Intergovernmental Oceanographic Commission
Workshop Report No. 108

UNESCO-IHP-IOC-IAEA Workshop on Sea Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region

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UNESCO


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1. OPENING

Dr. A. Tolkatchev opened the Workshop and welcomed the participants on behalf of the Secretary IOC. He then informed on the background leading to the Workshop.

The rapid rise of the sea level during the last 15 years (more than 2 meters) has created great concern in the region and resulted in changing of the water regime, hydrochemical regime, dynamics; it has a strong impact on agricultural and industrial facilities, towns and settlements along the coast and fisheries. We need to understand the causes of the sea-level changes in order to make reliable assessments and predictions of the changes and their implications on the environment and human life.

Upon the initiative of the delegation of the Islamic Republic of Iran the Twenty Seventh session of the UNESCO General Conference in 1993 requested the IOC, in collaboration with the International Hydrological Programme of UNESCO, to organize a Workshop on the causes of the sea level rise of the Caspian Sea to pave grounds for regional co-operation on the devising of a project aimed at deciphering the underpinnings of the rise of the Caspian Sea Level.

At the same time, several other UN Agencies took initiatives regarding the Caspian Sea environment. Co-ordination and co-operation became necessary in order to avoid overlapping and duplication. A first step, IOC followed the invitation of the IAEA to take part in the joint IAEA/IOC mission to the riparian countries of the Caspian Sea in August/September 1994, to discuss the problem with national organizations/institutions; and to assess the willingness, capabilities and commitments of individual countries to participate in the regional project proposed by IAEA on *"Multidisciplinary Studies of Environmental* Processes *in the Caspian Sea".* The mission was endorsed by UNEP and WHO and pursued all aspects relevant to a concerted action of all these organizations.

All countries expressed their willingness to co-operate and participate in the proposed project aimed at a better understanding of the causes of the sea level rise and assessment of environmental situation in the Caspian Sea region through a multidisciplinary approach to research and observations. All countries also confirmed that the established monitoring of environmental/ecological systems in the Caspian Sea region had deteriorated considerably during the last years, thus making difficult the reliable assessment and forecasting of environmental changes in the Caspian Sea.

Several interagency consultations on the Caspian Sea problem in 1994 and 1995 identified that during the last few years a number of meetings, workshops and missions had been held on the Caspian Sea problem among the riparian countries and under the aegis of international organizations (UNEP,WMO,IAEA,UNESCO, IMO). At present two such missions are being undertaken by WMO and by the World Bank, UNDP and UNEP. The agencies agreed that a multidisciplinary and multisectorial approach is required to the Caspian Sea problem and agreed to co-operate in developing a co-ordinated Caspian Sea programme.

Taking into account the above mentioned activities, UNESCO and IAEA agreed that this Workshop should focus on:

(i) review the present knowledge of the causes of the Caspian Sea-level rise and

(ii) formulation of the co-ordinated action plan to initiate without delay the implementation of the Caspian Sea Regional Project (the feasibility, study of which was launched in 1995 by IAEA and is being supported by IOC). The project will apply isotope methods and routine oceanographic, hydrological and meteorological observations for understanding of causes of sea-level rise and environmental implications.

(iii) future co-ordinated efforts of the countries in research and monitoring activities.

The prerequisite for the success of any international programme is the willingness of the countries to co-operate and to make national commitments as to mobilizing national human and financial resources to solve the problem. International organizations can help in bringing international knowledge and providing expertise to the countries of the region ready to co-operate

We expect that the project will become a part of the Comprehensive Caspian Sea Environmental Programme presently being developed by the World Bank, UNDP and UNEP and will receive support through the GEF. We hope that a recommendation on this matter will be prepared and agreed upon by the Workshop.

We invite you to work closely with national commissions for UNESCO as well as other national organizations concerned on the Caspian Sea problem.

The objective of the IOC as a body of UNESCO with functional autonomy is to promote scientific research of the World Ocean and related ocean services. IOC is not a funding agency. It can offer its co-operation and support through provision of expertise and experience in areas such as:

(i) oceanographic data/information management;
(ii) establishment of sea-level observation network;
(iii) marine pollution monitoring and analysis;
(iv) training of specialists in marine observations, analysis;
(v) establishment of contacts with oceanographic communities of other countries.

Dr. Tolkatchev pointed out that co-operation and co-ordination among the countries of the region as well as among international organizations concerned is essential for the success of an international initiative aimed at solving the Caspian Sea environmental problem.

Mr. Krasnoperov, on behalf of WMO, warmly thanked the IOC for its invitation to his Organization to be represented at this Workshop. He welcomed all participants of the workshop.

He reminded that the WMOís main mission is to co-ordinate and facilitate the setting up and operation of systems for the observation of meteorological and hydrological elements of the environment, requested at national, regional and global level.

He emphasized the great importance and consideration given now by WMO to the Caspian Sea region. During the recent meeting on Meteorological and Hydrological Services in support of the Sustainable Development in the Newly Independent States (Europe and Central Asia), held in Geneva, 11-12 April 1995, two projects on this subject have been considered. The first one deals with the international co-ordination of environment and water management of the Caspian Sea drainage basin project. The second one refers to the assessment of water level changes in the Caspian Sea Basin. The details of these projects were discussed under the appropriate agenda items.

There is no formal co-ordinating body for the management at the Basin wide level of the water resources on the environment. WMO considers that a co-ordinated system which could be used for all studies of environmental processes in the Caspian Sea Region would be an essential element of the system proposed by the UNESCO/IAEA project for the region.

Mr. Krasnoperov took the opportunity to assure the participants of the workshop that WMO is providing and will provide in the future the support needed for the development of the Caspian Sea projects.

He concluded, wishing to all participants every success in their deliberations during this Workshop.

Dr. K.Froehlich addressed the Workshop, on behalf of IAEA, and expressed their appreciation of IOC-UNESCO initiative to organize the meeting and, hence, to support the IAEA project on the Caspian Sea.

He gave an overview of previous activities in preparing the project, among other things, a consultants meeting organized in December 1993 by IAEA, and the IAEA-IOC pre-project mission to the Caspian countries. Appreciation was given to the interest and support by other organizations (IOC, UNESCO, UNEP, WHO, WMO).

Scope and objectives of the meeting were considered as follows:

(i) to review present knowledge of the causes of the sea-level rise and predictions thereof;

(ii) to review the project proposal and

(iii) to review the draft action plan for the implementation of the project and formulate recommendations for its initial implementation;

(iv) to present an overview of relevant activities undertaken by other organizations and through national, bilateral and international programmes.

Dr. Froehlich underlined that the main aim of the meeting is to start the implementation of the IAEA project and to pursue the following objectives:

(i) to finalize/refine the workplan;
(ii) to schedule the activities;
(iii) to agree on national and IAEA input and on the national counterparts;
(iv) to discuss potential contributions of other UN organizations.

Dr. Szollosi-Nagy, Secretary of the International Hydrological Programme of UNESCO, welcomed the participants on behalf of the International Hydrological Programme (IHP) of UNESCO. He stressed the importance of the meeting and recalled that the XIth of the IHP Intergovernmental Council has adopted, its Resolution XI-12, a motion in which it was recommended that the IHP of UNESCO be closely associated with the Caspian Sea Action Plan adopted at the 27th Session of the UNESCO General Conference.

He then outlined that the available scientific evidence indicates that the hydrological cycle plays an important role in the Caspian Sea level rise. It seems that the water balance dynamics is indeed a factor that needs to be further studied and considered as a key issue in the problem. He suggested that co-operation both at national level - by setting up IHP National Committees - and at international level - by fostering regional co-operative arrangements amongst the IHP National Committees of the Caspian region - needs to be strengthened. He added that the IHP network could provide an ideal mechanism for exchanging and further developing scientific knowledge related to the hydrological aspects of the Caspian Sea level rise.

He subsequently outline the planned Fifth Phase of IHP that will cover the time period of 1996-2001. The Fifth Phase will be devoted to Hydrology and Water Resources in a Vulnerable Environment and contains several themes and projects that will be closely related to Theme 1 (Global Hydrological and Geochemical Processes); if the Caspian Sea countries, through their regional cooperation, would take part in it, this would certainly contribute to the solution of several important methodological issues. He also suggested that, within the framework of the IHP regional co-operation, a FRIENDS (Flow Regimes from International Experimental and Network Data Sets) activity be launched in order to better understand flow pattern changes and regional variations in runoff into the Caspian Sea.

Dr. S. Partovian was elected Chairman of the Workshop and Dr. V. Ferronsky as Rapporteur.

The participants discussed and agreed upon the programme and time-table of the Workshop as given in Annex I. The list of participants is given in Annex II.

2. OVERALL REVIEW AND DISCUSSION OF THE PRESENT KNOWLEDGE OF THE CAUSES OF THE SEA-LEVEL RISE OF THE CASPIAN SEA AND ITS IMPACT ON THE COASTAL ZONE

The following scientific/technical presentations were made:

1. Water Balance of the Caspian Sea and Reasons of Water Level Rise in the Caspian Sea (by I. A. Shiklomanov, V. Yu Georgievsky & Z.D. Kopaliani, State Hydrological Institute, Russian Federal Service for Hydrometeorology *&* Environmental Monitoring)

2. Isotope Studies of Caspian Sea Level Rise Implications (by V.I. Ferronsky, V.S. Brezginov, V.V. Romanov, L.S. Vlasova, Water Problems, Institute of the Russian Academy of Sciences, and V.A. Polykov, A.F. Bobkov, Research Institute of Hydrogeology and Engineering Geology, Russia)

3. Principal Approaches to the Solution of the Problems associated with the Sea-Level Rise of the Caspian Sea (by K. Salykov, Committee on Water Resources of the Republic of Kazakhstan)

4 Determination of Background Value Level of Caspian Sea for Perspective and its Level Rising by Effect of Wind (by A.A. Skakov, V.V. Golubtsov, S.P. Shivareva, Kazakh Scientific Research Hydrometeoro-logical Institute (KazNIGMI) of the Republic of Kazakhstan)

5. Long-Standing Fluctuation of the Level and Flooding of the Caspian Sea at the Contemporary Stage (by M. R. Mansimov, State Committee on Hydro-meteorology of the Azerbaijan Republic)

6. Caspian Sea Level Rise and associated Ecological and Socio-economic Implications in the Caspian Sea Coastal Area of Turkmenistan (by D.M. Gurbanov, National Coordinator on the Caspian Sea Problems of Turkmenistan, Ministry of Nature Exploration and Protection of Turkmenistan)

7. Co-ordination of the tasks to be carried out in Iran in conjunction with the International-Regional Multidisciplinary Studies on the Caspian Sea (by Reza Khazaneh, Atomic Energy Organization of Iran)

8. Realization of the Integrated Programme on Hydrometeorology and Environmental Monitoring in the Caspian Sea Basin - a pre-condition for the solution of SocioEconomic and Environmental problems in the Region (by A.A. Maximov -Russian Federal Service for Hydro-meteorology and Environmental Monitoring and A.V.Frolov-Hydrometeorological Center of RUssia)

9. Paleohydrology, paleoclimatology and paleoenvironmental reconstruction of the caspian Sea during the last tens of thousand years: a clue for understanding causes and mechanisms of its present-day water level fluctuations by F.Gasse, French Coordinator of the programme, contribution of F.Chalie *8* of French participants: G.Blanc, M.-M.Blanc-Valleron, N.Glauer, A.Desprairies, A.Foucault, P.Gautret-Maire, P.J.Giannesini, E.Gibert, F.Guichard, F.Melieres, F.Orszag, M.Steinberg, N.Tribovillard, D.Badaut-Trauth, P.Tucholka & G.M.Zuppi.

10. Some tritium and stable isotope measuremental of water samples from the Caspian Sea (by K. Froehlich and K. Rozanski, IAEA).

Written information was submitted by the Water Research Center of Iran on a project called *"Caspian Sea shoreline protection against the recent sea-level rise".*

The participants proposed to include the presentations in the Supplement to this report.

The sea-level has been increased since 1978 by 2.3-2.5 meters and continues to grow. Joint strengthened efforts of the scientists and institutions of the region are required to understand the causes of sea level rise and to develop a method for prediction (computation) of the water level in the Caspian Sea for the next decades in order to plan and take protective and adjustment measures by the riparian countries and develop their response strategy.

The presentations and discussion of the present knowledge of the causes of the sea-level rise of the Caspian Sea led the Workshop to the following basic ideas in the understanding of the causes of the Caspian Sea level rise:

(i) Variation of water balance components: runoff, precipitation and evaporation. Input and output ratio is changing continuously. Short-period and long-period variations are identified by palaeoclimatological data.

(ii) Changes in global and regional climatic parameters (temperature, precipitations in catchment area, cyclonic activity over the continent, wind direction) are the main causes of the sea-level variation.

(iii) Water dynamics of the sea body: mixing of water between the northern, middle and southern basins; vertical mixing of cold bottom and warm surface water masses - the process which leads to decrease of the surface temperature and evaporation.

(iv) Tectonic and geological processes also can influence the sea-level variations, but most probably at a long-term scale.

Many presentations indicated a strong negative impact of sea-level rise on agricultural and industrial activities and fisheries; towns and settlements along the coast. Of great concern are endangered oil fields in Kazakhstan and Azerbaijan. The cost of preventive measures against the rising water level is already substantial and will increase dramatically in all riparian countries. The major factors that govern the present emergency situation in the region resulting from the sea-level rise include the changes in the water regime; changes in hydrochemical regime of river mouths; changes in of the dynamics and chemical composition of groundwater; changes in the structure and productivity of biological communities; changes in sediment deposition patterns, pollution by petroleum, heavy metals, synthetic organic substances, radioactive isotopes etc.; increased severity and duration of storm surges.

Many participants emphasized the great need for improved systematic hydrometeorological observations with high accuracy and resolution in the Caspian Sea Basin and creation of a regional data bank as a basis for reliable assessment of changes and research.

3. THE IAEA/IOC CASPIAN SEA REGIONAL PROJECT

3.1 SCOPE, OBJECTIVES AND ELEMENTS OF THE PROJECT

Dr. K. Froehlich presented the report on the objectives and elements of the Caspian Sea Regional Project proposed by IAEA and supported by IOC. The Project will focus on the study of the mechanisms and factors affecting the Caspian Sea hydrology using isotope techniques together with oceanographic, hydrometeorological and other techniques. A description of the Project is given in Annex IV to this report. The use of isotope techniques for the study of the Caspian Sea level rise and implications is described in the presentation made by Prof. V.Ferronsky published in the Supplement to this report. The initial Project Proposal entitled "A Project on Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region" had been discussed with the riparian countries during the Joint IAEA/IOC mission in August/September 1995. All countries had expressed their willingness and interest

to participate in the project. The project proposal was also presented at two interagency meetings: one organized by IAEA in Vienna in October 1994 and second organized by UNEP in Geneva in January 1995.

There are two projects on the Caspian Sea, to be carried out within the framework of the Agencyítechnical assistance and co-operation programme: a moderately funded project entitled "Preparing a study of Caspian Sea water level fluctuations (RAW/8/004) and a more comprehensive project entitled ÑStudy of Caspian Sea water level fluctuations" (footnote a/project). Objectives and elements of these projects were presented during the Workshop and can be summarized as follows.

3.1.1. Project RAW/8/004

The objective of the project is to initiate and co-ordinate a comprehensive study of the water level fluctuations in the Caspian Sea and related environmental problems using isotope techniques together with oceanographic, hydrometeorological and other techniques. The budget allocated at present for the project through the Agencyís technical co-operation programme, amounts to US $34,200 for expert services in 1995, and US $66,000 for expert services and provision of training in 1996. Additional funds have been raised by IOC through organization of the Paris Workshop. It is envisaged that IOC will provide additional funds for further training activities within the framework of RAW/8/004.

The Agencyís input to the project includes expert services, guidance and group training for the preparation of the comprehensive study; technical and scientific support for the preparation of field investigations; analytical support through the Agencyís laboratories. The input of IOC is as mentioned above.

The participating countries are expected to actively co-operate in elaborating a work plan for the comprehensive study; they are expected to make available local facilities, equipment and information, assure the availability of national specialists and provide local financial and other support including logistics.

It is expected that the project will:

(i) stimulate collaboration between riparian countries;
(ii) represent a 'feasibility study" for specialists of the participating countries.

3.1.2. Project RAW/8/005

The more comprehensive project RAW/8/005 is entitled "Study of Caspian Sea water level fluctuations". This project requires extrabudgetary resources allocation of about US $1 million for a period of two years. For this project, donors are being sought. The problems which can be tackled using isotope techniques in combination with other investigations, include: water balance and dynamics of sea water; pollution of the surface water; impact of the rising sea level on coastal groundwater resources; training and analytical quality control services. The plan for the comprehensice project envisages several campaigns for field work including collection of samples. The campaigns would be carried out jointly between the IAEA and other local institutes, with logistic support of the riparian countries and support by IOC and possibly other UN organizations (provision of training, organization of workshops). The reinforcement of the regional network for precipitation sampling as well as the establishment of a network for river water sampling and of hydrometeorological stations is expected to be arranged by concerned riparian countries, which could be realized through major support from other concerned UN organizations including donors. The long-term impact of the comprehensive project would include a better understanding of the CaspianSea hydrology and the mechanisms of sustained water balance of the hydro-system in the region. This will be the basis for the formultaion of recommendations and programme of measures to be undertaken by the countries to cope with the existing and future environmental problems in the region.

3.2. ACTION PLAN FOR THE IMPLEMENTATION OF THE PROJECT RAW/8/004

The plan of actions for the implementation of the moderately funded project entitled *"Preparing study of Caspian Sea water level fluctuations (RAW/8/004)"* has been outlined by IAEA and it was expected that the draft work plan would be revised and finalized by the IOC-UNESCO-IAEA Workshop in May 1995. (The draft work plan is appended in the final report of the Workshop).

The following modifications of the draft work plan of the project were agreed upon by the participants, bearing in mind that this work plan will be brought to the attention of the respective govenmental organizations for approval and necessary support: (i) field work including expert services and training; (ii) monitoring and regular sampling at selected stations; (iii) seminar-workshop.

3.2.1. Field work including expert services and training

The meeting suggested that the major part of expert services and training activities should be provided in conjunction with field work to be undertaken during one or two cruises on the Caspian Sea.

3.2.1.1. Cruise in August/September 1995

(i) Participation of all countries with 1-2 participants, IAEA (probably 2 experts), IOC and

others (probably France because of experience from 1994 cruise with Russia).

(ii) Vessel: to be provided by one of the riparian countries (probably Kazakhstan or Azerbaijan). Since the cruise is meant to be both a training activity (measurement of oceanographic, hydrometeorological and other physical parameters, sampling for chemical analysis including pollutants and isotopes) and a field work activity including measurements and sampling, part of the training money envisaged in the budget of the project, is expected to be taken to support the hosting of the training on board ship. The maximum amount envisaged to be available for this was considered to be US$10,000.

(iii) Major Equipment: A Rosette (a water sampling system) was considered necessary for the efficiency (in terms of time and money) of the cruise. Mr. Maximov, Russia, indicated that there is a possibility to get the Russian rosette landed. He agreed to look after this problem.

(iv) Measuring and sampling locations: it was agreed that at least 12 to 15 measuring/sampling locations should be covered by the cruise. The sampling includes a north-south and two or three west-east sections. At least 3 stations in the southern basin and 3 stations in the middle basin should be sampled in terms of depth profiles.

(v) Parameters to be measured, in addition to water samples to be collected: water temperature, salinity, water depth, surface water level, meteorological parameters (air temperature, pressure, humidity, wind velocity, wind direction, precipitation).

(vi) During the cruise, lectures and exercises will be provided to the participants by experts to be invited by IAEA and possibly IOC and other co-sponsoring organizations. Since the cruise is meant to combine training activity with field work, the remaining funds for 1995 are suggested to be used for this purpose.

3.2.1.2. Cruise in August/September 1996

In principle this cruise should follow the same lines as the one for 1995. Therefore, this activity is expected to be further discussed after execution of the first cruise.

3.2.2. Monitoring and regular sampling at identified coastal stations

As soon as possible, but not later than July 1995, measurements of oceanographic, hydrometeorological parameters will be undertaken at operational stations currently available in the coastal zone of the riparian countries. It is crucial that the monitoring includes regular collection of water samples for chemical and isotope analyses to be carried out at the IAEA laboratories (monthly in the case of precipitation and river stations, quarterly in the case of coastal stations). For the coordination of this monitoring activity the following participants of the meeting indicated their readiness to act as coordinator ("contact person") for the IAEA project management. Azerbaijan: Mr. Mansimov, Iran: Mr. Khazaneh, Kazakhstan: Mr. Skakov, Russia: Mr. Maximov, Turkmenistan: Mr. Gurbanov. The final nominations are subject to the approval by tje respective Governments which should be sought by the persons indicated.

The following list of monitoring stations has been agreed upon:

Country	coastal stations	river stations	precipitation stations
Azerbaijan	3	1	2
Iran	2	2	2
Kazakhstan	4	1	1
Russia	2	1	2
Turkmenistan	3	1	2
		(Kara Bogaz Gol)	

The locations of the stations were discussed and it was requested that the *"contact persons"* should fax the details to the IAEA, Vienna as soon as possible. The samples for chemical and isotope analyses should be shipped quarterly or half-yearly to the IAEA in Vienna.

3.2.3 Seminar-Workshop in 1996

A seminar-workshop was suggested to be held in September 1996 to review the achievements of the project, provide further training, and continue field work. One to two persons from each country will attend the workshop. The following locations were considered: Astrakhan, Machachkala, Baku, and Turkmenbascha. The workshop is also mean to prepare the final report of the project and to discuss and agree upon follow-up activities to be undertaken within the framework of the comprehensive IAEA project and/or co-ordinated action programme of all concerned UN organizations.

4. OTHER RESEARCH AND MONITORING ACTIVITIES REQUIRED FOR UNDERSTANDING AND PREDICTION OF SEA-LEVEL RISE

The Participants pointed out that further strengthened efforts are required by all riparian countries in order to understand and predict sea-level changes in the Caspian Sea and its environmental and socio-economic implications. Multidisciplinary and multisectoral approach is required to tackle the problem of the Caspian Sea. Joint activities of the riparian countries should include:

(i) Scientific research in understanding climatic (hydrometeorological), geological and anthropogenic factors which determine sea-level changes and developing predictive models;

(ii) Establishment of co-ordinated multidisciplinary monitoring/observation system (meteorological, hydrological and oceanographic) observations which had deteriorated considerably during the last years. This system to be based on the use of routine and new technology, including satellites, is required to provide reliable and comparable data for research, monitoring and assessment purposes;

(iii) Training of national specialists on the use of modern methods and technology for observation, data interpretation and analysis and basic research.

(iv) Establishment of a regional interdisciplinary data bank.

The following actions have been already taken or planned to establish collaboration among the countries of the region in solving Caspian Sea environmental problem:

(i) Russia prepared a proposal on the Integrated Programme on Hydrometeorology and Environmental Monitoring of the Caspian Sea and its Drainage-basin, which had been sent to all countries of the region for review . This proposal was presented by Mr.Maximov during the Workshop and its description is given in the Supplement to this report.

Other countries of the region also prepared similar proposals on the coordinated observing/monitoring system.

(ii) An International Congress and Technical Exhibition "Water: Ecology and Technology" will be held in Moscow in September 1996, to include the issues of the Caspian Sea problem. The Congress is organized by the Russian Federal Committee for Water Management jointly with other national organizations of Russia and SIBICO International Company.

(iii) Workshop on "Caspian Sea Research and Monitoring" will be held in Iran with the support of IOC/UNESCO, in August 1995.

(iv) The second meeting of the UNEP Regional Task Team on the Implications of Climate Change in the Caspian Sea Region will be held during the autumn 1995.

The IOC Training Course on "The Collection, Processing and Usage of the Marine Geological and Geophysical Data for the Black and Caspian Seas countries will be held in September/October 1995 in Gelendjik, Russia.

(vi) WMO has initiated the development of the World Hydrological Cycle Observing System (WHYCOS) in cooperation with the World Bank and other UN Agencies concerned (Description of the system is given in Annex VII.

4.1 CO-ORDINATION WITH OTHER INTERNATIONAL ORGANIZATIONS

The Participants emphasized that in view of the multidisciplinary and multisectorial nature of the environmental problem of the Caspian Sea, close co-ordination required both on national level (among various scientific and environmental institutions) and international levels, first of all among the riparian countries themselves and the international organizations concerned: IAEA, UNEP, UNESCO and WMO and other international organizations.

In this regard, it was noted that some actions had been already undertaken by UN agencies and bodies to ensure interagency co-ordination and cooperation on the Caspian Sea problem. Two interagency meetings had been held in October 1994 in Vienna organized by IAEA and in January 1995 Geneva organized by UNEP. During those meetings, IMO, UNDP, UNEP, UNESCO, WHO, WMO and the World Bank agreed to co-operate on the environmental problems faced by the Caspian Sea countries and invited UNEP to serve as a co-ordinating agency for this problem.

The actions that have been already taken or planned include the following:

(i) UNEP, jointly with UNDP and the World Bank, has undertaken a mission in April 1995 to the countries of the region to initiate the preparation of the Caspian Environmental

Programme which are expected to be implemented in co-operation with other international organizations.

(ii) IAEA and IOC of UNESCO agreed to co-operate in the Regional Caspian Sea Project and organized a joint mission to the riparian countries in August-September 1994 to discuss their interest and possible participation in the proposed project considered as a contribution to the Comprehensive Caspian Sea Environmental Programme. This Workshop was organized and sponsored jointly by UNESCO (IOC/IHP) and IAEA to focus on the proposed regional project.

(iii) WMO has developed two following projects on the Caspian Sea problems:

(a) International co-ordinated environment and water management of the Caspian Sea Drainage Basin;

(b) Assessment of the water level changes in the Caspian Sea Basin.

These projects are one of the main part of the Programme for the Caspian Sea Basin proposed by the European Bank of Reconstruction and Development.

(iv) The Intergovernmental Council of the International Hydrological Programme) of UNESCO, adopted Resolution XI-12 on the "Caspian Sea Action Plan" which recommended that UNESCO closely associates itself with the Caspian Sea initiatives and promotes intensive studies of the riparian countries and urged the Director-General of UNESCO to seek extrabudgetary funds to assist with the implementation of the programme of the Caspian Sea.

(v) UNEP has established a Regional Task Team on the Implications of Climate Change in the Caspian Sea Region to consider the problem of climate change and sea-level rise and their impacts on the coastal and marine ecosystems as well as socio-economic activities. The Task Team held its First meeting in May 1994 in Moscow and recommended preparation of national reports and regional overview on the implications of climate change and sea-level rise in the Caspian Sea region. The second meeting of the Task Team is scheduled for the second half of 1995.

The participants pointed out that international agencies should co-ordinate their activities related to the Caspian Sea problem in order to ensure a rational use of international and national human and financial resources in solving the problem. The international organizations in coordinating their efforts regarding the Caspian Sea Environmental programme should take into account the following aspects: complexity of the environmental problem which requires multidisciplinary and multisectoral approaches; emergency situation in the countries of the region caused by sea level rise during the last 15 years; appearance of newly independent states in the region; and complexity of national mechanisms for coordination of their activities with various international agencies.

The Participants urged UNESCO and IAEA to work together with other international agencies, particularly WMO and UNEP, in developing a comprehensive multidisciplinary Caspian Sea Programme to assist the Caspian Sea countries in tackling the environmental problems and associated socio-economic impacts. The Workshop felt that the development and implementation of a regional integrated programme in the field of hydrometeorology and environmental monitoring could be the first important phase in such a comprehensive programme.

The comprehensive multidisciplinary programme should take into account the limited financial and human resources available in the riparian countries and should include training and technical assistance activities. The programme should also include: establishment of an international regional mechanism for co-ordination; establishment of a central data bank to be accessible to all participants; co-ordinated monitoring programme and co-operative research on the development of a numerical model of the Caspian Sea; and provision of satellite data.

Dr. Szollosi-Nagy, Secretary of the International Hydrological Programme, informed the participants of the possible support by IHP in implementing the project and research aimed at better understanding and modelling water balance, including training on computer information systems, national co-ordination among hydrological committees.

5. CONCLUSIONS AND RECOMMENDATIONS OF THE WORKSHOP

The participants of the Workshop, having discussed the reports submitted by the experts, as well as the project proposals submitted by IOC and IAEA within the framework of the IAEA project, came to the conclusion that there is an urgent need to develop and realize a more comprehensive *programme in this disciplinary of* studies of natural and anthropogenic processes in the Caspian Sea, as *an essential scientific and information base for the solution of the socio-economic and environmental problems in the region.* Within the framework this programme, the following activities should have priority:

(i) Implementation of the IAEA project supported by IOC which is an important and feasible initial step in solving the Caspian Sea problem and creates the basis for the regional co-operation.

(ii) Development of integrated monitoring system for the Caspian Sea and major river deltas(in co-operation with international organizations and bodies concerned, particularly WMO, UNEP,UNESCO,IAEA and GEF (1995-1999).

(iii) Development of a multidisciplinary, problem-oriented data bank (meteorology, oceanography, hydrology, ecology, etc) and an information support system for economic activities and nature protection, accessible to the countries and specialists(in the region (in co-operation with WMO, GEF, UNESCO, IAEA and other international organizations and bodies (1995-1999).

(iv) Development of pollutants balance in the Caspian Sea Basin and forecasting of possible environmental changes; assessment of environmental consequences of the combined impact of sea water contamination and surface level change (in co-operation with UNEP, UNESCO, WHO, IAEA and others, 1995-1997).

(v) Improvement of the assessment methods and integrated analysis of the elements of the Caspian Sea water balance, especially the inflow forming factors in the basin (in co- operation with UNESCO, IAEA and others, 1995-1997).

(vi) Development of methods for the assessment and forecasting of natural hazards due to storm surges, extreme floods, heavy sea, currents, ice drifts, etc, leading to emergency situations and ecological catastrophes on the Caspian Sea water surface and coastal areas (in co-operation with UNESCO, WMO and others, 1995-1997).

(vii) Comprehensive study of multi-annual variations of the Caspian Sea water balance and Sea surface water level oscillations, aimed at working out and introducing long-term forecasts, with lead time from 2 years to 10-20 years (in co-operation with UNESCO, WMO, IAEA and others, 1995-1998).

(viii) Integrated field investigations and experimental studies of the deltas of major rivers, coastal semi-closed zones and the most vulnerable areas (in co-operation with UNESCO, UNEP, IAEA and others, 1995-1999).

(ix) Study of the possibilities to use the Caspian low lands for the regulation of the Caspian Sea water levels, in the case of its further rise (in co-operation with UNESCO, WMO, UNEP and others, 1995-1997).

The implementation of the programme of multidisciplinary studies of natural and anthropogenic processes in the Caspian Sea region should reflect also the contributions to its objectives of the on-going and planned projects mentioned in items 3 and 4.

The participants of the Workshop suggested that a joint draft resolution related to the Caspian Sea be presented to the next UNESCO General Conference, through their respective UNESCO National Commissions.

The Workshop recommended that National Commissions for UNESCO of Turkmenistan, Kazakhstan and Azerbaijan approach the Director General of UNESCO with request to allocate US$45.000 from the UNESCO Emergency Fund for newly independent countries of the former USSR in order to help these countries with the training and equipment required for their participation in the Regional Caspian Sea Project endorsed by the Workshop.

In order to have a fruitful co-operation and co-ordination of the Caspian Sea projects, the Workshop recommends the governments of each Caspian country to:

(i) nominate a national focal point for the Caspian Sea project;

(ii) inform all international organizations involved in the Caspian problems on their focal point for that subject;

(iii) invite all international organizations involved in the Caspian problems to participate in
the next workshops or meetings similar to this one.

The participants were requested to bring the results of the Workshop to the attention of other national organizations and institutions involved in the Caspian Sea Environmental problem in order to ensure proper coordination on national level as well as coordination with various international organizations through appropriate national channels.

The participants called upon UNESCO and IAEA to take action for the co-ordination of the Caspian Sea programme with other international agencies concerned.

ANNEX I

PROGRAMME OF THE WORKSHOP

Tuesday,* 9 *May 1995

0900-1000 Opening: Statements by representatives of IOC, IAEA, IHP and WMO. Overall review of the present knowledge of the causes of the sea level rise of the Caspian Sea.

1000-1300 Session 1: Discussion of the problem, national experts presentations on the problem.

1430-1800 Session 2: Overall review and discussion of the present knowledge of the causes of the sea level rise of the Caspian Sea-presentations by national experts.

Wednesday, 10 May 1995

0900-1300 Session 3: Presentation of the scope and objectives of the Caspian Sea Regional project.
Discussion of the project proposal.

1430-1800 Session 4: Participation of countries in the project. Presentations by national experts.

***Thursday, 11 May* 1995**

0900-1300 Session 5: Presentation of the action plan for the implementation of the Regional Caspian Sea project.

1430-1800 Session 6: Discussion of the project elements:

(i) network of observations/sampling (coastal and open sea stations);
(ii) data collection and exchange (data centers);
(iii) data/samples analysis (data analysis centers);
(iv) preparation of data products and distribution (regional centers/newsletters);
(v) mechanism for co-ordination (national contacts).

Session 7: Revised Action Plan.

Friday, 12 May 1995

0900-1300 Session 8: Revised Action Plan for the implementation of the Project. Review of the other research and monitoring activities related to sea-level rise.
Recommendations to the participating countries and sponsoring agencies for the project implementation.
Consideration and approval of the Revised Action Plan and the report and recommendations of the Workshop.

Closure of the Meeting.

ANNEX II

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ANNEX III

SCOPE AND OBJECTIVES OF THE IAEA PROJECT INCLUDING ISOTOPE TECHNIQUES

I. SCOPE AND OBJECTIVES OF THE IAEA PROJECT AND ISOTOPE TECHNIQUES

Consultations and experts opinions showed that, in spite of almost one century of research, there is no satisfactory acceptable explanation of all aspects of the fluctuations of water-level in the Caspian Sea. Therefore, any attempt to predict the sea-level fluctuations in the future is plagued by a large uncertainty. A new approach and new scientific tools are required to understand the phenomenon of "breathing" of the Caspian Sea.

Nuclear methodologies based on isotope tracers (both radioactive and stable) and trace elements studies are considered as a promising tool to be applied in further investigations of the Caspian Sea problem. These methods include the use of:

- variations in isotopic ratios of stable isotopes of the elements of the water molecule ($^{2}H/^{1}H$, $^{18}O/^{16}O$) and of organic and inorganic compounds occurring in the water ($^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{34}S/^{32}S$);
- naturally produced cosmogenic (radionuclides) such as ^{3}H, ^{32}Si, ^{14}C, ^{36}Cl) etc.;
- radionuclides of the natural U and Th decay series;
- anthropogenic radionuclides released into atmosphere and hydrosphere by nuclear weapon tests and in normal operation and accidents of nuclear installations (^{3}H, ^{14}C, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{239}Pu, ^{240}Pu, etc.);
- trace elements and organic compounds released into the input rivers and the sea as a result of intensive industrial and agricultural activities in the region.

The IAEA, through its technical expertise and analytical capabilities available in the Department of Research and Isotopes, could offer assistance in applying isotope and trace element methodologies within the framework of a field project. The following problems could be addressed by the project.

Related to Sea-level Rise

1. *Water balance and transport of moisture in the region*

An independent method for the determination of the evaporation could contribute to a better knowledge of the water balance of the sea and likely also of the causes of the sea-level fluctuations. Given the known effect of evaporation on the isotopic composition of sea water and evaporated water vapour, the analysis of $^{2}H/1H$ and $^{18}O/^{16}O$ in sea water and atmospheric moisture is expected to yield an independent estimate of the evaporation flux.

Isotopic effects connected with atmospheric evaporation and condensation processes give rise to variations in stable isotope composition of atmospheric moisture and precipitation. A powerful natural labelling is thus provided by the stable isotope content of precipitation in relation with any hydroclimatic variation. For instance, present-day variations on the whole basin are of the order of 4°/oo in ^{18}O content. Such natural labelling could be used to assess the variations in condensation temperature which would accompany any significant difference in the amount of precipitable vapour moving over the region. It is also expected that measurements performed on the atmospheric vapour itself allow to draw a balance of the respective parts of regional vapour and of vapour generated by the Caspian Sea itself. Thus,

an isotopic study in the Caspian Sea region requires to establish a regional network on *"Environmental isotopes in Precipitation"* and additional sampling of atmospheric water vapour.

2. *Dynamics of sea water and sediment transport*

These processes include (i) water movement and sediment transport from the river mouths to inner parts (basins) of the sea, (ii) vertical mixing and exchange of water, precipitation of inorganic particles and organic matter and (iii) sedimentation on the sea floor. A study of these processes is necessary to elucidate the causes of the observed changes in the water and hydrochemical regime and changes in structure and productivity of biological communities.

Stable and radioactive isotopes naturally occurring in the elements of the water molecule, incorporated in dissolved substances or in particles, are important to study water dynamics and residence time (^{2} H, ^{18} 0, ^{3} H, ^{14} C, ^{137} Cs), vertical water mixing (^{137} Cs, ^{90} Sr); scavenging processes and particle transport (^{234} Th, U and Pu isotopes). For example, preliminary results of stable isotopes and ^{3}H have shown large variations between the input (e.g. Volga river and northern basin of the Caspian Sea) and the sea itself. Mixing processes of the water masses can thus be identified.

3D modelling of movement of water masses and dispersion of radionuclides based on the above input data will enable to understand hydrodynamics of the Caspian Sea.

Pollution and Environment related

3. *Pollution of water body and sediments by both radioactive and non-radioactive* substances

Studies of inventories of radionuclides in water and sediments are necessary to define the status of a radioactive pollution of water and sediment and to predict changes of this pollution. This includes anthropogenic radionuclides released into atmosphere and hydrosphere by nuclear weapon tests and in normal operation and accidents of nuclear installations (^{3} H, ^{14} C, ^{90} Sr, ^{134} Cs, ^{137} Cs, ^{239} Pu, ^{240} Pu, etc.).

Isotopic ratios such as ^{2} H/^{1} H, ^{13} C /^{12} C, ^{15} N/^{14} N in organic and inorganic compounds can be examined to identify sources of pollution such as petroleum products and agrochemicals.

Tracer elements and organic compounds studies will identify sources and present levels of pollution due to industrial and agricultural activities in the region.

4. *Impact of rising sea-level on coastal groundwater resources*

The stable isotopes ^{2}H and ^{18} 0 of the groundwater can be examined to study origin and extend of salination, ^{3} H and ^{14} C can provide information on changes in the dynamics of the coastal aquifers, and heavy isotopes of hydrogen, carbon, nitrogen and sulphur can assist in identifying origin and movement of contaminants.

5. *Exploring Caspian Sea sedimentary sequence* as a natural archive of past climatic and environmental changes

Detailed dating (^{14} C, ^{230} Th/ ^{234} U, ^{40} K/ ^{40} Ar, ^{39} Ar/ ^{40} A) of the sedimentary sequence for the last millennia is important for establishing the time scale for past climatological and environmental changes.

The ^{18}0 content of authigenic carbonates (both inorganic and organic) is an indicator of climate changes matter (^{2} H, ^{13} C, ^{15} N, ^{18} 0) in addition to pollens and macrophytes can be used for palaeoenvironmental reconstructions.

6. Training and Analytical Quality Control Assistance

Training, including laboratory training, a training course and a field training, analytical quality control assistance in analysis of radioactive as well as non-radioactive samples with intercomparison exercises and support with environmental reference materials, and database support would considerably improve the performance of the Member States laboratories participating in the project.

II. IMPLEMENTATION OF THE PROJECT

The project will be executed in close co-operation between the IAEA and institutes of riparian countries as well as other UN organizations.

Field investigations (cruises for sea water and sediment sampling, groundwater sampling campaigns) should jointly be carried out between the IAEA and local institutes, under logistic support (including provision of a ship for sea expedition and vehicles for land-based field work) of the riparian countries. The reinforcement of the regional network for precipitation sampling as well as the establishment of a network for river water sampling is expected to be arranged by the concerned riparian countries. The water and sediment samples can be analyzed by the Agencyís laboratories in Vienna and Monaco and other laboratories of riparian countries.

ANNEX IV

PREPARING STUDY OF CASPIAN SEA WATER LEVEL FLUCTUATIONS (RAW/8/004) F2 New

CORE FINANCING

YEAR	Experts		Equipment	Fellowships		Scientific Visits		Training	Sub-contracts	Misc. Comp.	Total
	m/d	US $	US $	m/d	US $	m/d	US $	US $	US $	US $	US $
1995	3/ 0	34,200	-	-	-	-	-	-	-	-	34,200
1996	3/ 0	36,000	-	-	-	-	-	30,000	-	-	66,000

First Year Approved: 95

OBJECTIVES: To initiate and coordinate o comprehensive study of the water level fluctuations in the Caspion sea using nuclear techniques.

BACKGROUND: The Caspian Sea basin Is a typical example of a macroregional system which has evolved over a long period of time. under variable environmental conditions. During the past 15 years the sea level rose by more than 2 metres. The rising trend continues. The rising water level has a strong negative impact on agricultural and industrial facilities. towns and settlemenfs along the coast of the riparian countries. The cost of preventive measures against the rising water level is already substantial and will increase dramatically. Therefore, a coordinated effort to study all the mechanisms and factors affecting the Caspian Sea hydrology is needed. This project, closely related to the footnote *a/* project, will concentrate on preparations for a comprehensive study which will include: wooer balance and transport of moisture in the region: dynamics of sea water and sediment transport; pollution of water body and sediments by both radioactive and nonradioactive substances; impact of rising sea level on costal groundwater resources: Caspian Sea sedimentary sequence os a natural archive of post climatic and environmental changes: training and analytical quality control assistance.

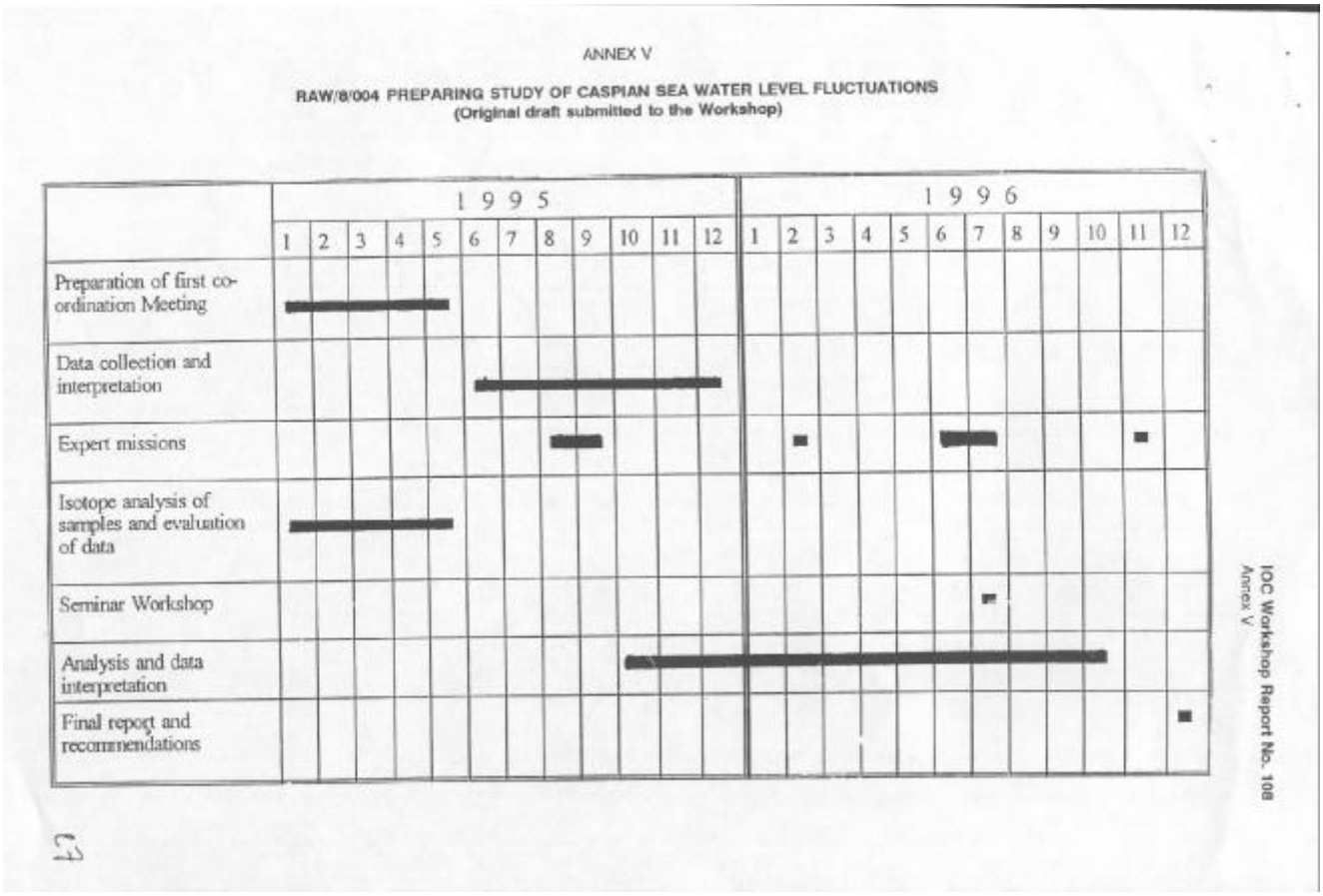
REGIONAL AND NATIONAL COMMITMENT: The participating countries will actively cooperate in elaborating a workplan for a comprehensive study: they will make available local facilities. equipment and information. assure the availability of national specialists and provide local financial and other support.

AGENCY INPUT: Expert services. guidance and group training for preparation of the study: organization and co-ordination of the worlk: technical and scientific support for preparation of field investigations; sampling and measurements at Agency laboratories.

IMPACT; The project would provide on assessment of the present environmental situation of the Caspian Sea region which would help In the elaboration of an environmental strategy and formulation of a workplan for comprehensive studies of the water level fluctuations in the Caspian Sea.

ANNEX V : RAW/8/004 PREPARING STUDY OF CASPIAN SEA WATER LEVEL FLUCTUATIONS (original draft submitted to the Workshop)

[image rotated for convenience]



ANNEX VI

INSTRUCTIONS FOR FIELD WORK WITHIN THE FRAMEWORK OF THE ON-GOING IAEA PROJECT SUPPORTED BY IOC

1. COASTAL STATIONS

1.1. PARAMETERS TO BE MEASURED/MONITORED AT THE OPERATIONAL

Water: temperature, salinity as function of depth in the water column, sea surface (water) level.

Air: meteorological parameters (pressure, temperature, humidity, wind velocity, wind direction, precipitation (mm per month).

1.2 SAMPLING

Water samples (if possible) at several depths (surface, 10m, etc,).
Amount of water per sample: 500 ml for tritium, 50 ml for stable isotopes, 500 ml for chemical analysis.

2. RIVER STATIONS

Water sampling:
One sampling per month, (if it can be afforded, one sampling per week would be better). The water should be taken from the middle of the river rather than from the river bank (representativeness of the water sample).

Amount of water per sample:
500 ml for tritium, 50 ml for stable isotopes, 500 ml for chemical analysis.

3. PRECIPITATION STATIONS

The normal rain gauge used in meteorological stations can also be used for the collection of precipitation. During normal rain events, rainwater of the gauge should daily be tranfered to a 2 litres bottle and closely tighted, to avoid evaporation. After a month, the bottle should be shaken well and one sample (25 ml) be taken for stable isotope (2 H and 18 0) analysis and one sample (500 ml) for 3 H and chemistry analysis. When there are only a few showers during a particular month, it is important to collect the rain water immediately after the shower to avoid evaporation of water in the rain gauge. In general, to avoid evaporation in the rain gauge, one should use a few ml of paraffin oil, which forms a film on the surface of the water. (For bottling the sample, the oil cas easily be separated from the water as it is immiscible with water.) The daily rainfall should be noted. Other parameters such as air temperature and relative humidity should also be noted.

For the precipitation stations, full meteorological data including air temperature, humidity, wind, wind direction, and precipitation (once per month) should be provided.

It is necessary to provide the exact geographic position of the stations (coastal, precipitation, river).

ANNEX VII

WORLD HYDROLOGICAL CYCLE OBSERVING SYSTEM (WHYCOS)

Understanding the hydrological cycle is a high priority since this cycle connects the three basic elements of our world, the atmosphere, the sea and the land. A good knowledge of the terrestial component of this cycle, based on reliable, timely available observations and data is therefore necessary, not only for the improvement of water-resources measurements and assessment for national and regional purposes, but also to understand global and large-scale processes. For example, the water budget of the ocean, fed by rivers and precipitation, is critical in assessing the reasons for the observed rise in mean sea level over the past century and the likely rate of rise in a projected warming climate. Determining the sources of pollution of the seas and oceans requires information on the quality and quantity of river discharges to these bodies. Finally, observing the hydrological cycle assists in the validation of general circulation models of the atmosphere.

Records of river flows for the worldís streams are collected at the Global Runoff Data Centre (GRDC), which was established under the auspices of WMO with UNESCO co-operation in Koblenz, Germany. A similar collection of water quality records is carried out by the GEMS/Water Quality Monitoring Centre which is managed by the Canadian Centre for Inland Waters, under the auspices of UNEP, WHO, UNESCO and WMO. However, neither of these two centres provides adequate coverage of the world as regards both the number of countries sampled and the length of the records. The data sent by the countries are also of variable quality.

This is the reason why WMO, as a UN Specialized Agency in charge of meteorology and operational hydrology is promoting, in association with the World Bank and other UN Agencies concerned, the establishment of a World Hydrological Cycle Observing System (WHYCOS), based on a world-wide network of key stations linked by satellite with an associated quality-controlled database for river flow, water quality and climatological variables.

WHYCOS is in direct response to the need expressed by the International Conference on Water and the Environment (ICWE), in Chapter 18 of UNCED's Agenda 21 and by the call of the Second Session of the Commission for Sustainable Development (1994) for an improved knowledge base for water. WHYCOS would consist initially of about 1000 stations world-wide, sited on the major rivers. Each station would monitor about 15 variables such as flow, sediment load, water chemistry and on-bank meteorological variables. The data collected would be transmitted via geo-stationary satellites to regional and global centres. The WMO WWW data transmission system would be employed where applicable. In the developing world, substantial investment would have to be allocated for the stations themselves and for capacity building in the Hydrological Services participating in WHYCOS. In the developed world, where many of these stations already exist, WHYCOS would essentially be a matter of upgrading and networking.

This concept is being developed currently for Africa, Latin America and the Caribbean and for the Aral Sea Basin. The implementation of a MED/HYCOS project has recently been initiated for countries bordering the Mediterranean Sea under a World Bank grant. A similar system could be envisaged for the Caspian Sea countries.

ANNEX VIII

LIST OF ACRONYMS

GEF	Global Environment Facility (UNDP-World Bank-UNEP)
GEMS	Global Environment Monitoring System
GRDC	Global Runoff Data Centre
IAEA	International Atomic Energy Agency
ICWE	International Conference on Water and Environment: Development issues for the 21st Century
IHP	International Hydrological Programme
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
UNCED	United Nations Conference on Environment and Development (Rio de Janeiro, 1992)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO)

the natural river runoff variations; the range of these variations usually exceeds the amount of induced changes; thirdly, reliable data are not always available on a complete account of all water diversions and waste discharges in the basin, as well as infornation characterizing the time, scales and rates of different projects within the basin.

Multipurpose investigations of the SHI on the assessment of the effect of different types of manís activity on river runoff in the Caspian Sea region and water inflow to the Sea are made since the beginning of 1970s; the last more accurate assessments were made for the Caspian Sea area durirLg 1993-1995.

The dynamics of river inflow to the Caspian Sea under the effect of a variety of manís impacts are given in Table 6. These data were obtained by using two independent approaches, i.e statistical approach and water balance approach. The statistical approach was applied for an integral assessment of anthropogenic changes in runoff by studying long-term variations of river runoff from observational data available in combination with the analysis of natural runoff-forming factors in the basin. The water balance approach is based on the account of direct water diversions for economic needs and on the study of water balance components imnediately on the areas of watersheds where the conditions of runoff formations are changed because of some type of man's activity. Moreover data of experimental and field studies were widely applied for the water balance approach.

Table 6. Changes in Water inflow to the Caspian Sea under the effect of manís impact

Sea, rivers	Conventional natural inflow km3/year	Years					
		1936-40	1946-50	1956-60	1966-70	1976-80	1986-90
Caspian Sea	298	6.3	10	33	22	38	40
including:							
Volga	240	4.8 0.2	6.3 0.6	26	13	21	25 2. 4. 3.
Ural	9.3 18.0	0.2 0.4	1.0 0.9	1.2 1.6	1.5	2.3	
Kura	13.4			2.2	1.2 3.4	3.0	
Terek and Sulak						3.7	

Particular methods for the assessment are described in details in (26, 27).

Before 1940 water inflow to the Sea was practically natural, the effect of anthropogenic factors was estimated to be equal to 2.2% of the normal inflow under natural conditions. A sudden decrease of inflow began since 1950s mainly due to reduced water discharge from the Volga River, - that was the time when a filling of very large system of Volga-Kama reservoirs was started. At present, the reduced water inflow to the sea due to manís impact is about 40 kmí/year, or 13% of total normal inflow. A major portion of the anthropogenic decrease of water inflow to the Sea is contributed by the Volga River basin. The effect of individual types of manís activity for reducing water inflow to the sea during the study period is different. During 1956-1975 a construction and operation of reservoirs were the basic factors of manís activity which intensified the decrease of water discharge to the Sea; during 1980s the major water losses were caused by irrigation.

It is quite natural that inflow change to the Sea because of manís activity stimulated the change in the water level position in the Sea. Computations made on the basis of the water balance of the Sea in greater details for each year show (28) that most intensive water level fall in the Sea occurred during 1932-1940 (with water level fall by 1.68 m) is explained by a sudden decrease in the income terms of the water balance caused by the natural climate factors effect: the water inflow to the Sea during that period of time was equal to 77% only, meanwhile precipitation equaled 90% of the norm at the total evaporation (evapotranspiration) being close to normal. All these factors explained the water level fall in the Sea by about 1.58 m; the remaining water level fall by 0.10 m

may be related to the effect of manís activity in the basin. Later the effect of manís activity on the water level fluctuations in the Sea becomes most impressive (Fig. 2).

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