Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern

Regional Water Quality Monitoring Plan

August 2009

Regional Water Quality Monitoring Plan
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CONTENTS

INTRODUCTION

This Regional Water Quality Monitoring Programme has been developed as part of the project "Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern's (CaspianMAP)". This project has been financed by the Tacis Programme of the European Union (EU) which amongst others promotes regional co-operation on environmental protection.

On of the main objectives of the CaspianMAP is to support the Caspian Environment Programme (CEP), which is a partnership between the five littoral states - Azerbaijan, Islamic Republic of Iran, Kazakhstan, Russian Federation and Turkmenistan, and International Partners like EU, UNDP, UNEP, and the World Bank. The CEP's mission is to assist the Caspian littoral states to achieve the goal of environmentally sustainable development and management of the Caspian environment for the sake of long-term benefit for the Caspian inhabitants.

In November 2003, the littoral countries adopted the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention), which entered into force in August 2006. The Tehran Convention lays down general requirements and provides an institutional mechanism for environmental protection in the Caspian. The Strategic Caspian Action Programme (SCAP), which sets the long-term agenda and framework for the implementation of the Tehran Convention and its Protocols over a period of 10 years, was adopted by the littoral countries in November 2008. Littoral countries have expressed their intention to implement the SCAP through the Convention Programme of Work and National Convention Action Programmes. Especially relevant for this project is the target from paragraph 2.6.3: Develop and implement a regional water quality monitoring programme focused on critical contaminants and hot-spots.

The beneficiary countries of the "CaspianMAP" are the four coastal countries that are eligible under the TACIS Program: Azerbaijan, Kazakhstan, the Russian Federation, and Turkmenistan. Iran's participation was limited, due to the fact that it had an observer status only as it does no fall under the TACIS Programme. The Project implementation activity included all the Caspian waters and its coastal areas with potential pollution sources, and direct impact zones where wastewater is discharged in rivers within 100 km from the sea.

The need to elaborate a more efficient water quality monitoring program is felt strongly for a number of reasons. Substantial gas and oil resources attract economical and geopolitical attention. There are many industrial facilities, including abandoned ones, which pollute the marine waters. Rivers are carrying thousands tons of pollutants into the sea annually. A disastrous decline of economically valuable fish species is being observed, together with a deteriorating biodiversity. One of the causes of this deterioration is the continuing water pollution and the accumulation of pollutants in the bottom sediments.

At the same time there is limited authentic or systematically collected information available to assess conditions and to predict trends in water quality in the area. Information is based on fragmented, ad-hoc and incomplete assessments of the existing environment conditions. Information does not originate from specifically designed marine monitoring programmes, but comes mostly as a side product of inspectorate work and through stand alone scientific research. Despite earlier efforts to improve the situation, a.o. within TACIS and CEP frameworks, the existing monitoring system for the Caspian Sea is simply not adequate. At present, 18 years after the break up of the Soviet Union, all littoral countries suffer from a lack of dedicated resources, limited analytical capabilities, and a lack of proper cooperation and data exchange mechanisms between institutions and countries. Moreover, differences in legislation, different priorities in natural resources management, poorly formulated regulations, poor use of quality standards, confusion over inspectorate and ambient monitoring functions, and poorly defined monitoring programmes in general do not support the development of an adequate system of environmental protection.

The Caspian Sea, a land-locked basin, has a more limited capacity to handle pollution than other seas. The pollutants that enter the sea through rivers as the Volga, the Kura, the Terek, and the Ural, from sources of oil pollution, and industrial and municipal wastewaters, are inevitably spread throughout the Caspian. A large part of the toxic pollutants, including persistent organic pollutants, accumulate in bottom

sediments. It is therefore necessary that marine environment observations include observations of basic hydrological features (regime), unlike compliance monitoring; and these assessments must be supplemented by systematic observations over fluctuations in sediment accumulation.

One of the most important project activities has been the inter-calibration exercise between the laboratories that are expected to play a role in a future regional monitoring program. This activity was carried out under the methodological supervision of the IAEA Marine Environment Lab, Monaco. The outcome shows that the analysis of a wide range of the proposed pollutants is not attainable yet for most of the analytical laboratories in the area. Therefore, Governments should pay more attention to the development of programmes to strengthen these capabilities. During the initial stage of the project many countries of the area expressed their concern on the potential pollution of bottom sediments by radionuclides of natural origin, mostly uranium and thorium chain that can be accumulated in waste (activated charcoal) and could enter the sea from extraction sites (radium, barium). Some expert assessments were made during the project, and they indicate that the problem appears to be exaggerated, although no laboratory has carried out qualitative measurements of uranium and radium concentrations in sediments. It was proposed to review the strategy for metals concentrations by reducing the focus on their concentration in water, and at the same time increasing the observations in sediments and in suspensions in coastal and river waters. This approach was successfully applied in the project with regard to metals as well as organic pollutants. Application of satellite information was also considered during workshops.

The results of the first TACIS-CEP program on monitoring (2001), and the earlier scientific survey (S.Demora et al., 2004) proved to be of much help in developing the approaches and concepts for the strategy of the future regional monitoring program.

When planning the project it was assumed that the same strategy could be applied as during the 2001 cruises when teams of experts from various countries collected samples under the guidance of experienced experts, and all samples were analyzed in one of the leading analytical laboratories. However, this approach was not approved by the countries, and it was decided that expeditions would be carried out on the vessels of the respective countries with the participation of their experts and project experts. The results are described in national reports, briefly summarized in this report. The expeditions carried out in this project demonstrate the actual capabilities of the participating institutions. At the same time the results of this cruise do not necessarily meet the high scientific standards of the 2001 expedition.

The intercalibration exercise and the analysis of the current state and potential development of the monitoring infrastructure and its management are the basis for this report. Consideration was given to best practices and model monitoring arrangements that are being applied in the Black Sea and the Baltic Sea, and other modern concepts of environmental monitoring as an element of information support in marine environmental management.

The national expedition reports, the inter-calibration exercise (CMIPT, 2008), and many others can be found on the project's web site www.caspianmap.org, and on the CEP website: www.caspianenvironment.org

1. PRESENT STATUS OF THE CASPIAN SEA MONITORING NETWORK

1.1. Legal and Regulatory Frameworks

Significant attention has been paid to the legislative and regulatory issues related to the marine monitoring programs in the Caspian countries. Much of the weakness observed in the legislative and regulatory provisions related to marine monitoring are typical for countries in transition and developing countries.

A common problem for all Caspian countries is the lack of distinction that is made between the various types of monitoring, such as effluent monitoring by industries, regulatory compliance monitoring by Inspectorates, water quality monitoring related to public health, and ambient or trend monitoring. These different functions can often not be found back in the legislation, or are poorly defined.

Typical for the Caspian countries is that the monitoring departments of the Hydro-Meteorological Services have been assigned with ambient monitoring, though the involvement of these Services in marine water quality studies varies.

Best prepared for implementation of RWQMP tasks are the monitoring related divisions of the Hydro-Meteorological Services of Kazakhstan and the Russian Federation. They have managed to preserve the skills for arranging and carrying out monitoring operations. But for the time being, their observations are mainly carried out in the coastal areas, and they are significantly reduced compared to the extensive programs of the past. In these countries, responsibilities for the environmental inspection control and compliance monitoring programs are formally with the Regional Departments of the respective Environmental Protection Ministries. Cooperation between these agencies with regards to information exchange and harmonization of sampling and measurement methods is not satisfactory.

In Azerbaijan and Turkmenistan the main responsibilities for environmental supervision and marine water quality monitoring programs are not separated and assigned to agencies with inspectorate and surveillance duties, in Azerbaijan this is the Caspian Sea Environment Monitoring Administration and in Turkmenistan it is “Kaspecokontrol” (Caspian Environment Supervision). The combination of such responsibilities is not necessarily an issue, provided that they are carried out within the framework of separate regulations and programmes. Until now, legislative and regulatory provisions, and the technical capacities of these institutions, do not allow them to carry out both functions effectively. It can be assumed that the main causes of the unsatisfactory performance of the ecological surveillance water quality monitoring programs in the countries are related to the lack of regulatory requirements with regard to the contents of the programs, their implementation strategies, responsibilities and quality control.

In all countries of the region there are problems with financing environmental monitoring programmes. Financing for the implementation of monitoring programs is through competitive bidding, and usually for short periods which hampers the long-term development of the networks and investments in capacity building, as there are no long-term guarantees.

Financing terms to support the laboratories for monitoring services have been put on the same footing as the terms for carrying out environmental inspections, while long-term marine monitoring observations should be financed with a longer perspective in mind. The resources which are accumulating in the Ecological Funds, can not be directed for improving the analytical and technical capacities of the laboratories, which are involved in the marine monitoring programs, while its funds might provide for technical capacity building improvement and also on incentives for highly skilled and qualified analysts and technicians of the analytical laboratories. Therefore the issue of regulatory provision for financing support of the monitoring programs implementation are also in need of further improvement, but taking into account peculiarities of the current legislation in the countries of the region.

In all countries of the region functions as “industrial environmental supervision” are defined as part of pollution source monitoring programs. These functions are carried out, financed and implemented by industries polluting or potentially polluting the marine environment. However, the methods and results of the “industrial environmental supervision” programs are seldom coordinated with, or used in, the ambient monitoring programs in the same areas.

Coordination arrangements between the various laboratories and agencies, including data exchange procedures, are not covered by the existing environmental regulations in the Caspian countries. This prevents the creation of an effective Data Management System at regional level, which may provide decision makers the reliable data needed for taking decisions that might have an impact on the marine water quality or marine biodiversity.

The regulators in all countries of the region have not yet defined quality control and quality assurance requirements for laboratories involved in marine monitoring programmes. The main regulatory requirements that are in place relate to standardization and certification of analytical instruments, but these requirements do not cover procedures and methodologies, which could only be tested through regular participation in internal and external inter-laboratory calibration programs (proficiency testing) in accordance with ISO 17025 procedures.

Evaluation carried out in the frame of this project show that in general commercial laboratories deliver higher quality results with regard to analytical measurements. This is not only due to the modern equipment used. Most commercial analytical laboratories have established QA/QC programs and procedures, which are required by supervising companies and clients.

In the Caspian countries the Environment Quality Standards and methods for the environment impact assessment have not yet been harmonized and/or agreed at the regional level. No environmental regulatory authority has developed, and in case of emergency situations with potential transboundary effects no regionally agreed response activities have been included in the tasks of marine agencies.

The nature and level of development of existing legislation differs considerably. In Kazakhstan the main document regulating environment monitoring, including the Caspian Sea, is the Ecological Code, with Government orders and decisions on implementation issues as annexes. In the Russian Federation the list of relevant laws and regulations is quite long, but specific requirements for marine areas monitoring programs with distinct separation of functions and responsibilities have not yet been defined. The legislation of Azerbaijan and Turkmenistan is clear in requiring environmental monitoring programs. However, the regulatory provisions should be significantly enhanced as a basis for further developing compliance and trend monitoring programs.

Coordination of environment monitoring and ecological surveillance activities related to the marine environment is with Environment Protection Ministries or other institutions that have a mandate to act for and behalf of the Coordinating Bodies.

All countries of the region are signatories to the Tehran Convention. Under the Tehran Convention several protocols are under development, including a Protocol on Monitoring which would provide the frame for further development of the Caspian Sea Regional Monitoring Program. Further development of the Protocol on Monitoring should take into consideration the flaws and shortcomings of the current legislation and regulations. In the initial stages national action plans must be elaborated to provide for harmonization and overall improvement with regard to the legislation related to the national and regional marine environment quality programs; resolve issues of harmonization; further improvement of methodologies and monitoring programs coordination; and also resolve the issue of special training of personnel and ensure sustainable financing for activities to be implemented under an agreed Regional Water Quality Monitoring Plan.

1.2 The Caspian Sea Monitoring Programs Development

1.2.1. Concept

Since the first TACIS program in the framework of the Caspian Environment Program the awareness has grown that reliable environmental management for the Caspian Sea is only possible when decisions are based upon the outcomes of a well coordinated and agreed regional monitoring program: getting a clear picture of the trends in the overall varying conditions; establishing the true causes of environment deterioration and, consequently, design programmes with well justified mitigation and prevention measures.

At the regional level the program has to define and adopt similar requirements in order to ensure the quality of observation data. The implementation of quality control programs (QA/QC) for analytical measurements is one of the most important issues, which also may bring trust and confidence in the data. The regional status of the program means the availability of a coordinated work program for regular observations with appropriate and accepted procedures of data exchange and circulation.

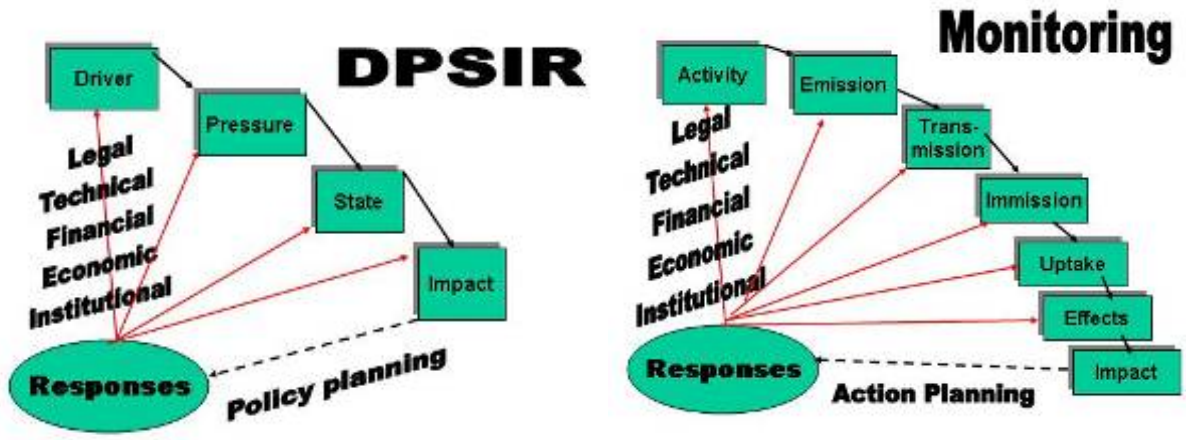
Elaboration of an effective regional water quality monitoring program would encompass the following steps:

- Elaboration, approval, and implementation of the respective national and regional water quality monitoring programs.
- Agreement between experts and approval by the environment authorities of the priority list and parameters of the pollutants and contaminants being discharged into the Caspian Sea, and the stations for sampling, list of parameters to be included for baseline observations, and analytical measurements in frame of the monitoring programs at the national and regional levels.
- Elaboration of the requirements and procedure for marine environment assessment in accordance with the agreed and approved environment quality criteria and procedures.
- Elaboration of the centralized regional and national marine pollution integrated database as a basis for further data processing, data interpretation, environmental assessment and decision making support, providing information for experts, managers, and public.

To address these issues within the framework of this project requires a further development and consideration of the principles previously elaborated.

The Concept for enhancing an effective marine environment monitoring program has been based on the «DPSIR» (Fig.1a), a causal chain between Driving Forces-Pressures-State-Impacts-Responses, which serves as a tool to support decision making procedures and manage environmental problems.

This approach confirms that effective environmental management strategies can only be on the basis of a comprehensive analysis of the causal relationships.



a b

Fig. 1.1 – The structure of various components of the efficient sea monitoring system which may be implemented as an instrument of information support for environment quality management in pursuance to the DPSIR principle.

In such way, source monitoring programs (emission) shall be agreed in compliance with monitoring programs covering process parameters, governing the transport of the contaminants in the sea (transmission) and data collection related to the (pollution) state of the marine environment (immission). Accordingly, the observation programs concerning the marine water pollution should be coordinated with source pollution monitoring programs (industrial ecological supervision). The research programs should also cover such phenomena as accumulation of the contaminants in the marine ecosystems (uptake), as well as studies on toxicological effects on the environment (effects) and its consequences (impacts) for the marine environment (environment and human health).

The acceptance of such a systems approach means that problems facing various monitoring programs may become effective elements of the marine environment management system only if they have been coordinated between themselves, optimized according to their terms and observation frequency, and harmonized according to methods that allow the comparison of data from various programs in a single system of interpretation, analysis and assessment. This way, the monitoring results

can result in an impartial diagnosis of the current state of the marine environment, assess trends, and consequently allows assessing risks, and justification of mitigation or protection measures. The various sorts of monitoring arrangements can be separated into four main groups:

- pollution trend monitoring;
- compliance monitoring with regard to regulatory criteria (the regulatory surveillance programs to be carried out by inspectorates and enterprises);
- environment ecosystem monitoring (individual environment toxicological effects on marine biota);
- Baseline monitoring (Baseline observation on marine hydrological, physical and chemical parameters of the sea, related to the processes determining the transfer and transformation of pollutants).;
- Observations over pollutants getting into environment from the identified pollution sources must be carried out in the framework of environment supervision programs, and also by the owners of the pollution sources. Regulations for such observations must be established (approved) by the regulatory agencies themselves, and may be regularly reviewed depending on varying conditions of the pollutants sources activity.

Information about background levels (natural or near natural levels of environmental pollution) may help to assess the effects of the combined impact of the various pollution sources, but it does not usually allow the identification of individual pollution sources. However, the results of such complex observations assist in determining trends as a response to discharges to the sea from land-based and seaborne sources of pollution. Data from background monitoring also provides the basis for a comparative assessment of marine pollution between areas with specific pollution loads and areas without such specific loads. These sorts of observations are most efficiently implemented through the regular hydro-meteorological observation monitoring network in the coastal area and in the open sea.

Regular observations and studies of the marine water masses dynamic, physical and chemical transformation of the pollutants in the marine compartments, their accumulation at the particulates phase and marine organisms as well as eco-toxicological effects are usually carried out as part of national and international research programs.

At the same time, even within one country observation data from various monitoring institutions and surveillance laboratories are very often not comparable. At present, there is no center of excellence or reference laboratory in the Caspian countries, which can provide methodological support to program implementation, or assimilate monitoring data for different applications or environmental impact assessment. The establishment of an institutional frame for the Caspian regional water quality monitoring program will demand overcoming of inter-Agency dissociations, preparing for a better institutional level of cooperation (data exchange and data reporting) inside the countries, but also achievement of a lot of political arrangements within the framework of Tehran Convention, Protocols and developing clear mechanisms of their practical implementation.

The implementation of a comprehensive water quality monitoring system might be more successful if it happens in conjunction with an improvement of the legislative basis and the taking into account of the following arrangements:

- Effluent monitoring to the rivers and coastal waters is primarily a task for enterprises
- Regulatory authorities will see to the consistency and quality of monitoring data from the laboratories related to industrial ecological control programs, through the laboratories of Environmental Inspectorates or their partners laboratories.

The environmental trend monitoring programs including background observation shall be carried out as a part of a RWQMP, which should be elaborated on a routine sample collection basis, identified basic and reference laboratories, and a sustainable long-term monitoring stations network.

1.2.2. Identification of the key ecological problems of the Caspian Sea

A number of international and national projects have focused on identifying key cause-sequences chains to formulate priorities for monitoring activities. Some pilot marine expeditions and research activities have been carried out during the last decade. A similar assessment was done in this study, including four sampling surveys. The results help to identify the principal environmental problems and pollution sources, and the areas of their impact that need special attention. The following problems of the Caspian Sea are the principal ones:

- Euthrophication (the coastal, especially shallow water areas adjacent to settlements and encompassing almost all coastal areas of Iran, Azerbaijan, Dagestan, northern part of the Caspian Sea and the Turkmenbashi Gulf).
- High level of oil exploration and pollution from their by-products (open seas, coastal waters and rivers that flow into the Caspian). Special importance may be attached to Baku Bay, Turkmenbashi city, and the Dagestan coastline where there are many obsolete and abandoned oil extraction sites.
- Considerable amounts of anthropogenic organic and inorganic pollutants in bottom sedimentation (however in less degree in water and biota) as a result of industrial and agricultural activities and atmospheric deposits from burnt waste gas from refineries and oil extraction installations.

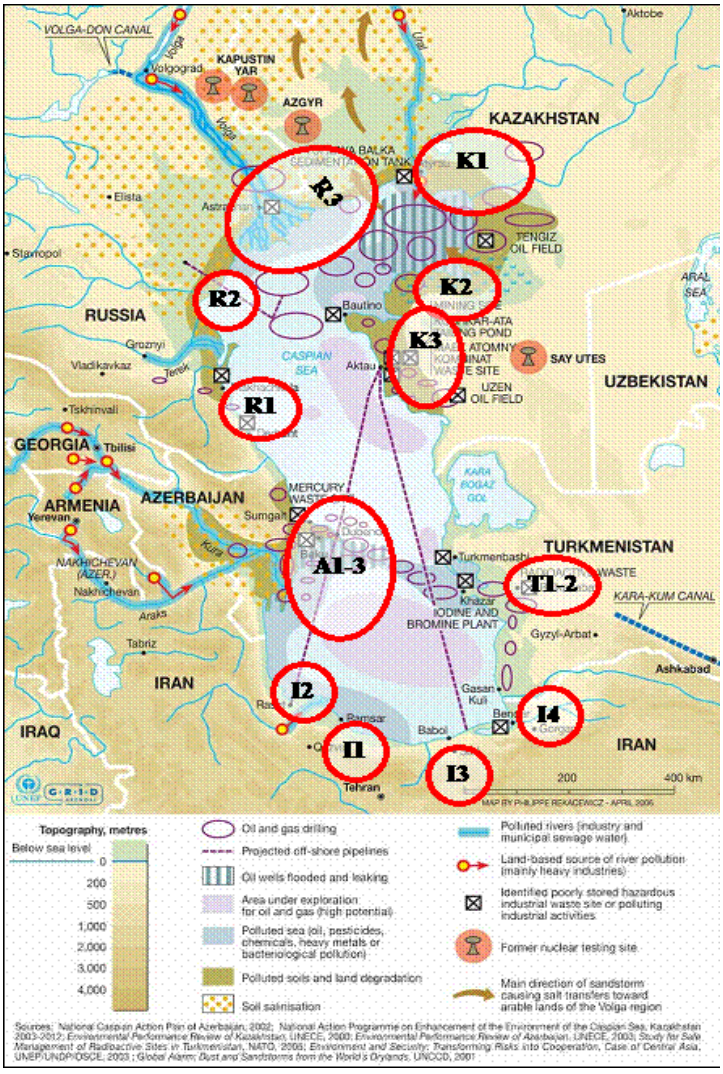


Fig.1.2. The principal areas of Caspian Sea pollution sources impacts as proposed for observations in the framework of RWQMP.

A significant problem in some areas of the Southern part of the Caspian Sea, especially in the water areas along the Turkmen shoreline and the western part of the Iranian shoreline, is the algae bloom with environment toxicological effects. These, and monitoring of some other hydrobiological parameters, could be included in the national and regional observation programs as well.

Special attention should be paid to nutrients and trace elements in the rivers and the coastal zone. It is commonly accepted that the main part of the total pollution load comes from the Volga, Ural and Kura rivers. The contribution of the Terek, Samur and other rivers in Iran is relatively low. At the same time their regional impact is considerable, due to the specific water circulation mode. It is a peculiarity that the larger part of toxic substances that comes through the Volga river is deposited in its delta and in the adjacent sea area, and that the Ural river deposits in the eutrophic environment system of the shallow northern part of the Caspian Sea.

Therefore, for obtaining a better picture of the relative impacts of pollution sources on the quality of the open sea, it is

necessary to harmonize the open sea monitoring programmes and make them compatible with river and coastal water pollution monitoring programmes and regulations. Observations over these sources must become the priorities for the environment supervision agencies. The environment supervision agencies and the marine environment monitoring programs must pay considerable attention to the areas affected by impacts from oil extraction sites situated in the open sea along with the areas accumulating pollutions in the bottom sediments, e.g., in the seaport areas of Baku Bay and Turkmenbashi Bay.

Polluted sediments may be buried under clean sediments but when stirred-up pollutants will again be freed and affect the bottom fauna and cause secondary water pollution. When scheduling priority areas to be included in the regional monitoring program various sources of potential pollution along with features of the marine environment were considered. The principal areas are marked and shown on Fig. 1.2

The principles and procedures which were elaborated in the framework of the previous TACIS and CEP program on data quality arrangements, information exchange, reporting and other requirements are still actual and essential.

However, political decisions must be made to change legislation that will result in arrangements that provide trust and reliability with regard to monitoring data along with the possibility to involve international experts from the countries of the region for making use of independent monitoring means as the use of satellite images.

Since the first recommendations for the regional water quality monitoring program arrangements (TACIS, 2001) and CEP recommendation (P_RAG, 2005), tangible progress has been made in technical development of the labs and in creating awareness of the urgent issues that needs to be solved. At the same time little has changed with regard to the monitoring programs in the region, the quality of their methodical support, and efficiency of their implementation.

In fact, in all Caspian countries there is lack of scientific support for monitoring observation. Nevertheless, the motivation to create an effective monitoring program is still high in the countries and a willingness exist to contribute to priority setting, selecting the most important parameters for a RWQMP and discussing improvements of monitoring management structures in the region.

Discussions on an optimal management structure have taken place with experts and managers of key departments in environment protection ministries. From these discussions the following five directions resulted:

- Strategy development for monitoring programs based on strategic tasks, existing regulations and available financial resources;
- Establishment and management of the observation network, including marine coastal observation stations, sampling stations in the open sea, transport, research vessels and other;
- Analytical provision, including the maintenance of the laboratory premises and facilities, equipments and other related activities including provisions of the obligatory elements of the quality assurance and quality control programs (QA/QC);
- Data processing and data analyses, scientific and methodological support, observation data interpretation and assessment, including preparation of bulletins and strategic reports based on the environment quality safety criteria and risk assessment ;
- Risk communication and risk management based upon monitoring data and risks analysis.

The activities under this TACIS project focused on the analysis of operating monitoring programs, the management systems in the countries within the context of these directions, assessment of technical and staff potential of possible future RWQMP subjects, and the preparation of recommendations for further elaboration of regulations and securing arrangements for program implementation.

2. EVALUATION OF THE NATIONAL WATER QUALITY MONITORING PROGRAMS AND KEY ANALYTICAL LABORATORIES

The present regular water quality observational system is based on the former coastal marine stations and open sea stations which belonged to the former State Hydrometeorological Committee of the USSR. Further development of the observation network and analytical facilities after the disintegration of the former Soviet Union took place in parallel with the development of national environmental legislation, using the remaining infrastructure and in accordance with the developing economic and human resource potential.

In the Russian Federation, where research institutions, educational centers and qualified experts remained operational, the basis for a functioning monitoring network is present. Coordination of all monitoring activities, and the management and development of the monitoring network has been assigned to the State Federal Service for Hydrometeorology and Environment Monitoring (RosHydromet). Observations on marine environment pollution are also conducted by the Fishery Ministry of the Russian Federation, regional departments of the Ministry of Natural Resources, Institutions of the Academy of Science, and other agencies. However, the annual marine water quality monitoring programs are underfinanced, and coordination leaves much to be desired.

In Kazakhstan, the regular water quality observations are carried out as a part of the hydrometeorological programs of KazHydromet. Environment surveillance programs and ecological inspectorate supervisions are a task of the regional departments of the Kazakhstan Environment Protection Ministry, situated in the Mangistau and Atyrau oblasts. Regular sampling surveys are carried out by Gas and Oil exploration companies according to their license conditions. However, the existing monitoring and surveillance programs are not harmonized with any strategy or subject to joint quality assurance programs.

In Azerbaijan, all institutions responsible for the implementation of environmental monitoring programmes belong to the Ministry of Environment Protection and Natural Resources. From 1998 to 2004 the Caspian Sea Pollution Data Center, created within the framework of the CEP, was located in Baku. A special Caspian Sea Environment Monitoring Administration has been established by the Ministry, with tasks on environmental monitoring and inspectorate supervision service over the Caspian Sea. This institution has a research vessel equipped with relatively good sampling and sample preparation facilities as well as hydrological devices. There is also a considerable number of independent analytic laboratories. However, no common state monitoring program for the Caspian has been elaborated, which could involve all potential partners for its implementation.

Turkmenistan has only one official marine monitoring institution – Kaspecocontrol, which belongs to the Ministry of Natural Resources. This institution combines all functions, acting as environment inspectorate and as monitoring body, controlling waste water discharges to the sea and looking for the establishment of regular sampling programs for the open sea. However staff employed in the laboratory of Kaspecocontrol, have limited experience in sea surveys and carrying out analytical measurements for most trace elements and organic pollutants.

This chapter contains an evaluation of the analytical laboratories and management practices in those laboratories and institutions, which have been proposed as potential partners of the Ministry of Environment Protection and Natural Resources. Estimates of the technical capacities given below reflect the findings of this Tacis project within the framework of this project.

2.1. Azerbaijan

The infrastructure of the marine environment quality state observations system in Azerbaijan is rather developed (Fig.2.1). State institutions, which to various degrees are involved in the environment surveillance and monitoring implementation belong to the Ministry of Environment Protection and Natural Resources. The source pollution surveillance programs are implemented by Gas and Oil exploration companies which are licensed by the Environment Protection and Natural Resources Ministry. Research institutions and analytic laboratories could perform quality management programs for observation and provide scientific and methodical support for the monitoring programs if they would be involved in the implementation of the monitoring programs.

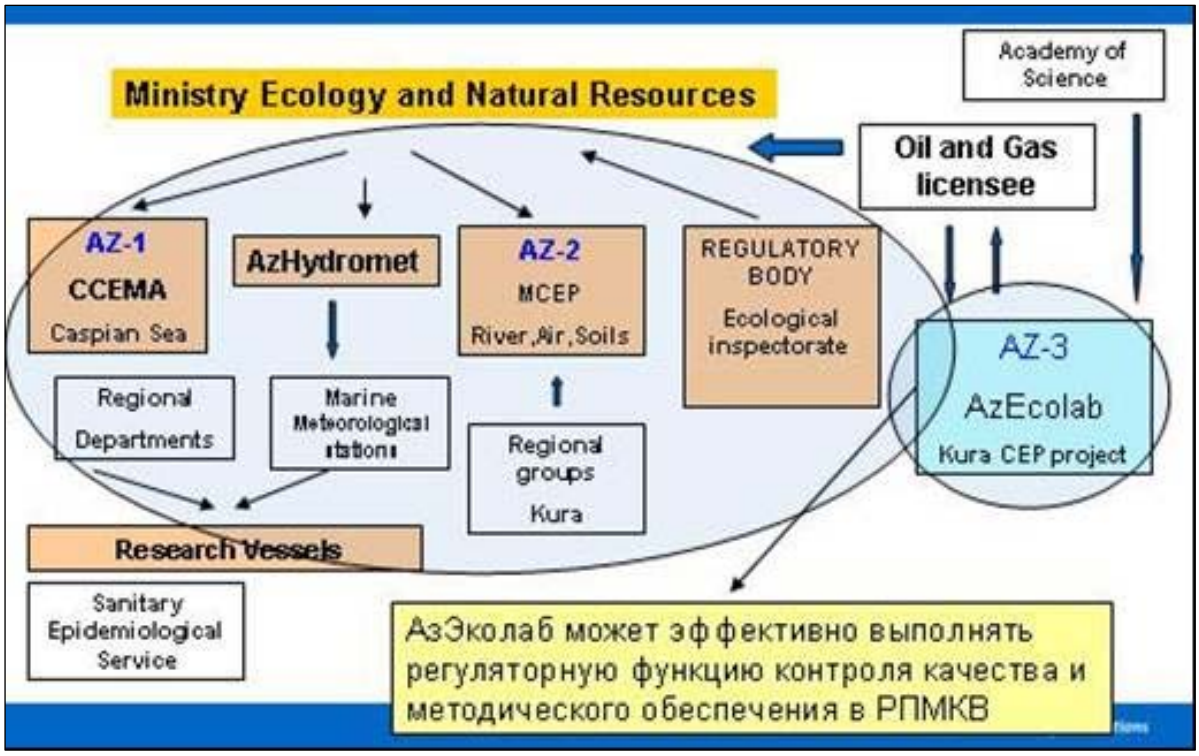


Fig. 2.1- The institutional structure for Caspian monitoring in Azerbaijan

The Caspian Complex Environment Monitoring Administration has the responsibility to arrange and coordinate water quality monitoring activities in Azerbaijan, including the regular sampling programs and its analytical studies for the Azeri sector of the Caspian Sea - extending from its northern frontier with Russia to its southern frontier with Iran.

The main tasks related to the Caspian Sea monitoring programs are the following:

- To reveal and identify sea pollution sources, which create anthropogenic loads to the marine ecosystem;
- To carry out regular observations on water and sediment pollution in the areas of settlements and resorts, fishing, and also on gas and oil extraction sites in the Azeri sector of the Caspian Sea.

CCEMA has a well-equipped research vessel, «Alif Gajiev». Being equipped with its own sea vessel the Caspian Complex Environment Monitoring Administration could be considered as one of the best among the Caspian countries.

At present, the work programs implemented on board of the vessels at sea do not benefit from scientific and methodical support, and various groups of experts (e.g., hydrological and monitoring

groups) often carry out works without coordination, independently. Such work arrangements do not allow for an efficient implementation of monitoring programs in the Azerbaijan sector of the Caspian Sea. Usage of the vessel, and its potential capacities for carrying out works at sea, could be more rational and reasonable if its full employment, equipment and machinery would be put under the requirements of the comprehensive regional monitoring program for the Caspian Sea

Fig. 2.2 – Cruise vessel CCEMA “Alif Gajiev” and some available equipment in use for monitoring studies

. At the disposal of the department are several affiliated analytic labs, data processing and analysis sections, management decision-making sections, and a number of other subdivisions including those located in other regions of the country. But due to issues of technical, personnel and financial nature the performance of the Department can’t be accomplished effectively. Until recently, the main priority of the CCEMA was its inspectorate function.

It is expected that in the future the Department will gradually develop and improve including upgrades of the analytic capabilities and expertise levels

Laboratory of Caspian Complex Environment Monitoring Administration (CCEMA)

There are several analytical laboratories, data processing section, management support sections and regional divisions operating under CCEMA. However, lack of resources for daily operations, low salaries and lack of highly qualified analytical personnel prevent CCEMA from providing effective management of the monitoring activities.

Sampling facilities and in-situ instruments to study marine oceanographic at the research vessel are also limited. There are no devices for water filtration, pre-concentration, microwave decomposition, etc. There is also a lack of calibration sources and necessary chemical reagents, chemical vessels, and other

small items needed to perform qualified analytical measurements. The staff is open and enthusiastic for new methods and challenges; however their qualification level should be improved to be able to operate AAS and chromatography methods efficiently.

Fig. 2.3 - Impression of available analytical facilities in CCEMA laboratories

The most used method in daily measurements are calorimetric and gravitation methods by means of which the ions of ammonium, nitrates, nitrites, phosphates and silicates are to be determined in the sea water. Extraction and photometrical methods are applied to define synthetic surface-active substances and the main cluster of phenols. Total concentration of oil products is also to be defined by means of extraction and photometrical method.

Trace metals concentration in water and bottom sedimentations is to be defined on atomic adsorption spectrometer with graphite seal. But the lack of calibration sources does not allow to carry out works appropriately in the full range of pollutants to be detected in the marine environment .

There is a «Varian» (CP-3800) gas chronograph available in the laboratory. The chronographer is out of order and in need of repair.

During 2009, analytic equipment was delivered to the lab of the Department under a parallel supply project (EuropeAid/122682/C/SUP/Multi). However, adjustment and fine-tuning of the gas chromographing methods will require specially refined argon, hydrogen and nitrogen. This problem is still outstanding.

“AzEcolab” Laboratory

“AzEcolab” laboratory is one of the most technically advanced, developed and well-organized laboratories in Azerbaijan. This laboratory was created initially on the basis of the Radiation Problems Institute of the Academy of Sciences of Azerbaijan Republic and supported by the CRDF International Fund (Fig. 2.4). This lab may potentially become a partner of the CCEMA and may provide

methodological support and quality assurance for data collection within monitoring programs in the Azerbaijan sector of the Caspian Sea.

The laboratory employs about 20 persons, including management, analysts and technicians. But judging from its existing level of technical provision, skills and qualification of its staff, and system of performance, this lab might be counted among the most advanced, efficient and well-equipped ones not only in Azerbaijan but in the whole Caspian area. There are modern analytic appliances and means including various sorts of atomic adsorbent spectrometers, three semiconductor gamma-spectrometers and other machinery which allow to practically providing all main type of analytic measurements of the environment samples.

Fig. 2.4 - Analytical equipment at the laboratory “AzEcolab” potentially available to support WQMP

A quality control system for analytic measurements has been introduced and the laboratory has a fine-tuned supply of reagents. An affiliated training center has been established at the lab in the framework of the national funds of the Academy of Sciences of Azerbaijan Republic. This center also provides training courses for staff from other labs.

Until now this lab has not been involved on a regular basis in the monitoring programs of the Environment Protection and Natural Resources Ministry of Azerbaijan, as it has the status of a commercial entity. At the same time, its independent status, high level of technical equipment and skilled personnel qualifies it to be appointed as the main reference lab in the country on issues of methodical support.

According to their licenses all industrial and mining companies extracting hydrocarbons in the Caspian Sea, (such as Sate Oil Exploration Companies, British Petroleum (BP), Azeri-Iodine, LUKOIL etc.) shall implement their own monitoring programs in the areas adjacent to their enterprises. Usually such companies do not have their own labs, and they use commercial labs, such as “AzerEkolab”, “Aqualab”, etc.

The responsibility of the CCEMA itself is the independent marine environment supervision in the areas of oil exploration activity, along with supervision over waste water discharges into the sea. But the

measurements which take place in the labs of the CCEMA allow assessments only by measuring concentrations of nutrients substances, total concentration of hydrocarbons (TPH) and phenols.

Established cases of infringements of environmental legislation are to be published on the Ministry website, and in these cases companies are to be fined. Monitoring results are to be regularly published in bulletins and disseminated among more than 10 State departments and institutions. However, data shown in a bulletin represent a restricted list of indicators of pollution, and there are no analysis and forecast on the conditions and consequences to the marine environment pollution.

At the same time, notwithstanding the technical level, there is no scientific and methodical support for the marine environment programs, and the research institutions of the country are practically excluded from participation in monitoring related programs. A model for a more efficient monitoring system must be created, also with an eye to the RWQMP, with active participation of CCEMA and its potential program implementation partners.

2.2. Kazakhstan

Environmental monitoring activities as a whole, and the Caspian Sea water quality monitoring in particular, are regulated by the Ecological Code of the Republic of Kazakhstan and a range of further regulations that are being developed. The State agency responsible for the Caspian Sea monitoring programs is the State Enterprise KazHydromet, which belongs to the Environment Protection Ministry (EPM) of Kazakhstan. The Government of the Republic of Kazakhstan has assigned the EPM with overall responsibilities to elaborate environment protection measures and to make arrangements for environment monitoring programs for the Kazakh sector of the Caspian Sea.

KazHydromet has the specific task to elaborate and implement the regular observation monitoring network, including water quality sampling stations for the Caspian sector. There are several Regional Hydrometeorological Centers of KazHydromet undertaking regular sampling programs in the Caspian Sea: Mangistau in Aktau city, and one in Atyrau. Analytical provision of the state monitoring programs is carrying out by the laboratories to the KazHydromet State Enterprise.

Also both Caspian oblasts have their own analytical laboratories which are part of Inspectorate bodies responsible for surveillance data collection programs and compliance monitoring programs.

Apart from government institutions (monitoring and surveillance bodies) industries have their own monitoring programmes. “Industrial ecological supervision” programs are common practice in Kazakhstan for companies as «Kazmunaygas», AGIP, LUKOIL, etc. These companies elaborate their own marine water quality monitoring programs and subcontract the implementation of the programmes. Sometimes these companies have their own laboratories, or they make use of external laboratories. Companies that provide these services include companies as «Kazakhstan Agency for Applied Ecology», «EcoProect Ltd.», « Ecoterra Ltd», etc.

The overall scheme of the principal water quality monitoring subjects in Kazakhstan is shown in Fig. 2.5. The overall scheme illustrates that the Republic of Kazakhstan has a well developed and advanced infrastructure and a number of qualified agencies and companies, which could be involved into the Caspian Sea RWQMP implementation. However, the current legislation and regulations of the Republic of Kazakhstan do not provide a clear distinction between the different types of monitoring related to the marine water quality.

The main function of KazHydromet is the establishment and operation of the basic observational (meteorological and hydrological and marine stations) network. One of the priorities is to forecast weather conditions which might cause inundation of obsolete oil exploration sites in the coastal areas. The marine hydrometeorological station network consists of five stations: Peshnoy Island, Igolkinski Peninsula, Kulaly Island, Fort-Shevchenko, Aktau, plus an additional nine observational points. The regular water sampling stations in use by KazHydromet are presented in Fig. 2.6.

Water samples for chemical analysis are taken regularly in six river observation points including the Ural River and some tributaries of the Volga River on the Kazakhs territory and also on 12 stations in the Northeastern part of the Caspian Sea including 2 stations at the Ural – Caspian Sea Canal (navigable). Water samples are taken from rivers and from the Caspian Sea by the Atryrau Hydrometeorological Center from April to November.

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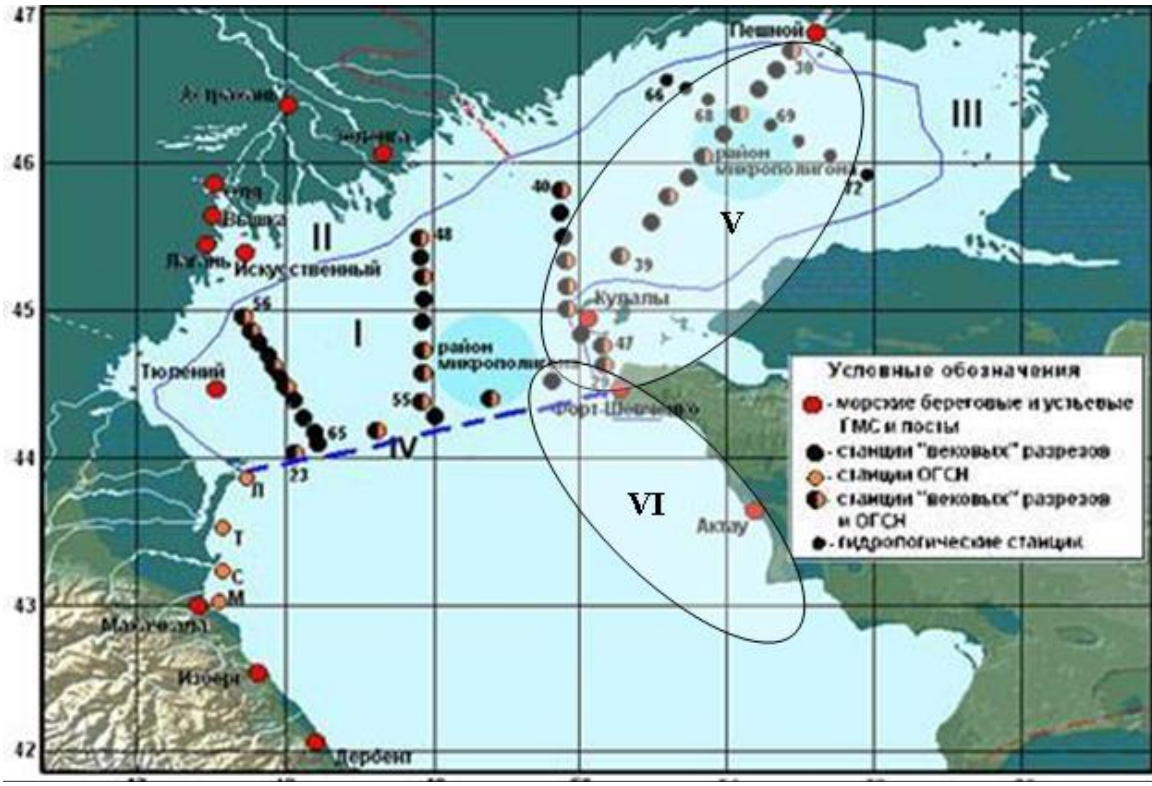

Fig. 2.6 – Observational network in the Northern part of the Caspian Sea in the Russian and Kazakhstan sectors The monitoring stations of KazHydromet are mainly situated in sectors III, V and VI

The Mangistau Regional Hydrometeorological Center is responsible for the water samples taken quarterly from the 3 following shoreline stations: Fort-Shevchenko, Fetisovo, Kalamkas, and also in the open sea following the 3 cross-sects: Mangishlak – Chechen, Kenderli-Divichi, Peschanni-Derbent. Water samples are also taken regularly from the areas of potential impact of two oil explorations: Karajanbas and Arman. Sediment samples are being taken one to two times a year, in the open sea only.

The analytical work is carried out by three main laboratories that belong to KazHydromet and are situated in Almaty, Aktau and Atyrau. The analytical labs of the regional centers in Mangistau (Aktau city) and Atyrau are considered by the Ministry as likely future partners for the Caspian Sea RWQMP. However, to become efficient partners these laboratories should extend their analytical capacities and take available analytical and sampling equipment in operation. Also, methodical support and additional training of the laboratory personnel is needed.

Analytic Laboratory of the Regional Hydrometeorological Center in Aktau

The Mangystau Center for Hydrometeorology is in Aktau city. The Center operates five marine meteorological stations, which programs include monthly sampling of the waters in the coastal zone.It also carries out special observations at the Aktau Seaport (Morport Aktau). The analytical laboratory responsible for analyses belongs to the Mangystau Hydrometeorological center of KazHydromet. This laboratory carries out regular observations on air, water and sediment contamination in the seaport and adjacent areas. The laboratory is equipped with basic analytic instruments for determining the hydro-chemical composition of sea water, oil product concentrations, phenols and metals.

Earlier, the regular observations were included into the background observation program of the center. There is an agreement between KazHydromet and RosHydromet on the continuation of these works and to take water samples at least two times per year on the cross sects (showed on Fig. 2.6) and sediment samples one time per year. However, this activity is carried out irregularly only. One of the key problems for the further development of analytic labs and their efficient participation in RWQMP is the lack of skilled personnel and analytic data procession groups.

Analytic Laboratory of the Regional Hydrometeorological Center in Atyrau

Fig.2.7 – Research Vessel «Tagibat», which belongs to the Atyrau Monitoring Centre and some desk equipment available.

The regional center in Atyrau oblast is a typical regional branch of KazHydromet. KazHydromet has the intention to establish the Caspian Sea Regional Monitoring Center with this regional center as basis. In line with this concept the Environment Protection Ministry of Kazakhstan has delivered a lot of analytic equipment; supports repairs of the laboratory premises and supports them by providing floating facilities for water and sediment sampling. However, the laboratory has not been put into operation as yet. Most part of the equipment is still kept in the storehouse of the center. Instruments include an atomic-adsorption spectrometer, modern gas chromatographs of several types, amongst which a Chromo Mass Spec Clarus-500. But to take this equipment into operation and use it in monitoring programs extensive

methodical aid and adjustment of the equipment is needed. A good monitoring program in place will facilitate this process.

A brand-new marine vessel “Tabigat” is available for the Atyrau Hydrometeorological Center. The vessel is equipped with all instruments necessary to carry out sampling in the coastal area of northern part of the Caspian Sea and in the mouth of the Ural River. There is also equipment available on the vessel to carry out first-day analysis. The vessel was ordered as an inspection motorboat to carry out air and sea pollution supervision in areas of oil and gas extracting. For that reason the lab room of the vessel was equipped with a gas analyzer, various field air and water sample collectors, a spectrophotometer along with various sampling devices including samplers for sediment coring (Fig. 2.7).

At the same time, the vessel has limited capacities for longer trips and it can operate only in shallow areas, as the hand operation winch allows sampling up to 30 m depth. There is no special compartment on the vessel for an expedition team, which prevents the effective employment of the vessel in a monitoring programme in the Caspian where a survey would last five to six days at a minimum. There is no space on the vessel for a hydrochemical laboratory, and this kind of work is supposed to be carried out on deck only.

The Regional Inspectorate and Surveillance Laboratories of the Environment Protection Ministry of Kazakhstan

Two coastal regions (oblasts) of Kazakhstan have analytic laboratories belonging to the Regional departments of the Environment Protection Ministry of Kazakhstan. The responsibilities of these laboratories are mainly inspectorate surveillance of the water quality at the sites where polluted waters discharge into the sea. They also conduct supervision observations in the areas of operating and abandoned oil extraction sites and provide regular supervision over the working of industrial enterprises. Some labs have modern equipment and instruments, but the programs of analytic measurements is limited as are the skills and experience of their staff with regard to performing measurements of a wide range of pollutants. However, there is much overlap with the tasks and sampling programs of KazHydromet. Better coordination and co-operation is needed to make better environmental assessments.

Independent analytic labs and companies involved in sea water quality monitoring

The independent analytic labs in the Republic of Kazakhstan are operating on the basis of the Ecological Code and mainly provide services to the Oil and Gas exploration companies. They also do sampling and analytical studies under «industrial ecological supervision» schemes as subcontractors. The Municipal Environment Protection laboratory in Atyrau and the labs of the Kazakhstan Agency for Applied Ecology are the most active ones on this market.

The Municipal Environment Protection Lab in Atyrau was affiliated with the Environment Department of the Akymat (Regional Government) of the Atyrau oblast. The lab was equipped with the basic analytic instruments at the expense of the Environment Protection Ministry. Due to lack of state financing the lab has entered the commercial market. Client requirements and the need to compete have stimulated the lab to arrange and organize its activities according to ISO-9000 and ISO 17 025 guidelines. As a result, the lab has transformed itself into one of best labs in the area. It has modern analytic equipment and well-trained and skilled personnel providing services for all sorts of environmental research, including water soil and sediments. The lab was contracted to conduct measurements of sediment and water samples from the project cruise in the Kazakh waters. However, lack of regular financing and the uncertainties of the market make it difficult to forecast its future performance.

Fig. 2.8 - The KAAE vessels are shipped in the Bautino Sea Port

The Kazakhstan Agency for Applied Ecology

The Kazakhstan Agency for Applied Ecology (KAAE) is a private company that studies the environmental problems in the Caspian and provides services to the oil and gas industry. The technical capacities are well-developed. It has three regional branches including ones in Aktau and Atyrau. The Agency has three well-equipped sea vessels in Bautino port (near Fort-Shevchenko).

The vessels have received national certification and are included in the marine register; and they are potentially available to carry out tasks for KazHydromet to implement monitoring programs. The project has used the vessels during its expedition in the Kazakhstan sector of the Caspian Sea in 2008.

The Agency's labs can provide as yet only analysis of the water's hydrochemical composition, measurements of biogenic substances concentration, and gross concentration of oil products. Methodical support and quality supervision in the framework of contracts with international clients e.g., AGIP or BP, are carried out by the labs of these clients.

An analysis of the monitoring system state in Kazakhstan has shown that it is needed to involve a large number of agencies of different origin. Technical equipment is in general sufficient, but a lot of the equipment has not been put into operation yet due to staff problems and lack of finance for their operation and maintenance. .

Other potential partners for RWQMP

Activities in the framework of industrial environment supervision and monitoring are usually not coordinated, even when they take place in the same part of the sea, nor subject to regulations and methodical support. There is no single uniform system of information support, data analysis or methodical center for quality guarantee programs. However, potentially this support exists through the Oil and Gas Institute in Atyrau city, the Al-Farabi State University in Almaty, etc. These organizations could contribute to a successful RWQMP implementation.

The lack of skilled and experienced personnel in the institutions, especially related to the marine domain, might be the largest obstacle. The only vessels which can assist in the RWQMP operation and implementation in open sea are the ones of the Kazakhstan Agency for Applied Ecology. The relationship between the Agency and KazHydromet, and how to make use of the potential of the Agency is the responsibility of the Environment Protection Ministry.

The problems with the creation of the National Center for the Caspian Sea Environment and Monitoring need to be solved urgently. International experts could assist the Environment Protection Ministry of the Republic of Kazakhstan in elaborating an optimal structure and work program for that

Center including further coordination of activities in the Kazakh sector of the Caspian Sea within the framework of the RWQMP.

2.3. The Russian Federation

According to the current legislation of the Russian Federation the Federal Office for Hydrometeorology and Environment Monitoring (RosHydromet) is responsible for the Caspian Sea monitoring network. This Agency also provides state services in hydrometeorology and environment monitoring.

The State Oceanographic Institution in Moscow is the main institution to provide methodical support to the operational network of hydrometeorology and marine water quality monitoring studies in Russia. This Institute has elaborated the national water quality monitoring program for the Russian sector of the Caspian Sea, with monitoring activities to be carried out by the regional subdivisions and other institutions of RosHydromet. However, this program has not yet been approved by the RosHydromet Authority and its implementation has not yet started.

The analysis of observation data on meteorological, hydrological and hydrochemical conditions and contamination of the northern part of the Caspian Sea is the main activity of the Caspian Marine Research Center in Astrakhan. This Center was established in 1995 as a part of RosHydromet. The main responsibility of the Center is to provide methodical support to activities of operating agencies including the weather (hydrometeorology) and environment monitoring centers in Astrakhan, Dagestan and Kalmykia.

Annual Reports on the conditions of marine pollution in the Russian Federation are published in the “Annual Bulletin on Marine Water Quality in Hydrochemical Characterization». The Bulletin «Annual Publication» is also available on the State Oceanography Institution’s web-site. The web-bulletin of the Caspian Marine Research Center is updated weekly.

The leading institutions of the Academy of Sciences of the Russian Federation are engaged in various issues concerning the environment conditions of the Caspian Sea, including monitoring issues. Among them are the following: the P.Shirshov Oceanology Institution, Institute of Water Problems of the Academy of Sciences of the Russian Federation, and their regional branches. The Astrakhan Branch of the All-Russian Fishery and Oceanography Institute, and regional institutions of the Rostekhnadzor (Technical and Industrial Supervision), as well as the regional inspections of the Natural Resources Ministry of the Russian Federation are also engaged in studying the Caspian Sea problems.

Many NGOs in the Russian Federation are engaged in marine environment issues. They carry out independent assessments and large projects with enterprises contaminating the marine environment, especially with oil companies. Many of them have participated in the Caspian environment program between 1998 and 2007.

Pollution monitoring in areas of oil-extraction are carried out by oil-extracting companies as well. «LUKOIL» works in close cooperation with the Caspian Marine Research Center in Astrakhan.

Thus, the potential of the institutions is the highest among the Caspian countries. The number of the specialized agencies and institutions along with personnel is quite sufficient.

At the same time, the activities of all these agencies and institutions offices are not framed by a single uniform inter-departmental and approved monitoring program, including arrangements for data exchange, improved methodical support and a system of quality control. The poor technical basis of the regional analytic labs is a limiting factor.

Existing Water Quality Monitoring Programs

The concept of the national marine environment monitoring system for the Caspian Sea has been elaborated by the State Oceanographic Institute (SOI), and it defines the following tasks for monitoring activities:

- The assessment of hydrochemical parameter modes including fluctuation trends in oxygen and nutrient concentrations in the Northern and Central parts of the Caspian Sea;
- The assessment of the current conditions and long term trends in pollution caused by oil-products, phenols, and synthetic floating contaminants;
- The assessment of the current state and long term trends in sediment pollution caused by oil-products, pesticides, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and toxic metals.

These priorities have a conceptual nature thus far, since observations are more or less regularly carried out only for the hydro-chemical regime of the sea, nutrients substances in the water, total petroleum hydrocarbons, phenols, and some other ingredients. A comprehensive system analysis of the persistent organic compounds in water and sediments is not carried out yet. Estimates are the results of international expeditions.

The location of observation areas in the Russian sector of the Caspian Sea is pictured in Fig. 2.9.

Main areas of observation at the Russian Sector of the Caspian Sea

1. Transboundary area at the Russia-Kazakhstan border.
2. The Volga River Delta, and area of the main impact.
3. The area of the Terek River
4. Area of Makhachkala city and its sea port
5. Area of Derbent city impact, Samur River and transboundary monitoring along the Russia and Azerbaijan border.
6. Station for background observation

Fig. 2.9 – Location of the observation areas over the marine water quality monitoring at the Russian Sector of the Caspian Sea.

The Regional Hydrometeorological Center in Dagestan is the principal executors of the basic activities under the routine water quality monitoring programs of RosHydromet in the Caspian Sea. The Dagestan center uses two vessels that regularly undertake monitoring activities, mainly in the framework of commercial contracts. The vessels have basic rigging equipment (winches, bathometers), rooms for primary processing and storage of samples. However these vessels don't have modern oceanographic equipment and instruments, and multi-parametric probe-bathometers.

The “Neptun” mainly operates in the coastal area and has limited navigability (seaworthiness) capacities. The “Tantal” vessel has stationary equipment and electric winches by means of which samples of water and bottom sediments may be taken from the depths more than 1000 m. The oceanographic equipment aboard the vessel consists of the Rotan probe for conducting temperature and water salinity measurements in depths up to 100 m, and the deep-water Teflon bathometers with volume of 10 and 5 l.

Until 2009 there was no experience in Dagestan GMC in sediment sampling and analytical studies. There is a big sample-collector on board of the “Tantal” vessel, which was used for taking samples in deep-water sea areas in spring 2009 during the project’s expedition. Project experts advised on the sample-collector operation. Samples were taken and dispatched to the labs of SPA (scientific and production association) “Typhoon” for appropriate measurements.

a) b)

Fig. 2.10 - The “Tantal” research vessel, which belongs to the Dagestan hydrometeorological center in open sea (a) and the “Neptun” vessel on lease (b) to take samples in the shallow area of the northern part of the Caspian Sea, and in the mouth of the Volga River.

The Environment Chemistry Center of the SPA “Typhoon” is a basic analytic laboratory, which can carry out all sorts of analytic measurements at a high quality level. At present the Center is a leading analytical body of RosHyddromet in analytic support for the monitoring programs on hazardous pollutants getting into environment. The Center was formed and established to provide analytic support in emergency toxic environment situations in the Russian Federation, which explains the equipment and skills they have. This allows this Center to provide analytic measurements on a wide range of pollutants in all elements of the environment. The highly qualified experts, who work in the Center for Environmental Chemistry, can provide training programs for personnel from the labs in the network of the Caspian Sea.

The quality of measurements is annually certified through participation in comprehensive test programs (international and national inter-laboratory cross-check programs) which are held jointly with the leading analytic laboratories from the USA, Canada and Western Europe.

Due to this, the project selected the Center to become one of the reference laboratories for preliminary characterization of reference samples under the project’s proficiency test exercise in 2008. The project also proposes to use the potential of this Center to become the principal regional laboratory that can liaise with other qualified labs in the area (e.g., “AzEcolab” in Azerbaijan) and that can lead the introduction of the regional program on quality assurance and quality control that would be needed in the frame of a Caspian Sea water quality monitoring program.

2.4. The Republic of Turkmenistan

The Environmental Protection Ministry of Turkmenistan has appointed “Caspecocontrol” as the principal national institution for implementation of a future Regional Caspian Sea Water Quality Monitoring Program.

The main tasks for “Caspecocontrol” related to monitoring and environment supervision are as follows:

- Compliance monitoring on waste water discharges into the sea
- Assessment of pollution sources in coastal areas and in the open sea, hydro-chemical assessments, and reporting about the state of the marine environment along the Turkmen bay.
- Environmental impact assessment of project proposals which may cause pollution of the Caspian sea and lead to harmful impacts on the marine environment.

These tasks are primarily inspectorate tasks. The development of a water quality monitoring program for this agency is in its initial stages. Effective implementation of a water quality monitoring priorities will require the availability of a well functioning analytic laboratory.

The Caspecocontrol laboratory carries out a limited number of measurements on marine environment samples; indicators of hydrochemical composition, nutrient concentrations (nitrates, nitrites, total nitrogen, phosphates, total phosphorus) and total concentration of oil products. No practice exists with the analysis of sediment samples.

Under a parallel TACIS project (EuropeAid/122682/C/SUP/MULTI) additional equipment was delivered to Caspecocontrol. The equipment will considerably strengthen the capacities for taking water and sediment samples, and analytic measurements of pollutants. The equipment included a gas chromatograph to identify organic pollutants, an atomic adsorption spectrometer for metals identification, a set of standards and chemical reagents, auxiliary laboratory equipment, probes for defining physicochemical features and other equipment for activities on vessels and in the laboratory. It significantly extends the laboratories analytical capacity to implement a RWQMP. However, lack of qualified analysts and technicians trained to operate with this modern equipment is a significant constraint. The new equipment for sampling and in-situ measurements may be efficiently applied when a specific vessel for monitoring purposes will be procured or rented.

At present, Caspecocontrol carries out regular observations in the Caspian Sea mainly in the costal as a part of their inspectorate supervision, including the coastal area along Turkmenbashi with special attention to the waste waters discharged by the Turkmenbashi oil refinery, heating plant, and municipal waste water collectors, and in coastal zone around the Avaza resort. Monitoring in the open sea takes place occasionally, and in consultation with oil and gas companies as Dragon Oil.

3. THE RESULTS OF INTER-LABORATORY CALIBRATION TEST

3.1. The method

One of the activities under this project was to make an assessment of the capabilities of laboratories to carry out qualitative measurements of water and sediment samples as an important condition for an effective implementation of the proposed RWQMP for the Caspian Sea. The method was proposed by experts from Center for Monitoring Studies and Environment Technologies (Ukraine), using sediment materials that remained after the completion of the IAEA survey in 2006. The work was done under the supervision of the Monaco IAEA Marine Ecology Laboratory (MEL).

The samples were homogenized and prepared as reference materials according with methodical assistance from MEL experts, who have considerable experience in arranging proficiency testing programs between marine analytic laboratories across the world.

In line with the criteria agreed with MEL the following reference laboratories were selected:

- The Centre for Monitoring Studies and Environmental Technologies (CMSET) Kiev (Ukraine) in co-operation with the analytical laboratories of Ukrainian Hydro-meteorological Institute (UHMI) (sample preparation, homogenization, and arrangement of the PT activities)
- The Ukrainian Centre for Marine Ecology (UkrCME) Odessa (Ukraine), which previously acted as a Thematic Regional Activity Centre in the framework of BSEP and BSERP. UCME has significant experience in studying trace elements and organic pollutants in the marine environments.
- The Centre for Environment Chemistry from the Scientific Industrial Association “Typhoon” (SIA “Typhoon”), Obninsk (Russian Federation) a subsidiary of the State Hydro-meteorological Committee of the Russian Federation.
- IAEA Marine Environment Laboratories (MEL**),** Monaco, which is one of the most experienced and equipped analytical centres in the world, and which has substantial experience in organizing proficiency testing among the marine environment laboratories over the world.

Each reference laboratory obtained one set of bottled reference samples similar to those that were distributed amongst the test laboratories in the Caspian states, with clear instructions on how to perform and report the results. Internal quality control of the analytical process were obliged for these laboratories, using certified reference materials (IAEA-433, IAEA-444) prepared by MEL.

Participants were requested to determine by their routine procedures as many trace elements as possible out of the following elements: (Al, As, Cd, Co, Cr, Cu, Fe, Hg, Li, Mn, Ni, Pb, V, Zn) and also organic pollutants with an oil origin (chlorinated, aliphatic, aromatic and petroleum hydrocarbons), and chlorinated pesticides, which were widely used in some parts of the Caspian basin.

3.2. Evaluation of the results

The performance of the analytical capacities for trace elements measurements in the respective laboratories of the region was demonstrated by their Z-scores, which were calculated based on the accuracy of reported results compared to established reference (recommended) target values. The ability of the laboratories to provide analytic measurements of organic components in the reference samples

was simply demonstrated by the very limited number of reported elements by the participating laboratories in comparison with the recommended values as averaged results of reference laboratories and assigned uncertainty values for each measured elements of the organic pollutants.

All results were treated strictly confidential, and each laboratory was identified with a code to guarantee anonymity. The data sets reported by the laboratories and the technical and statistical evaluations of the results for each element can be found below.

The conclusion about the analytical capacities of the tested laboratories has been prepared and could be considered a basis for plans to improve the analytical capacities of the Caspian Sea monitoring institutions. The results were discussed during a workshop in Atyrau, where participants agreed to open the coding and discuss results with a view to future improvements.

In total nine laboratories took part in the test. However, only several laboratories submitted complete reports on the trace elements, allowing qualified analysis and assessment of the obtained procedures and results. The organic pollutants measurement results of the standard samples were submitted by only several labs, and on a limited number of the proposed test parameters No laboratory performed measurements for naturally occurring concentrations in the sea sediments.

3.2.1. Metals

The summarized results of the inter-comparison exercise are shown in Table 3.1. These data demonstrates the correspondence of the measured values of the trace elements presented by the tested laboratories in comparison with recommended target values and their uncertainties. The results, which are marked in blue and presented for all elements are just two and several more accepted laboratory means exist. Results that have not been validated by appropriate quality control (i.e., no reference material results reported) are not marked or indicated as missing data in Table 3.1.

The data in Table 3.2 provide the detailed scoring in determining trace elements determination for each element and each particular laboratory. The relative bias for each measured element and Z-score values are given as well and it demonstrates the laboratory performance on criteria as “satisfactory”, “questionable” or “unsatisfactory”.

According to the Z-score criteria described in (CMSET,2008) the data for many of the elements may be sufficiently well grouped to permit provisional measurements of the marine sediment samples to be collected during further regional monitoring studies.

The laboratories related to groups 1 and 2 got an acceptable quality rate. With some training and advice to such laboratories, rather good results with acceptable quality can be achieved. The laboratories in group 3 are in need of training their personnel. Such labs have got the adequate equipment but don’t use them effectively due to lack of qualified personnel and the necessary level of supplies. The labs in group 4 failed on all indicators. They are in urgent need of being (re-)equipped, trained and reorganization and rearrangement of their analytic measurements processes.

Таблица 3.1. Comparison between measurement results submitted by the analytic labs from the Caspian area, and recommended values of metals concentration in a standard sample being supplied for the test

Laboratory code No.	Al	As	Cd	Co	Cr	Cu	Fe	Hg	Li	Mn	Ni	Pb	V	Zn
2					0,023	2,05	13,1			3,49	2,31	< 0,005		1,73
					0,01	0,04	0,2			0,15	0,07			0,1
4			0,05	11,1		21,9	33181			391	30,4	53		119
			0,002	0,33		2,23	762			14,2	1,01	5,28		9,6
5	73646	22,6	0,21	18,9	105	65	46520	0,15	50,3	986	66,2	16,9	114	91,7
	475	0,46	0,01	0,39	2,32	1,82	416	0,01	0,39	7,37	0,72	0,46	2,44	0,72
7	75900	17,6	1,2	19,4	85,2	58,2	42300	<0,05	47,5	1043	78,3	17,1	153	89,7
	900	2,1	1,2	0,6	10	6,3	300		4,8	19	1	2,7	8,2	2,2
8*						1,6					5,1	0,4		
						-					-	-		
9			<1,0			40,0		0,055				21,3		71,1
						0,16		0,002				0,78		0,57
13	-	-	0,12	2,38	7,03	19,1	30235	0,034		962	56,5	70,3		104
			0,01	0,25	0,20	0,66	156	0,003		14	1.2	3,1		2,8
14	15600	4,56	3,1		37	51,3	26300	0,036	52	86,7	62	21	41,7	83
	700	0,21	0,1		1,73	2,52	360	0,003	3	4,04	2,64	2	2,52	2
Recommended target value for evaluation	**72040**	**13,8**	**0,19**	**17,7**	**106**	**57,9**	**39350**	**0,04**	**46,6**	**980**	**73,2**	**18,4**	**138**	**97,2**
Recommended uncertainty , Standard deviation	**1474**	**2,18**	**0,005**	**2,8**	**11,8**	**5,57**	**3261**	**0,005**	**7,2**	**53,1**	**5,76**	**1,46**	**17,1**	**8,65**

Only 3 laboratories in the Caspian region - Laboratories № 5 (AzEcolab), № 7 (Turkmengeology) and № 9 (Municipal lab in Aktau city) fall in the first or second group with regards to the measurements of metals in sediments. They can be considered as key analytical laboratories for further development of the regional analytical capacities within a Caspian Sea Monitoring Programs. These laboratories also may serve as the institutions where staff of other national analytical laboratories could be trained under supervision of experienced analysts. Two laboratories can be allocated in group 3. These laboratories have enough analytical capacities to provide sufficient number of measurements. Most probably laboratories № 13 and № 14 (both of them belong to RosHydromet) have a lack of calibration sources and require more methodical support and training for their staff.

Table 3.1. Overall assessment of the performance of the laboratories: Group Classification

Laboratory Code	$\|Z\|<3$, number of results	%	$2<\|Z\|<3$, number of results	Total number of results	Group
2	0	0	0	7	4
4	2	25	1	8	4
5	12	86	0	14	2
7	12	92	1	13	1
8	0	0	0	3	4
9	4	80	3	5	3 (2 *)
13	5	50	0	10	3
14	7	54	1	13	3

***)** Laboratory № 9 successfully passed the 75% limit for acceptance of the analytical results. However, this laboratory did not present results of all recommend analyses.

The rest of laboratories were placed in group 4. They need significant improvement of their technical analytical capacities, and also training in basic and specific knowledge of laboratory staff.

Among the laboratories in category 4, two laboratories (№2 and №8) failed to conduct the measurements because they didn't have the appropriate analytical equipment. Laboratory № 4, № 9 and № 13 were not able to provide measurements in more than 50 % tested elements (metals), mainly due to the lack of experience and lack of reliable calibration. Methods of measuring metals such as Cr (chromium), Cu (cupper), Cd (cadmium), V (vanadium) were the most problematic for laboratories in groups 2 and 3.

This part of the proficiency test shows that only laboratories, which have implemented for their daily analytical practice QA/QC programs, have passed the test This fact demonstrates the importance and need for the development and application of quality control and quality assurance programs in all laboratories to be involved in a Caspian Sea Water Quality Monitoring Program.

Laboratories with erroneous results should carefully check their procedures. Erroneous calibration standards may be a source of bias. For instance, it is important to note that losses can occur in low-concentration working standard solutions, which would result in overestimates of the concentrations of elements in the samples.

In addition to the Tables 3.1 and 3.2, the distribution of laboratory means for some selected elements is illustrated graphically in Figure 3.1. The laboratory means are plotted in ascending concentration on the y-axis with their corresponding laboratory code noted along the x-axis. Error bars represent laboratory means ±1 standard deviation. The horizontal lines on the figures indicate the confidential limits representing ±2 standard deviation of the calculated mean value such as described in (CMSET,2008).

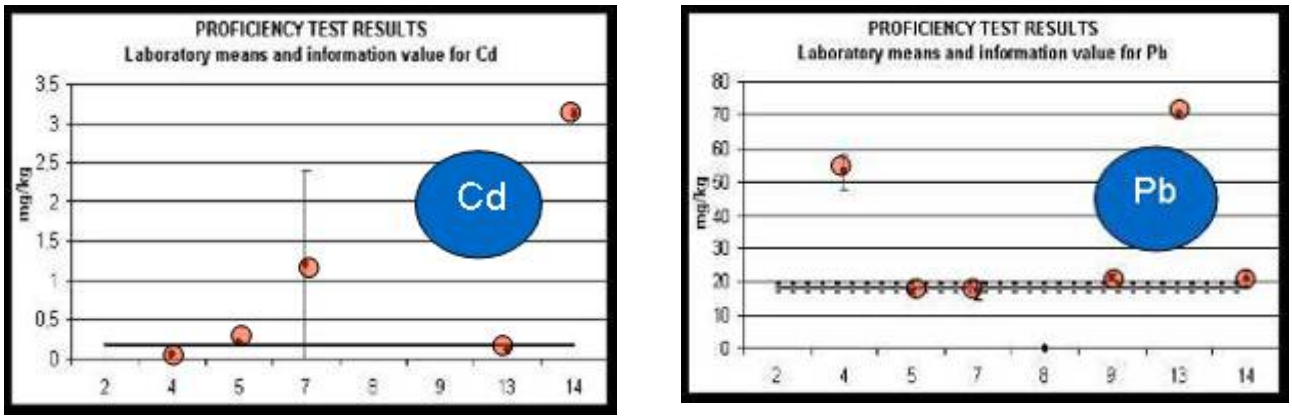

Fig. 3.2 – The outcome of comparison of the results of the metals measurements in the standard samples carried out in the labs of the Caspian area, and the confidentiality interval of the recommended values. The labs numbers are shown along the axes of the abscissas.

3.2.2. Organic Pollutions

The evaluation results show that none of the laboratories has submitted a full set of organic pollutants recommended for analytical measurements in sediment (Attachment 2), including POPs (persistent organic pollutants). Laboratory №5 (AzEcolab presented the most complete set of measured parameters on aliphatic and polycyclic carbohydrates. Some organic pollutants, summarized carbohydrates and pesticides, were submitted in the results of laboratories №13 and №14 (RosHydromet monitoring Laboratories from Astrakhan and S-Petersburg). Acceptable quality in content measurements of chlorine organic pesticides and several PCB was found in the results of laboratory №14. The rest of the laboratories either did not submit any result, or did not meet acceptable quality results.

In general. the results of testing the entities of regional monitoring have shown that only the laboratory № 5 in the region and in some respect laboratory №14 are eligible to be involved in chemical and analytical measurement in order to determine the contents of organic pollutants in bottom sediments of the Caspian Sea.

The poor analytical capacity of laboratories to provide sufficient analyses of most organic contaminants in the marine environment should become a main focus of technical assistance.

3.3. Conclusions and Recommendations

The Proficiency test show that laboratories in the Caspian Sea states still have serious problems with their analytical capacities, and in particular with their abilities to carry out qualified measurements on the contents of contaminating substances found in the marine environment.

None of the participating laboratories that submitted results of analytical determination covered the complete composition of contaminants (metals, organic pollutants, radionuclides). The most completed list of high quality measurements related to trace elements and the majority of organic substances in the reference samples was submitted only by laboratory № 5 (Azerbaijan).

Only three laboratories passed the test for the determination of trace elements in sediments with good results. The results of trace element measurements conducted by laboratories № 9, № 13 and № 14 could be accepted for a limited number of elements. The other laboratories were not able to pass the proficiency test for analytical laboratories. This should raise serious concern with the respective Environment Authorities, as it indicates the need for the development of specific programs on technical assistance, training and fellowship for the personnel of these laboratories.

As shown by the test only three laboratories (№5) and partly №13 and №14 are capable to conduct measurements of total content of carbohydrates and some other organics in sediments. In the case of aliphatic hydrocarbons only laboratory №5 presented an almost full list of quality measurements, and laboratory №14 provided a compliant measurement of chlorine-organic pesticides. This means that only these laboratories could be involved in the chemical analytical measurements on organic pollutants in sediments.

Laboratory № 9 was found potentially capable of providing measurements on organic pollutants, taking into account the relevant experience of this laboratory and the satisfactory results obtained in the other testing programs (i.e. participation in AGIP). At the same time, laboratory № 9 failed to conduct analytical measurements on organic pollutants in a reference sample because a gas-chromatographer was not available due to maintenance.

None of these laboratories (except one figure from laboratory №14) provided a compliant quality measurement result on poly-chlorines biphenyl's (PCBs) in spite of the perfect amount of PCBs available for reliable analysis in a reference sample.

Only laboratories №5 and №9 are certificated in accordance with ISO 9001 (17025). The quality assurance and quality control programs (QA/QC) for analytical measurements are only implemented in these regional laboratories. Other laboratories remain unconcerned or do not have daily quality assurance programs in operation.

The main problem is the lack of professional qualification and skills to carry out preparation and measurement of organic pollutants using gas chromatography.

Recommendations for the laboratories to improve the quality of analytical chemical measurements include the following:

1. Develop training programs for laboratory staff on procedures for analyses of water and sediment samples with the use of atomic absorption, and gas-chromatography techniques. These trainings may be carried out in experienced laboratories in the Caspian Sea region (i.e. laboratory №5). It is also recommended to arrange for internships in the Center for Environmental Chemistry SPA "Typhoon" or the Ukrainian Centre for Marine Ecology (Odessa, Ukraine) .
2. It is recommended to establish at least one reference laboratory in each country with well equipped capacities and a well organized management system.
3. It is necessary to provide a wide set of calibration standards and certified reference materials (including calibration sources and standard solutions of sea water) to all laboratories participating in the Caspian Sea monitoring programs.
4. The issue of staff training along with the preparation of highly skilled experts for the labs that might play a part in a RWQMP must become a priority for national and international programs in the years to come.
5. The laboratories proposed by the Governments of Caspian region should also receive more technical and financial support from their own states.

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4. THE MARINE EXPEDITIONS

4.1. The four sampling surveys

Four marine expeditions were planned and carried out in 2008 – 2009, one in each of the four participating countries and thereby covering all national sectors apart from Iran. All cruises were carried out by organisation and experts from countries, with support form international staff. The cruise programmes were discussed and finally agreed during the project workshop, which was held in July 2008 in Atyrau.

The following were the main objectives of these cruises:

- to assess the capacities of the countries to independently plan and carry out comprehensive monitoring activities in marine zones of impact of both land based sources of pollution and open-sea based;
- to assess technical capacities of the monitoring agencies and analytic labs of the countries to implement regional marine water quality monitoring programs, and to assess the needs for further support to enable them to participate in a regional water quality monitoring program;
- to assess the equipment and modern monitoring instruments, and to employ the equipment supplied in the framework of the parallel TACIS supply contract;
- to study and investigate the particularities and trends (characteristics) of the marine environment pollution as a reference for future surveys;
- to train experts to develop expedition programs, to operate hydrological equipment and instruments to take samples, and to prepare, analyse and report on samples.

The project experts familiarized themselves with the vessels and regular equipment, consulted national experts, developed cruise programs and discussed problems, priorities and working methods during a regional workshop in Atyrau on 9 and 10 July 2008.

The expeditions were carried out during autumn 2008 for Kazakhstan, Azerbaijan, and Turkmenistan. The two Russian legs were carried out in spring 2009. Project experts took part in all expeditions.

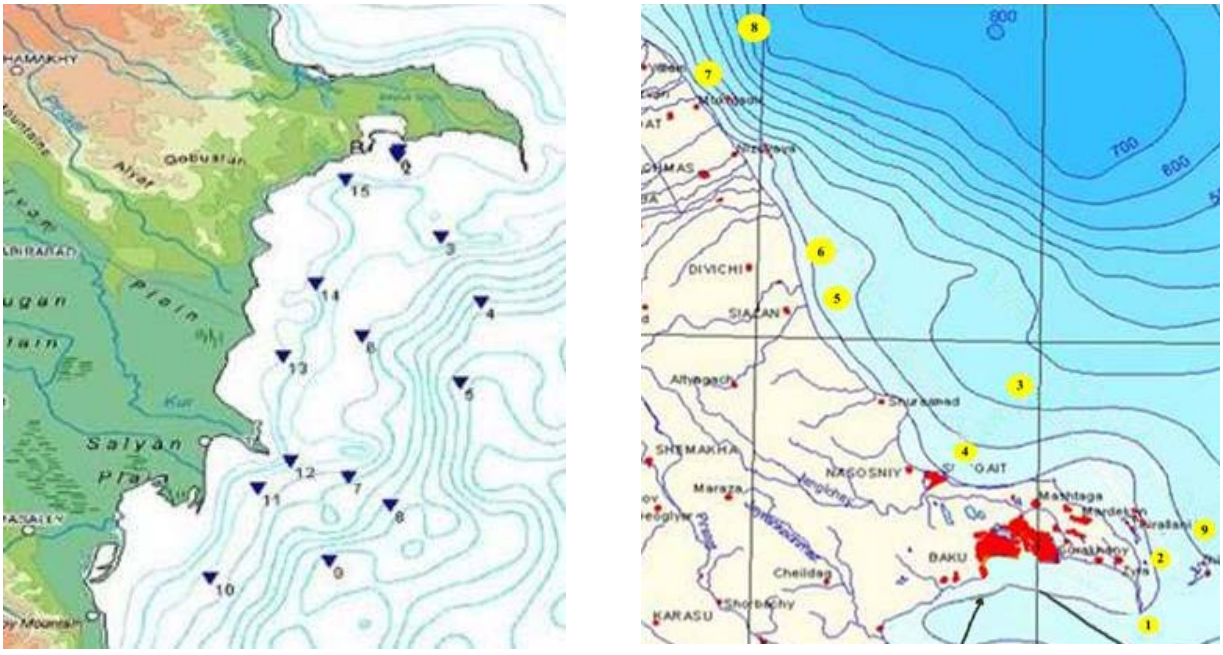
The water and bottom sediment samples taken during the Cruises were analyzed in the national laboratories, which were selected on the results of the intercalibration test. The quality of the analytical measurements and reports can be compared with the results of the proficiency tests, and therefore not all samples and data have been analyzed adequately yet. The most completed set of requested sample analyses were carried out by “AzEcokab” and SIA “Typhoon” laboratories. TPH and trace metals concentrations have been presented more or less satisfactory by all laboratories while organic pollutants have been analyzed for samples taken along southern part of Azerbaijan Coast and for samples taken in Russian sector of the Caspian Sea. The final reports on expedition results were compiled in the countries and available at the “CaspianMap” project web-site.

4.1.1. Azerbaijan

Cruises were carried out by staff from the Comprehensive Caspian Environment Monitoring Department in two stages. The first stage was implemented in the southern part of the Azeri sector between 10 and 17 November 2008 with the participation of project experts to instruct and train staff. The second stage in the northern part was carried out independently by Department staff between 25 November and 2 December 2008. The expeditions were carried out on the research vessel "Alif Gajiev" using its regular equipment and special equipment delivered by the experts. The sample-taking program was worked out by TACIS experts and staff.

Sediments and surface water were chosen as the principal object of investigations for a broad range of pollutants. During the expedition training on sample taking and preparation was provided.

The analytic measurements of the samples taken during the first stage were carried out in AzEcolab. The analytic measurements of the samples taken during the second stage were carried out in the laboratories of CCEMA and partly in AzEcolab. Fig 4.1 show the sampling points.



a b

Fig. 4.1- Location of sample-taking stations in the southern (a) and northern (б) sectors of Azerbaijan.

The total number of sample-taking stations in the southern sector was 15. During the expedition in the northern sector 9 sediment samples and 20 water samples up to 30 m deep were taken. Hydro-meteorological conditions and sea water physical-chemical characteristics were measured in each station (temperature, electric conductivity, oxygen concentration, etc.). The measurements were carried out on board of the vessel. Also the primary measurements of biogenic concentrations in water took place on board. Then the samples were preserved, properly packed and stored in coolers (water) or freezing chambers (15^0C below zero).

The shallow area sediments and continental decline of silt sand nature were taken up by a regular big dredging machine of Wan-Win Design (Tom Karr, USA). One section of the dredging machine was always left open to prevent sediment washing out during uplifting.

Additional sampling of soft silts was done using a DTSh-3 small columnar sample collector with 30 cm metal tube that was delivered to the vessel by project experts. Using these instruments and electrical winches allowed sample taking from 30 to 650 m deep. Particular attention was paid to the sedimentation area of suspended solids coming from the Kura River which have a relative high rate of pollution caused by pesticides and other kinds of organic pollutants, and also to sediments in Baku Bay and samples in the area of oil extraction facilities and the Sumgait impact areas.

Fig. 4.2 – Sampling procedure. Taking up sediment samples using the Wan-Win and the DTSh-3 small corer

All water and sediment samples were properly packed. Collection and storage conditions were written down and registered in the expedition field journal. The samples were packed and kept in storage in accordance with national standards and CEP recommendations (2008).

The outcome of the expedition is presented in detail in the field report of the Comprehensive Caspian Environment Monitoring Department. Analysis of obtained data and their further interpretation will be continued by local experts. Below are some preliminary conclusions:

The water samples did not show high metal or organic pollutant concentrations. High levels of oil product and phenol concentrations were found in the samples from Baku Bay and the coastal area of Sumgait.

The main focus was on sediments. Results are grouped by areas of sedimentation in accordance with depths and hydrodynamic conditions. Concentrations of metals and oil products were found in the Baku Bay sediments. In particular arsenic concentrations were high compared to natural levels in soil in all stations. It could be connected to natural factors as volcanic activity peculiar to the area from which the sediments originate. Nevertheless in all cases its concentration was less then the Netherlands' recommended average safety limit of 70 mg kg^{-1} and the admissible Concentration Limit Value of 30 mg kg^{-1}.

Concentrations of pollutants in sediments stand out in samples from the area of the Shirvand sewage canal (St5), the sedimentation area of the Kura River and from Baku Bay. High rates of chromium, copper and other metals were also observed in these samples. No high concentrations of cadmium were found compared to natural background levels. High concentrations of cadmium were only observed in the area of Baku. The data on the chart are grouped by distinctive areas of pollution in sediments as shown in Fig. 4.3 -4.6.

It has to be noted that at present only part of the samples have been analyzed, i.e. those that were analyzed in Azecolab. The results of measurements of the Comprehensive Caspian Environment Department (Department) for the northern sector have been completed only for a very limited set of parameters. The measurements are supposed to be completed in cooperation with AzEcolab.

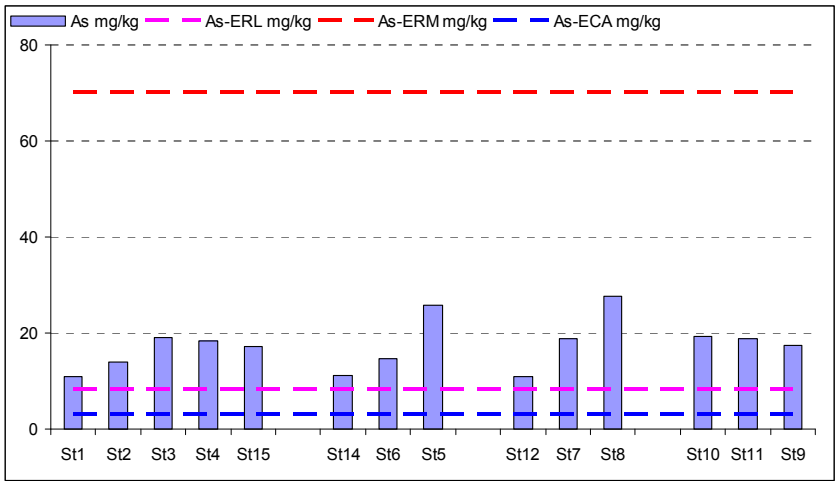
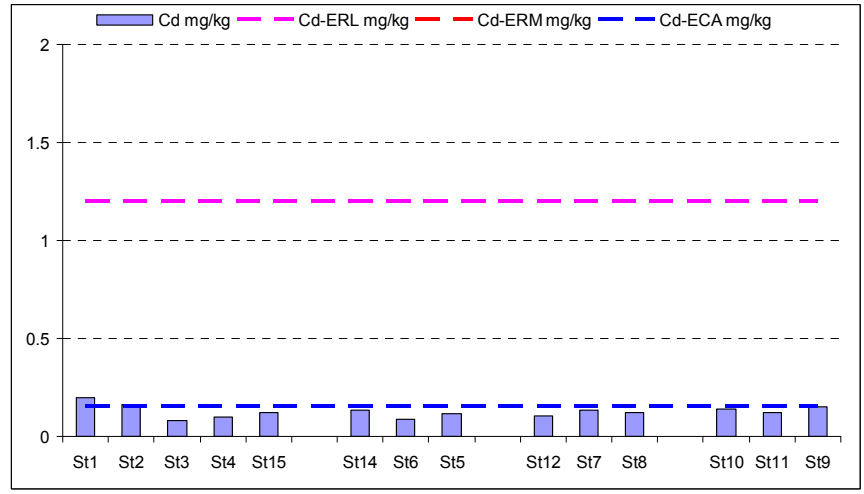
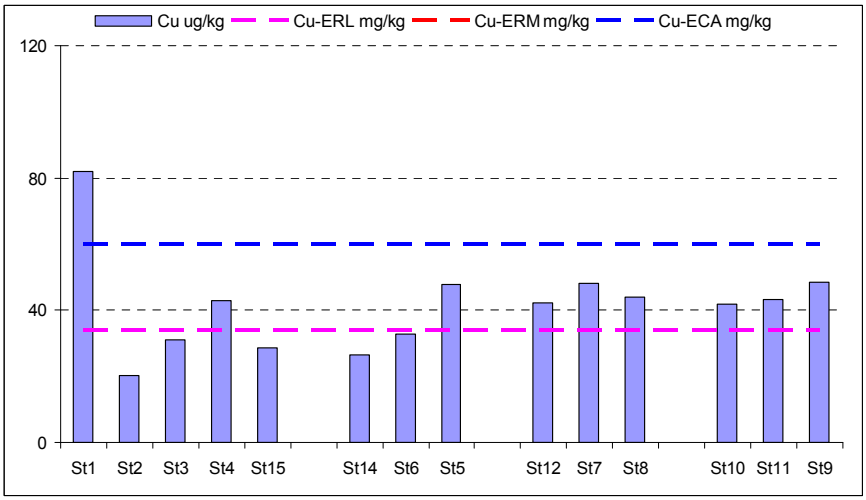


Fig. 4.3. - Arsenic concentration (As) in sediments from the southern part of the Azerbaijan sector.





The experience of the expeditions in the Azerbaijan sector of the Caspian Sea on vessels of the Department shows that comprehensive monitoring activities, as required under a Regional Water Quality Monitoring Programme, can be implemented successfully in cooperation with leading analytic labs of Azerbaijan (AzEcolab in particular).

The results show that Azerbaijan has all needed capacities to effectively carry out marine monitoring: vessels, technical support for monitoring and sampling, analytic labs with skilled personnel, and resources. Active participation in a TWQMP will facilitate the upgrading of the efficiency of the Department in monitoring activities

Fig. 4.4 – Concentration of Cd (upper) and Cu (below) in sediments in the southern part of the Azerbaijan sector.

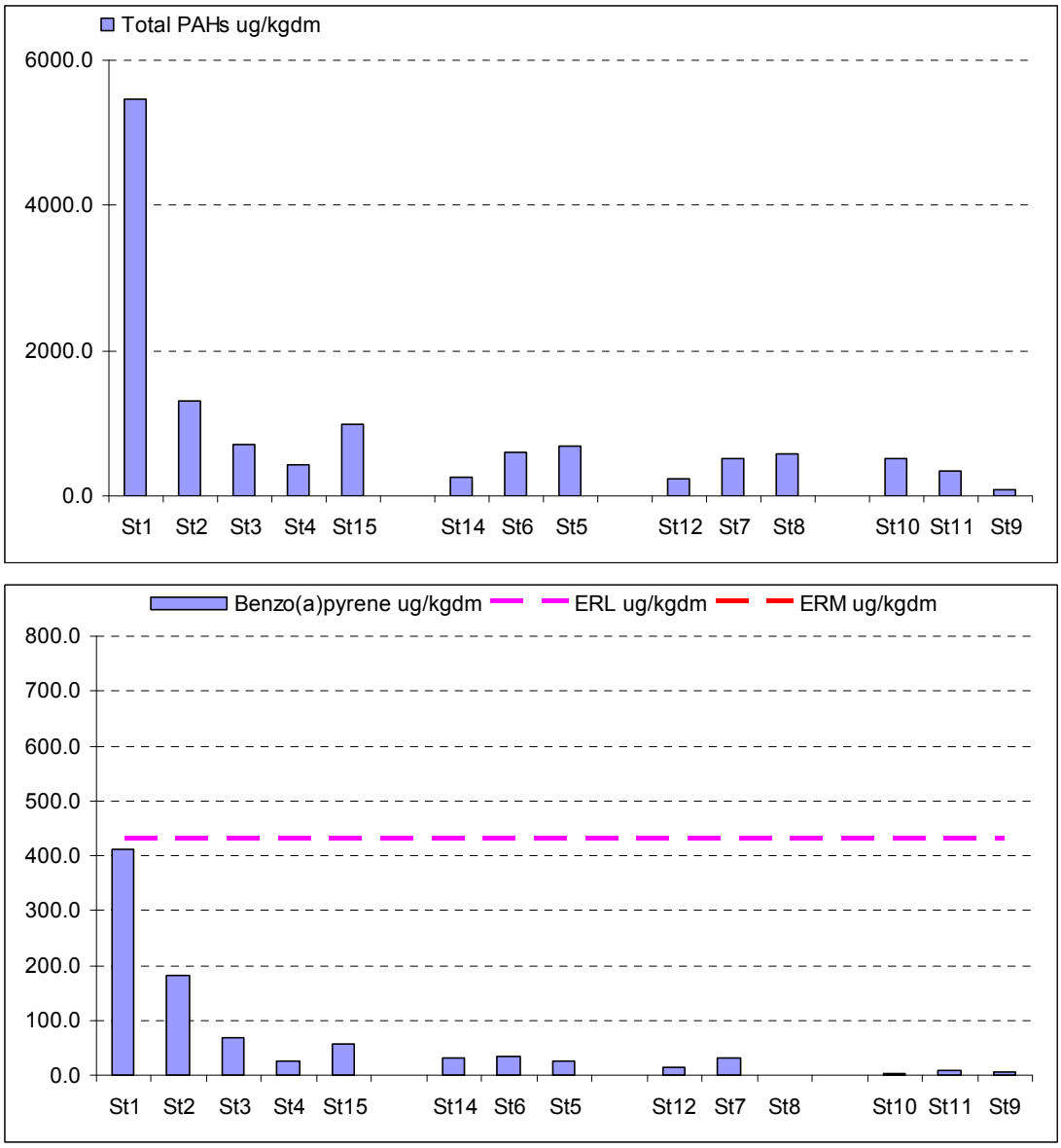


Fig. 4.5 – Concentration of total polycyclic aromatic hydrocarbons (upper) and benzo(a)pyrene in sediments in the southern part of the Azerbaijan sector

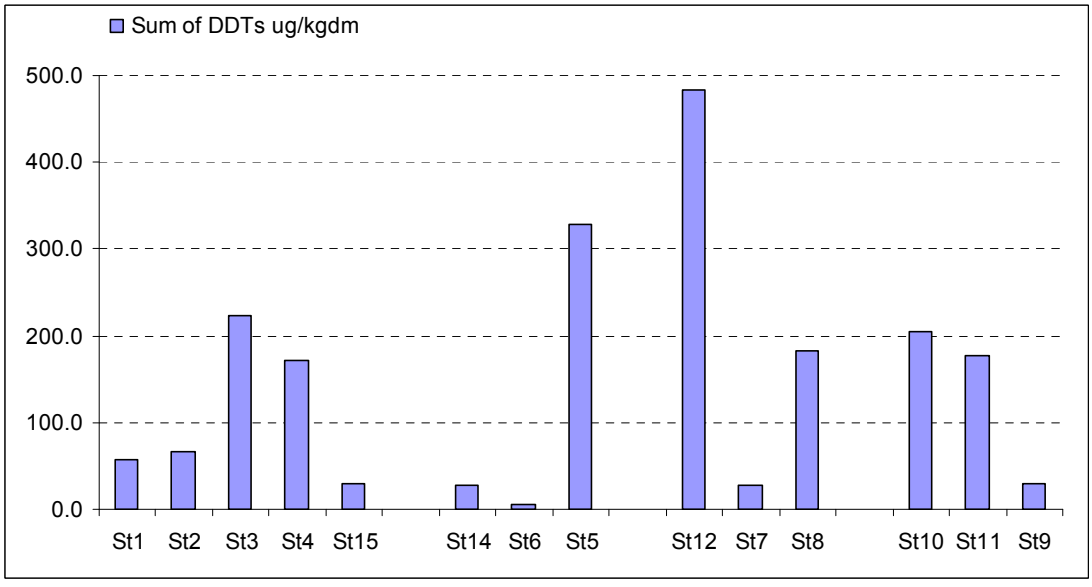


Fig. 4.6. Concentration of total DDTs in sediments of the southern part of the Azerbaijan sector.

4.1.2. Kazakhstan

The Kazakh cruise covers the north-eastern part of the Caspian Sea, including the cross-sects described in Fig. 2.6. at the sea ports of Aktau and Bautino and also near Ural River delta.

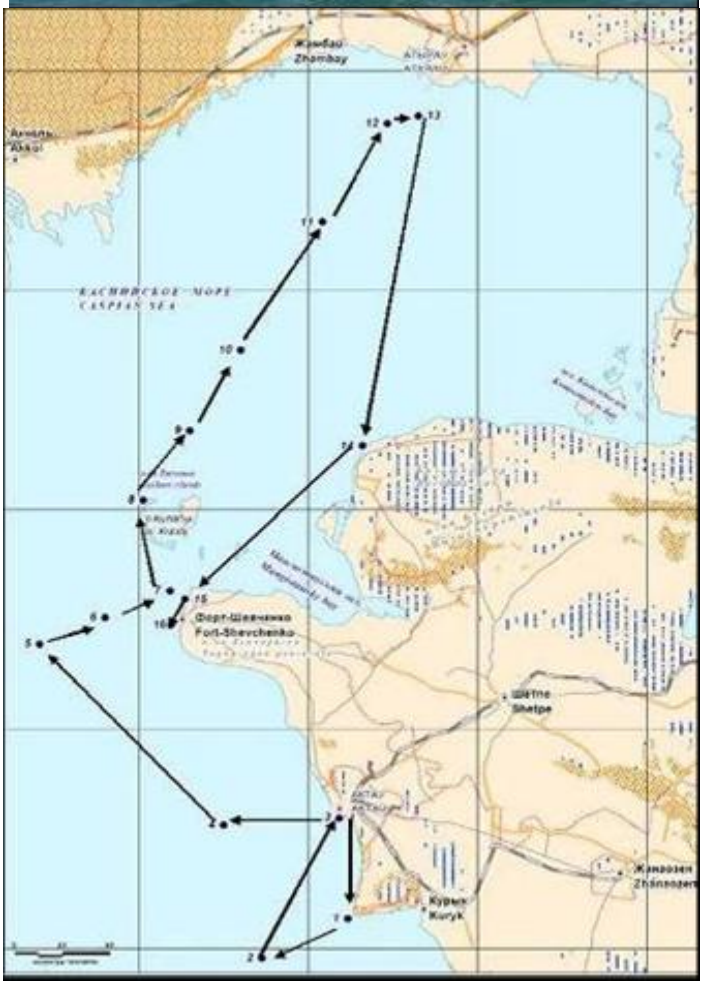


Fig.4.7 - Cruise track during expedition in Kazakh sector of the Caspian Sea carried out on the Vessel “Elen” (2008)

The expedition was implemented by the Kazakhstan Agency for Applied Ecology (the Agency) in coordination and agreement with the National State Enterprise KazHydromet. Representatives of the analytic labs of the Aktau Seaport and the municipal environment protection lab in Atirau also took part in the expedition. Consultations on sampling and marine works were carried out by project experts from the Ukraine Marine Ecology Center, Odessa.

The expedition was carried out between 8 and 20 September 2008 on board of the Research vessel “Elen” of the Kazakhstan Agency for Applied Ecology. The vessel is equipped with basic equipment, a freezing chamber, windlasses, and it has sufficient deck space for various activities. Equipment delivered by the experts was also used.

During the expedition samples were taken with regular equipment of the vessel, which is quite well equipped and prepared for works at sea. Primary processing of samples was carried out on board, then the samples were properly packed and stored in the freezing chamber until they were dispatched to an analytic lab. In accordance with the contract all analytic measurements of water and sediments were carried out in the analytic ‘environment protection lab’ of Atirau, which is one of the labs with the potential to participate in the RWQMP. This lab passed the preliminary test in the analytic measurements quality assessment program in 2008. This lab is also certified under Kazakh regulations.

The route of the expedition was planned to take samples in areas of potential impacts from land based sources (the Aktau Seaport, Bautino, Atyrau), and areas of potential impact from the main sites of hydrocarbons extraction in the northern part of the Caspian Sea. The locations of the stations and the route are shown in Fig. 4.7.

Considering that the areas are shallow and that the waters mix sufficiently, most of the sampling was carried out by a Teflon hand collector. At stations with waters of 20 to 50 m deep the sampling was carried

out by hand windlass from two levels.

Measurements of temperature, pH, dissolved oxygen, salinity, electric conductivity were carried on board using a portable «Horiba U-10» tester and other multi-parametric testers. Salinity measurements were calibrated by special solutions that were prepared beforehand in a lab. Additionally water samples were taken into prepared containers for further defining concentrations of biogenic substances (ammonium salt, nitrites, nitrates, total nitrogen compounds, phosphates, chlorides, sulphates) and the COD, oil products, and phenols. Water samples for analysis of metals were taken separately.

Sediments collected during the expedition were sifted, i.e. sand and seashells were separated. Then these samples were properly packed in plastic for further storage and analysis on metal concentrations – nickel, cadmium, lead, copper, chromium, zinc, mercury; and in glass containers or cleaned foil for analysis of concentrations of oil, chlorinated-organic pesticides, polychlorinated biphenyls and other organic derivatives.

A total of 24 water samples from 15 stations, and 14 sediment samples from 14 stations were collected. The samples were delivered to the analytic lab in Atyrau where the main analysis was carried out. The results were presented in the final report.

Fig. 4.8 – Water and sediment collectors in use during the expedition on the Vessel “Elen” of the Kazakhstan Agency for Applied Ecology in September 2008.

The results showed in most water samples concentrations of metals as chromium, copper, nickel, etc close to or higher than Admissible Concentration Limits. The lab in Atyrau showed that mercury and phenol concentrations exceed limits 1,1-2 times This is surprising, especially for the samples from the open sea. Perhaps the measurements have been carried on with methodical digressions or the water samples have not been filtrated. Therefore these results deserve particular attention of national experts and additional studies would be needed.

Only in one sample the concentrations of oil products in water exceeded Admissible Concentration Limits (ACL), in the area of the Aktau seaport. Excess of biogenic substances concentrations in water were observed in some samples taken in the Aktau area and in the mouth of the Ural river,

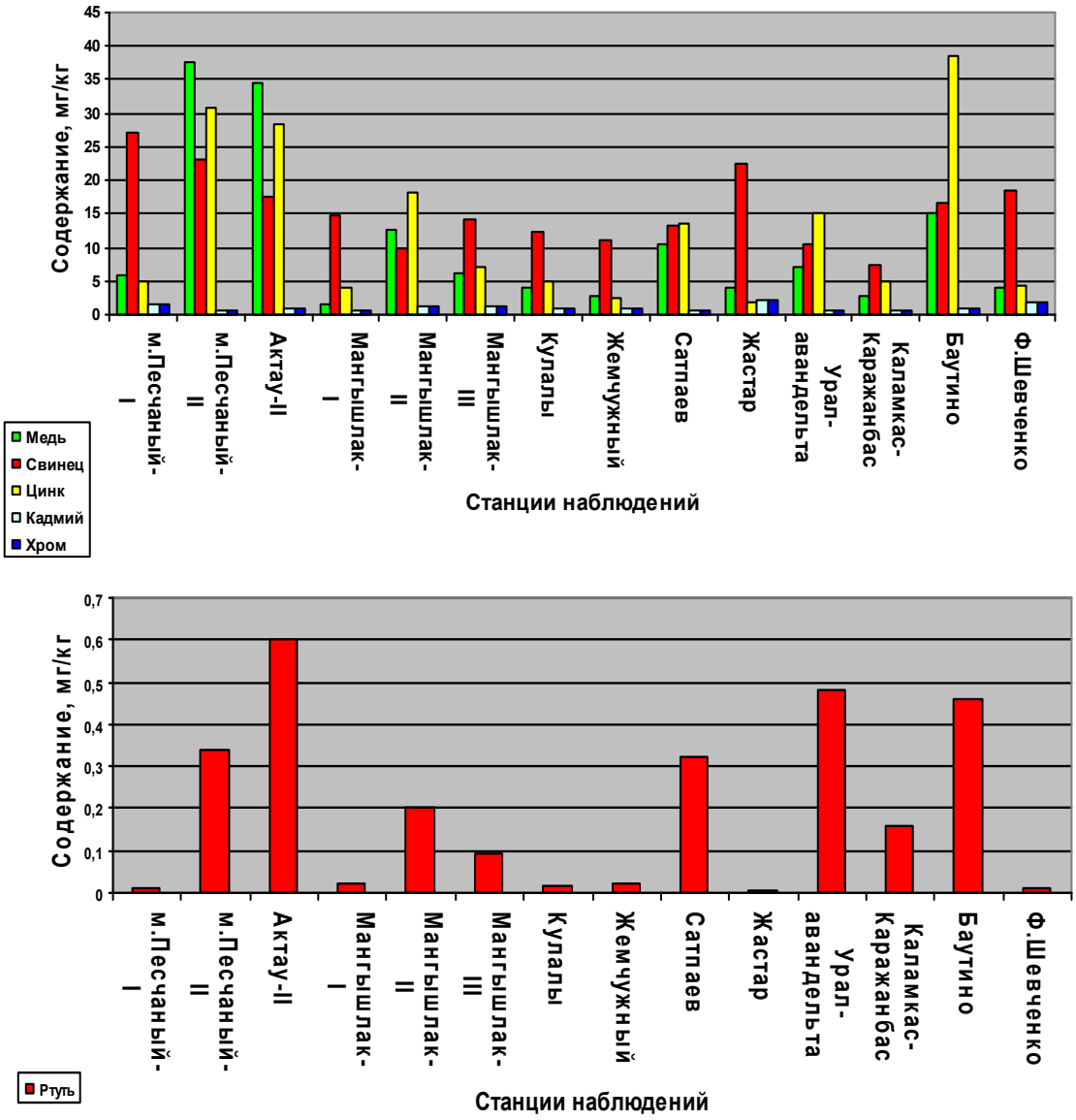


Fig. 4.9 – Oil products and metals concentrations in sediments from the Kazakhstan sector of the Caspian Sea.

The results of measurements have been compared with rates of the ERL (effect range low) as recommended by the Guidelines on Study of Compositions of Marine Sediments of the National Agency on Study of Oceans an Air of the USA. In comparison with the recommended indicators of the ERL (effect range low) relatively high concentrations of copper were found in two sediment samples, cadmium in five sediment samples, and mercury in seven samples. Compared to the Netherlands guidelines on pollutants in sediments all results were lower than the proposed standards of metal concentrations in sediments. Relatively high oil hydrocarbon concentrations were found in the areas of the Satpaev deposits (oil-field) and the Bautino seaport. This requires further investigation. Concentrations of derivatives from oil pollutions, such as polycyclic aromatic hydrocarbons and chlorinated-organic compounds in the sediments were not observed due to problems with analytic and methodical support and resources. .

The results of the 2008 expedition show that the state monitoring system institutions (including KazHydromet) are able to undertake the activities needed under a RWQMP in cooperation with independent analytic laboratories making use of the well equipped vessel of the Kazakhstan Agency for Applied Ecology.

It will be necessary to carry out analyses in independent labs to upgrade the level of trust in case of unexpectedly high values or otherwise doubtful results, independent of which analytic laboratory will be involved in analytic support for the RWQMP.

4.1.3. The Russian Federation

The expedition's main goals for the Russian sector of the Caspian Sea were the same as for the other countries:

- to show capacities and abilities of the monitoring institutions, in particular the analytic laboratory in Dagestan, for carrying out monitoring activities;
- to assess technical capacities and determine specific needs for methodical support to the local laboratories for further implementation of the RWQMP;
- to assess the main features of the water and sediment pollution in the shallow northern part of the sea and in the deep central part as a reference for future monitoring activities
- the expedition was carried out on board of the vessels of the Dagestan monitoring center, with the participation of the Center's experts and methodical aid of project experts. The work program was elaborated by staff of the State Oceanography Institution (SOI) of the RosHydromet.

The activities were carried out during two legs, using different vessels. First, in the shallow area of northern part, with the vessel "Neptun", then in the deep-water area with the vessel "Tantal". The areas and sampling stations are shown in Fig. 4.10 and 4.11.

Fig. 4.10 - Sampling stations in the first stage of the expedition in the Russian sector of the Caspian Sea carried out by the "Neptun" between 16 and 29 April, 2009

The physical values, features and characteristics of the marine environment as salinity mineralization, temperature, oxygen concentration, pH, Eh were measured on the vessels. Biogenic substances concentrations were determined immediately after completion of the expedition in the labs of the Dagestan monitoring center

Water and sediment samples were delivered to the environment chemistry center of the SIP

"Typhoon". Measurements on oil products, phenols, detergents, and also on 14 metal (Fe, Al, Cu, Zn, Ni, Ba, Cr, Pb, Mn, As, Cd, Mo, V, Hg) concentrations were carried out.

The detailed expedition results can be found in the report of the State Oceanography Institution.

Fig. 4.11 - Sampling stations in the second stage of the expedition in the Russian sector of the Caspian Sea carried out by the "Tantal" between 22-30 May, 2009

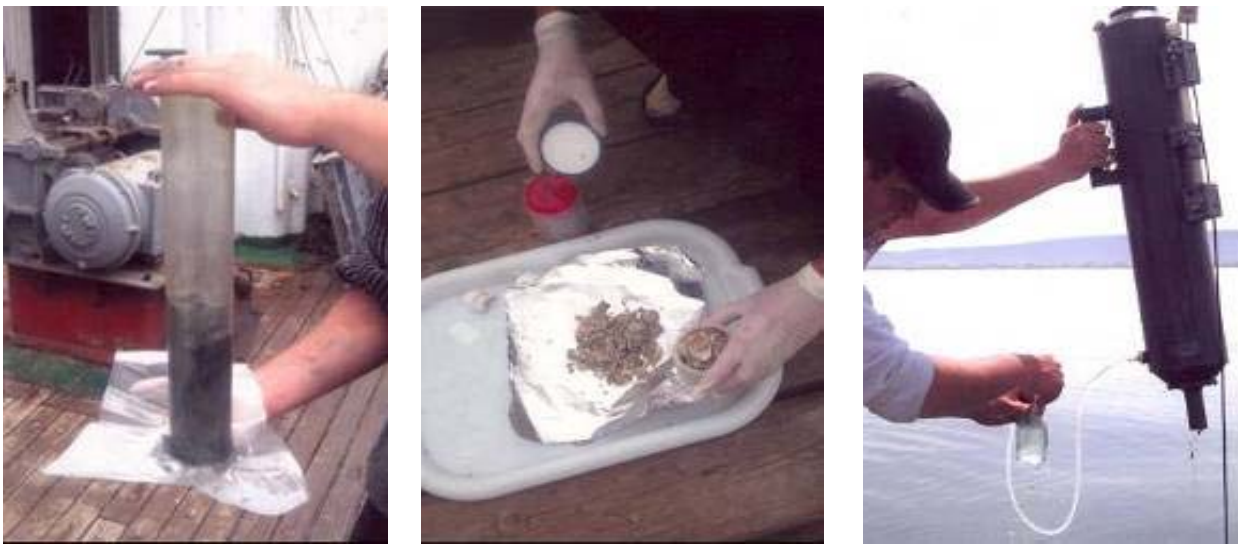


Fig. 4.12- Sediment (left) and water sampling procedures during the expeditions in the Russian sector of t Caspian Sea.

Conclusions and recommendations

During the two-leg expedition in April and May 2009 measurements of hydrological and hydro-chemical indicators, and water and sediment sampling were carried out. Sampling areas covered the shallow area of the sea near the Volga River delta, and the deep-water area in the central part of the Caspian Sea.

The samples were partly processed in the laboratory of Dagestan Hydrometeorological Center in Makhachkala (mainly water) and partly in the Environment Chemistry Center of the SIP “Typhoon” (Obninsk city near Moscow). Concentrations of nutrient elements in the water samples were analyzed immediately after completion of the expedition. Concentrations of pollutants in the water samples such as total oil hydrocarbons, phenols and 14 metals (Fe, Al, Cu, Zn, Ni, Ba, Cr, Pb, Mn, As, Cd, Mo, V , Hg) and in addition the concentration of organic substances in the samples including chlorinated pesticides (of 20 forms), polychlorinated biphenyl (PCB), polycyclic aromatic hydrocarbons (PAH) of 20 forms were analyzed in the laboratory of Typhoon after the delivery of samples in frozen state.

In general, the hydrochemical composition of the waters and concentrations of nutrients (biogenic elements) were typical for this part of the Caspian Sea during the spring season.

Concentrations of total oil hydrocarbons in the water were relatively high on all stations as is typical for this area of the sea. They were estimated as two – three times exceeding the maximal permissible levels (admissible limit concentrations) recommended for water bodies used for fishery. In some stations at the seaside of the mouth of the Volga River, the concentration of hydrocarbons in water reached five times the Admissible Limit Concentration standard (ALC). In the coastal waters of Dagestan the concentration of hydrocarbons was relatively low - approximately half the Admissible Limit Concentration (ALC) standard, and lower, for all stations both for surface and near bottom strata. For a background deep-water station a high concentration of oil products was fixed in a sample: up to six times the ALC standard near surface and three times the ALC standard near the bottom stratum. This station proved to be an exception. This fact shows that oil pollution in the open water of the Caspian Sea has become a regular occurrence. Background monitoring programmes should therefore be covering all water area. The monitoring pogram of Roshydromet should be more detailed for areas that might be impacted by open sea pollution sources, areas of hydrocarbon extraction activity in the Russian and Kazakhstan sectors of northern part of the Caspian Sea, and more detailed for the flow of the river Volga. This also highlights the need for a much closer cooperation in sea water quality monitoring.

Phenols and superficially active substances (SAS) concentrations in the sea water were lower than the ALC standards in all the investigated areas. Locally higher concentrations, i.e., SAS pollution ‘patches,’ were not found out in the delta of the river Volga, or in the Dagestan coastal waters. In general, metal concentrations in water were not high, and only exceeded ALC standards near the coast of Dagestan.

Sediment pollutions caused by pesticides of DDT and HCCH (herbicide) groups were observed only in the mouths of the rivers at the Dagestan coast, but their values were not high in general. The high values were connected to an increase of the share of finely dispersed fractions in sediment and an increase in organic substances concentrations. In the south part of the Terek, β-HCCH concentration exceeded the ALC standard seven times. Other pesticides, including hexachlorbenzols, were practically never observed in the sediments of the investigated areas.

Sediment concentrations of polychlorinated biphenyl (PCB) were not high, reaching levels of 1,16 ng/g и 0,84 ng/g, respectively 0,06 of the Admissible Concentration, and 0,04 of the Admissible Concentration in the mouth of the river Terek and at Izberbash.

Concentrations of PAH in the investigated areas of the Caspian Sea were high near the Dagestan coast - reaching levels of 161 ng/g; at the mouth of the Samur River – 130 ng/g; near Derbent – 89 ng/g, and near Makhachkala – 150 ng/g. The fine grained silt fractions dominated, and organic substances were proliferated in the sediments of these areas. Concentrations of most metals in sediments were within average limits, and reflected the features of the dominant geological background of the area.

The results of the expeditions and analytic works have shown the abilities of the institutions to participate in a Regional Water Quality Monitoring Programme. The obtained results will help to improve and upgrade the existing system of monitoring and might provide the foundation for a further elaboration of a

regional monitoring program as a scientific basis for an adequate selection of points to carry out supervision, to define parameters for supervision and a methodology to carry out supervision.

4.1.4. Turkmenistan

The expedition in the Turkmenistan sector of the Caspian Sea was completed in November, 2008.

The goals were the same as for the other countries. However, Turkmenistan is the only country in the Caspian area that does not have its own vessel for monitoring activities at sea. At the same time Turkmenistan was the only country that was able to arrange for customs clearance of the equipment supplied under the parallel TACIS project before the start of the cruise. However, due to the absence of its own vessel and due to the absence of an on-board powered stationary winch for handling the equipment could not be used fully..

Caspecocontrol leased a fishing vessel (a transportation seiner) to carry out the expedition. The proposed activities, however, could only be carried out on the vessel's deck, and there was no possibility to install a stationary deep-water windlass on the vessel. Therefore the water sampling process was carried on by using a hand windlass and hand collection instruments both for water and sediment samples. Sediment sampling was carried out by a dredging machine and a core collector to depths up to 80 m.

The works were carried out in two stages. First, samples were taken in the shallow part of the Turkmenbashi Gulf and the Saymonov Bay. Sampling was done from a small motorboat. Then the sampling program was carried out in the open sea. Samples of water and sediment were taken on 22 stations in total. The sampling route is shown in Fig. 4.13. Despite the mentioned technical difficulties and stormy weather all scheduled sampling activities were completed. Staff from Caspecocontrol was properly instructed and trained in water and sediment sampling, methods for samples treatment, and preservation and preparation for further storage and analyses.

Fig. 4.13 – The sampling stations track during an expedition at the Turkmenistan sector of the Caspian Sea, November, 2008.

Fig. 4.14 – Monitoring activities at sea during the expedition in the Turkmenistan sector of the Caspian Sea.

In order to effectively execute comprehensive expeditions it would be necessary to further train Caspecocontrol, also on the use of the newly delivered equipment. However, an adequately equipped vessel is a pre-condition for any further expedition. The Environment Protection Ministry of Turkmenistan is likely to purchase such a vessel in the nearest future.

Measurements of electro-conductivity, pH, temperature, salinity, oxygen concentration were carried out by using a portable multi-parametrical probe for all stations.

Sampling was conducted in surface and near-bottom strata at the shallow stations with depths up to 20 m. At depths exceeding 40 m, samples were taken from surface stratum – 1 m from the surface, and from 30 m depth (full length of the rope of the minor hand windlass). 27 water samples from 18 stations along with 16 samples of sediment were collected in total. The samples were well preserved, put into specially prepared containers, and stored in a freezing chamber until their dispatch to a lab.

Sediments were taken by using a Van-Vin drag sampler. Sediment cores have also been taken from depths between 40-80 m, using a small lake type corer at several stations. When sediments were uplifted their type, structure, and bentic communities were described. Collected samples were stored in the freezing chamber on-deck or in a cooler.

In the Caspecocontrol laboratories measurements of the following parameters were carried out: chlorides, sulphates, COD, nitrites, nitrates, phosphates, total nitrogen and phosphorus, and also phenols and total oil hydrocarbons concentrations were determined. The metal concentration in water and sediments were analyzed in the laboratory of «Turkmengeology» Enterprise after being delivered in frozen state.

Measurements of oil products and phenols in sediments were carried out in the laboratory of Caspecocontrol. The Environment Protection Ministry of Turkmenistan has been trying hard to put into operation a gas chromatograph, which was supplied in the framework of the parallel Tacis project to be able to analyse organic pollutant concentrations in sediments. However, it had not yet succeeded within the framework of this project. It is expected, though, that finally all analyses will be done later with involvement of local analysts, who were trained to operate gas-chromatographs for marine samples.

Preliminary results of measurements have shown that the Al-Fe-Mn-Co-V-Ni metal concentrations were not high compared to naturally occurring concentrations for this part of the Sea, and their concentrations were found to be in good correlation between themselves over the whole shelf of the Turkmenistan sector of the sea. As for other metals, such conformity was not observed. Absolute concentrations of metals in sediments from the Turkmenistan sector of the sea were found to be relatively low in comparison to some other areas. Some high concentration were observed only with regard to phenols. Samples taken from sediments of the Turkmenbashi (former Krasnovodsk)Gulf proved to be the most polluted ones by oil products.

On the whole, the experience of arranging an expedition in Turkmenistan has shown that Caspecocontrol is able to become an effective partner for the implementation of a regional monitoring program. Substantial amounts of analytic and monitoring equipment have been delivered to the labs. The principal priority for the future is to provide further training to staff and improvement and fine-tuning of regulations for the overall analytic laboratories performance.

4.2. Procurement of Equipment and its Deployment

One of the principal priorities of the project was to assist defined monitoring institutions to put into operation the equipment to be delivered under the parallel Tacis project. “Supplies for the Caspian and Black Sea Environmental Projects – Georgia, Kazakhstan, Moldova, Russian Federation, Turkmenistan and Ukraine” (identification number: EuropeAid/122682/C/SUP/Multi). The specifications for the equipment were defined by EU experts who visited the laboratories during 2004. The supply tender was won by AGMIN, Italy.

On the whole, the supplied equipment met the actual needs of the partner’s laboratories, taking into account the features and peculiarities of the national water quality monitoring programs for coastal and deep-water areas. The list of equipment included different types of desk sampler for sea water and sediment (including Van-Vin and corer type samplers) and also a wide set of oceanographic equipment, in-situ probes and analytical devices.

The basic part of the equipment was composed of modern analytic measurement instruments such as atomic adsorption spectrometers, gas chromatographs, spectrophotometers, and other devices to develop capacities of the laboratories, thereby enabling them to make analytical provision of the RWQMP.

However, none of the institutions, as end users of the equipment, was actually ready to accept and properly operate the equipment due to various reasons: problems with customs clearance; lack of qualified and instructed staff that could operate atomic adsorption spectrometers and gas chromatographs properly; no adequate conditions for deploying the equipment on vessels, etc. Therefore, the objectives regarding the deployment of equipment were only partly accomplished.

Analytic equipment to the lab of the Caspecocontrol was delivered and repacked one day before the Cruise was started. Therefore, the experts were not able to install oceanographic devices and train personal properly. The analytical devices were delivered to the laboratory after the Cruise. Experts from Italy and Ukraine helped to put the equipment into operation, and at present time it is operated by local experts.

The equipment delivered to the Russian Federation has not yet been installed at the time of the Project completion, due to issues with customs clearance. Reportedly, these issues were now solved.

The equipment which was supposed to be delivered to Kazakhstan was not delivered, as the EC decided to re-sentthe equipment to Azerbaijan for the above-mentioned Department of the Caspian Comprehensive Environment Monitoring. The equipment has now been delivered to the Department. However, personnel of the labs need to be properly trained.

Therefore it is very important to look for further possibilities to continue staff training, including training in baseline monitoring studies using oceanographic devices and analytical instruments and methods. The national reference analytical laboratories may help other laboratories to utilize properly the state-of-the-art equipment delivered during the project implementation stage.

5. CASPIAN SEA REGIONAL WATER QUALITY MONITORING PROGRAM (RWQMP)

5.1. General

The development of the Caspian Sea regional water quality monitoring program is a politically, economically and ecologically important task for the countries of the Caspian area. The main strategic objectives of the program are the following:

- to provide an information basis for the development of an optimal regional strategy for water quality management, and to support coordinated reactions to ecological emergency situations;
- to provide an information basis for selecting conservation and remediation measures to reduce the negative impacts of pollution sources on the sea environment;
- to improve trust between the countries and inhabitants of the region with regards to marine and environmental assessments;
- to facilitate research programs to study the marine ecosystem and preservation of biodiversity

Above mentioned aims are in accordance with the DPSIR and BTA concepts which are recommended as conceptual bases to develop an optimal monitoring system for the marine environment (see explanations in 1.2 and picture 1.1.).

The strategic aims of RWQMP are in accordance with the Tehran Convention Action Plan for the Protection and Sustainable Development of the Marine Environment of the Caspian Sea. This document states that a water quality monitoring program should mainly focus on the most polluted areas (so called hot points) and recreational zones

The following aims are included in the proposed RWQMP concept:

- To upgrade and harmonize the legislative and regulatory framework, and increase social and political support for program implementation as well as financial support.
- To identify the main sources of pollution and the variety of activities that might have an impact on the marine environment, including abandoned sources or activities from the past.
- To develop a network of background and regulatory (industrial) pollution monitoring stations, to develop a common framework that fits regulations and parameters of observations, and to set up system of interactions between participants
- To identify organizations in each country that could act as authorized participants in a regional monitoring program
- To elaborate basic elements of quality assurance and quality control programs in participating laboratories facilitating inter-laboratory calibration programs and proficiency testing
- To elaborate proposals for sustainable funding of the regional monitoring program
- To promote data exchange and the development of integrated data collection and processing systems, and access to databases
- Set up a regional network of national analytical centers (centers of excellence), using the experience of existing reference laboratories.
- Create regional mechanisms for RWQMP coordination in accordance with arrangements under the Tehran Convention, including a possible Monitoring Protocol.

The principles developed under the second phase of the Caspian Environment Program (TACIS, 2001) and the DPSIR and BTA concepts provide an adequate framework. The proposed approach is open for further discussions between the riparian countries. Further development is needed and details of future implementation and work programs have to be worked out by national experts.

The development of the Caspian water quality monitoring program will stimulate the development of national programs, services and observation systems and provide more focus, and also assist in solving local problems of environment control.

5.2. Identification of the Water Quality Monitoring Network

The regional water quality monitoring network should cover the areas of potential impact from land-based and sea-borne sources of environmental pollution. In addition stations are needed to observe regional background levels of contamination, and for trans-boundary supervision tasks.

Several types of potential pollution sources can be identified:

- Activities (industrial and agricultural) carried out in watersheds and in the coastal areas, which may discharge polluted water and other releases into the sea through surface and underground waters, or via precipitation.
- Activities carried out in the coastal area and in the open sea, including cargo shipments, gas and oil explorations and others, which may have a direct impact upon the sea, including waste disposal.

Deterioration of the marine environment can also be a result of emergencies like oil spillage and wastewater disposal from defect water treatment works. These sources can not be identified beforehand.

Each type of source requires special observation guidelines taking into account the characteristics of the potential impact of the source on the marine environment, its location in regard to the impacted area, the environmental conditions, and the regulatory requirements of environmental quality regulations and licenses.

Programs of the industrial ecological controls (source monitoring programs) have to be coordinated and agreed with the environmental water quality monitoring programs that are implemented by the monitoring institutions.

In contrast with source monitoring programs for which all sources of pollution need to be identified, trend environment monitoring programs look at the integrated effects of the various types of releases and discharges to the environment. Analysis of sediment samples plays an important role, while source monitoring programs focus upon water samples from the areas near the sources.

However it is very important to organize common analyses of data collected in both source monitoring programs (industrial ecological supervisions) and environment monitoring programs (including background level of pollution studies). Ministries of Environment or other authorized agencies may establish regulatory requirements for those who carry out monitoring programs to provide all data to an overall system for quality control to guarantee comparability of the results utilized and to be able to make a synthesis.

Proposed sampling stations for the RWQMP have been chosen based on the results of prior carried studies, experience of national experts and also on the marine water quality assessment as a results of the “CaspianMap” expeditions executed during 2008-2009, see Table 5.1.

The labeling of stations is the same for all countries of the region and consists of a country index (for example, AZ, KZ, RF and TM), a station serial number, and an index, which reflects its nature, namely situated at the coastal zone or watershed (C - coastal and land based); in the open sea (M-marine); and also stations for observation of trends or changes in natural background of pollutions (B-background) and stations related to transboundary monitoring (T-transboundary).

The number of type of stations to be included can vary, and will have to take into account technical and financial opportunities to implement the program. However, once the countries approve the list of the stations to be included into the RWQMP, the sampling program has to be executed. The stations included in national programs can be considered as an extension in each sector.

5.2.1. Monitoring impact from land based sources of pollution

It is recommended to include in the sampling plan stations situated in or near areas with a potential impact from land based sources of pollution, such as large cities, refineries, regionally important oil exploration facilities and large industrial enterprises. The project's "Baseline Inventory Report" made an inventory of these sources. The results of this study were taken into account when selecting areas to be covered.

Table 5.1 proposes stations where pollutants come from these sources. These stations have a C label. Also stations are included from areas of larger river inflow and coastal sedimentation zones such as closed bays, seaport areas, lagoons and sea bays. Monitoring these stations will allow estimating trends for different seasons and establishing long-term trends. Seasonal variability will require water sampling at least 2 times per year. Long-term pollution trends may be studied by analyzing sediment contaminations in specific areas, taking samples at least once per 1-2 years. These programs can be reviewed at certain time intervals taking into account trends and priorities. However, it is not recommended to do this more often than once in five years and a revision of monitoring programs under a RWQMP needs to be done in consultation with all RWQMP partners in a region.

5.2.2. Monitoring impact from sea borne sources of pollution

Potential sea borne sources of pollution include oil and gas exploration facilities, artificial islands created in shallow sea basins, works at the sea bottom (pipe laying), and emissions and oil spills from the intensive navigation by cargo vessels. From a RWQMP perspective the most important are the oil exploration facilities on platforms and islands. Table 5.1 includes the recommended stations labeled with index "M"

Priority areas for regular monitoring of water and sediments in Azerbaijan include zones of potential impacts such as the Oil Stones field and the ones mentioned in Table 2.1 earlier. In Kazakhstan the areas for regular monitoring shall include the Karajambas and Kulaly fields. It is recommended to continue observations over the cross-sect sections in cooperation with RosHydromet (see picture 2.7.) with further studying monitoring data from representative monitoring stations to control the influence of pollution sources on the marine environment of the high-sea. In Turkmenistan monitoring areas shall also include the area with platforms belonging to "Dragon oil" and other exploration companies.

Special chapters of RWQMP could include actions needed in case of accidents and emergencies and their aftermaths at drilling platforms, or after oil spills. Programs should be selected taking into account typical water circulation and seasonal wind dynamics. The priory tasks for monitoring programs in the open sea should be the study of concentrations in sediments near these facilities. The best results will be obtained in deep areas with relatively stable sedimentation rates, as pollution of the sediment particles are good indicators of regional pollution loads even at far distances from the sources. Therefore it is important to have data obtained in the wider frame of a RWQMP and data obtained from areas close to these platforms

Table 5.1. Recommended water and sediment sampling program for the Caspian Sea Regional Monitoring Program (RWQMP)

№ station	№ station during Cruises	Depth м	Area of monitoring studies, where sampling stations are recommended	Approximate coordinates	Related potential sources of impact	Com-ment
1*	2**	3	4	5	6	7***
Azerbaijan sector						
A-1C	0	10-15	Baku bay, coastal zone		Municipal waste water and Oil refinery facilities	
A-2C	1S	5-10	Baku Bay, Seaport and Oil terminal area	40^{0}18'403 " 49^{0}55'499"	Seaport, Oil shipment and accumulated oil fractions at the bottom of the Bay	D
A-3C	2N	11	Dubendinsky Oil Terminal	40^{0}13'539" 50^{0}26'292 "	Oil Exploration area at the Absheron site and Dubendinsky Oil Terminal	D
A-4M	9N	33	Pirallaly island	40^{0}27'347" 50^{0}36'456"	Oil exploration area of impact	D
A-5M	3N	75	Sumgait spot check	41^{0}05'047" 49^{0}29'291"	Open sea area under potential impact from Sumgait Industrial zone	D
A-6C	4N	23	Sumgait coastal near shore zone	40^{0}44'023" 49^{0}42'527"	Close area of potential impact area from Sumgait Industrial and municipal zone	
A-7B	8N	615	Jalama deep station	41^{0}42'070" 49^{0}04'574 "	Deep station transboundary	D
A-8T	7N	90	Jalama costal station	41^{0}42'065" 48^{0}55'574"	Transboundary tasks . Samur river impact area	D
A-9M	2S	9,5	Nargin island	40^{0}17'403" 49^{0}55'501"	Potential impact of the Oil exploration area "Oil stones"	D
A-10M	4S	550	Deep water	39^{0}46'397" 50^{0}11'502"	Background observation stations	D
A-10C	6S	53	Open sea	39^{0}40'397" 49^{0}46'497"	Open sea are of impact from the Shirvand waste water discharges point in to the sea	D
A-12C	12S		Marine part of Kura River avandelta	39^{0}15'392" 49^{0}31,'495"	Close area of the Kura River inlet area of impact	D
A-13B	8S	630	Deep water	39^{0}04'391" 49^{0}51'498"	Far area of the Kura river solids sedimentation in the deep sea	D
A-14T	10S	28	Lenkoran- coastal	38^{0}51'388" 49^{0}13'492"	Transboundary monitoring station (Azerbaijan-Iran sector of the Sea)	

Comments:

*) Labeling of stations indicate country (AZ), serial number and an index, which reflects the nature of pollution sources, such as "C" (coastal and land based born); sea born (M-marine); stations where observation on trends of a natural background of pollution of the sea waters (B-background) and also stations related to the tasks on transboundary monitoring (T-transboundary).

**) Numbering used during cruises 2008 and indicated at the sampling tracks in chapter 4.1. Index S - designates stations of sampling in a Southern part of the Azerbaijan sector of the sea, index N - stations of sampling in Northern part of the Azerbaijan sector of the sea.

***) At all stations water samples are recommended, while at the stations marked as "D" sediment samples to be taken as well.

Continuation of Table 5.1.

Kazakhstan sector						
1*	2**	3	4	5	6	7***
KZ-1T	0		Transboundary station		Transboundary area (Kazakhstan-Russia Federation)	D
KZ-2C	12	4,6	Ural River (avandelta) Peshnoy	46^0 45,994′ 51^0 27,998	River water Влияние стока р. Урал	D
KZ-3M	11	6,2	Zhastar	46^0 18,986′ 51^0 05,014′	Exploration Zhastar area of impact	
KZ-4M	10	9	Satpaev	45^0 43,969′ 50^0 36,001′	Satpaev exploration area of impact	D
KZ-5M	9	4.5	Zhemchuzhniy island	45^0 22,010′ 50^0 17,998′	Area of integrated impact to the Semi-natural state of the marine environment	
KZ-6C	8	2.5	Island Kulaly	45^0 02,874′ 50^0 01,286′	Oil Exploration Area of impact	
KZ-7C	6	23	Cross-Sect Mangyshlak - Chechen	44^0 30,812′ 49^0 48,007′	Monitoring station according bi-lateral agreement between RosHydromet and KazHydromet	D
KZ-8C	5	28	Cross-Sect Mangyshlak - Chechen	44^0 23,492′ 49^0 24,786′	Monitoring station according bi-lateral agreement between RosHydromet and KazHydromet	D
KZ-9C	14	4	Kalamkas- Karajambas	45^0 18,156′ 51^0 18,293′	Area of potential impacts of obsolete oil wells being inundated at the near shore zone	
KZ-10C	15	11	Bautino Port	44^0 35,793′ 50^0 16,194′	Sea Port influence area	D
KZ-11C	3	11	Aktau Port	43^0 35,991′ 51^0 11,016′	Sea Port influence area and area of city municipal activity impact	D
KZ-12C	4	71	Aktau, open sea	43^0 34,454′ 50^0 52,459′	Station of the deep see. Background natural conditions of the water pollution	D
KZ-13C	1	17	Cape Peschany -1	43^0 08,517′ 51^0 13,993′	Coastal area	
KZ-14B	2	70	Cross-sect Peschany-2	43^0 01,830′ 50^0 54,656′	mn +/ckground natural conditions of the water pollution.	D
KZ-15T		20	Kara-Bogaz , coastal.		Transboundary area between TM and KZ sectors of the Sea	D

Comments:

The lines with station descriptions marked in the Table have been agreed as national priority for RWQMP, while unmarked to be considered as potentially useful for including in the RWQMP.

*) Labeling of stations related to Kazakhstan sector of the Sea (KZ), serial number of stations, and index reflecting the nature of potential pollution such as “C” (coastal and land based); sea borne (M-marine); stations where observation on trends of a natural background of pollution of the sea waters (B-background) and stations related to the tasks on transboundary monitoring (T-transboundary).

**) Numbering used during cruises 2008 and indicated sampling stations in the Kazakhstan sector(see chapter 4.2).

***) At all stations water samples are recommended, while at the stations marked as “D” sediment samples are to be taken as well.

Continuation of Table 5.1.

Russian sector						
1*	2**	3	4	5	6	7***
RF-1M	1	2-3	Border with Kazakhstan sector of the sea	45º 54,564’ 49º 16,052’	Transboundary tasks for observation	D
RF-2	2	1,5-2	Volga River Delta	46º 03,192’ 49º 04,232’	Obzhorsky canal	
RF-3C	3	3	Volga River Delta	45º 47,068’ 48º 51,260’	Belinsky canal	D
RF-4	4	1,5 2	Дельта р. Волга	45º 23,119’ 48º 01,484’	Kirovsky canal	
RF-5C	5	1.5-3	Волго-Каспийский канал	45º 20,485’ 47º 43,355’	Major shipping canal “Volga-Caspian Sea”	
RF-6		4	Kizlyar bay	43º 57,019’ 47º 33,012’	Sedimentation area of solids inlet by the Terek River	D
RF-7C			Volga River Astrakhan city	46º 18,063’ 47º 58,212’	Area of impact from Astrakhan Industrial and recreation zone	
RF-8C	8	2	Terek River Estuary.	43º 35,519’ 47º 33,215’	Terek river inlet area of impact	D
RF-9	10	8	Sulak River Estuary	43º 50,100’ 47º 35,046’	Sulak river inlet area of impact	D
RF-10C	11	8	Makhachkala, coastal zone	42º 59,278’ 47º 32,075’	Makhachkala city and Oil SeaPort Terminal area of Impact	D
RF-11		11	Caspiysk town, coastal zone	420 51,800’ 470 46,202’	Caspiysk town municipal waste water impact area	
RF-12		22	Izerbash town, coastal zone	420 34,736’ 470 55,188’	Iserbash town municipal waste water impact area	D
RF-13	15	11	Derbent town, coastal zone	420 03,364’ 480 20,183’	Derbent town municipal waste water discharges and industrial impact area	
RF-14T		10	Samur River	480 30,222’ 410 55,237’	Samur River area of Impact . Transboundary station AZ-RF	D
RF-15C	16	12	Cross sect Chechen-Mangyshlak	430 58,500' 480 03,000’	Open sea monitoring. Sea water exchange between north and central part of the Sea	
RF-16	17	21	Cross sect Chechen-Mangyshlak	440 09,000’ 480 38,000’	Open sea monitoring. Sea water exchange between north and central part of the Sea	
RF-17M	18	26	Cross sect Chechen-Mangyshlak	440 23,500’ 490 24,500’	Open sea monitoring. Sea water exchange between north and central part of the Sea	D
RF-18	19	26	Cross sect Mahachkala- Sagyndyk	430 07,000’ 470 54,000’	Background monitoring at the Central Caspian gyre area	
RF-19M	20	47	Cross sect Mahachkala- Sagyndyk	430 22,000’ 480 44,000’	Background monitoring at the Central Caspian gyre area	D
RF-20	21	30	Cross sect Mahachkala- Sagyndyk	440 00,000’ 490 00,000’	Background monitoring at the Central Caspian gyre area	
RF-21B	14	122	Reference station	420 30,000’ 480 40,000’	Natural condition and Regional Impact area	D

Comments:

The lines marked by color in the Table related to the sampling stations that have been agreed as a national priority for RWQMP, while the not colored lines include extended national monitoring

*) Labeling of stations related to Russian sector (RF), serial number, and an index that reflects the nature of the potential source of pollution such as “C” (coastal and land based); sea borne (M-marine); stations where observation on trends of a natural background of pollution of the sea waters (B-background) and also stations related to the tasks on transboundary monitoring (T-transboundary).

**) Numbering used during cruises 2009 and indicated sampling stations at the Kazakhstan sector (see chapter 4.3).

***) At all stations water samples are recommended, while at the stations marked as “D” sediment samples to be taken as well.

Continuation of Table 5.1.

Turkmenistan Sector						
1*	2**	3	4	5	6	7***
TM-1C	5	3-5	Turkmenbashi SeaPort	costal	SeaPort and OilPort areas of impact	D
TM-2C	6	5-6	Turkmenbashi Bay	39°59'605" 52°54'680"	Area of municipal waste water Potential impact from Saymonov Bay	
TM-3C	--	3	Turkmenbashi, Avaza	Coastal	Coastal area near Resort Avaza	
TM-4C	8	7,5	Cheleken 1	39°16'104" 53°02'959"	Area of the Cheleken Industrial area potential impacts	D
TM-5T	7	11	Cheleken 2 - Osushnoy	39°39'572" 53°10'021"'	Area of integrated impact from Cheleken and Turkmenbashi OilTerminal	D
TM-6T	1	72	Bekdash – Karabogaz	41°20'109" 53°15'045''	Transboundary area between TM and KZ sectors of the Caspian Sea	D
TM-7T	4	62	Livanov (banka) Shallow	38°46'067" 52°18'770"	Oil and Gas exploration site area of impact (Dragen-Oil)	D
TM-8 M	9	40	Zhdanov (banka) Shallow	39°27'455" 52°41'155"	Oil and Gas exploration site area of impact (Dragen-Oil)	D
TM-9 B	10	80	Cross sect Ogurchinskiy 1	39°10'827" 52°14'066"	Deep Sea area station for assessment of background level of pollution	D
TM-10 M	11	30	Cross sect Ogurchinskiy 2	39°00'095" 52°49'994"	Open see station	D
TM-11M	12	10	Cross sect Ogurchinskiy 3	39°59'896" 53°01'307"	Coastal Sea station	
TM-12B	15	11	Okarem 2	38°00'013" 53°00'071"	Coastal Sea area station for assessment of background level of pollution	D
TM-14T	16	-	Etrek river		Transboundary monitoring station (Turkmenistan-Iran)	D

Comments:
The rows marked by color in the Table relate to the sampling stations, which are agreed as national priority for RWQMP, while the non-colored rows marked stations recommended to include into the national extended national monitoring

*) Labeling of stations related to the Turkmen sector of the Sea (TM), serial number, and also an index that reflects the nature of the potential source of pollution such as "C" (coastal and land based); sea borne (M-marine); stations where observation on trends of a natural background of pollution of the sea waters (B-background) and also stations related to the tasks on transboundary monitoring (T-transboundary).

**) Numbering indicated sampling stations at Kazakhstan sector of the Caspian Sea during Cruise in 2008

***) At the stations marked as "D" sediment samples are to be taken in addition to water samples.

5.2.3. Background level of regional pollution

Stations for background observations have been recommended for each of the sections mentioned above. Such stations have to be established relatively far from defined land-based or sea borne sources of pollution. At least one or two background observation stations should be set up in each national sea sector (one in the shoreline, and one in the open sea). The results of observation at such stations may demonstrate long term trends of pollution. Background monitoring stations are marked in yellow, and presented in Table 5.1.

It should be mentioned that almost no areas in the Caspian are left without anthropogenic impact on the environment. Nevertheless there are some zones, relatively far from the land and sea based pollution sources, which can be characterized as having natural conditions.

5.3. Regional water quality monitoring program design

Sampling design and observation plan are an essential part of the Monitoring Water Quality Monitoring Program, which describe types of observations, place of sampling, periodicity and type of analyses to be applied. Program designs can be detailed and reviewed in line with stipulated tasks and technical conditions of their implementation. The elaboration of the RWQMP design for the Caspian Sea has taken into account previous experience and recommendations from the P_RAG (program regional advisory group) and also best practices from similar programs for the Baltic and Black Seas.

Basic parameters to be analyzed in water and sediment samples are stipulated in Annex 1 (Table A1 and A2). Useful recommendations from (CEP, 2005) for data reporting are attached in Table A2. Basic recommendations on sediment sampling, sediment sample processing and analyses are given in (J.-P.Villeneuve et al. / "Methods for sediment sampling and analysis"// CEP-2008).

5.3.1. International practice of establishment of priority pollutants in marine monitoring programs

European legislation related to marine environment protection emphasizes the importance to set up appropriate monitoring and control systems for the marine environment, thus facilitating actions and measures to address the pollution of the marine ecosystem.

The OSPAR Convention on the protection of the marine environment of the North-East Atlantic defines the list of priority pollutants that present a threat to the living resources of the sea. Concentrations of listed priority pollutants include toxic metals: As, Cd, Cr, Hg, Ni, Pb, Zn; Chlorinated pesticides: DDE, Lindanes; Polycyclic Aromatic Hydrocarbons and PCBs and should be controlled in sea and monitored in their contents in the bottom sediment.

EU Council № 96/61 from 24.09.96 regulates issues regarding the prevention of contamination of the marine environment with pollutants, and provides the list of most toxic heavy metals and organic pollutants to be under strict control for discharges into the seas.

The Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter of December 29, 1972 is directed to prevent the dumping of wastes and other matter. These regulations do not cover matters that could be easily neutralized through physical, chemical or biological processes in the sea.

The Stockholm Convention on Persistent Organic Pollutants, which obliges to monitor on POPs contamination in the environment has been signed by all Caspian countries except Turkmenistan. It provides a good basis to include typically occurring organic pollutants in the Caspian marine environment.

Within the frameworks of elaboration of Teheran Convention Protocols on monitoring, it would be necessary to approve a list of typical contaminants for which the concentration shall be under a strict regulatory monitoring regime in different regions of the Caspian Sea.

Experts from Caspian countries recommended to set-up a Pilot Regional Pollution Monitoring Program (RPMP) based on National Programs, having a modular structure and in accordance with above mentioned international criteria, at the 4th Meeting of the Pollution Regional Advisory Group (P-RAG), which was in Baku 11-13 October 2005. During this meeting it was noted that the CEP Phase I had identified that the major POPs problem in Caspian were DDT, Lindanes, Petroleum Hydrocarbons (PH), and some trace metals. It was also concluded that the capacity of the region was limited for POPs/PTS analysis, which must be considered in a realistic RAP development. In spite of many existing constraints for implementing monitoring programs for POPs and PTS, this type of pollutants should be a part of a future RMQWP, to be established with technical assistance of the international community and using international experience in developing regional monitoring. It was also stated that sediment pollution should be considered as a main subject for a RWQMP, as a more stable media, accumulating toxic pollutants due to high adsorptions, and it may serve as a long term indicator of anthropogenic loads in the marine environment.

The following specifications for sediments were recommended for the pilot national monitoring programs as a prototype of the minimal specification requirements for further RWQMP.

- *DDT, Lindane, TPH (Total Petroleum Hydrocarbons). TM (Trace Metals): Hg, Cu, Zn, other Complementary parameters: grain size, TOC (Total Organic Carbon), Al, CO_3 and Fe*
- *Number of stations at least 5 – 8 at each national sector*
- *Sampling frequency for sediments: once per year*

This list of requirements was used as the minimum set when designing RWQMP plans. In fact, the list of parameters given in Annex 1 recommends extending the list of parameters.

The complete list of contaminants can be assessed at specially selected stations, which must be representative for the specific sea sectors. The regulatory agencies should establish specific requirements for POPs.

5.3.2. Parameters to be analysed in water and sediments

During the fist stage of implementation of a regional monitoring program, the list of characteristics of water and sediments that will be suggested for measuring will be the same for all participating laboratories, and based on the mandatory parameters as recommended in Table A1 and A2. It is also recommended that reference laboratories, having advanced analytical devices and high analytical experience, measure all recommended parameters including the optional ones.

Such an approach during the initial stage of RWQMP implementation (3-5 years) will help to clarify some extended priorities of various contaminants in different sea regions, improve technical capacities of the laboratories, and provide more training opportunities needed for program implementation during later stages.

The constraints of the suggested list may include problems as lack of specific equipment for laboratories and insufficient experience of work with corresponding measuring methods. Gradual development of potential of equipment and the professional skills of program participants is a high-priority in the next stage..

Specification of the parameters of marine environment pollution (Annex, Table A1.1) includes lists of parameters for surface layers and in some cases water layer located lower than the density barrier layer (usually lower than 30 m) may include:

- Physical and physical-chemical characteristics of marine environment
- Content of nutrients in the water
- Trace metals (only at stations influenced by land based sources and areas influenced by wastewaters in the coastal zone) and in sediment
- Total Petroleum Hydrocarbons (TPH), phenols and surface active matters (near the large towns and defined waste waters spots).

As a minimum, a program for sediment studies should include the list of recommended parameters from CEP (see chapter 5.3.1) including the extended list of trace metals and organic pollutants such as TPH, total amount of DDT, as mandatory. The optional list of parameters includes (total) polycyclic aromatic hydrocarbons, pesticides and other persistent organic pollutants as stipulated in the tables of Annexes, Table A1.2.

5.3.3. Frequency of sampling

The most dynamic parameters can be found near river inflows and in the coastal zones where waves and currents play a role. Water dynamic and climatic factors also have a significant impact upon pollution loads. So will the pollution load in the northern Caspian substantially differ between early summer, with large inflows from the river Volga, and winter, when the northern sea basin is frozen.

Sampling frequency within the framework of source monitoring (industrial ecological supervisions programs) will be higher than is needed for a RWQMP. Harmonization of the sampling plans may significantly improve the efficiency of data analysis needed in decision making processes. Water sampling within the framework of a RQWMP in zones of potential influence of sea based pollution sources should be done by vessel in principle once per season, but not less than two times a year. Sampling of sediments should be in accordance with the "Method of sampling and analysis of bottom sedimentations" guidelines (CEP-2008), and to be taken at least once per year. To receive comparative results sediment samples must be taken only from the top layer of the bottom, and only silted and clay particles are to be analyzed after sieving and separating sandy and shell fractions.

Many scientific projects are implemented annually to study water pollution in rivers, sea and sediments and marine biota. These data should also be made available for annual analysis. It will help to fill some gaps in data analyses taking into account limitations in frequency. Application of remote sensing techniques for some baseline sea parameters, algae blooming, river water spatial intrusion and oil pollution will certainly facilitate data analyses.

5.4. Harmonization of the regional ecological quality criteria

The Caspian countries agree in general terms that it would be good to harmonize marine environment quality standards to asses the condition of the water ecosystem using monitoring data. Solving this issue is an urgent matter both for national monitoring programs and a RWQMP. Moreover, this issue is extremely important when setting up a common system of data collection and analyzing water and sediment samples, both when making assessments and when taking administrative decisions.

Some general approaches were proposed during the second stage of the Caspian Environment Program (CEP, 2001), when harmonization of acceptable waste dumping practices and assessment of sea water quality were scrutinized based upon the concept of acceptable environment risk. At an earlier stage, in recommendations elaborated by CEP, it was proposed to decline the ALC methodology (admissible limit concentration) accepted for water management and fishing purposes, and use a system of sea water quality assessment based upon international standards. This is a complicated issue to agree upon, and to a considerable degree it depends upon the harmonization of legislation and regulatory principles of sea water quality assessment within the framework of the Tehran Convention.

Taking into account the above, and prior to solving this issue during the initial stages of development of the regional water quality monitoring program (RWQMP), it could be recommended to use fixed sea water quality criteria which were accepted in some countries of the European Union. In the 4th Water Management Policy Document for the Netherlands (1998 – 2006) there is annex that sets standards for sediments: http://www.waterland.net/nw4/Nederlands/wk-9-bij/index.html.

Typical for the standards in use in the Netherlands is that ecotoxicologic standards are used for both water and sediment. The proposed standards are based on long-term ecotoxicologic studies in the North Sea where the anthropogenic load is high. The annex provides standards for toxic metals, compound, polycyclic aromatic hydrocarbons, TPH, phenols, chlorine benzene and aliphatic hydrocarbons, organo-phosphorous compounds and detergent agents. All of the above mentioned POPs components were found in the sediments of the Caspian Sea and therefore these standards could be considered by the partners of RWQMP of the Caspian Sea as indicative for an assessment of relative environment safety based on the monitoring data.

5.5. Partners institutions for executing RWQMP

In accordance with the Concept discussed in section 1.2, and based on the evaluation of the existing structure of the existing monitoring networks in the Caspian countries the most prepared institutions may be proposed as RWQMP potential partners. The partners have to be proposed according to their clear duties and potential ability for executing key functions in the RWQMP management such as following:

- Elaboration of programs, financial management and coordination
- Maintenance of the observation network and infrastructure, vessels, technical services etc;
- Maintenance, provisions and quality managements of analytic laboratories;
- Data processing, Data management and reporting; Environment Impact Assessment, Methodological support of the monitoring programs implementation.
- Risk Analyses, Risk Communication, Decision Making. Program and Environment Management.

The above stated functions are in compliance with the main tasks associated with the strategic aims of the RWQMP proposed for different partners in a region as given in Table 5.3. However, the list of proposed institutions as the national partners for RWQMP should be considered only as an indicative one based upon project expert findings. A decision about what partners should be included in a RWQMPis to be approved by the Environmental Authorities.

Table 5.3. Potential partners for RWQMP and their role

Country	Program management, financing and coordination	Maintenance of the observational network and vessels	Maintenance and Quality management of analytical laboratories	Data management Environmental state Impact assessment / and Reporting	Environment Risk Management
	1)	**2)**	**3)**	**4)**	**5)**
Azerbaijan	Ministry Environment Resources	CCEMA	Лаборатории УККЭМ АзЭколаб	CCEMA*	Ministry Environment Resources
Kazakhstan	Ministry Environment protection	KazHydromet Partners	Atyrau Regional Lab. KazHydromet Partners in Atyrau and Aktau	Caspian Monitoring Cemter of KazHydromet**	Ministry Environment protection
Russian Federation	Ministry Natural Resources & RosHydromet	Dagestan and Astrakhan Hydromet Centers	Regional Labs & “Center for Environment Chemistry” (“Typhoon”)	«SOI» (Moscov) Caspian Research Center (Astrakhan)	Ministry Natural Resources & RosHydromet
Turkmenistan	Ministry environment Protection	Caspecocontrol	Caspecocontrol Turkmengeology Lab.	Caspecocontrol Academy of Science Turkmenistan Rep.	Ministry environment Protection

Comments:

* CCEMA structure contains a section for monitoring data analyses and assessment. However, due to a lack of skilled staff and a monitoring program strategy this Center should developed further before it could effectively function within a RWQMP framework.

** This center is under creation, a decision about its creation already done by KazHydromet Authority and Ministry of Environment Protection of Kazakhstan Republic.

5.6. Quality management of the monitoring programs

5.6.1. Quality control and quality assurance of the analytical data

A well developed quality control and quality assurance system will be essential. Its requirements will also provide a harmonized approach and guidance on how to carry out all activities under the monitoring program. Results would only count when activities were implemented in accordance with approved procedures. Such an approach to the implementation of program envisages:

- harmonization of technical supplies of laboratories and vessels carrying monitoring research by means of measuring facilities;
- approval and agreement of all main procedures of obtaining monitoring data, strictly following stipulated instructions and recommendations on sampling, processing and analytical measuring of every element as required by regulations on marine environment pollution;
- regular execution of internal quality assurance procedures, proper calibration of the analytical devices and measuring reference samples with known content of pollutants and also participation in external proficiency testing programs as regular inter-laboratory calibration exercises;
- establishing the reference laboratories, which will act as national methodical centers and supervise performance quality of national laboratories.

QA/QC programs must be elaborated and implemented in each laboratory participating in national and regional monitoring programs. The content and structure of these must be approved and constantly checked by regulatory agencies. In practice these programs are not implemented in most laboratories in the Caspian countries at the moment.

Quality control programs shall include:

1. Corresponding maintenance services, regular check-up and calibration of equipment and instrumentation.
2. Data Quality control during all stages of monitoring data management
3. Description of analysis of calculative and measuring errors.
4. Report requirements.

Time

Place

Laboratories, operators and procedures

Participation in programs of regular inter-laboratory comparison of analysis results (inter-calibration) and proficiency testing of laboratories is an important element of implementation of monitoring quality. It ensures that inter-comparable results are received in different laboratories, for the same reference (standard) samples with known level of pollutants in different mixtures.

Participation in programs of professional testing could be proposed at two levels: the regional level (i.e. only at level of participants of Caspian water quality monitoring program) and the international one in the framework of a regular testing program. Testing at regional level shall be compulsory for all participating

national laboratories. International testing should include model laboratories that provide scientific and methodical support for the regional monitoring program and provide assistance to laboratories from the region in upgrading professional skills.

Participation in these tests provides transparency. It is important to note that the main purpose of these tests is not an assessment of individual laboratories, but revealing problems and suggesting measures for development and improvement.

5.6.2. Enhancing the national reference laboratory network

The creation of national model laboratories in each country of the Caspian region is already under discussion for more than 10 years, starting from the first mission of experts who assessed conditions of existing laboratories. General requirements to arrange such laboratories were elaborated by international experts (CEP) in 2001.

It was assumed that these laboratories could be created in the countries. Development of some laboratories was pending on the parallel Tacis supply contract. In 2008-2009 selected laboratories received a substantial deliveries of analytical equipment. Moreover it was installed, put into operation and staff received basic operation training. However these deliveries did not result in the establishment of a network of model laboratories in the Caspian Sea countries. The key problem is the absence of national strategies with regard to such networks, unclear sources of financial support for this kind of laboratories and insufficient work conditions for personnel.

It appeared that in some countries, irrespective of the received equipment, such laboratories already exist (for example “Centre for Environment Chemistry” SIA “Typhoon” the Russian Federation or “Azecolab” laboratory in Azerbaijan), even as modern analytical equipment was delivered to support other laboratories. Unfortunately these laboratories didn’t become model ones due to problems with the operation of the installed equipment and absence of software and quality guarantees of analytical laboratories.

One laboratory of this type, as a minimum, should be established in each country in the Caspian region and corresponding to international operation requirements (for example ISO Standard 17025).

Qualification level of personnel in such laboratories has to be high and assessed on test results and quality obtained measuring results. Staff should have basic knowledge of regulatory requirements for QA/QC in analytical laboratories.

Specialists of model laboratories should not only have these technical capacities, but they should also be respected for their knowledge and experience, and able and motivated to share experience with other laboratories that participate in monitoring programs.

The training needs for regional specialists are high. Training should not only be conducted by international projects, but they should also be carried out by qualified national experts. It is necessary to create conditions for efficient sharing of experience and knowledge.

5.7. Interrelations between partners of RWQMP and stakeholders

5.7.1. Data exchange and access to monitoring information

Exchanging monitoring results and archiving results in a database will be an important element for efficient implementation and the establishment of partnerships. If clear and simple procedures to access available information, especially on observation data of all types of monitoring are not established, then it will not be possible to achieve the goals of a RWQMP.

Access arrangements to observation data have to be established at the very first stage of RWQMP implementation. This critical issue has to be solved in line with Tehran Convention conditions related to data exchange by all countries. The following activities need to be undertaken in this regard:

- Archive observation data before and after 1991 (year of disintegration of the unique monitoring system of the Caspian Sea by former states of the USSR);
- Archive results of observations obtained by national agencies in the established regions of the Caspian Sea for the period prior to RWQMP implementation;
- Archive results received in framework of regional monitoring program starting from the period of program's implementation;
- Exchange data from inter-laboratory cross-check comparison programs between RWQMP partners.
- Exchange reference samples and samples (water, sediment and biota) to be analyzed in the regionally selected reference laboratory and international laboratories
- Exchange results of research programs, related to the issues of methodical support and assessment of marine environment condition in the Caspian Sea.

It would be useful to provide access to primary and summarized monitoring data, obtained within the Caspian Sea monitoring program of the former USSR, and data obtained by monitoring agencies after 1991 in framework of national monitoring programs. Special amended and detailed publications of RosHydromet (State Oceanography Institution)' yearbook "Hydrochemical characteristic and quality of sea waters" focused on the Caspian Sea problems could be used as a basis for summarizing earlier received information.

Data and results of marine hydro geological observations and analytical measurements of marine environment samples, which will be obtained in the framework of a regional monitoring program, should be collected by corresponding national coordination monitoring centers. Furthermore, after checking primary data for quality and summarizing them in an agreed format, information must be submitted to a Regional Data Centre and included into the web-site of the regional monitoring program for free access. Primary data shall be available to all participants. Corresponding guidelines should be elaborated by experts within the framework of the Teheran Convention protocols.

Observation results which are received by industrial licensee laboratories should be provided to the national regional inspection agencies, and summaries to national data processing centers. However such data could also be asked by national centers, coordinating RWQMP implementation, or a regional analytical center in line with procedures to be agreed upon.

It is essentially important to establish access to monitoring database of the scientific and research institutions. Results of scientific research carried out in the Caspian Sea have to be considered as an important information source to frame results of routine water quality monitoring.

Data related to research and monitoring the Caspian Sea are partially received by the special Informational Data Center (ВНИГМИ МЦД) of RosHydromet and also by the State Oceanographic Institute (Moscow). Summary results are regularly published in its annual report and is available at the web-site of the State Oceanographic Institute (SOI) of RosHydromet.

It must be taken into consideration that at present monitoring data, and results of quality monitoring on water and sediments, especially the ones obtained by industrial monitoring and non-governmental subjects of monitoring, have a confidential and proprietary status and are not accessible for analysis in the framework of state monitoring.

The issues stated above should be solved in accordance with provisions of the possible forthcoming Protocol on Monitoring under the Tehran Convention.

5.7.2. Monitoring Data quality control

Reliable monitoring results are a precondition for an effective environmental management system, and would require participants in the RWQMP to agree on:

- regulations for data preparation, and terms and procedures for exchange of monitoring results;
- common principles for "control and quality guarantee" of monitoring data. QA/QC procedures will be clear, transparent and agreed between all parties for all stages, from sampling to issuing reports.

A data flow system shall be set up to guarantee access to data. Laboratories shall set up tracing procedures for samples covering all stages of sampling and analyzing. At all stages details of analyzing procedures should be reported in sample logs and all data have to be stored in laboratories. A QA/QC coordinator has to be appointed in all analytical departments.

All laboratories participating in monitoring program shall gradually incorporate into their activities **ISO 9000 and 17025** standards starting from taking samples up to the sample processing and testing. Following these regulations in context of data managing implies that:

- All data and related information could be found easily and used when necessary
- Data of several monitoring participants during the systematization process in countries shall finally be stored in a common database and reported in common format

Participating countries have to come to an agreement on the establishment of a regional data collecting and processing center for marine environment pollution. Arrangements for of such a regional center have to be elaborated in the framework of the next stages of the caspian environment program implementation.

5.7.3. Involvement of non-governmental laboratories and organizations into RWQMP planning, implementation and data analyses

The network of institutions involved in studying the conditions of the Caspian Sea includes non-governmental laboratories and analytical centers. Many of these institutions possess well equipped analytical laboratories, professional experts and well established systems of data processing. The majority of these centers appeared in the market of analytical and consulting services during the last 10-15 years. They operate within country specific legal frameworks, and their main clients are international and national extracting companies.

Technical opportunities, relatively high salaries and efficient management of these commercial laboratories and centers attract highly qualified experts. In general, these companies work according to international quality management standards. Involving them in the RWQMP, together with state institutions, is a logical step from an efficiency point of view.

Participation in national and regional monitoring programs for governmental and non-governmental organizations under market conditions contributes to a sustainable economical development of the countries.

5.7.4 Assessment of the transboundary pollution in frame of RWQMP

The development of a RWQMP and the creation of an integrated database with free access is an important step to come to coordinated environmental management. Establishing relations build upon trust, and creating mechanisms to respond adequately to accidents that might have a transboundary impact is also an important issue. Therefore it is recommended to make arrangements for joint marine environment conditions test in border areas.

Development of independent tools for satellite and distance monitoring of oil spills, formation of regional eutrophication effects at the coastal water areas and wastewater spills or transport accidents may facilitate such arrangements.

Discussions and potential conflicts are not limed to international boundary areas only. The outcome of monitoring activities could also create disputes. Laboratories that are able to make independent analyses corresponding to international quality levels are therefore essential. Each country needs at least one such analytical laboratory.

Settling disputes with regards to pollution issues should be in accordance with the SCAP adopted within the framework of the Teheran Convention (Teheran, on November, 10-12, 2008). The given report supposes establishment of the Regional center which can carry out independent estimations of safety of a condition of the sea in a context of the project of the Report on regional emergency preparedness and cooperation in case of the incidents causing pollution by oil.

It is recommended to involve international laboratories and agencies into settling disputes related to pollution as for example mass water blooming, death of the Caspian Seals, fish suffocation or oil films.

5.8. RWQMP coordination

Coordination of activities within a RWQMP framework is important for its effective implementation. Coordination will cover all stages of program implementation, and might include:

- Planning and elaboration of works regulations,
- Technical support,
- Data quality control ,
- Arrangement of international expeditions and bi-lateral sampling programs at the cross-sections in the national sea sectors and trans-boundary areas
- Harmonization of work and reporting methods,
- Financing and issues of technical and experts' assistance

Coordination of works in the framework of national programs should be executed through analytical centers and experts' groups established under the competent Ministries responsible for the implementation of regional water quality monitoring programs. Coordination of activities will be difficult without the establishment of centralized data processing centers and the creation of an integrated information system of data analyzing and processing at regional level. The most effective way to coordinate activities would be the creation of a coordination group consisting of key experts from participating countries. Experts could work on rotating terms under the Teheran Convention secretariat.

6. RWQMP FINANCING

Financing environmental monitoring programs is not a straightforward issue, given the generally poor state of public finance in the region. Items that need to be financed include the following:

- management and coordination of works,
- maintaining of the coastal monitoring stations network,
- maintaining of vessels for carrying out works at sea,
- carrying out expeditions at sea for taking samples and inspection supervision over pollution sources situated at sea,
- providing for qualitative performance of labs or to pay cost of samples' analytic measurements carried out by outsourced agencies;
- processing and making summary of results
- issuing bulletins and support of the information subdivisions in the work with customers of monitoring information, etc. (public relations)

The cost of supporting such programs may amount from $ 500,000 to $ 2,000,000 a year, and more, depending on salaries, infrastructure conditions, energy etc. Cost effectiveness and creating sustainable financing is a critical issue for the whole system of environmental monitoring.

The starting point has to be that financing the implementation of national and regional monitoring programs has to come from the region itself.

Financing for source monitoring has to come from the industries that are discharging. However their data should become available for national and regional monitoring programs.

It could be considered to establish a regional fund for common activities as: joint regional expeditions; measures on securing analytic labs' performance quality guarantee and supervision; conducting workshops and professional training; maintaining inter-regional centers for data processing and analysis; coordination of activities; publication of regional bulletins, etc., International organisations might want to contribute to this.

The principal sources of financing would be the following ones:

- Budgets of ministries and departments which are responsible for national monitoring programs and RWQMP implementation in the countries of the Caspian region.
- Non-budget environmental and other funds, e.g those receiving fines and penalties
- Special target programs and funds including international ones and the involvement of the insurance industry.

CONCLUSIONS

The Project has been implemented in Azerbaijan, Kazakhstan, the Russian Federation and Turkmenistan during a two and a half year period. Experts from twelve labs, consulting companies, independent experts, and specialists from various ministries, departments and agencies, along with international experts, were involved in achieving the objectives of the project. Methods, assessments of current monitoring programs and proposals on further RWQMP development and implementation were discussed during workshops, with the ministries and departments involved, and also during discussions and collaboration with experts. The findings, concepts and conclusions in this report are the result of this intensive regional co-operation. It has been a process that took time and efforts, but it has produced significant outcomes that are recognized as such by the countries.

For the first time since gaining independence the monitoring services of the countries of the region have independently carried out complex expeditions using their own vessels in their respective territorial waters, and used national laboratories for analyzing samples. Notwithstanding the fact that not all analytic measurements have been completed as yet, this is a major achievement.

Modern analytic equipment and needed sampling appliances have been delivered to the national labs. Late delivery due to problems with customs and other administrative obstacles made that not in all cases use could be made of this equipment during the implementation of this project, and not all equipment has been installed properly. Not in all countries expeditions were carried out successfully due to the lack of adequate vessels at the disposal of the competent agencies, and/or insufficient level of technical outfit. At the same time, it can be acknowledged that all countries have now labs with adequate equipment, and skilled and experienced staff. In principle, these labs are able to fulfill their tasks and to function adequately under the Regional Water Quality Monitoring Program for the Caspian Sea.

The main bottleneck remains the inadequate management structure, as illustrated by the lack of long term programmes on marine water quality monitoring and strategies, and the absence of effective co-operation and coordination arrangements between the (potential) partners in the Regional Water Quality Monitoring Program. The further development of the RWQMP will enhance the efficiency of the national programs in water quality monitoring.

The principles stated in the present report, including the recommendations on improving the analytic measurements capabilities, will basically allow the implementation of the measurements and observations which have been set forth by the RWQMP. At the same time, their implementation will be impossible if there are no detailed plans and schedules adopted at national level, and no further development of methodical support centers and research programs.

The program will also not be implemented effectively, if arrangements for coordination and data exchange are not properly elaborated between the partners in regional water monitoring. In other words, if there are no guarantees on impartiality and objectivity, regular testing of analytic labs procedures, and training for the personnel of the partners in the monitoring network. A Monitoring Protocol under the Tehran Convention would be the appropriate place to ensure reliability and efficient use of monitoring data in handling and solving the environmental issues in the Caspian region.

The program can also not be effective if no further development takes place of related monitoring programmes, such as "industrial ecological supervision" (source pollution monitoring), compliance monitoring and research programs, and when these programmes are not subject to common mechanisms of data quality assurance and integrated data management. Such a broad basis is needed for effective environmental management of the Caspian. Enhancing regulation and establishing such requirements is a task for regional cooperation in the next stages of development.

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ANNEXES

ANNEX 1 **Table A 1.1. Recommended specifications of parameters to be measured in water samples taken**

ANNEX 1 **Table 1.2. Recommended specifications of parameters to be measured in sediments**

ANNEX 2 **RWQMP Reporting formats**

ANNEX 1 Table A 1.1

Recommended specifications of parameters to be measured in water samples taken

		Salinity	pH	O_2	O_2	TSS	Secci	BOD-5	TOC	H_2S	P (PO_4)	P total	N (NH_4)	N (NO_3)	N (NO_2)	N, Total	SiO_4
		‰		%	µmol/l O_2	mg/L	m	µmol/l O_2	mg/L	mg/L	µmol/l P	mkg/L	µmol/l N	µmol/l N	µmol/l N	mkg/L	µmol/l Si
Mandatory or optional		m	m	m	m	m	m	m	op	op	m	m	m	m	m	m	m
Background values																	
Admissible level of concentration																	
Surface horizon																	
Deep horizon																	

Continuation Table A 1.1.

Cd	Cr	Mn	Co	Cu	Fe	Hg	Pb	Zn	DDT	DDD	DDE	a-HCH	b-HCH	Lindane	PCBs total	Phenols volatile	Phenol chlorinated	Detergents	TPH	Total PAHs
µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	ng/l	ng/l	ng/l	ng/l	ng/L	ng/l	ng/l	µg/l	µg/l	mg/l	mg/l	ng/l
op	op	op	op	op	op	op	op	op	op	op	op	op	op	op	op	m	op	m	m	m

m- to be measured obligatory (as a rule)

op – to be measured optionally (if possible)

*) the metals composition to be measured in samples taken from the land based sources of impact to be filtered

ANNEX 1 Table 1.2.

Recommended specifications of parameters to be measured in sediments

	TOC dry weight,	P total	Cd	Co	Cr	Cu	Fe	Hg	Pb	Mn	Zn	Al*	Ni	DDT	DDD
	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	g/kg	mg/kg	µg/kg	µg/kg
Sediments	op	op	m	m	m	m	m	op	m	op	m	m	op	op	op
Background values															
Top layer (0 - 3 sm)															

Продолжение Таблицы П-2

Petroleum Hydrocarbons Total (TPH)	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Floranthene	Pyrene	Benzo[a] antracene	Crisen	Benzo [a] pyrene	Benzo (ghi) perilen	Dibenzo [a,h] anthracene	Indeno (1,2,3-c,d) piren
mg/kg	individual PAHs(µg/kg)													
m	op	op	op	op	op	op	op	op	op	op	op	op	op	op

a-HCH	b-HCH	DDE	Lindane	PCBs	Phenols Chlorinated	Cs-137	Ra-226	Total beta radioactivity
ng/l	ng/L	µg/kg	µg/kg	µg/kg	µg/kg	Bk/kg	Bk/kg	Bk/kg
op	op	op	op	op	op	op	op	op

* Aluminium is used only for reference as a tracer of clay particles

m- to be measured obligatory (as a rule)

op – to be measured optionally (if possible)

ANNEX 2

RWQMP Reporting formats

These reporting formats were recommended by CEP PRAG IV in 2006 and could be accepted

Format templates are provided in file_ ***Formats.xls***. It consists of several worksheets. The first one is named "Samples info" and contains full meta-information about samples including:

- Station Name
- unique Sample Identified (Sample_ID)
- Country code
- Area description, e.g. "Ural river seashore"
- Sampling date and time (GMT)
- Coordinates on geographical and / or decimal form
- Bottom depth (in meters with the necessary precision)
- Sampling layer
- Sampling characterization (e.g. "silt", "whole mud" etc)
- Supplementary parameter such as sea water temperature and salinity at the bottom and at surface, pH, transparence, etc
- Comments

There can be also additional comments lines, if necessary. Additional columns that are useful from the point of view of the researcher can be added to the table (for example, distance offshore, other supplementary parameters etc).

Following data worksheets in template file contain formats for different groups of parameters agreed to be analysed under RPMP:

- Organic content (Total Petroleum Hydrocarbon TPH, Total Organic Carbon TOC), CO3 and Grain Size Data
- Chlorinated Pesticides (Lindane and DDT)
- Trace Metals (TM): Al, Cu, Fe, Hg, Zn

Each data worksheet contains Sample_ID, which links sample data with sample information of the "Samples info" worksheet. If data of some parameter(s) are absent, the corresponding worksheet cell must be empty. Additional columns with data or other useful information from the point of view of the researcher can be added to the worksheets.

Examples of reporting worksheets are given below.

Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern
TACIS/2005/109244

Samples information worksheet

Station	Sample_ID	Country Code	Area	Sampling Date (DD/MM/YYYY)	Sampling Time (GMT HH:MM)	Latitude (geo) DD°MM'SS"	Longitude (geo) DD°MM'SS"	Latitude (dec)	Longitude (dec)	Bottom Depth (m)	Sampling Layer (cm)	Sample characterization	Supplementary parameters*			Comment
													T°w (bottom)	S (bottom)	…	
7	KZ_07_1	KZ	Ural river seashore	02/08/2006	10:55:03	46°53'00"	51°26'00"	46.88333	51.43	1.6	5	whole mud (yellowish)				Example
10	KZ_10_1	KZ	Ural river seashore	02/08/2006	13:03:11	46°40'00"	51°40'00"	46.66667	51.66	1.8	5	sand with shells				Example
8	KZ_08_1	KZ	Ural river seashore	02/08/2006	14:15:48	46°48'00"	51°39'00"	46.8	51.65	1.4	5	silt				Example

Explanation:

Coordinates (dec) precision: 0.00001.

Depth precision: 0.1.

* Any other supplementary parameters can be added into the table, e.g.: pH, Tair, O2, transparency etc.

Organic Content and Grain Size Data worksheet

Sample_ID	Analysis Date (DD/MM/YYYY)	TPH ()	TOC (%)	CO3 ()	Grain Size Data* Fines <62.10 µm (vol%)			Comment
					2 mm - 200 µm, % (g per g)	200 µm - 63 µm, % (g per g)	< 63 µm, % (g per g)	
KZ_07_01	10/09/2006		0.34		4.3	77.6	18.1	Example
KZ_10_01	10/09/2006		0.16		5.5	84.6	9.9	Example
KZ_08_01	10/09/2006		1.8		0.7	24.3	75	Example

* Grain Size Distribution should be provided as detailed as possible, for example, with 20 µm step

Chlorinated pesticides worksheet

Sample_ID	Laboratory	Analysis Date (DD/MM/YYYY)	Analysis Method	Dry weight or Wet weight (DW or WW)	DW / WW Ratio	Fraction	Lindane (pg.g-1)	pp' DDT (pg.g-1)	op DDT (pg.g-1)	Comment
KZ_07_01	Test Lab	11/10/2006		DW	0.6	< 200 µm	<2	4	8	Example
KZ_10_01	Test Lab	11/10/2006		DW	0.7	< 200 µm	4	45	11	Example
KZ_08_01	Test Lab	11/10/2006		DW	0/8	< 200 µm	2.5	47	15	Example

Trace metals worksheet

Sample_ID	Laboratory	Analysis Date (DD/MM/YYYY)	Analysis Method	Dry weight or wet weight (DW or WW)	DW / WW Ratio	Fraction	Al (µg.g-1)	Cu (µg.g-1)	Fe (µg.g-1)	Hg (µg.g-1)	Zn (µg.g-1)	Comment
KZ_07_01	Test Lab	15/09/2006	AAS	DW	0.6	< 63 µm	74400	43.9	37600		84.5	Example
KZ_10_01	Test Lab	15/09/2006	AAS	DW	0.7	< 63 µm	65800	<5	37100	0.028	51	Example
KZ_08_01	Test Lab	15/09/2006	AAS	DW	0/8	< 63 µm	74400	34.4	40900		81.2	Example

Explanation:

Analysis method: provide international method code or codes, if different methods are used for different parameters.
In last case provide list of parameters associated with each method.

Dry weight or Wet weight: indicate **DW** if concentration is based on dry weight, otherwise indicate **WW**

Parameters: if parameter concentration is below the method Detection Limit (DL), provide it in the form "<DLV", where DLV is the value of DL

Client	:	the European Union
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File	:	
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Contributions	:	
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