

**ASSESSMENT OF POTENTIAL
CASPCOM CONTRIBUTION TO THE
TEHRAN CONVENTION IMPLEMENTATION**

1. THE ACTIVITIES OF CEP AND TEHRAN CONVENTION TOWARDS ENVIRONMENTAL MONITORING IN THE CASPIAN REGION

Throughout a decade of its activities, the Caspian Environmental Programme (CEP) had been keeping the Caspian Sea contaminant screening and pollution monitoring at the focus of its activity. There were several project accomplished which made a significant contribution to the assessment of the Caspian Sea contamination for a period after 1990.

1.1 CEP-2000

ASTP: Contaminant Screening Programme

The first large-scale investigations of the sediments quality in the coastal zone of the entire Caspian Sea were conducted as a part of the CEP-lead *At Sea Training Programme (ASTP)* with a financial support from UNDP-GEF in October 2000 through September 2001. A total of 105 samples of the bottom surface sediments were collected using a Van Veen grab. The focus was primarily on sediments from shallow depths, although material from as deep as 100 m was also obtained. Sample collection was accomplished during four separate oceanographic missions:

- 19 sediment samples were collected from transects along the Azerbaijan Republic coastline using the vessel *R/V Mammed Suleymanov* during the period of the 15-24 October 2000;
- 21 sediment samples were collected from transects near the Russian coast of the Caspian Sea from *R/V Gidrohimik* and *R/V Issledovatel Kaspiya* owned by the Caspian Fisheries Research Institute (Russia) during mid- to late October 2000;
- 29 sediment samples were collected from transects along the Iranian coastline using the *R/V Issledovatel Kaspiya*. During this mission, 2 deep-water samples from the water area offshore Turkmenistan and 1 deep-water sample offshore Kazakhstan were also obtained;
- 33 sediment samples were collected from transects in the Northern Caspian Sea off the Kazakhstan coast using the Russian *R/V Midiya*.

The samples from the waters off the Russian coast were analyzed at the chemical laboratory of the "Typhoon" Center for Environmental Chemistry (Obninsk, Russia). All other samples were analyzed at the International Atomic Energy Agency Marine Environmental Studies Laboratory in Monaco. The samples were analyzed for grain size distribution, heavy metals, petroleum hydrocarbons, polyaromatic hydrocarbons, chlorinated pesticides, polychlorinated biphenyls (PCBs), total organic carbon, lipids.

The results of Contaminant Screening Programme were given in the following reports

- International Atomic Energy Agency-Marine Environment Laboratory, *Final Report: Caspian Sea 2000, Phase 1, Contaminant Screening*.
- Scientific Production Association “Typhoon” Institute of Experimental Meteorology - Center for Environmental Chemistry, *Determination of Heavy Metals and Organic Pollutants in samples of bottom sediments of Russian Sector of Caspian Sea*, Final Report on the Contract RER/98/G32 – Caspian Environment Programme Contract ENVP-PS-110205.
- International Atomic Energy Agency-Marine Environment Laboratory, *Final Report: Caspian Sea 2001, Phase 2, Contaminant Screening*.
- International Atomic Energy Agency-Marine Environment Laboratory, *Final Report: Caspian Sea 2001, Phase 3, Contaminant Screening*.

1.2 CEP-2002

TDA: Transboundary Diagnostic Analysis for the Caspian Sea

A Transboundary Diagnostic Analysis (TDA) of 2002 summarized the existing data of monitoring and scientific investigations of the Caspian Sea environment. Based on this analysis, pollution hotspots were identified. These hotspots were to become targets for further monitoring efforts.

1.3 CEP-2005

Scientific Sea Cruise 2005 (SSC-2005)

Scientific Sea Cruise 2005 (SSC-2005) was implemented in summer–autumn 2005 as a part of the CEP Strategic Action Plan. Three research vessels (RV) were employed to cover the entire Caspian coastal waters: RV *V Gilan*, IFRO, I.R.Iran (Leg 1), RV *Alif Hadjiev*, MENR, Azerbaijan (Leg 2) and RV *Tantal*, Roshydromet, Russia (Leg 3). A total of 74 duplicate sediment samples were collected including 16 in waters adjacent to Azerbaijan, 19 – Iran, 8 – Kazakhstan, 13 – Russia, 18 – Turkmenistan.

One of the main features of the project was the Training Programme which included a short on-land training course (half a day) followed by on-board practices on sampling methodology, sample handling and preservation for laboratory analyses. The training was provided by a representative of IAEA Marine Environment Studies Laboratory (MESL) and was viewed as a contribution to improved skills for bottom sampling monitoring in the Caspian Sea countries.



Fig. 1.1 Legs by RV *V Gilan*, I.R.Iran (green dots), RV *Alif Hadjiev*, Azerbaijan (yellow dots) and RV *Tantal*, Russia (purple dots) during Scientific Sea Cruise 2005

The laboratory analyses of the collected samples included determination of more than 100 different contaminants, including Trace Metals, Petroleum Hydrocarbons, Chlorinated Pesticides and others. Analyses were conducted by qualified national and international laboratories:

- MESL, IAEA, Monaco (Leg 1)
- AzEcoLab, Azerbaijan (Leg 2)
- Shirshov IO RAS / Typhoon consortium, Russia (Leg 3)

The SSC-2005 results were presented at the CEP Steering Committee Meeting in December 2006.

An inter-laboratory study was undertaken by CEP with the help of IAEA-MESL in 2005 in order to assess the regional capacity to carry out required analysis of sediment samples. The results of the proficiency test were made public at the P-RAG 4 meeting in Baku in October 2005.

1.4 Volga Cascade 2005 (Volga Delta-2005)

In 2005, a study and review for determination of major pollutants flow from the Volga Cascade was accomplished under an umbrella of the UNDP/GEF Project “Implementation of Convention and Action Plan on Caspian Sea Environment Protection – Phase II” by Roshydromet, Center for International Projects (CIP) and Institute for Water Problems of the Russian Academy of Sciences.

Analysis of the published and archive data on the main persistent toxic substances (PTS) in water and bottom sediments in the Lower Volga within a distance of 200 km from the Caspian Sea was carried out. The data came from Roshydromet monitoring network in the upper and central parts of the Volga Delta as well as from scientific expeditions. A description of temporal dynamics and spatial distribution of pollutants in water and bottom sediments in the Lower Volga and its delta as well as in the estuarial seashore shallow zone was prepared. Zoning was carried out and data on hydrological regime in the delta and estuarial seashore shallow zone were summarized for the last 10 years to estimate a mean annual pollutant discharge by the Volga River into the Caspian Sea.

To support the results of the desk study, field investigations were implemented in the Volga Delta and estuarial seashore shallow zone. All 37 samples collected were subject to laser granulometric analysis and determination of content of total organic carbon, and 5 most fine-grain samples, to a comprehensive chemical analysis (metals, aliphatic and polyaromatic hydrocarbons, chlorinated pesticides and polychlorbiphenyls).

The results of the desk and field studies on the bottom sediment pollution in the Volga Delta were compared. Gaps in knowledge of water dynamics and pollutants evolution processes in the Volga Delta were revealed and major tasks for future scientific research in the area proposed.

1.5 Kura-2005

Contaminant fluxes from Kura River

In order to have a better understanding of the contribution of Kura River to pollution loading of the Caspian Sea, a CEP regional project “Study and Survey Project to Determine the fluxes of major contaminants from the Kura to Caspian Sea (Mingechaur Reservoir to Kura Delta)” was conducted. The general objective of the project was to determine the fluxes of major persistent toxic substances (PTS) from the Kura river basin located in Azerbaijan Republic. For this purpose, PTS in Suspended Materials (SM) of Kura River in certain locations between Mingechaur reservoir and the Kura mouth during critical flow (highest and lowest flow) periods were determined. The field study involved collection of one sediment sample and twelve suspended sediment samples in the outlined areas in June and August 2005. The survey also focused on identification of obsolete pesticides hot spots in the region of Kura river.

1.6 Terek-2006

Contaminant fluxes from Terek, Sulak and Samur Rivers

To obtain an estimate of contaminant fluxes from Terek, Sulak and Samur Rivers “A Desk Study Project to determine the fluxes of major contaminants from the Terek River into Caspian Sea” was implemented in 2006. The historic

monitoring data for 2002 – 2005 were applied to assess concentrations of petroleum hydrocarbons, heavy metals, phenols, detergents, nutrients (nitrites, nitrates, ammonium and total nitrogen) and silicates. Complimentary data on both water and sediments collected in several scientific expeditions at hydrological Karagalinsky hydro system and Alikazgan stations in the Terek delta for 2002-2004 were also used for the river discharge rate and pollution estimation .

1.7 TACIS-2005 CaspianMAP

The most recent activity in support of the Caspian Sea monitoring was the EU / TACIS project “Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern’s (CaspianMAP)” which started in 2005 and finalized in 2009. The overall objective of the CaspianMAP was to achieve improved quality of the marine and coastal environment of the Caspian Sea. Among the main targets of the project was a revision of a present status of the Caspian Sea monitoring programmes of littoral states with special attention to key ecological problems and main analytical laboratories in the region.

Four ship-borne pollution surveys were carried out in 2008–2009, one in each of the four participating countries except for Iran. All cruises were carried out by organization and experts from countries, with support from international staff.

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 and open-sea based sources of pollution;
- 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 on a 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, analyze and report on samples.

The expeditions were conducted for Kazakhstan, Azerbaijan, and Turkmenistan during autumn 2008. 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 based on the results of the inter-calibration test. The most complete set of requested sample analyses were carried out by “AzEcoLab” (Azerbaijan)

and SPA “Typhoon” (Russian Federation) laboratories. TPH and trace metals concentrations were presented more or less satisfactory by all laboratories while organic pollutants were analyzed for samples taken along southern part of Azerbaijan Coast and for samples taken nearby the Russian coast of the Caspian Sea.

In the frame of additional Contracts with each littoral country the TACIS Programme provided equipment mainly for field sampling and laboratory chemical treatment.

In the frame of the CaspianMAP Project the basic recommendations for a regional water quality monitoring program (RWQMP) were developed, including program design covering description of background level of regional pollution; international practice of establishment of priority pollutants in marine monitoring programs; description of parameters to be analyzed in water and sediments; frequency of sampling; quality control and assurance; proposed improvements in the regional laboratories practices . Recommendations by CaspianMAP project are of great importance for the future Caspian monitoring program and will be widely cited below.

Thus, under CEP and TACIS guidance, for the first time since gaining independence, the monitoring services of the Caspian littoral countries had carried out complex expeditions in their respective territorial waters using their own vessels and national laboratories for analyzing samples. Modern analytic equipment and sampling appliances were delivered to the national labs. However, not in all countries expeditions were carried out successfully due to the lack of adequate vessels and/or insufficient level of technical outfit or/and trained personnel.

1.8 Draft First Caspian State of Environment Report

The 97-page First SoE-2010 Report drafted by an international group of experts on request of the Interim Secretariat of TK covers various aspects of the Caspian Sea state of environment. The most important issues are:

- pressures including extraction of bio- and non-living resource, changing run offs, air emissions and waste (solid domestic waste, radioactive waste, industrial waste, agricultural waste);
- state of the environment including marine water quality and air, soil , sediment , incoming fresh water quality and current situation with biodiversity;
- impact of pressure in social and economic sector and environmental services and bioresources;
- response to the pressures including regional and national governance, policy and legislation, monitoring activities and sharing of information;
- in general, document looks balanced and covers all major problems in the region. Though the report could not describe all features of Caspian ecosystem and human pressure on it, nevertheless the main crucial points were mentioned.

In the sub-chapter *5.1. State of marine water quality and incoming freshwater* the main sources of pollution are noted including fresh-water discharge of different rivers. All major river systems are briefly described with a list of predominant pollutants, as well as identification of the main gaps in monitoring systems in different countries which have resulted in incomplete information on some aspects of the local environment. The large part of the text is devoted to identification and description of the long-term trends in concentration of major pollutants namely petroleum hydrocarbons, phenols, detergents, pesticides, ammonium, trace metals and oxygen conditions separately in Northern and Southern parts of the Caspian Sea.

It has to be admitted that the authors have faced difficulties in finding the necessary information. Thus, due to the lack of information, it is difficult to assess contribution from the non-point sources to marine environment contamination. The same is true for the industry discharges which substantially contribute to the Caspian Sea contamination as well as for the pollution sources upstream the Astrakhan District. There are not sufficient information related to pollution reaching the sea from Islamic Republic of Iran.

However, in general, the conclusions of the report look well-justified and acceptable.

Some comments and remarks can be still made:

- the DPSIR methodology has not been always followed, especially while assessing Drivers/Forces behind the changes in the marine environment;
- data on the water quality is not presented in a systematic way. For, example, MAC as a water quality index, is applied only partly, not to all sites/water bodies;
- data related to economical development are not coherent throughout the Assessment;
- data on the river run offs have not been properly collected thus not enabling an assessment of the river pollution loads. As a result, it is difficult if not impossible to assess the impact of the river pollution on the sea water quality;
- the description of climate change could be complemented with data on trends;
- it would be recommendable to complete each chapter with a paragraph of recommendations.

2. CASPCOM: ORGANIZATION, OBSERVATION NETWORKS, DATA AND PRODUCTS

2.1 History, organization and scope of activities

The Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea (CASPCOM) was established by heads of the National Meteorological and Hydrological Services (NMHS) of the Republic of Azerbaijan, Islamic Republic of Iran, Republic of Kazakhstan, Russian Federation and Turkmenistan (hereafter, littoral states) at a meeting in Tehran in September, 1994 with a view to foster

coordination and coherence of observations and practices in the fields of hydrometeorology and pollution monitoring of the Caspian Sea. The Statute of CASPCOM was adopted at the same meeting.

The Coordinating Committee unites, on a voluntary basis, the efforts of NMHS of the Caspian littoral states towards a proper regional system for obtaining and exchanging information on the state of the Caspian Sea, in order to ensure safety of lives and facilitate sustainable economic development of the region. In their activities, the regional NMHSs are guided by the Integrated Programme on Hydrometeorology and Pollution Monitoring of the Caspian Sea which was adopted by CASPCOM in late 1990-ies.

The CASPCOM meets once a year and is headed by Chairperson and Vice-Chairperson who change every two years on rotation basis. At present, the CASPCOM Chairperson is Dr. Alexander Frolov, the Head of Roshydromet. The inter-session activities are facilitated by the permanent CASPCOM Coordinator who is Dr. Sergey Monakhov, Director, Caspian Marine Research Centre of Roshydromet, based in Astrakhan.

The scope of CASPCOM activities mirrors the scope of the domestic responsibilities of NMHSs in the Caspian littoral states. All of them are responsible for weather and sea state observation and forecasting and climate monitoring in their respective states. In-land hydrology is handled by NMHSs of Azerbaijan, Kazakhstan, Russia, and Turkmenistan while environmental pollution (that of air, fresh and sea water, soil) is included into mandates of only two NMHSs – those of Kazakhstan and Russian Federation. For this reason the mainstream of the CASPCOM activities resides in monitoring and forecasting of marine weather, climate and sea surface conditions (wind waves, storm surges, temperature). All CASPCOM members are interested in technologies for meteorological support to oil spill combat operations. The current pollution monitoring activities in the Caspian littoral states are also reported to CASPCOM, but mainly by Roshydromet and Kazhydromet.

The main lines of cooperation among the regional NMHSs are

- coordination of national plans for rehabilitation and development of national observation networks, data collection and processing systems, numerical forecasting systems;
- monitoring of real-time exchange of observation data from hydrometeorological and aerological stations in the Caspian Sea region following the World Meteorological Organization data exchange scheme;
- real-time exchange of meteorological and , partly, oceanographic forecasting products (mainly, high wave and wind-surge warnings);
- delayed-mode exchange of data of meteorological observations, marine coastal hydrological observations (sea level, sea surface temperature and salinity) and, partly, marine pollution monitoring;

- implementation of joint or coordinated ship surveys for marine hydrological, hydrochemical and pollution monitoring and research works in both off-shore and coastal zone of the sea;
- production of joint reference materials / assessments in the Caspian Sea hydrometeorology, hydrochemistry and pollution;
- joint action on NMHS - personnel training.

The following CASPCOM activities are related to TC implementation:

- forecasting and warning of adverse hydrometeorological events (strong wind, high waves, wind surges) – Art. 13
- forecasting sea currents – Art. 17
- regional climate monitoring – Art. 14, 20
- monitoring of hydrological regime of the sea (including sea level) and inflowing rivers – Art. 20, 16, 19
- monitoring of hydrochemical state and pollution of the marine environment – Art. 19

2.2 Past and planned CASPCOM activities and contribution to monitoring of the Caspian Sea hydrometeorology and pollution

Observations of marine water pollution in the Caspian Sea were launched in the mid-1960s, but they became systematic only in 1972 when State Service for Observation and Controlling Pollution of the Natural Environment was established in the USSR. The procedures for organizing and carrying out the observations were prescribed by the State Standard "Regulations of marine water quality control" (GOST 17.1.3.08-80, introduced on 1 January 1983).

Advantages of the monitoring system were determined by:

- using as a base the existing system of hydrometeorological and oceanographic observations both in coastal areas and at high sea (the system of the long-period, the so called "century", cross-sections);
- making meteorological, hydrological, hydrochemical and later hydrobiological observations at the same observation sites;
- relating the frequency of observations (both in coastal waters and at high sea) to the level of anthropogenic loading;
- using the data not only for marine water quality assessment, but also for identifying pollutants balance, which is an integral part of marine environment assessment in its present conception.

The main drawback of the system of marine water pollution monitoring was a limited list of controlled pollutants and the use of typically non-selective extraction - photometric methods in the analysis. In the mid-1980s, the list of controlled substances was extended to comprise heavy metals and

organochlorine pesticides. At the same time, bottom sediments were included in the list of monitored components of the marine environment.

The data on petroleum products (obtained with infrared spectrometry), heavy metals (obtained with atomic absorption spectroscopy), pesticides (obtained by gas-liquid chromatography) are regarded as reliable since they are comparable to the data obtained by modern methods and at other inland seas.

The system of marine water pollution monitoring covered the whole Caspian Sea with the exception of the area adjacent to the Iranian coast. Observation data were summarized in yearbooks of marine water quality, which laid the basis for the later reviews (Mekhtiev, Gyul, 2006).

The integrated nature of these observations made it possible to carry out a retrospective assessment of marine environment condition using hydrological and oceanographic data for calculating flows and balances of pollutant substances (Estuarine area, 1998). The following parameters were calculated for separate sea sectors: load, pollution potential and assimilation capacity of marine water regarding petroleum products (Environmental assessment, 2005, 2006). It should be noted that such tasks could hardly be accomplished if marine pollution observations stood apart from hydrological and oceanographic observations.

After the decay of the USSR, the pollution monitoring system of the Caspian Sea established in the 1960s was largely undermined because of lack of funding and a reformation of state agencies in the Caspian states. Thus, the NMHSs of Azerbaijan and Turkmenistan were deprived of the monitoring functions and that put a stop to observation at high sea (including those at cross-sections). Observations continued in the coastal areas, but less frequently. They lost their integrated character as a result of reduction of the controlled parameters list, and their mission was confined to marine water quality assessment.

This might be the reason why the 1st assessment of marine environment condition (in its current conception), such as Trans-boundary Diagnostic Analysis (TDA) implemented within the 1st stage of the CEP, failed to implement ecosystem approach in its full extent. TDA regarded the elements of marine ecosystems as well as different external factors, affecting its condition as not related to each other.

The recent years have seen favorable conditions for restoring integrated monitoring and extending its functions. These favorable conditions include:

- a) emergence of industrial environmental monitoring based on ecosystem approach carried out by oil and gas companies;
- b) development of hydrodynamic models of the Caspian Sea, which, as well as daily forecasts of waves, surges and currents, allow calculation of fluxes and budget of pollutant substances;
- c) extension of satellite monitoring capabilities, taking into account that satellite data have become more available and

are used for observing not only physical, but also biological parameters and the pollution of water area;

d) development of a set of indicators used for marine environment assessment, including the assessment of pollutant activity (which impact on biota depends on pollutant activity more than on its concentration); quality assessment of marine water and bottom sediments; assessment of plankton and benthic biodiversity, assessment of anthropogenic load on the water area, assessment of weather and climate impact on marine environment and economy.

On the whole, the abovementioned products can be regarded as a system of hydrometeorological support of monitoring and marine environment assessment. Services provided by the system include the following:

- a) data of ship-borne, coastal and buoy hydrometeorological observations, estuarine hydrological and hydrochemical posts;
- b) currents and sea level fields calculated on the basis of actual observations as well as water exchange indicators;
- c) satellite data on temperature, ice cover, chlorophyll and suspended matter in the water, oil film on the sea surface;
- d) indicators of the state and pollution of marine environment, where the calculation technique requires hydrometeorological and oceanographic data.

Currently this system, though not completed, is used for the assessment of conditions of water areas where facilities of oil and gas complex are located.

The major CASPCOM projects including those implemented in collaboration with CEP and TACIS are:

- joint Russian-Kazakh ship survey of the Northern Caspian Sea pollution and hydrochemistry (2002);
- survey of the Northern Caspian pollution patterns as a part of the CEP-sponsored Scientific Sea Cruise 2005;
- survey of the Volga Delta pollution patterns as a part of the CEP-sponsored Volga Delta Field Study (2005);
- evaluation of historic Volga Delta pollution as a part the CEP-sponsored Volga Delta Desk Study (2006);
- Hydrometeorological Atlas of the Caspian Sea (2006)
- survey of the pollution patterns in the Northern Caspian Sea and at the sea edge of the Volga Delta as a part the EC/TACIS Project "Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern" (2008);
- Guide to Internet Resource on Hydrometeorology of the Caspian Sea (2009);
- General Catalog of the Caspian Sea Level (2010);
- International Conference "Climate and Water Balance Change in the Caspian Region", Astrakhan, 2010;
- CASPCOM Information Bulletin. First Issue (2010).

2.3 Observation networks and procedures and their impact on data quality

2.3.1 Hydrometeorological networks

Caspian NMHSs maintain meteorological, aerological and hydrological networks.

The number of coastal marine hydrometeorological stations (observing, apart from standard meteorology, also water temperature, level and waves) is 13 in Azerbaijan, 4 in Iran, 7 in Kazakhstan, 8 in the Russian Federation and 6 in Turkmenistan. In addition, the fresh water discharge into the sea from large rivers is measured by 15 hydrological posts in the Russian Federation and 3 in Kazakhstan. Most marine stations are equipped with automated meteorological units. More information about the hydrometeorological network can be found on the CASPCOM website <http://caspcom.com/hydromap/index.html>

Marine autonomous hydrometeorological stations are planned to be installed in the coastal areas of Kazakhstan, Turkmenistan and Russia (2 buoy stations near the Iranian coast are already in operation). It should be noted that the Caspian NMHSs have experience in deploying floating buoys (drifters).

"Elektro L" (GOMS 2) satellite covering the Caspian Sea in its surveillance area was successfully launched to the geostationary orbit on 20 January 2011. The satellite is designed for conducting multi-spectral survey within the visible and infrared ranges, resolution being 1 and 4 km respectively, as well as for analyzing the state of marine and ocean water areas (waves, surface temperature, and coastal surges). Another application of the satellite "Elektro L" is to receive and retransmit the data from autonomous meteorology platforms.

2.3.2 Hydrochemistry and pollution monitoring networks

Roshydromet and Kazhydromet maintain networks for hydrochemical and pollution monitoring in the Caspian Sea (Fig. 2.1).

Red points are marine coastal hydrometeorological stations, black points are stations on the long-term hydrological cross-sections, grey yellow points are the pollution monitoring stations, half black – half grey yellow are the hydrological stations where pollution sampling is made (the so called "combined" stations) . Areas I-II and III - VI are monitored by Roshydromet and Kazhydromet, respectively.

East of the Russian – Kazakhstan border meridian the water samples for chemical analysis are taken regularly at six river observation sites including the Ural River and some branches of the Volga River on the Kazakhs territory and also at 12 stations in the Northeastern part of the Caspian Sea including 2 stations at the Ural – Caspian Sea Channel. In these areas, water samples are taken by the Kazhydromet Atryrau Hydrometeorological Center from April to November (the ice-free period).

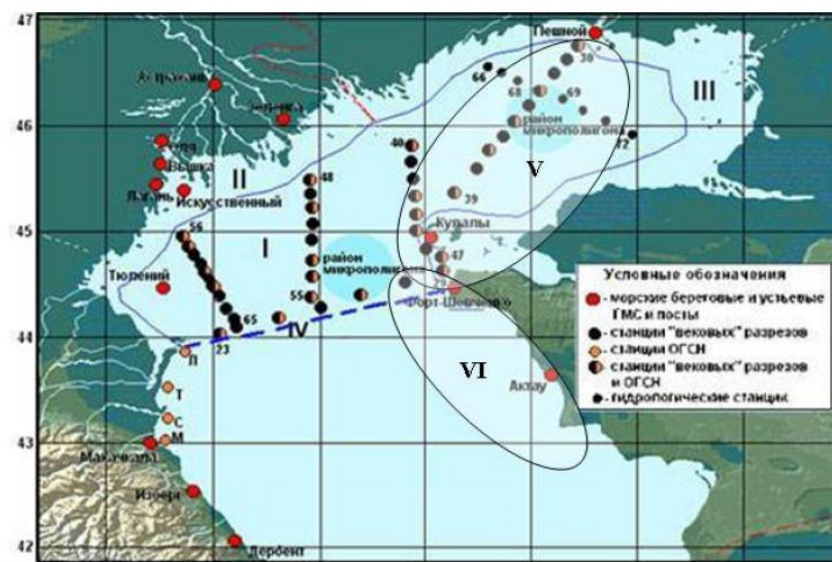


Fig. 2.1 The network for hydrochemical and pollution monitoring in the Northern Caspian Sea

The Mangistau Regional Hydrometeorological Center is responsible for the water samples taken quarterly at 3 stations (Fort-Shevchenko, Fetisovo, Kalamkas) and also in the open sea along 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.

Research Vessel «Tagibat» belonging to the Atyrau Monitoring Centre is used for sampling operations. Sediment samples are being taken in the open sea only once or twice a year.



Fig. 2.2 Research Vessel «Tagibat» and some its on-board equipment

Pollution monitoring areas along the Russian coastline, from the border with Kazakhstan to the border with Azerbaijan (Fig. 2.3) are served by the Roshydromet Dagestan. Regional Hydrometeorological Center in Makhachkala.



Fig. 2.3 Main areas of pollution monitoring along the Russian coastline 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 trans-boundary monitoring along the Russia and Azerbaijan border. 6. Station for background observation

The Dagestan center operates two vessels (Fig. 2.4) that regularly undertake sampling, mainly under commercial contracts. The vessels have basic rigging equipment (winches, bathometers), rooms for primary processing and storage of samples. However, these vessels do not carry modern oceanographic equipment and instruments, and multi-parametric probe-bathometers.

“*Neptun*” operates mainly in the coastal area and has a limited navigability (seaworthiness) capacities. “*Tantal*” has a stationary equipment and electric winches by means of which samples of water and bottom sediments can be taken from the depths more than 1000 m. The oceanographic equipment aboard the vessel consists of the Rotan probe for water temperature and salinity measurements at depths up to 100 m, and the deep-water Teflon 10- and 51 liter bathometers.



Fig. 2.4 The “Tantal” research vessel, which belongs to the Dagestan hydrometeorological center in the open sea (on the top) and the “Neptun” vessel available to take samples in the shallow area of the Northern Caspian Sea and in the Volga River Delta (at the bottom).

The observations are more or less regularly carried out only for the hydro-chemical regime of the sea water (including nutrients), 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 Environment Chemistry Center of the “Typhoon” Scientific and Production Association (Obninsk, Russian Federation) 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 Roshydromet in analytic support for the hazardous pollutant monitoring programs. The highly qualified experts, who work in the Center for Environmental Chemistry, can provide training programs for personnel from the labs of the Caspian Sea littoral states. 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 Center can 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 environmental monitoring program.

In Kazhydromet, the analytical work is carried out by three main laboratories that are established in Almaty, Aktau and Atyrau. The analytical labs of the regional centers in Mangistau (Aktau city) and Atyrau are considered by Kazakhstan authorities as likely future partners for a Caspian regional monitoring program.

2.3.3 A likely impact of observation and analytic procedures on data quality

Meteorological, aerological and hydrological observations are performed in accordance with the standards established and supervised by the World Meteorological Organization. The observation standards include periodical calibration of observation instruments, as well as regulations for their installation and maintenance. These procedures guarantee the quality of meteorological and hydrological observations within the international standards.

The quality of the chemical data is not so certain. The data of sea water routine monitoring on concentration of petroleum products, heavy metals, pesticides obtained in the regional Caspian laboratories are regarded as rough but reliable as they are comparable to the data obtained by more modern methods and in other inland seas. For this reason, the data on the sea water pollution available since mid-1960-ies is an important background information indispensable for long-term trend identification.

On the other hand, a much more precise and most valuable information on water and especially bottom sediments pollution was obtained from several CEP and TACIS projects. These Projects completed in 2000, 2005 and 2009 produced a lot of detailed information on concentration of specific organic and trace elements pollution over the whole shelf zone around the Caspian Sea. The list of measured organics is very long and covers practically all most important pollution substances in the region, including petroleum hydrocarbons, polyaromatic hydrocarbons, organochlorine pesticides, polychlorbyphenils and many others. All these analysis are very expensive and require a high level of chromatography and experienced staff. In many local laboratories in the Caspian Sea littoral states there is no capability to analyze organic compounds with acceptable detection level, as it was confirmed with several inter-calibration conducted in region under the CEP and TACIS umbrella. So, international projects could be considered as a major source of deep knowledge on the real state of organic substances and trace metals pollution, especially in sediments.

The third important source of knowledge on the Caspian Sea conditions are the targeted environmental surveys (the so called industrial ecological monitoring) usually conducted under the contracts with oil and gas companies. A set of environmental parameters determined in those surveys might be very useful for the assessment of marine ecosystem health.

Therefore, a combination of different approaches and sources of information, complementary to each others, would be the best solution for a rather difficult question how to find

the proper data for the assessment of the current state of marine environment and its historic evolution.

2.4 CASPCOM capabilities and resources in data collection and analysis

Roshydromet holds the data on marine hydrochemistry and pollution from both routine monitoring and dedicated ship surveys from early 1970-ies till nowadays. At the moment, an extensive work is on to transform the historic hydrochemical and pollution data into digitized form and, eventually, to feed them into a database.

Such a database on the marine environment pollution, including that of the Caspian Sea, has been under construction in Roshydromet for further incorporation into the Unified System for Information on Situation in the World Ocean (Russian acronym – ESIMO).

CASPCOM has developed a General Catalog of sea level data allowing an insight into the history of the mean sea level changes during the last 100 years or so.

Since late 1960ties, Roshydromet has been annually publishing *Year Book on Sea Water Quality based on Hydrochemical Indicators* which summarizes the data on pollution of all 10 seas washing the Russian coastline (including the Caspian Sea).

The Roshydromet data analytical experience has come also from participation in drafting the *State of Environment of the Black Sea* (2008) sponsored by the Black Sea Commission and earlier Periodic Assessments of the Baltic Sea Environment.

NMHSs use the products of hydrodynamic model calculation in their activities. Wave models are in operation in Azerhydromet and the IRIMO, models for surges and sea current, in Kazhydromet and Roshydromet (Fig. 2.5). The latter are the key element in both providing a real-time support to oil spill combating operations and assessing trans-boundary pollution fluxes averaged on monthly or annual bases.

Roshydromet possesses a model predicting transformation of the oil spill (Fig. 2.6) due to physical and chemical processes (spreading, evaporation, emulsification, coagulation, etc.) as it is carried by wind and sea currents with a due account to the oil physical and chemical properties of oil (density, ratio of light and heavy fractions, etc.) and environment (temperature, waves).

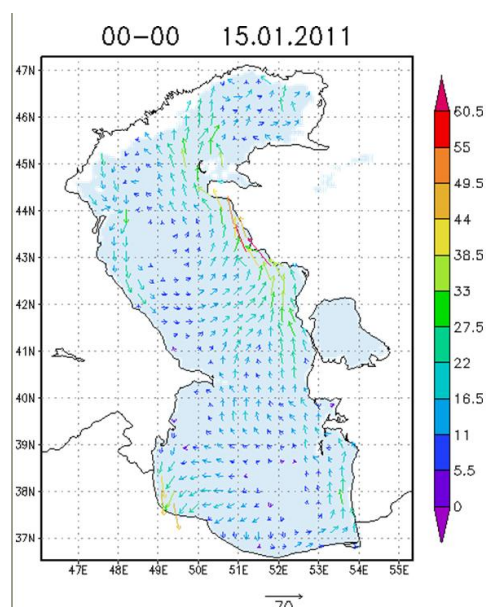


Fig. 2.5 Forecast of the sea currents for the next 48 hours issued by Roshydromet at 00 hours GMT 15 January 2011

Source: <http://hmc.hydromet.ru/sea/casp/surge/CaspSurge.php>



Fig. 2.6 Simulating an evolution of an oil spill at Filanovsky Oil Field in the Northern Caspian Sea at 28 hours (on the top) and 85 hours (at the bottom) after the spill occurred.

In October 2010 CASPCOM held international scientific conference "Climate and water balance changes in the Caspian region" (19-20 October 2010, Astrakhan), where the majority of participants represented the NMHSs of the Caspian states. The resolution adopted at the conference states that the natural systems of the Caspian region are "vulnerable to climate and water balance changes. Environmental and social-economic consequences of these changes are ambiguous. In case preventive adaptation lacks, the damage can be catastrophic". Taking into account strong dependence of the Caspian Sea ecosystem on climate and water balance changes, it was recommended to improve climatic support of the activities in the field of protection of the Caspian Sea environment.

2.5 Gaps in the present monitoring system and capacity needs in the Caspian region

Hydrometeorological monitoring

In general, the Caspian states have a sufficient capability to conduct hydrometeorological monitoring and provide a general picture of the hydrometeorological conditions of the Caspian Sea. The principal gap in hydrometeorological monitoring system is a lack of automatic stations capable of reporting meteorological and hydrological conditions at the remote locations. The littoral states are now trying to fill that gap but it will require funds and take time.

Hydrochemical and pollution monitoring

The system of hydrochemical and pollution monitoring has much more gaps than the hydrometeorological one. They are old survey ships, shortage of laboratory equipment and, the most important, lack of trained personnel.

According to the TACIS Caspian MAP project findings, the main bottleneck remains the inadequate management structure, as illustrated by the lack of long term programmes on marine water quality monitoring and strategies. The recommendations on improving the analytic measurements capabilities will be impossible to implement if there are no detailed plans and schedules adopted at national level, and no further development of methodical support centers and research programs.

Important is the absence of effective cooperation and coordination arrangements between the countries in the water pollution monitoring in the Caspian region. 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. 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.

Any regional monitoring program or protocol can not be effective if no further development of related monitoring programmes takes place, such as industrial ecological supervision/monitoring (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. Enhancing regulation and establishing such requirements is a task for regional cooperation in the next stages of development.

Another recommendation is to pay more attention to monitoring the river mouths and adjacent sea areas in order to take into account the dynamics of the geochemical barrier across river and sea waters and its role in accumulation, transformation and depositing pollutants.

Also important is to complement the in-situ hydrometeorological and pollution monitoring with remote sensing techniques to ensure timely identification of adverse natural processes in river delta areas and on the sea coast and to conduct a regular monitoring of temperature, concentration, chlorophyll, sea ice and oil pollution (films) on the sea surface.

The TACIS Caspian MAP project provided the following recommendations for the regional laboratories to improve the quality of analytical chemical measurements:

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. It is also recommended to arrange for internships in the Center for Environmental Chemistry SPA "Typhoon" (Obninsk, Russia) 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.

3. CASPCOM POTENTIAL CONTRIBUTION TO MONITORING OF THE CASPIAN SEA ENVIRONMENT

3.1 Provisions of the Tehran Convention, requiring hydrometeorological data for their implementation, as the legal basis for TK-CASPCOM cooperation

The legal basis for cooperation between the Tehran Convention and CASPCOM is provided by the Convention provisions which require hydrometeorological and oceanographic information for their implementation. These provisions, as stated in the text of the Convention, comprise the

those provided by Art. 13, par. 1; Art. 14, par. 1; Art. 16; Art.19, par. 1 and 3; Art. 20.

The exact wording of the above mentioned provisions as well as the description of ways and methods for using hydrometeorological and oceanographic information for the implementation of these provisions is presented in the Table 3.1. The table suggests that information on environment is required to carry out the following activities on Tehran Convention implementation:

- marine environment protection from natural and man-made emergencies (Art. 13);
- protection, preservation, restoration and efficient use of marine living resources of the Caspian Sea (Art. 14);
- monitoring and assessment of environmental conditions of the Caspian Sea (Art.19);
- improvement of knowledge on the hydrological regime and ecosystem dynamics of the Caspian Sea including sea level fluctuations to mitigate their consequences (Art. 16 and 20)

Table 3.1

Provisions of the Tehran Convention requiring hydrometeorological and oceanographic information for their implementation

NN	Provisions (article, paragraph) of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea	Ways and methods for using hydrometeorological and oceanographic information
1	2	3
1	Ar. 13, par. 1. The contracting Parties shall take all appropriate measures and cooperate to protect human beings and the marine environment against consequences of <i>natural or man-made emergencies</i> . To this end, preventive, <i>preparedness and response measures</i> , including restoration measures, shall be applied	A system for early warning of hydrometeorological hazards (storms, surges, rapid ice formation etc.) is to be established and maintained to enable <i>preparedness and response measures</i> . Marine hydrometeorological forecasts are widely used in planning and implementation of <i>response measures</i> in case of emergency related to contamination of environment (e.g., oil spills)
2	Ar. 14, par. 1 The Contracting Parties shall have particular regard to the protection, preservation, restoration and rational use of marine living resources and shall take all appropriate measures on the basis of the <i>best scientific evidence</i> available to:	Since hydrometeorological and oceanographic conditions belong to the major environmental factors, determining <i>the potential of living resources and their sustainable yield</i> , the relevant data are a part of the <i>best scientific evidence</i> required for protection, rehabilitation and efficient use of biological resources of the Caspian Sea

Table 3.1

1	2	3
	(a) develop and increase <i>the potential of living resources</i> for conservation, restoration and rational use of environmental equilibrium in the course of satisfying human needs in nutrition and meeting social and economic objectives; (b) maintain or restore populations of marine species at levels that can produce the maximum <i>sustainable yield</i> as qualified by relevant <i>environmental and economic factors</i> and taking into consideration relationships among species	
3	Ar. The Contracting Parties shall co-operate in the development of protocols to the Convention prescribing to undertake the necessary <i>scientific research</i> and, insofar as is practicable, the agreed <i>measures and procedures to alleviate implications</i> of the sea level fluctuations of the Caspian Sea	The data of hydrometeorological observations both in the Caspian Sea proper and in its basin constitute a basis for <i>scientific research</i> of the sea level fluctuations, including a development of long-term forecasts which is a <i>measure to alleviate implications</i> of the sea level fluctuations
4	Ar. 19, par. 1. The Contracting Parties shall endeavour to establish and implement individual and/or joint <i>programmes for monitoring environmental conditions</i> of the Caspian Sea	Hydrometeorological and oceanographic observations (both in-situ and remote) are a part of the <i>programmes for monitoring marine environmental conditions</i> and are used for interpretation of marine environment characteristics
5	Ar. 19, par. 3. The Contracting Parties shall, at regular intervals, carry out individual or joint <i>assessments of the environmental conditions</i> of the Caspian Sea and the effectiveness of measures taken for the prevention, control and reduction of pollution of the marine environment of the Caspian Sea	The indicators of marine environment assessment include the indicators (e.g. pollutants budgets) calculated from hydrometeorological and oceanographic data.

Table 3.1

1	2	3
6	Ar. 20 The Contracting Parties shall co-operate in the conduct of research into and development of effective techniques for the prevention, control and reduction of pollution of the Caspian Sea and, to this effect, the Contracting Parties shall endeavor to initiate or intensify specific research programmes, where necessary, aimed, inter alia, at: (g) improvement of <i>knowledge about the hydrological regime and ecosystem dynamics of the Caspian Sea</i> including sea level fluctuations and the effects of such fluctuations on the Sea and coastal ecosystems	The data of hydrometeorological and oceanographic observations in the Caspian Sea are an integral part and the source for improvement of <i>knowledge about the hydrological regime and ecosystem dynamics of the Caspian Sea</i>

Thus, TC implementation should involve an integrated monitoring covering the following components of the marine environment:

- natural hazards (to prevent natural disasters) – Art.13;
- marine species population (including endemic, rare and endangered marine species), biodiversity parameters and ecosystem dynamics – Art. 14, 20;
- sea level – Art. 16;
- parameters of water and air mass transportation (to assess a possibility of trans-boundary effects) – Art. 17;
- pollution and radioactivity of the marine environment - Art. 19, 20;
- hydrological regime – Art. 20.

3.2 Potential use of the CASPCOM data for the implementation process of the Tehran Convention

The data and products produced by the Caspian NMHSs–CASPCOM members could be applied to the TK implementation process in several ways.

Firstly, two NMHSs (Kazhydromet and Roshydromet) bear national responsibility for pollution monitoring of the sea water areas adjacent to Kazakhstan and Russian coasts which together make roughly 40% of the Caspian Sea area. In this capacity, these agencies are formally authorized by their governments to implement the national commitments on Tehran Convention in the field of pollution monitoring and are full-fledged partners in TC implementation. They hold monitoring data on hydrochemical state and pollution of the

Caspian Sea for several decades (since mid-1970-ies). And, though not all of these data could now days be viewed as being of top quality, they still allow a glimpse into the history of the Caspian Sea contamination process.

Secondly, some of NMHS products (e.g., water discharge rate in the river mouths or modeled sea currents) can be used directly in evaluation of the pollution loading by rivers or pollution transportation / re-distribution within the sea itself. Numerical simulations of pollution transport and dispersion from land sources, based on predominant sea current fields, vertical and horizontal turbulence, concentration of suspended particles and bottom absorption properties could also be helpful in understanding pollution spatial and temporal patterns in the Caspian Sea. The information on prevailing sea current fields is required for any kind of trans-boundary environment impact studies. The emergency oil spill response operations will be ineffective unless they fully assimilate information on the forecasted winds and sea currents. Thus, implementation of at least two protocols much depends on the data and products from NMHSs.

Thirdly, NMHSs are the primary source of data for regional climate change evaluation. Apart from human activities, climate change is a major driver for ecosystem shifts, both on land and at sea. For example, more fresh water influx by rivers, lighter winds in summer and warmer air temperatures in winter can lead to a weaker vertical exchange in the sea water column and eventually detriment oxygen ventilation conditions in the bottom layers.

In the field of pollution monitoring Kaz- and Ros-hydromets:

- operate a total of three survey ships;
- run four regional and one reference (Obninsk, Russia) hydrochemical laboratories;
- monitor waters in 4 coastal regions in winter and 8 in summer;
- restore observations on water chemical composition and pollution at the long-term (so called, century) sections in the open sea;
- involve large national and international oil companies and other water uses in cooperation on implementation of industrial monitoring and analyzing its results;
- update methods for determination of chemical substances in marine environment based on modern equipment and expendable materials;
- monitor the chemical composition and pollution of the waters in the low flows and mouths of the Volga, Terek, Sulak and Ural Rivers;
- develop data bases (including those with a remote access) of chemical composition of water and bottom sediments;
- prepare assessments of the state of environment at the national territories.

According to CASPCOM experts, the chemical parameters essential for the Caspian Sea water quality assessment under TK provisions are as follows:

Sea water

- Background parameters: temperature, salinity, total suspended substances (TSS), transparency
- Nutrients: phosphorus (total, phosphates), nitrogen (total, nitrates, nitrites, ammonium), silicates
- Heavy metals: Fe, Cr, Cu, Pb, Zn, Cd, Hg, Ni, Mo, Mn
- Organic toxicants: total petroleum hydrocarbons, phenols
- Detergents
- Organics: BOD₅, oxygen, chlorophyll

Bottom sediments

- Grain size distribution / Al / total organic content (any of those parameters can be applied to identify samples with high clay content as pollution indicators)
- Heavy metals: Fe, Cr, Cu, Pb, Zn, Cd, Hg, Ni, Mo, Mn
- Organic toxicants: total petroleum hydrocarbons, phenols
- Persistent organic toxicants: pesticides (DDT, DDE), PCBs

Some of those substances are to be examined regionally since, for instance, phenols in the Volga Delta and Northern Caspian are mainly of natural origin, while PCBs are typical for areas immediately affected by industrial sites or large ports.

A “standard” sampling frequency might be once a season for water and once in 1-2 years for bottom sediments.

The outlined parameters are essentially the same as earlier proposed by the Caspian MAP project experts.

4. POTENTIAL AREAS OF COLLABORATION BETWEEN CASPCOM AND THE TEHRAN CONVENTION IN THE FIELD OF MONITORING, DATA COLLECTION AND ANALYSIS

Based on the above analysis, the potential areas of collaboration between CASPCOM and the Tehran Convention (TC) in the field of monitoring, data collection and analysis are:

- (a) direct involvement of the two NMHS (Kazhydromet and Roshydromet) into TC monitoring program as the nationally authorized agencies;
- (b) development and maintenance of joint historic databases on
 - concentrations of pollutants in water and sediments of the Caspian Sea obtained from routine monitoring and scientific cruises from beginning of observation till now;
 - estimated influx of the most important pollutants into the Caspian Sea based on observed river

discharge rates and chemical composition of the incoming waters;

- mean sea level along the entire coastline of the Caspian Sea;
- (c) undertaking periodic (every 2-3 years) joint (or coordinated) ship surveys for bottom sediment monitoring based on an agreed program;
- (d) working out a common standpoint on procedures of trans-boundary environmental impact studies related to pollution transport by sea and air currents;
- (e) estimation of regional climate change and its actual or possible effect on environmentally-significant features of hydrological regime (temperature, salinity, sea level, vertical exchange, sea currents, etc.);
- (f) joint elaboration of models and technologies essential for prediction of oil spill drift in case of emergency in high seas;
- (g) working out a common standpoint on the contents of the sections of the future reports on the state of the Caspian environment related to hydrometeorological conditions and climate change.

The concrete responsibilities of CASPCOM in the Tehran Convention implementation process is a matter of agreement between the two regional organizations. However, the existing potential of CASPCOM allows it to become the indispensable partner in the following aspects of the Caspian environment assessment:

- a) regional climate and its trends;
- b) hydrological regime and its trends, (especially, in biologically-significant elements: temperature, salinity, oxygen saturation, etc.)
- c) river discharge rates and their trends.

NMHS of CASPCOM will also be important partners in implementation of the Tehran Convention protocols on the oil-spill response and EIS.