, administered by the Department of Environment, will be responsible for implementing monitoring activities of marine waters. It will function as the national focal point for ROPME. The laboratory equipment is almost in place and will be operated by three national staff. The general status of environmental laboratories is far from being strong, mostly because of a scarcity of trained manpower.

H. Other laboratories in the region

Environmental laboratories in other countries of the region vary in strength and stage of development. In Qatar, for example reasonable facilities to monitor air and water have been made available in the University of Qatar as well as in the Technical Centre for Industrial Development. In Bahrain, environmental affairs are handled by the Department of Public Health of the Ministry of Health. The Sultanate of Oman has come a long way in recent years in strengthening its national capacity for environmental protection. Perhaps the biggest constraint facing Oman is the scarcity of trained manpower to manage and operate environmental laboratories. The situation in Yemen is still in the formative stage. However, environmental studies or monitoring are being handled by the University of Sana'a through its laboratories of the Faculty of Science. The situation in Democratic Yemen is still fragmented. Some modest laboratories are operating in the Ministry of Fisheries, the General Organization of Water and the Ministry of Health. In both countries, the scarcity of manpower and the low level of financial support given to environmental protection programmes will continue to be a constraint in attaining the desired strength in both structure and function.

IV. ISSUES, DISCUSSION AND CONCLUSIONS

A. Organizational fragmentation of environmental laboratories in the ESCWA region

Laboratories engaged in environmental activities are administered by various institutions or organizations. It is true, of course, that not all laboratories within any one country play the same role in environmental affairs. What concerns us in this report are the functions directly related to protection and management of main elements of the environment. These elements include:

- Inland waters both surface and underground;
- Marine waters, especially along the coasts;
- Marine life with particular reference to fisheries and their food sources;
- Air in the cities and their vicinities;
- Ambient air in industrial buildings and other public facilities where workers carry out their activities;
- Work environment in general, including materials and machines that are handled by labourers or workers;
- Agricultural, range and forest soils;
- Wild plants and forests and their ecosystems;
- Wild animals and their habitat;
- Food sources and food industries.

The major laboratory functions that are related to environmental protection and management encompass:

- Systematic monitoring of environmental elements to check for changes, presence of pollutants and other materials that are considered to cause deviation from the standard quality of such elements;
- Methodologies of monitoring, including sampling techniques, physical, chemical and biological analysis of samples as well as techniques involved;
- Assessment of data obtained from analysis and its interpretation based on approved national environmental protection standards;
- Scientific capacity to recommend measures needed to maintain quality consistent with required state or levels;
- Scientific capacity to develop and formulate models or systems to manage environmental elements and to maintain them in a safe, clean and/or productive state;
- Scientific capacity to improve national environmental protection standards and management systems;
- Documenting, storing and disseminating information that will enhance national awareness and capacity to maintain a clean, safe and/or productive environment;
- Developing and identifying researchable topics aimed at strengthening the capacity of the laboratories to carry out previous functions. Research activities may or may not be implemented by the same laboratory.

With this understanding of environmental elements and functions, the fragmentation in the administration and organization of environmental laboratories poses a multi-dimensional problem. First, there is the duplication of efforts and spread of resources, a situation that few, if any, of the countries of the region can afford. Secondly, there are the difficulties faced in co-ordinating the work both in type and quality. Thirdly, there is the difficulty of providing suitable services and good level of support. In looking at the status of environmental laboratory organizations, one finds a trend to organize such laboratories under the Ministry of Health. Kuwait, Iraq, Egypt and the United Arab Emirates are examples of countries that opted for this arrangement. The strong argument for this alternative is the fact that such ministries have been traditionally in charge of quality control and preventive services of food, household water and public health in general. Becoming in charge of those services related to air, marine waters, inland public waters, occupational health problems and plant and animal wild life presented an institution organizational problem to all countries of the region. It is not within the scope of this study to solve such a problem but rather to present it as a state of fact requiring some co-ordination and co-operative measures both at the national and the regional levels. However, the following comments may not be out of place regarding the issue.

(a) Whatever model a country may choose to adopt to organize its environmental protection services, the environmental functions outlined above should be consolidated in one centrally administered unit of laboratories. Naturally, branch laboratories may be established in various regions of the country.

(b) There seems to be a strong argument to organize such services and laboratories under the Ministry of Health. Functions related to wild life management and protection as well as marine waters and marine life may be contracted or delegated to strong existing laboratories.

(c) Research activities related to environmental protection should, inasmuch as possible, be separated from the functions of environmental laboratories doing regular monitoring, assessment and other functions.

B. Diversity of monitoring methodologies

Each country of the region has developed methodologies to sample and analyse environmental elements in its own way. Some have obtained their methodology from other countries through consultant services. Others have followed international standard methods. It is not uncommon to find two institutions or laboratories in the same country using different methods. The problem becomes more acute when more than one country is considered. All in all there is a need to homogenize methodologies and techniques used in analysis within each country and in the region. The more such methodologies are standardized the more the results may be compared and analysed for the mutual benefit of all. After all, in many of these countries air, surface waters and marine waters are common. Furthermore, problems of soil degradation are also similar. Vehicles to bring about co-ordination of standards should be established.

C. Diversity of equipment used in laboratories

One of the most disturbing aspects of environmental laboratory functions and operation is the diversity of equipment used in monitoring and analysis services. The diversity of equipment is present at the level of one laboratory within a country and naturally at the level of the region. This problem is common in most developing countries, which obtain equipment from various sources. Some of this equipment came as part of technical assistance projects. Some was imported from various equipment exporters. What makes the problem worse is the fact that this equipment is being operated far from where it was manufactured, thus presenting automatically a service and repair problem. The equipment in question ranges from mobile air samplers, atomic absorption, various chromatographic apparatus, ultraviolet spectrophotometers, infra-red spectrophotometers, pH meters, flame photometers, various types of centrifuges, analytical balances, autoclaves, and various types of microscopes. Some of the laboratories in the region have amino-acid analysers, mass spectrometers and nuclear magnetic resonance (NMR) and various types of electronic microscopes. When there is more than one type of any of these pieces of equipment, problems of how to operate, maintain and repair such equipment arise. In interviews with personnel in charge of environmental laboratories, most of them reported on these problems. Part of these problems may be solved or minimized through regional co-operative plans in which resources are pooled. In addition efforts devoted to operation, testing and maintenance may become more effective if directed to groups of instruments distributed throughout the region rather than when directed to individual pieces in one or more laboratories within any one country.

D. The acute need for equipment maintenance in the region

Equipment maintenance has become part of an independent discipline now called Terro-technology. It means the science of optimization of the life cycle, in this case equipment. Maintenance of equipment as used in this study includes management and proper utilization of inputs in a laboratory and in particular the following:

(a) Scheduled and programmed preventive maintenance scheme designed to keep equipment in proper function and to intercept any malfunction that may develop soon. Based on international standards, an inspection of equipment is carried out at least twice a year;

(b) The actual repair of malfunctioning or non-operative equipment.

Countries of the ESCWA region have spent millions of US dollars to purchase equipment. The estimation of sums of money involved in establishing environmental laboratories was beyond the scope of this study. However, the establishment of properly functioning laboratories to carry out all standard tests for quality of water, air, soil, occupational health and food materials requires an investment of at least 1 million US dollars. The cost of such equipment varies of course with the number of tests required and the kind of pollutants sought. In any case, the results of this study showed that there is a vast variety and number of each of the pieces of equipment or instruments

needed for environmental analysis. There were, for example, 15 gas chromatographs of various makes available in the laboratories visited. Of these, there were only six that were functioning. This is just an example, which is typical of many others.

1. The status of equipment maintenance capabilities

All officials and personnel interviewed in laboratories engaged in environmental work reported equipment maintenance as one of the weakest feature of their operations. The problem as reported has several dimensions as follows:

(a) Absence of experienced national personnel capable of carrying out maintenance services in most cases, even for some of the simplest pieces of equipment. In some cases where maintenance services were available, the personnel were not experienced in maintaining a variety of equipment;

(b) In most cases, services offered by manufacturers were either very expensive or irregular;

(c) In the majority of cases, ordering equipment was not done in the proper way to ensure availability of spare parts, operational manuals or maintenance manuals. Even if manuals were provided by the supplier or manufacturers, they were either misplaced or not used;

(d) Except for rare cases, no system of maintenance was in place. This implies that no inventory is kept for equipment type, storage, spare parts, components and maintenance history.

2. The special characteristics of equipment maintenance of environmental laboratories

Maintenance of equipment is essential for any laboratory but has special significance for environmental laboratories. Analysis of samples of environmental elements must be timely. It cannot be postponed for a long time until equipment is repaired or repurchased. Furthermore, analysis is usually carried out in a series of tests requiring different instruments or types of equipment. If one piece or type is not functioning, the results of other tests may turn out to be of little or no value. Thus the importance of keeping the laboratory in operation does not need much elaboration. If equipment is not a proper functioning state, investments and cost of personnel and other operational cost are spent with no returns.

3. The small national base for the maintenance of environmental laboratory equipment

The establishment of a maintenance unit for laboratory equipment is an expensive operation. In the majority of the cases of countries of the region, the alternative is not feasible. First, there is the scarcity of trained manpower in this special field. Secondly, there is the size and number of equipment available in any one laboratory or group of laboratories that should be there to warrant the establishment of a maintenance unit. One speaks here

of the critical mass of type and numbers of pieces of equipment required to make the establishment of a maintenance unit feasible. Therefore, the more sound option to overcome this problem is to have a regional co-operative effort. All available information as well as the special characteristics of the problem at present works in favour of a co-operative effort.

E. Scarcity of trained manpower

Environmental analysis with all of what is involved in sampling techniques, analysis procedures and operation of special equipment is new to the majority of the countries of the region. In reviewing the situation in the field, many laboratories, especially those in smaller countries, suffered from a scarcity of trained manpower. In many cases, the commitment of the Government to develop its environmental services was there but the lack of progress was a result of the scarcity of qualified manpower. Naturally, countries varied in their needs for qualified manpower. Some had technicians and analysts but were weak in managers or more qualified personnel, while some had a few but needed more. In the majority of countries the manpower which may become competent to work in environmental laboratories was there but required further training in the special methodologies and procedures.

The situation may be summarized as follows:

(a) Higher commitment for allocating manpower to research. In a number of countries of the region, priority was given to allocate qualified manpower resources to research activities in environmental problems. These countries have developed their research capacity to a degree far more than their capacity to provide other environmental services.

(b) Diverse needs for trained manpower. Personnel working in some environmental laboratories often have the capability to collect samples and analyse them. However, these personnel do not have the scientific capacity to interpret results. In some cases, when the volume of work is large, the load may be divided among a team of workers where some carry out the analysis while others do the interpretation of data obtained. In other cases, however, it may be essential that personnel be trained both in analysis of environmental elements and data interpretation. Some authorities in this field prefer the situation when most personnel get experience in the total spectrum of laboratory functions. In a group of countries that are members of ESCWA, one expects to find diverse needs for trained manpower. The needs are diverse in type, numbers and levels of training. Such training needs may be outlined as follows:

- (i) Training in laboratory management: Most, if not all, countries of the region need this type of training for people in charge of managing environmental laboratories. The training may include planning of programme implementation, resources for various functions, planning of laboratory needs for materials, planning of equipment maintenance, and monitoring and evaluation of laboratory performance;
- (ii) Training in sampling techniques: this includes operation of sampling instruments and principles of sampling water, air and soil for different types of analysis;

- (iii) Training in operation of analysis equipment: the training courses may be of a general nature but may focus on the operation of special equipment and the use of standard procedures;
- (iv) Training in data interpretation: often personnel in many laboratories have the know-how to collect data but are weak in making the interpretation. There is a special need in this area.

(c) Resources available for training. Countries of the region vary in the availability of resources needed for training. The majority of the countries have neither the trainers nor the number of trainees required to hold training courses of their own. However, some countries are strong in manpower as trainers in some fields while others have excellent facilities for training. The majority of the countries do have the resources for trainees. In other words, countries of the region complement each other, creating a situation where regional training courses are the more feasible option.

F. Exchange of experiences and information in environmental protection

Countries of the ESCWA region are at different stages of development in the organization, operation and effectiveness of their environmental protection programmes. Every country has undertaken in its own way to formulate policies, establish co-ordinating institutions, build environmental laboratories, formulate standards and take measures to protect its environment. As the process went on, some have benefited from experiences of countries outside the region and some have benefited from experiences of other countries of the region. During the past 10 years, groups of countries have entered into regional co-operative programmes to deal with more urgent environmental problems. Pollution protection in the Red Sea and the Gulf of Aden as well as in the waters of the Gulf were examples of such areas in which groups of countries are co-operating.

In reviewing the present status of national experiences of countries in environmental protection, there seems to be a strong case and urgent need for exchange of information. Information flow among countries concerning important questions like standards, procedures and results obtained on the state of the environment in each country is scanty. Some countries of the region like Egypt, Kuwait, Saudi Arabia and Jordan have a lot to offer on their experiences of applying standards and measures to curb pollution of their environment. Other countries are in the midst of formulating standards and strengthening of their national capacity in environmental protection. In this connection, a number of countries like the Yemen Arab Republic, Syria, Qatar and the United Arab Emirates are considering either consolidating their present capacities or establishing new operational departments to implement environmental protection programmes. Certainly in the work of environmental laboratories, there is a need to exchange information on performance of equipment, co-ordination of procedures for analysis and the state of the environment in air, water and soil. The vehicle for such exchange of information may be periodic publications or newsletters and periodic meetings of personnel involved in special topics. The establishment of a regional network whose functions may include publication of a newsletter is envisaged.

V. RECOMMENDATIONS

The following needs are particularly important.

- R.1. The need to establish laboratories specially mandated for environmental monitoring. It is recommended that countries of the region which have not done so proceed to establish environmental laboratories in charge of analysis, data interpretation and recommendation of protective measures to be taken. Most countries of the region have done so but some like the Yemen Arab Republic do not have such laboratories. Decisions related to such action are decided by a cabinet of Ministers. ESCWA may do well to promote the establishment of such laboratories.
- R.2. The need to consolidate environmental protection functions in one national laboratory. Most countries of the region have established laboratories working in one or more environmental elements. However, the functions are fragmented among several laboratories. It is recommended that the functions related to pollution of water, air, soil, occupational health (worker environmental) and food be consolidated into one laboratory. Implementation of this recommendation may be done in phases as follows:
- (a) Each country which has not done so designates one institution as a national focal point to be responsible for the implementation of environmental laboratory activities.
 - (b) The designated national institution will take necessary measures to consolidate all environmental laboratory activities under its direct management. As a transitional measure, the national institution would either delegate or contract those functions to other institutions presently implementing them on the understanding that such functions would eventually be implemented by the national institution.
 - (c) The designated national institution, in the meantime, takes necessary measures to strengthen its capabilities to become fully in charge of implementing all activities of environmental monitoring. The national institution would also play a major role in the identification of researchable topics in environmental protection in general and pollution in particular. It would then act as a client for other research institutions in the country and receive results and recommendations of such studies for action. The ESCWA role in this is promotion and encouragement of decision makers in countries to implement the recommendation. ESCWA could also provide advice and models for interested countries.
- R.3. The need for the formulation and adoption of national standards for environmental protection. It is recommended that countries of the region which have not done so yet proceed to formulate and adopt national standards for environmental protection. Such standards will be the basis and reference for environmental laboratories to compare data collected on the state of the environment. It would serve as a reference for other countries to compare them with their own with the eventual possibility of having unified or similar standards. The environmental protection standards that are involved include the following:

- Ambient air quality standards and procedures or methods of measurement. These include standards for sulfur dioxide, inhalable particulates, photochemical oxidants as ozone.

- Nitrogen oxides, carbon monoxide, hydrogen sulfide and fluorides. Levels allowed of such compounds in ambient air should be defined to maintain acceptable ambient air quality in cities, work-places, public facilities, industrial facilities etc..

- Air pollution source standards: such standards include emission limits and all measures required to filter or clean emitted gases to required standards of air quality. The sources include combustion engines or facilities, storage facilities of liquids, fuel gas combustion processes, fertilizer plants, cement plants, primary aluminium reduction plants, iron and steel plants, petroleum and petrochemical plants and various other manufacturing plants emitting gases.

- Water quality standards include monitoring of physical, organic or non-organic chemical and biological levels of pollutants that are required to maintain water quality suitable for human use, plant life animals and marine life.

- Wastewater, directly discharged waters or liquids and other receiving water standards include standards of municipality and any discharged water from industries or treatment plants before they reach rivers, dams, soils, coastal waters or any other sources of water used by man, animals, plants or marine life in general.

- Other standards for soil quality, food materials, habitats of wildlife and any other natural environment. ESCWA programme for the forthcoming Medium-Term Plan includes publication and distribution of basic information of some standards and principles behind formulating such standards. ESCWA encourages countries to formulate such standards and inasmuch as possible co-ordinate such standards through workshops and information flows. Whenever standards are formulated, procedures to measure pollutants should accompany such formulation. Any co-ordination effort should include procedures as well.

R.4. The need for laboratory equipment inventory. It is recommended that each environmental laboratory be asked or encouraged to prepare an inventory of available equipment. Information to be included in inventory would include the name of equipment, type, manufacturer, specification, spare parts available, components available, performance history, maintenance history and number. Such an inventory is essential for any future maintenance services, for exchange of information especially about performance, and for possible use by other laboratories especially in the case of expensive and highly specialized pieces of equipment. Responsibility for implementation is with the laboratory management. Inventories like these may be used as sources of information in the work of a regional network.

R.5. The need for a regional centre for laboratory equipment maintenance. It is recommended that ESCWA, in co-operation with national and international institutions, formulates a plan of action to establish a regional service for maintenance of laboratory equipment. The majority of the countries of the region are in urgent need of such service because of the common occurrence of equipment malfunctions, the non-feasibility of most countries to establish such service, and the other side effects of promoting co-ordination and standardization of laboratory activities. It is further recommended that ESCWA should take advantage of maintenance facilities existing in some countries of the region in implementing such regional service. Support for establishing the service may be sought from international, regional and national sources concerned with technical assistance and/or environmental protection. A service for laboratory equipment is not to be provided to countries free of charge but some subsidy may be given to financially disadvantaged countries.

R.6. The need to strengthen capacity of manpower in data interpretation. Because of the urgency of such weakness in the performance of environmental laboratories, it is recommended that measures be taken to strengthen the capacity of personnel working in environmental laboratories in data interpretation and in the formulation of corrective measures. A series of courses should be developed on selected topics of environmental laboratory operations. Participants in these training courses are to be drawn from technicians working in environmental laboratories of the region. Duration of such courses may range from four weeks to two months. Training courses may be held in a number of existing research institutions of the region cultivating the strengths of each institution in specific topics. Maintenance of equipment training courses may be held in Jordan, for example, calibration and operation of equipment in Kuwait, data interpretation in Egypt and so on.

Training activities may be developed as part of an action plan of a regional network of environmental protection. The ESCWA role in the implementation of this recommendation would be in supporting the establishment of a regional framework (regional network) with a regional focal point in one of the countries. In the meantime ESCWA, through its Environmental Co-ordination Unit and in co-operation with the United Nations Environment Programme (UNEP), may organize one or two of such workshops or training courses. Support from regional or national funding sources like OPEC, Arab or national funds may be sought to implement one or more of the training courses to be taken to correct harmful actions or activities. Strengthening of capacity may be addressed in future training courses but more immediate action would be to cultivate the expertise of competent nationals already existing in many research institutions. Such expertise may be assigned to work in environmental laboratories on a part-time basis or any feasible arrangement. National authorities may be encouraged by ESCWA to implement this recommendation.

R.7. The need for training of manpower. It is recommended that a series of training workshops and courses be developed and implemented to strengthen the capacity of manpower working in environmental laboratories. Training is needed at all levels including management, operation of equipment, data interpretation, primary maintenance of equipment, i.e., how to take care of equipment to keep it operating, sources and methodologies of analysis and organization of data for documentation and publication. The following are especially important:

(a) Training in management of environmental laboratories: participants in these training workshops are to be drawn from those responsible for the administration and management of laboratories in the region. Duration of workshops is from two to three weeks;

(b) Training courses in environmental laboratory operations.

R.8. The need for strengthening flow of information and information exchange. Because of the increasing data and other information on environmental protection in countries of the region, it is recommended that vehicles for exchange of information and information flow be developed. Such an activity may also be part of the tasks of a regional network. Types of information that may be included in a newsletter form are: who is who in environmental protection in the region, organizational structure and function of environmental laboratories or environmental protection in general, news of state of the environment in countries of the region, new techniques or methodologies in environmental analysis, news of workshops to be held in environmental laboratories, summaries of workshop or conference proceedings and summaries of scientific articles in environmental protection.

The role of ESCWA again would be to initiate and promote efforts to establish a regional network of which information exchange may be part of its functions. Short of forming a fully operational network, ESCWA could start an information newsletter along the suggested outlines in co-operation with UNEP.

R.9. Other recommendations

(a) It is recommended that ESCWA in co-operation with UNEP produce a manual of environmental laboratories with the following suggested contents:

- List of basic equipment needed for analysis of air, water, soil and food materials for environmental protection purposes. The list may include some specification required for proper analysis;

- Sources of obtaining information on laboratory equipment maintenance, procedures of analysis and standards of environmental protection;

- Information on how to prepare an inventory for maintenance, how to implement primary maintenance, how to store equipment when not in use and other fruitful tips in laboratory operations.

(b) It is recommended that concerned institutions in the member States, take the necessary measures to standardize procedure of analysis used by various laboratories both at the national and regional levels. While such an objective may be achieved through other recommendations, more speedy efforts may be taken to bring about more consistency in the ongoing efforts of analysis in the region. Such consistency is vital for any comparative study to be made on the actual state of environment both at the national and regional level. Such an issue may be part of an agenda of one of the proposed workshops.

- R.10. The establishment of a regional network for environmental information. It is recommended that ESCWA, in co-operation with other concerned organizations both at national and regional levels, initiates efforts to establish a regional network for information-exchange on environmental issues of common concern in Western Asia. The network is to be the organizational framework under which most of the proposed actions or recommendation may operate. It is not recommended, however, that implementation of most of the above recommendation be subject to the establishment of such a network. The network will be formed from nationally recognized focal point institutions of environmental protection in countries of the region. The network need not locate all of its functions in one country.
- R.11. The convening of a regional workshop to consider results and recommendations of this study ESCWA envisages convening a meeting of environmental protection officials in countries of the region in the fourth quarter of 1987. The meeting may review results and contents of this report and discuss future actions.

VI. PLAN OF ACTION

A. Bodies to be established

The following should be established and developed:

1. Environmental Information Network;
2. Regional Training Programme in Environmental Protection;
3. Regional Centre for Maintenance of Environmental Equipment in the ESCWA Region.

B. Goals and purposes

The overall goal of the plan is to strengthen the capabilities of countries of the ESCWA region in environmental protection in general and the performance and productivity of environmental laboratories in particular. The strengthening will be through the following:

1. Creation of a mechanism which will increase the quantity and quality of environmental protection information flows among environmental protection institutions in the region;
2. Development and implementation of training courses designed to improve and upgrade the capability of manpower working in environmental laboratories;
3. Establishment of a regional maintenance centre to extend the life cycle and improve the operation of equipment used in environmental laboratories of the region.

C. Description of the plan

1. Background and reasons: All countries of the ESCWA region have been taking measures and steps to protect their environment from pollution and deterioration. Protection measures are aimed at achieving an optimal level of utilization of resources while maintaining a clean, safe and productive environment. Most countries of the region have established environmental protection institution, with many having fully operational environmental laboratories. Other countries are in the process of either establishing environmental protection institutions or environmental laboratories to monitor, assess and interpret the quality of the environment. In reviewing the state of affairs of environmental protection activities in general and environmental laboratories in particular, the following features and needs were identified:

(a) There seem to be an increasing volume of information that is being produced by several countries of the region. Such information includes:

- (i) Data on levels and types of environmental pollutants in air, water, soil, food and work environment. Such information is available in one degree or another in all countries but especially in countries like Egypt, Iraq, Jordan, Kuwait and Saudi Arabia. Information on sources of such pollutants is also available in most countries of the region.

- (ii) Parameters and/or standards that have been developed by which pollution levels may be compared or interpreted. While most countries do not have approved national standards for elements of environment, many have adopted standards used or recommended by countries or organizations outside the region. Among the countries that have developed and adopted comprehensive standards is Saudi Arabia. Several countries like Jordan, Egypt, Kuwait and Iraq have standards for effluent water discharge or industrial waste discharge.
- (iii) Technologies and methodologies that have been developed to curb pollution or bring it down to lower levels. Countries like Egypt, Jordan, Kuwait are among those that have developed such information.

Through views expressed by interviewed officials of environmental protection institutions and because of the low level of exchange of information among environmental institutions, there seems to be a great need for exchange of experiences of respective countries in matters related to environment protection.

(b) The majority of the countries suffer from scarcity and quality of performance of manpower working in environmental laboratories. Manpower at the technician level has rarely had formal training in environmental laboratory operation. Many of them had graduated from high schools, receiving little if any preparation in equipment operation, maintenance or analysis procedures. Those at B.Sc. level have graduated from faculties of science with a major in chemistry or biology. Curricula of such disciplines are on the whole the traditional type preparing students for a general degree in chemistry or biology. These graduates occupy senior positions in the operation of environmental laboratories. Their preparation is far from being consistent with the type of work involved in such laboratories, which usually consists of special know-how in sampling techniques, the operation of complicated or sophisticated types of equipment and the interpretation of complicated data that have great impact on the quality of environment. Furthermore, measures recommended on the basis of data interpretation may be costly both for the industries or the Government. Officials in several laboratories expressed concern because of the deficiencies in the preparation of manpower working in the laboratories. Such manpower, it was pointed out, may become competent if their know-how is upgraded in the special fields in which they are working. Training courses in methodologies in several areas were therefore needed. Such courses includes: sampling techniques, procedures of analysis of pollutants, interpretation of data against standards, principles of how to maintain equipment or lengthen its life operation and measures to be taken to ensure quality of environment.

(c) Over the years, environmental laboratories have acquired a large variety of equipment which are mostly complicated and require special calibration, handling and care. Much of this equipment was ordered with little or no thought given to spare parts, spare components or maintenance manuals. The easier alternative for some of the laboratories has been to order a new piece of equipment rather than repairing the inoperative one. Others suffer from delays of maintenance offered by some manufacturing

companies and the costs involved. In other cases - not few - the equipment just sits idle, which interrupts or slows down the work of the laboratory. All in all, the costs of purchasing equipment or its replacements are quite high for many institutions to afford it. While there was no study on the average life span of operation of equipment, some officials reported malfunctioning of equipment soon after receipt. Such a situation may not be uncommon in many laboratories. All officials responsible for environmental laboratories in the region identified the poor levels of equipment maintenance as one of the major constraints facing their work. They all expressed satisfaction at any improvement in this area. They all were aware of the difficulties as well as constraints involved if every country attempted to solve the problem on its own. Each country faced one or more of the constraints, which outlined, i.e., either scarcity of trained manpower, weak level of know-how in the mechanics of maintenance service, low levels of funding or absence of critical number and types of equipment warranting the establishment of such service. The idea of having a regional co-operative effort in equipment maintenance was valued and supported.

2. Vehicles or mechanisms and how they operate: The plan calls for the establishment of a number of vehicles or mechanisms, each designed to serve a particular objective. The following is a summary of such vehicles or mechanisms and how it is proposed that they operate:

(a) The establishment of a regional information network of environment protection (Network): All countries of the region will be invited to participate in a regional effort to exchange information forming a network. The network will operate as follows:

- (i) One of the national institutions will be designated as the focal regional point for the network. An alternative for this is for the Environmental Co-ordination Unit in ESCWA to act as the regional focal point.
- (ii) Each institution will designate one of its employees to act as a liaison officer in the network. The liaison officer may be chosen from those working in the information activities in those institutions having such a structure. The officer will provide information pertinent to the state of the environment in the country, special environmental problems arising in the country, special achievements of the institution, new developments in the area of environmental protection, structure and functions of the institutions, manpower in the institution, new methods or technologies developed in the area of laboratory work or environmental protection and new standards or changes in older ones adopted by the country.
- (iii) Received information will be annotated by subject area and reviewed and published in a newsletter from.
- (iv) A newsletter is then circulated to the largest number possible of persons working or concerned with environmental protection.

(v) Special issues of the newsletter may be prepared containing feature articles on one of the issues relevant to environmental protection in the region.

(vi) Estimated cost of publication of the newsletter and distribution at the rate of one issue a month comes to \$ 24,000 a year.

(b) Manpower development. The second component of the Plan is the organization and implementation of a series of special training courses along the following lines:

(i) Environmental Laboratory Management Workshop

- Duration: two to three weeks

- Host institution: It is suggested that the Royal Scientific Society of Jordan (RSS) and the Kuwait Institute of Scientific Research (KISR) co-operate in the implementation of such a workshop. RSS may provide the place to hold the workshop and a number of specialists in laboratory management. KISR may also provide one or more of the experienced scientists.

- Participants: 12 to 15 directors of environmental laboratories or senior officials working in managerial positions in environmental protection.

- Contents: Major contents of workshop may include:

- Training opportunities available for environmental protection inside and outside the region;

- Principles of laboratory equipment procurement including type of equipment for major analysis work of environmental element, the spare parts or components to be ordered with every piece of equipment, manuals for operation and maintenance and comparative history of performance of major pieces of equipment;

- Sources of information available on procedures of analysis, environmental standards and data interpretation;

- Computer and system analysis and their application in environmental laboratory work.

- Costs in U.S Dollars: - Travel and <u>per diem</u> for 10 participants:	20,000
- Lecturers, travel <u>per diem</u> and renumerations (4 persons)	10,000
- Other costs	<u>5,000</u>
Total	35,000

(ii) Sampling Analysis, Operation and Primary Maintenance of Environmental Laboratory Equipment

- Duration: six to eight weeks
- Participants: 18 to 24 analysts holding B.Sc. or diploma in one of the sciences
- Host institutions(s): One of four institutions may host such a course. Alternatively, the training course may be held in more than one place with half the number of participants: The institutions are: The High Institute of Public Health of University of Alexandria, KISR, The Research Institute of the University of Petroleum and Minerals of Saudi Arabia, or the University of Jordan and University of Yarmouk through their Marine Biology Station in Aqaba, Jordan. Resource scientists contributing to this training course may be drawn from experienced manpower in Iraq, Egypt, Syria, Jordan, Kuwait and/or Saudi Arabia.
- Contents: The course content may include:
 - Sampling procedure of air, water, soil and food;
 - Sampling equipment, mobile, fixed, or portable;
 - Analysis procedures for major pollutants in air, water food and soil;
 - Calibration and operation of major equipment used in analysis;
 - Primary maintenance of laboratory equipment, which includes installments of spare parts and components, use of operation and maintenance manuals, storage of equipment when not in use, history of equipment performance and maintenance;

- Documentation, organization and reporting of date;
- Principles of standards and data interpretation.

- Costs in U.S. Dollars

- Travel and per diem for 12 participants at rate of six weeks each (note: some participants may be partially subsidized or their costs covered by their institutions) 30,000
- Lecturers, trainers and/or scientists, a total of six man-months 24,000
- Preparation of materials and other miscellaneous costs 10,000
- Total 64,000

(iii) Data Interpretation, Modeling and Environmental Management

- Duration: Scientists, engineers, or senior analysts numbering 12 to 16
- Host institution: One of the following institutions: KISR, National Research Centre of the academy of Scientific Research and Technology of Egypt. Resource scientists involved may be drawn from various institutions of Iraq, Kuwait, Saudi Arabia or Egypt.
- Contents: This course is designed for senior officials involved in interpretation and application of environmental data, application of technology in environmental protection and general evaluation and management of potential sources of pollution in respective countries. The course may include:
 - Evaluation of data on state of environment and its potential impact on environmental quality;
 - Use of modelling in forecasting state of the environment based on present and potential levels of pollution;
 - Use of modelling in environmental pollution;
 - Economic aspects of environmental protection measures;

- Evaluation of technologies used in environmental protection;
- Country experiences in impact and issues involved environmental management and protection.

- Costs in U.S. dollars

- Travel and <u>per diem</u> for eight participants (full or partial coverage)	20,000
- Senior scientists 8 man-weeks	15,000
- Other costs	<u>5,000</u>
Total	40,000

C. Regional Centre for Maintenance of Laboratory Equipment in ESCWA Region

- Duration: Three year period extendable by another two. At the end of the five-years, participant countries may decide to continue with the centre, modify its services or otherwise.
- Participant countries: All countries of the regional are invited to join in benefiting from services of the center.
- Host institutions(s): It is proposed that the Electronic Service and Training Centre (ESTC) of the Royal Scientific Society of Jordan be considered as the Regional Focal Point of the Maintenance Centre. Other national or subregional focal points may also be chosen to participate in the activities of the Maintenance Centre either on national or subregional level. The basis for choosing such additional focal points would be special expertise already present, special consideration for the large volume of equipment present in any one country or subregion or special consideration of ease of transportation and movement of personnel.
- Mode of operation: Once the regional focal point is designated, a director of the programme is appointed. The director will implement the programme as follows:

- A complete inventory of laboratory equipment is made: the inventory includes types, number, manufacturer and state of operation of equipment. It also includes extent to which spare parts or components, operation and maintenance manuals are available. The inventory will be used as a guide for determining needed type and number of manpower and type and quantity of spare parts or components.
- Based on the inventory above, the capacity of ESTC may need to be strengthened in areas needed to maintain the full spectrum of laboratory equipment in the region. This may be achieved by upgrading the capacity of one or more of engineers already working in ESTC. The situation may require the appointment of one additional engineer. Strengthening the capacity will be accomplished through intensive training courses in equipment manufacturing companies or in other centres outside the region known to have expertise in the needed areas.
- A number of engineers working in ESTC are to be designated to work in the regional centre. The number will be determined on the potentially needed services both in type and quantity. It is expected that a total of one man-year will be required for a preventive maintenance programme and another one man-year of engineer's time for maintenance by request. While the total man-years may be two, the number of engineers involved in maintenance may be two or more depending on the needed services. This flexibility is provided by the large number of engineers already working in ESTC.
- The designated maintenance engineers will make two visits a year (one every six months) to each of the laboratories participating in the regional centre. Such visits will be for preventive maintenance, which may include some training of national technicians, the preparation of needed lists of spare parts or components and/or the repair of

equipment that may be inoperable at the time of engineer's semi-annual visit. Each visit to any one laboratory may last from one to three weeks depending on the circumstances.

- The other service provided by the regional centre will be an on-call one in which engineers will respond to such calls by appropriate action. Action may require an on-site visit or the dispatching of the piece of equipment needing repair to the regional centre. Dispatching may be done through car, bus, or airplane services available in the region. It is worthwhile to note that regular car, bus and/or airplane services are available between Jordan and all other members of the ESCWA region.
- Financial arrangements: Funding should be sought from international, regional or national organizations or funds. The fund will be the seed money for the Maintenance Centre. Services provided to national laboratories will be charged either fully or in subsidized form.

- Costs in U.S. dollars for three years operation

- Engineers (6 man-years) (2 man years for three years).	150,000
- Travel and <u>per diem</u> : (100 days a year for 300 days)	50,000
- Components and spare parts	50,000
- Operational costs/3 years	<u>150,000</u>
Total	400,000

D. Phasing of the plan

Implementation of the plan is proposed to take place in three phases. The first is the establishment of the Maintenance Centre, followed by the training programme and later the information vehicles. The Environmental Protection Network will be established as a framework for the three activities but implementation of any one of them may not await the formation of the network.

E. Costs of the plan

	<u>(000) US dollars</u>
A. Information network 3 years x 24,000 dollars	72
B. Training programmes each implemented twice over three years	278
C. Regional Maintenance Centre	<u>400</u>
Actual total	<u>750</u>
Overhead for administration	<u>150</u>
Grand total	<u>900</u>

Sources of costs of the Plan

<u>Institution</u>	<u>Type of inputs</u>	<u>Costs in (000) U.S. dollars</u>
ESCWA	Overhead for administration	150
Regional organizations and/or funds	Subsidy funds or seed money	300
- Member countries participating in Regional Maintenance Centre (10 members at least)	Annual subscription refunded through provided services at rate of 5,000 a year	150
- Returns of services provided by Maintenance Centre		100
- Other sources		<u>200</u>